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# Biofactories: a new model for production and access to agricultural inputs in Latin America

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**The production and access to alternatives to chemical agricultural inputs are key issues today. In Latin America, solutions to these challenges (see Perspective 55, May 2021) are becoming available thanks to the rise of biological inputs – including biofertilizers, biocontrol agents and biostimulants – resulting from many years of public investment in research and development, and a significant industrial drive in developing technologies based on micro-organisms, macro-organisms or plant extracts. However, the sector is taking a different route from the traditional agri-supply channels: NGOs, farmer networks, public policies and even some private stakeholders are encouraging the production of bio-inputs in bio-factories, directly on farms or in community facilities in rural areas. While these biofactories open up new prospects, they also face major challenges.**

## Biofactories: decentralised units for the production of agricultural inputs

Three main components are needed to set up biofactories. Firstly, the physical infrastructure required for production, consisting mainly of metal or plastic tanks in which multiplication, fermentation and decanting operations are carried out. These often include oxygenation or ventilation systems, disinfection equipment and products, and possibly measuring or counting equipment to assess production quality, or refrigerated storage structures. The second component consists of the raw materials needed to produce the bioinputs: strains of micro-organisms (bacteria and fungi) with their cultivation substrates, possibly populations of insects to be multiplied, or materials of plant or animal origin intended mainly for fermentation. The third component entails all the knowledge and know-how needed to set up and operate these biofactories, which can be provided to farmers by various stakeholders in rural development and agricultural science and technology.

The liquid or solid products thus obtained are applied to the soil, with the objective to enrich it with micro-organisms, organic matter and nutrients, boost its biological activity, and stimulate exchanges between the soil and the roots of the cultivated plants. They can also be applied to plants as a foliar treatment to strengthen their defence against diseases and pests, or to directly attack the pests.

The boom in biofactories that can be seen in Latin America involves a wide range of producers practising organic, agroecological or conventional agriculture. They range from small-scale farmers, either working alone or collectively within their community, to large-scale growers cultivating tens of thousands of hectares, as in Brazil. Their interests in setting up biofactories varies: they may be involved in a transition towards more environmentally-friendly practices, using nature-based solutions; they are seeking autonomy from the agricultural supply chain through access to technologies that are still often unavailable from traditional input suppliers; or they have succeeded in reducing production costs, with on-farm or community production delivering inputs at much lower – albeit poorly documented – costs than those charged on the markets by agri-supply firms. This decentralised model of production and access to inputs is thus the antithesis of that associated with chemical inputs, which are usually imported or transported by lorries from factories situated far away from agricultural production areas.

## Proactive public policies

While community-based or on-farm biofactories have long been supported by non-state stakeholders in agricultural development (with the notable exception of Cuba), they are now being explicitly promoted by many Latin American governments. This is particularly true in Mexico, where the national program *Producción para el bienestar* has encouraged the setting up of community biofactories through agricultural extension initiatives, and has produced a series of *Practical manuals for the development of bioinputs.* In Brazil, the *Programa Nacional de Bioinsumos* is promoting the establishment of biofactories, including training courses

### From bioinputs to biofactories: definitions

Biological inputs for agriculture are more commonly known as bioinputs (*bioinsumos*) in Latin America. They fall into two main families of biological products:

**Biocontrol** refers to a range of technologies used in plant protection to combat pests (micro-organisms, insects, acarids, nematodes, etc.). There are generally four main types of biocontrol agents: macro-organisms, micro-organisms, chemical mediators (mainly insect pheromones), and natural substances of plant, animal or mineral origin.

**Biofertilizers** are used to increase soil fertility and promote plant growth. They are products based on organic matter (animal waste, plant residues, composts), or solutions based on micro-organisms, such as bioinoculants, which optimise the uptake of mineral elements by plants. Some of these products are also often referred to as biostimulants.

