

On Microbes, Biofactories and Sovereignties (Part 2)

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This publication corresponds to the second part of an article where the authors reflect on the relationships between microbial life, culture, knowledge development, food and agriculture. You can find the first part of the article [here](#).

Continuing with the ideas laid out so far, the authors present concrete experiences in the elaboration and use of bioinputs at different scales and types of production, with a special focus on the local production of bioferments for soil regeneration. Finally, they draw some conclusions about how the management of microorganisms in peasant hands, within the framework of collective processes, is central to achieving food sovereignty and autonomy.

Peasant biofactories as an instrument of sovereignty

Although a stew may have *chorizo* in one house, be vegan in another, and have fish, game birds or vegetables, it will never lose its condition of stew, carrying with it the mixture of aromas and flavors chosen by the cook or cooks. Each person has their way of cutting the meat, knows the moment to add the grains or noodles and orders the sequence and the dose of condiments. The quality of that food that will nourish bodies and relationships, will be taken care of during the whole process by choosing the ingredients, observing their origin and maintaining the hygiene of the utensils used.

The work in a farmer's biofactory or *chacarera* is very much like in a kitchen. The basic ingredients that will be transformed into assimilable nutrients, hormones, vitamins and growth-promoting substances for the plants are recombined there. As in the stew, each production situation, each geographical location and each person involved in its preparation will necessarily give a particular imprint to the preparation.

In view of this, three aspects are central and that will result in the quality of the biofertilizers: knowledge of the fermentation process, knowledge of the origin of the raw material to be used and knowledge of the production situation in which it will have to intervene.

The fermentation process

Fermentation is the biochemical process by which substances are transformed through the action of microorganisms. The metabolic pathways and the groups of microorganisms involved change according to the presence of oxygen, temperature, availability of water, presence of other microorganisms and the conditions imposed by the raw materials.

For example, in compost, aerobic reactions prevail and the groups of microorganisms are similar to those existing in healthy soil since the biochemical reactions of one and the other are related. Knowing the processes, the carbon/nitrogen ratio and the times in which the original organic matter degrades into simpler molecules - forming stable compounds that will contribute their nutrients in a balanced way to the soil - is the key to obtaining a quality product. The rise in temperature of the piles is caused by the metabolism of the carbon chains present, for example, in cereal straws. The main culprits are yeasts, actinomycetes and fungi that degrade these materials by releasing CO₂ and heat. Under conditions of good oxygenation and adequate humidity, the piles can bring their temperature to thresholds of approximately 60°C and maintain this temperature for several days. This condition allows the initial populations of pathogenic microorganisms to drop drastically or disappear. [1] Among these are enteric viruses, salmonellae, *escherichia coli*, and leptospire, etc.

The contribution of good quality soil and a high percentage of clays to the compost is also essential for the formation of stable humic compounds in the soil, generating structure, providing nutrients slowly and allowing water retention in the profile.

If in the soil the primary energy source is the sun, which is captured through photosynthesis and offered to the microbiota through the roots in the form of organic substances, in the biopreparations there must also be a source of energy that activates the processes of breakdown and synthesis. This source can be molasses, sugar, corn starch or syrups obtained from fruits.



Compost pile

Other groups of microorganisms can contribute to their metabolism to obtain products with a high impact on plant and soil health by developing their activity in anaerobic media, deprived of oxygen. This is equivalent to the transformation action performed by ruminants in their rumen. Here we find *bioles* or *Super Magro*-type bioferments where the role of the microorganisms is to recombine the initial substances giving rise to others that can be absorbed in foliar form by the crops. In closed containers (a jerrycan, a 200-litre drum or a tank) and a liquid medium, amino acids, proteins, vitamins, hormones and other compounds with diverse physiological actions on plants are produced. This is added to the bioavailability of minerals in what we call chelation, where nutrients such as zinc, magnesium, iron, copper, manganese, cobalt or molybdenum are embraced by organic molecules and are thus apt and stable to be absorbed by the leaves or remain in the soil solution.

These procedures, which can be carried out with minimal infrastructure, require the maintenance of basic hygienic conditions to guarantee the

minimum quality of the preparations. In no way is asepsis required as an essential condition. This is a characteristic of laboratory work and it is understood that life develops from the interaction of multiple species forming complex communities.

The raw materials

The way to carry out each microbial transformation procedure will be subject to the characteristics of the material we are working with, and this will give the product its characteristics, linked to the conditions of the environment.

From the place we are writing, the most abundant, cheapest and best quality materials for the aerobic composting process turn out to be horse bedding and manure from grazing animals, to which we can add brewery waste and ashes from boilers or bakeries. In other regions there may be waste from the forestry, fruit and vegetable, poultry, fishing and meat processing industries, among others; even household waste from the proper separation of urban waste. There are variables such as the humidity of the material, the carbon/nitrogen ratio or the presence of substances such as antibiotics, tannins, agrochemicals or preservatives that can modify the stabilization of the materials we work with. It is therefore important to know the origin of the materials properly and always use these materials to avoid abrupt changes in the quality of the preparations. [2]

The production situation

Biopreparations have a wide spectrum of use situations. The challenge is to think of them as tools within a broad soil regeneration strategy in which -even sometimes- their use can be dispensed with.

