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Groupe de Coordination sur les Bois Raméaux

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*«A Universal Pedogenesis Upgrading processus:
RCWs to Enhance Biodiversity
and Productivity»*

by the
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A universal pedogenesis upgrading processus: RCWs to enhance biodiversity and productivity.

Most of the world's agricultural land has a forested origin except for the Asian steppes, the South American pampas and the North American central prairies. These ecosystems are primarily grass growing under rather dry climate giving deep soils. Most cultivated lands beside these three ecosystems were originally forested lands.

A close look at forest ecosystems shows that plant tissues are very rapidly transformed into nutrients by soil microorganisms. Most of the time, these nutrients are bound to organic compounds within the humus complex that is partly mineral, partly organic. This organo-mineral complex, stable under deciduous temperate forest, becomes fragile under tropical conditions. The organo-mineral complex has several roles and therefore must be closely examined.

My purpose is not to repeat what is known to most of us but to underline new concepts and to some extent, observations and discoveries my colleagues and I have made over the last decade about agriculture and forestry. Back in the mid seventies, my colleague Guay, deputy minister of Québec Department of Lands and Forests began searching for new forest products. Some essential oil plants had thousands of tons of evergreen chipped twigs from which oil was steam extracted.

A first set of chemical analysis has shown a rather high protein content, with all amino acids, plus sugar, cellulose, pectin, starch, with a C/N ratio ranging from 30/1 to 150/1. First trials using this material on the soil surface as sheet composting gave interesting results, but when switching to deciduous trees, results were better in terms of productivity of a wheat crop.

I was then asked to provide answers about the mechanisms involved, because skepticism was at its best in the scientific community. Searching for clues, I was most disappointed after weeks of research in vain. Scientific literature has brought no light. **Besides Koslowsky and Winget in 1964**, no one has paid attention to nutrient content of trees and still much less to the potential organic contribution of wood to agricultural soils. In fact, we found no descriptions of twig nutrient content except in terms of chemical nutrients, which has not contributed information towards the mechanisms we were looking for.

In 1986 we gave both description and name to this material: Ramial Chipped Wood or RCW. We are using twigs of less than 7cm in diameter for agricultural purposes, because they are richer in nutrients and are not used as firewood most of the time. The first answer as to why evergreen RCWs are much less effective than deciduous lies within the lignin structure (**Swift 1991, Larochelle, 1993**). Gymnosperms' lignin gives aliphatic compounds primarily, while Angiosperms are providing fulvic and humic acids, for which Basidiomycetes are responsible through the depolymerization process (**Leisola & Garcia 1989**).

Although fungi are most important, they best perform for humus production when associated with soil mesofauna, mainly fungivore. This process, linked to bacteria, protozoa, and algae, is responsible for the release of nutrients when needed for plant growth. If these mechanisms seem rather simple and coherent, we all know that reality is much different. Why are small diameter twigs more effective than larger diameter stem wood? Its seems that the answer lies in the degree of polymerization of the lignin and polyphenol content (**Larochelle 1993**).

After more than fifteen years of field experiments in forestry and agriculture we can now say that:

1° Ramial wood has much less polymerized lignin than stemwood.

2° Lignin content of ramial wood is much higher in relation to cellulose than in stemwood.

3° The purpose of chipping is to allow a fast soil microorganism infection in order to capture available energy and nutrients into the humic complex.

4° This process gives birth to three types of organic matter such as inherited, soluble and bacterial organo-mineral aggregates (**Toutain 1993**).

I do not want to go too deep into this RCWs «success story» but I must stress that we do not unveil any secrets. The last decade was dedicated to bring together parts of the pedogenesis process that are scattered throughout the scientific literature. Every year, we have collected data from our own experiments and rather slim information from the scientific community.

AGRICULTURE

As previously mentioned the whole story began with the use of RCWs in agriculture in the late seventies. Guay has tied together three major ideas; bioconversion, sheet compost and Jean Pain's brush composting method in France; the upgrading pedogenetic concept was born. Humification can now be enhanced, affecting all types of soil life. Mineralization degrading effects can now be fought by an upgrading natural mechanism based on pedogenesis.

Experiments on wheat, oat, potato and strawberry have shown spectacular results with regard to yield increase, water needs, plant diseases, frost resistance, organic matter content of soil, increasing in pH values and nitrogen availability. After more than 10 years results from the first treatment can still be seen quite clearly.

A more recent African experiment in Sénégal (Seck 1993), gave even more spectacular results with regard to bitter tomato (*Solanum athiopicum*). Dr Seck from Cheikh Anta Diop University, has doubled fruit yield and total biomass within 43 days. He also reports much less aggressive weeds in experimental plots, an unbelievably high humidity content of soil and moreover, disappearance of root nematodes, which is one of the most costly parasites in garden vegetable growing.