**Biofactories** are facilities in rural areas for the production of these biological inputs, through the multiplication of microorganisms or macroorganisms, or the transformation of organic matter of plant or animal origin (compost, leachates, fermented products, etc.).

for farmers with the support of Embrapa, the national agricultural research institute. In 2021, a bill was submitted to the Chamber of Deputies to rescind any form of control or supervision by public authorities on-farm biofactories, with the objective to encourage farmers to develop this type of practice and facility. In Colombia, a national process to draw up a diagnosis of existing biofactories has been carried out from the end of 2023, under the direction of the Ministry of Agriculture and Rural Development, as part of the *Programa Nacional de Bioinsumos*. In this context, a diversification of funding sources was considered through a Fund for Access to Agricultural Inputs (FAIA), which was set up as a key element to support the design and implementation of biofactories.

Public support for the development of biofactories is part of a wider support package for the development of bioinputs, which includes various components: modernising regulations, support for research and businesses, tax incentives, and the creation of innovation networks. Depending on the countries and their political situation, these policies – in particular support for biofactories – are more or less geared towards certain models of agricultural development. In Mexico and Colombia, they are meant for promoting agroecology as an alternative to the agro-industrial model based on the intensive use of synthetic chemical inputs. In Brazil, the policies implemented are more consensual, supporting bioinputs as a set of technologies for all farmers, regardless of the size of their farms or their production practices. Bioinputs are presented there above all as complementary technologies to synthetic chemical inputs, and not as radical alternatives contributing to a planned decline of the latter.

## The market for biofactories in Brazil

The development of biofactories can be seen as part of the do-it-yourself (DIY) movement – more specifically the do-it-yourself-biology movement – in which users carry out scientific and technical activities previously implemented by scientists and manufacturers. Farmers, for example, produce micro-organisms at home and spread them on their soils or crops, whereas previously they bought products developed in the laboratories of national companies, which were themselves often founded as spin-offs from public research laboratories.

The DIY movement was built in opposition to centralised and commercial approaches to technological development, which reduce citizens to mere consumers. However, the development of biofactories on medium- and large-scale farms, particularly in Brazil, suggests a different reading of this critical component. The recent boom in biofactories is closely linked to that of a number of companies providing farmers with turnkey services to develop their facilities, including everything from bioreactor tanks to propagating strains, as well as an advisory service. More than being economic operators, these companies play an essential role in the development of a wider infrastructure supporting the development of bioinputs. For example, they are helping to develop microbiology skills within agricultural analysis laboratories in rural areas, creating around them a network of partners able to carry out the counts and identifications needed for quality control to ensure that biofactories are efficient.

Together with farmers, various economic actors, consultants and researchers, companies are part of a national network in Brazil, the GAAS (Grupo Associado de Agricultura Sustentável), that promotes biofactories and regenerative agricultural practices to "help farmers achieve independence from ready-to-use technical packages". Linkage with the scientific field is essential within this network, due to the nature of the technologies deployed, which are most often in the fields of microbiology and biotechnology. This linkage is also directly relevant to the companies providing on-farm biofactories: with their novel activity consisting of shifting the production of micro-organisms from the laboratory to the farm, there is a strong need to demonstrate the quality of the products and services they offer. In tune with a booming market, they have their own R&D laboratories, recruit staff with PhDs in microbiology and even leading researchers in the agricultural microbiology scientific community. Only few figures are available to describe the development of the market for these services for setting up and running biofactories on farms, but two indicators reflect its vitality: the number of companies offering such services has increased over the last five years, while the leading companies have increased their capitalisation thanks to the participation of major investment funds, enabling them to enter a phase of internationalisation.

## Resistances and controversies

The rise of biofactories, whether supported by economic actors or by public policies and NGOs, holds great promise and hope for reducing farmers' dependance on synthetic

chemical inputs. However, it is met with a range of resistances and controversies.