In the context of newer agroecological transition schemes, it is easy to fall into the temptation of pretending to replace inputs, especially chemical fertilizers with biofertilizers, sometimes even wishing for the existence of an "organic glyphosate" to deal with weeds. If this happens, it is most likely that the pillars on which soil nutrition should be based and the ecosystemic mechanisms that

lead to nutrient recycling and suppression of unwanted species are not yet understood.

There are several experiences of producers in Argentina that use different ways of combining biofertilizers, moments of use and technological resources appropriate to the context. Thus, for example, in orchards, the dynamics of bottom fertilization-green manure-cultivation-*fertigation* are usually followed; in extensive crops, seed inoculation and foliar fertilization gain importance; in fruit trees, fertilization in the active root zone, the use of cover crops **in cups**, stem protection and foliar fertilization is important. [3] [4]

Some of the experiences we have been developing with producers in agroecological transition in the west of Buenos Aires province and east of La Pampa, have to do with returning to the soil the microbiological complexity lost during years of conventional management, as well as the contribution of mineral micronutrients. This is done in conjunction with a scheme in which the contribution of organic matter through crop rotation or animal forestry plays a central role. In other cases, they are used for more specific purposes, such as strengthening the plant to resist the development of pathogenic fungi or ensuring mineral nutrition that leads to the establishment of adequate nodulation with nitrogen-fixing bacteria.

In intensive systems, it is possible to provide organic matter and the microbiological load that will boost the supply of nutrients in a single operation through composting. But this is very complicated in extensive systems from the operational and economic point of view since the amount per hectare should be between 10 to 30 tons of compost. In this situation, it is necessary to generate the stabilization of organic matter (from stubble, cover crops or animal forestry) in the field through the contribution of diverse microorganisms *in consortium*.

The options we are pursuing together with producer families include seed inoculation and *breeding* and the use of foliar biofertilizers with microbiological consortia and mineral sources. While this idea started with the inoculation of leguminous plants such as *vicia* using the reproduction of nitrogen-fixing microorganisms, we later extended it to several crops (winter cereals, pastures, corn, sorghum, etc.) using consortia of microorganisms. In the field, the results are noticeable in root development, resistance to water stress phenomena and nodulation of leguminous species. Then, as the crop

develops, the use of foliar biofertilizers aims to strengthen various physiological mechanisms in which the microminerals provided act in specific biochemical sites and moments. For example, this is expressed in root elongation, quantity of leaves or flowers, fruit set and fruit quality. In addition to allowing the plant to activate mechanisms to resist stress situations such as temporary droughts or the entry of a pathogenic fungus. The provision of microorganisms also reinforces the bioavailability of nutrients in the leaf zone and acts as a suppressor of fungal diseases, as is the case of lactic acid bacteria, present in milk or whey - a central component of several biopreparations.



Study of the effect of the application of consortia of micro-organisms and minerals on root development: with application (left) and without application (right).

In extensive systems, a limitation that usually appears is the lack of availability of sprayers for foliar applications. In places that are beginning to advance in the application of agroecological principles in their production, hiring a sprayer that comes from applying agrochemicals elsewhere is no longer an option and the scale of certain experiences does not allow the acquisition of one. An alternative option may be the municipal provision of the machinery -when dealing with peri-urban areas- or the collective purchase of the equipment within the framework of social organizations or groups of producers.



Application of biofertilizers in field crops

Farmer-indigenous metagenomics fields

The proposal of peasant biofactories, then, is based on simple premises such as the valuation of biodiversity, the use of accessible and low-cost materials and the valuation of local knowledge. The processes that accompany the agroecological transition should allow for regaining sovereignty and give back to the people of the land the possibility of deciding on their food and productive scheme according to their cultural patterns.

When we talk about contributing through our practices to strengthen soil health, we are inviting you to reconnect and be part as human beings of the scheme of links that soil microorganisms build and that sustain life at all levels. In short, contributing to restoring and healing the web of fungal *hyphae* and bacterial biofilms is how food production is made by strengthening the autonomy and sovereignty that makes us healthy communities.

In order to achieve this, professor Sebastian Pinheiro proposes a pedagogical and technical strategy called Indigenous Peasant Metagenomics Fields. [5] It is basically about generating the conditions in small plots to dynamize the relationship between minerals, organic matter and microorganisms through the contribution of rock flour, biochar, composted materials and straw. There, in-field composting will take place, generating the conditions for the development of a microbiological flora in tune with the site-specific environmental particularities. The evidence of this process will be manifested by the change in plant composition and through the use of integral analysis tools such as chromatography. This soil can then be used as *inoculum* for the generation of bioinputs appropriate to the environment.