As one can notice, results in temperate and tropical climate culture are much alike and even better under tropical conditions. We can now say without any reluctance that RCWs can be seen as an universal upgrading pedogenetic material through biological process with emphasis on humification and effects on timing and availability of nutrients.

FORESTRY

If agricultural results are obvious, what would be RCWs response under forest canopy or throughout all forestry and silviculture practices? When we began experiments in 1983, we knew that we would have a tremendous amount of difficulty with regard to funding and to years needed for to obtain data. In fact, we had, we still have and expect more difficulties to come, but results are worthwhile. We have first considered RCWs as an experimental material beyond compare because most forest experiments have an agricultural or laboratory scope. One could expect to have forest

answers to forest ecology and problems with regard to ecosystem complexity during a time span that is much longer than agricultural cycles.

We have set up two major sets of experimental plots under a sugar maple canopy and an open, sterile degraded soil being known as such for over half a century. It would be too long to go into detail, but some major points have to be underlined.

Degraded, almost sterile forest soil

1° Viable seedlings appeared between the third and fifth year after RCWs were applied.

2° Seedlings were from various tree species of the same forest pioneer ecosystem.

3° RCWs from rich ecosystems gave much better results than those from «poor forest ecosystems» in term of regeneration.

4° Under the same conditions and coming from the same ecosystem, some RCWs promoted conifer regeneration while others resulted in mostly deciduous saplings.

Sugar maple stand soil under canopy

Some changes have appeared with regard to vegetation species occurrence and frequency, but the most important change was the change in humus status. After five years, a very thick moder was transformed into a soft mull where all new litter is integrated to soil hypogeus ecosystem yearly. Here again, RCWs of tree species coming from rich stands gave best results.

One can raise some basic questions from these observations, but some can be partly answered even if the time span is short for a forest ecosystem. In every case, the humic system is involved, an element never assessed as fundamental in any forest management plan. In fact after timber exploitation, only soil and humus remains from the previous state.

Branches and brush were always perceived as a sign of poverty for centuries, and as trash when modern forest exploitation took place in the XIXth century. A first assessment of the production of small branches shows a mere 100 000 000 tons annually for Québec only and probably billions of tons throughout the world. Our experience shows that small branches are not used under tropical conditions. Small diameter branches can thus be transformed into a «soil food» instead of cattles'. Feeding soil microfauna and microflora is more likely to bring mid and long term benefits to either agricultural or forest ecosystems in redeeming costs and increasing benefits. To my knowledge, it is the only large scale upgrading technology. It involves a very large number of shrubs and tree species resulting in variable responses, but all positive with regard to the enhancement of the humic system. One can expect to give the benefits of forest soil to agricultural soil at the lower possible cost. Local small scale reforestation for RCWs production can now be envisaged for gardening and horticultural purposes.

A great deal of pollution, namely that having an agricultural origin, is born in depleted humic systems, as the soil is unable to retain water, nutrients or chelating heavy metals. Humic systems are after the oceans, the most powerful ecosystem on earth, to which no attention was ever paid. Both ecosystems are now in great trouble with regard to their management by man.

We are now well aware of positive results in turning RCWs into highly reactive humus, but changing customs is a more difficult mission. Agriculture, having

profound roots in our cultures, is making slow progress towards new techniques. It calls for a deep change in mentality by accepting support from an old adversary, the forest.

In forestry it seems to be more difficult, because large scale operations whether in Brazil or Canada, are for instant benefits, with no real concern for decades to come. This is largely due to our perception of an endless resource, allowing endless benefits. We all know that such is not the case, but no realistic proposals have been put forward to protect the basic forest capital wherever it is.

Such a material as RCWs, never having been seen as a fundamental value, needs to be looked at very carefully in Third World countries as well as northern hemisphere developed industrial ones. RCWs is the only material capable of increasing soil pedogenetic processes and at the same time, capable of regulating and increasing nutrient availability, as well as soil biodiversity, from virus to small mammals. The importance of this discovery is very hopeful but there is an urgent need for research, social and economic organization, and promotion. RCWs is bringing us into a new biological world at the global scale. It will soon be a new commodity. This universal biological material will have a direct effect in the short term as well as in the long term on soil, crops, economy, animal and human societies.

The time may not be suitable for large scale worldwide organizations dealing with planetary problems. Nevertheless, some thought should be given on the international level for the proper use of such a wealth. My experience tells me the great universal value of RCWs, but this value has never been experienced as such. RCWs will be seen as the most important biological contribution in our biotechnologic century.

I am grateful to Président Saintraint for his invitation to FAO and making public our knowledge on RCWs. I am also thankful, to Councillor Minister Andriago of the Canadian Embassy, for his kind assistance.

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