First of all, the growth of an industrial and commercial sector of on-farm biofactories for large-scale farmers is creating major competition for companies that are marketing ready-to-use biological inputs. Additionally, the latter are protesting unfair competition, arguing that farmers may buy their microorganisms and multiply them at home in their biofactories. The weight of this criticism is all the greater when companies in the biological inputs sector are organised. This is particularly true in Brazil, where CropLife – the seed, biotechnology and pesticide manufacturers' association – has also been representing the interests of the biocontrol industrial sector since 2020, following its absorption of the Brazilian Association of Biocontrol Companies (ABCBio). In any case, the debate is very similar to the one that has affected the seed sector in recent decades, with companies complaining that farmers could multiply for free the products in which they have invested in research and development.

In addition to the defiance of bioinputs companies, controversies are triggered by the academic microbiology community over the quality of the solutions obtained in biofactories. On the basis of measurements taken in biofactories, specialists in microbiology and biotechnology laboratories are expressing concerns about the uneven concentration of micro-organisms in the products. Worse still, they point to the risk of multiplying and releasing into the environment pathogenic micro-organisms that could harm the health of ecosystems, farmers and consumers. They therefore denounce the sometimes-uncontrolled processes used by farmers and the companies that work with them, which could not only compromise the reliability of biological inputs in agriculture, but also cause ecological and health disasters. In Brazil, the microbiologists of Embrapa (Brazilian Agricultural Research Corporation) scientists raised their voice in 2022 to criticise the government's intention to rescind any form of control on the establishment of biofactories by farmers on their farms. In Colombia, at the beginning of 2024, a draft resolution by the Instituto Agropecuario Colombiano (ICA) aimed at regulating production in family and community biofactories was unanimously rejected. Farming communities expressed their concerns, warning that the regulation could undermine their food security, sovereignty and autonomy. At the same time, the scientific community and input industries have stressed the importance of strengthening safety guarantees for products from small-scale biofactories to prevent the spread of infectious agents.

These debates raised the issue of how best to support and regulate the practices of those promoting and using biofactories, illustrating the sometimes-conflicting relationships between science and politics when it comes to regulating agricultural technologies, as well as the role that scientists can play in ringing alarm bells. Even though the need to formulate alternatives to chemical inputs is becoming ever more pressing, and even though researchers who have been working on breakthrough technologies for a long time are pleased to see their work having a real impact in the field, they consider that this move out of the laboratory cannot be at the expense of proper laboratory practices.

## The challenges of the "laboratorisation" of agriculture

Efficient and effective development of biofactories is based on what we might call the "laboratorisation" of agriculture or, in other words, the replication on farms and in rural communities of the conditions that prevail in the laboratories of the most advanced research institutions or companies. These conditions include high-quality equipment and raw materials, strict and standardised production, maintenance and storage practices, and quality control procedures. Developing and implementing these conditions involve a wide range of stakeholders (researchers, training and extension services, private agri-supply companies, government regulatory bodies and sanitary inspectors, etc.), whose prerogatives and modes of collaboration are likely to evolve as biofactories are rolled out. If they are to be unanimously recognised, the procedures and specifications governing biofactories will have to be drawn up on the basis of the positions of these different stakeholders.

A decentralised and localised input production model therefore poses major challenges for the agricultural sector as a whole. Yet, it is undoubtedly even more so for small farmers in remote rural areas. In addition to the logistical challenges (supply of raw materials, access to infrastructure), economic resources are needed to set up and run community biofactories, as well as a collective action to manage these facilities effectively (distribution of production and maintenance tasks, allocation of the bio-inputs obtained, etc.). Such crucial issues will have to be addressed by agricultural research for development operators. Doing so will require to involve a wide range of specialities and multiple partnerships with stakeholders in agricultural innovation systems, at the forefront of which will be the State administrations responsible for designing and implementing evidence-based policies. Regarding regulation and control, training of farmers, technicians and agricultural engineers, and access to credit and agricultural advice, public administrations' action will be decisive in ensuring effective conditions for this "laboratorisation" of agriculture. It is this commitment on the part of governments that will enable the controversies mentioned above to be resolved, on the one hand by objectivising good practices, and on the other hand by making the necessary trade-offs, particularly in the face of the demands from the input industries. ■

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## A few words about…

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