Numerous studies have shown the very high site-specific variability of microorganisms. Although the different functional groups (cellulose degraders, nitrogen fixers, phosphorus solubilizers, among many other functions) are maintained in each ecosystem, the species involved and the ratio of quantities among them are highly variable. This leads us to think that the development of regionally adapted crops must be accompanied by the generation of bioinputs made from inoculums obtained in each region, in biofactories where raw material, knowledge and local labor are combined.

This is the only way to strengthen the link between microbial networks and the social scheme present in the territory, generating autonomy, sovereignty and the expression of agriculture.

Discussion and conclusions

Beginning the transition to agroecology through soil regeneration is not a question that can be based solely on biochemical variables or on the relationship between yield and rate of return. The strengthening of soils and self-management of fertility is perhaps one of the strongest pillars to be addressed in the construction of models of society based on respect and recognition of biodiversity. Several authors, such as Ana Primavesi, have referred to the relationship between soil health and the health of societies. When the links that provide the system with its self-regulating properties are reconstituted, ancestral memories are awakened that help us connect with the origin of food, with its vital energy, and build sincere and lasting bridges with the rest of the people who share that land and food. This, which is easy to feel as soon as you "put your hands in the garden", seems to be the essence of the old cultures linked to the land.

Agribusiness and its logic have not only generated soil degradation but have also eroded the social and cultural fabric that was linked to them, in some cases over the millennia. Considering the **sovereignty of fertility** acquires then a higher dimensionality that exceeds the technical-productive to go back to political, cultural and spiritual issues. That is why we affirm that knowing and managing the technological practices and resources that dynamize soil and crop nutrition becomes key to the consolidation of agriculture.

Within the framework of the theories that support food production based on living soils, we deem the industrial-commercial proposal to use microorganisms isolated in laboratories -in a monospecific way- as risky and incomplete. In particular, when it comes to acting in a specific process such as making a nutrient bioavailable or acting as a pathogenic agent against an insect species. It is risky because once again we are betting on monoculture (this time of microorganisms), ignoring how these act with the others and endangering the balance that can only be achieved by guaranteeing biodiverse spaces. The pandemic context we have recently gone through is just a sample

of the devastating potential of dealing with nature from the old patterns that try to homogenize and industrialize the complex links therein. [6]

It is as well incomplete when these technologies are presented as new and play the same game as pesticides and industrially synthesized fertilizers, and even in several cases they share the moment of application on the crops. If we know the depressive potential that a herbicide such as glyphosate has on microbiology, the use of microorganisms in a crop where this herbicide was used will have a short life and the following year the combo will have to be used again. It is a vicious circle that deepens dependence. For this reason, the intended regeneration will never be real.

We can affirm that the two competing models of agriculture, that of agribusiness and that of *AgriCultures*, differ in conception, practices and objectives. In terms of conceptions and practices concerning microorganisms, the two positions are strongly antagonizing: agribusiness, through its companies and part of academia, seeks to intensely appropriate microorganisms, their genes, their processes and their products, through new legislation, and the sale of technological products linked to microorganisms. It does so by reproducing the logic of monoculture in it: focusing its work on a few species, and even specific strains; once again ignoring the role of the links that are only generated in biodiverse environments. To illustrate this, we can mention the multiple commercial options of microorganisms that aim only at input substitution (*Azotobacter* to substitute urea, *pseudomonas* to reduce the use of phosphates, *bacillus* to substitute fungicides or *beauveria* that do the same with insecticides); other companies "raise their sights" and begin to offer genetic lines of certain crops associated to their specific microorganisms. This, which constitutes an advanced step in the study of germplasm, once again aims at turning farmers into mere "users" of a technological package developed in the laboratory. All under a legal framework that protects these practices and restricts the processes of research, development and registration of products that can be adapted and managed by those who work the land.

At the same time, among the organizations linked to agroecology, food sovereignty, peasant and indigenous family farming, actions and proposals linked to the sovereign, independent management of microbiological processes, their research and popular dissemination are growing. It is from here that the proposal of soil regeneration and the sovereignty of its fertility

must be accompanied by the emergence of artisanal biofactories scattered throughout the territories and with multiple productive situations in mind..

This also requires the design and implementation of forms of quality evaluation that can be understood by the people and groups involved, based on simple premises and chosen in a participatory manner; operating under legal frameworks that contribute to the improvement of production (in terms of safety and effectiveness of preparations) without limiting the possibilities of development in favor of the most concentrated sectors of the industry.

The participation of the State in all its forms seems to be key to this. But for its action and contribution to be positive, the complexity of linkages that exist in healthy soil and how bioinputs play a role there must be understood and addressed. Otherwise, we will fall back into a biased vision governed by a linear and reductionist conception of nature and society.

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