Advancing fertilizer technology in Brazil

Written by

José Carlos Polidoro, PhD, *Senior Researcher and*
Daniel Vidal Perez, PhD, *Senior Researcher,* ***Embrapa Soils, Brazil***

Agricultural progression in Brazil can be summarized as a simple series of cycles of monoculture to supply foreign markets: sugar cane, from the 16th century to late 18th century, when it lost competitiveness to the Dutch colonies in the Caribbean. Then, coffee, starting in the 18th century up to the 1930s, which ended as a result of the world economy crisis in 1929.

The main trend is a reduction of the importance of labour and land

The profile of the rural producer in the early 20th century was that of a small producer who practiced subsistence agriculture without any support from government and trodden by "latifundiários", owners of large and less productive areas of land. This has led to Brazilian dependence on food imports and our constant supply shortages.

Between 1965 and 1980 the ideas of Delfim Neto and his team started to influence Brazilian agricultural development. For them, the answer for the expansion of the agricultural sector would be technical-agricultural-industrial integration. It would be characterized by a growing use of inputs such as fertilizers, pesticides, improved seeds, farming mechanization and integration between the primary production of food, raw-materials and various industrial segments.

Brazilian agriculture has shown a tendency for systematic growth over the last 40 years, mainly as a result of increasing productivity. According to CONAB, for example, grain production in Brazil increased between 1976/1977 and 2019/2020 by approximately 46.9 mn t to 257.3 mn t, while the farming area increased by approximately 37.3 mn ha to 66.0 mn ha. This means that the increase in land productivity was primarily responsible for the increase in production rather than an increase in farmed land. Thus, a 'land saving' effect of 138.5 mn ha could be calculated as a result from the hypothetical need of farmed land to attain the production of 2019/2020 with a productivity of 1976/1977.

An analysis of Agricultural Total Factor Productivity demonstrates that the productive growth of the Brazilian agricultural sector, in this period, is strongly based on science and technology. Based on labour, land and capital indexes, it is observed that the main trend is a reduction of the importance of the employment of labour and land, as well as the increase in the use of capital, resulting from the aggregation of the values of agricultural machinery and pesticides and fertilizers. This was an important transformation of agriculture towards its modernization.

Scientific developments

As a result, agriculture was responsible for 26.6% of the GNP in 2020, with 24.2% of the agricultural GNP being due to the industry and 45.6% to services (CEPEA). Also in 2020, 20% of the jobs and 48% in exports were in agriculture. Thus, it can be stated that Brazilian food security and sovereignty have been achieved only through recent technical scientific developments in agricultural production, as well as sectoral incentive policies.

The jump in production was noted by the better use of insums, with direct effects on productivity. Fertilizer consumption increased from 2.5 mn t in 1976 to 18 mn t in 2020, being the largest increase after 2000.

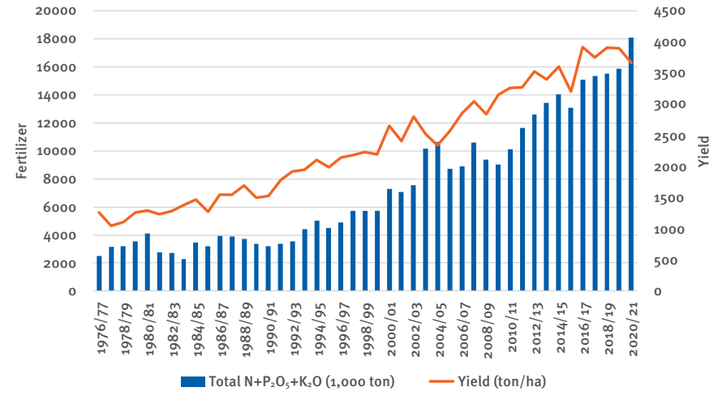
The direct impact of fertilizer use on grain yield can be evaluated in figure 1, which demonstrates a strong correlation between them. It is worth noting that the productivity decrease observed in the 2020/2021 crop was due to abnormal climatic issues (drought) in the main areas of corn production, mainly.

Brazil already has a series of sustainable systems that can be considered 'land-saving'

Projections indicate that Brazil's path as a major exporter will continue in the coming years and estimates from the Food and Agriculture Organization of the United Nations (FAO) indicate that Brazil will play an important role in meeting the growing global demand for food and agricultural products, which is expected to increase by 50% by 2050.

Brazil already has a series of sustainable systems and technologies that can be considered land-saving strategies in open adoption, such as: Integrated crop-livestock-forest (ILPF); agroforestry systems; no-tillage system (SPD) and organic agriculture; nitrogen biological fixation (BNF); biological control of pests and diseases; planted forests; recovery of degraded areas; treatment of animal waste; recovery and restoration of degraded pastures. However, the use of fertilizers is basically dependent on imports via multinational companies operating in the country.

Figure 1. Total data on fertilizer consumption and grain yield in Brazil from 1976 to 2020



Data sources: CONAB e ANDA

Impacting factors

According to GlobalFert Outlook 2021 "Brazil is the fourth largest consumer of Nitrogen (N), the third of phosphorus (P) and the second of potassium (K)" in the world. In 2020, the Brazilian external dependence of N, P and K was, respectively, 88%, 61% and 99%, and this situation is not expected to change in the next ten years (Outlook FIESP 2029). Only two multinational companies, Yara and Mosaic, control 45% of the fertilizer market in Brazil (GLOBALFERT, 2021). That is, 84% of the USD10 bn spent on fertilizers go abroad because of the import of most of the fertilizers consumed in Brazil, preventing states and municipalities and, therefore, their population from benefiting directly from jobs, tax collection and indirect benefits of the fertilizer industry.

Moreover, there are other impacting factors such as market fluctuation effects on profit margins of the rural producers and the threats to Brazilian sovereignty due to the interference of foreign nations, via public companies operating in the fertilizer market or through the imposition of economic sanctions on the main countries that export fertilizers to Brazil.

Faced with these scenarios of dependence on fertilizer production and technological innovation, the Federal Government published Decree No. 10,605 of 22 January 2021, where an Interministerial Working Group was established with the purpose of developing the National Fertilizer Plan (NFP), aiming to strengthen policies to increase the competitiveness of fertilizer production and distribution in Brazil in a sustainable way. The National Fertilizer Plan aims to order public and private actions to expand the competitive production of fertilizers (including fertilizers, lime and conditioners) in Brazil, reduce external technological and supply dependence, avoiding possible crises, and increasing the competitiveness of Brazilian agribusiness in the international market.

It became clear from the first quarter of the 20th century that anthropic changes in the structure and function of natural systems are threats to the continuity of life on the planet, at least in the way we know them. Since then, the risks associated with production and consumption patterns have been gradually worked by science and technological development, moving to the political and regulatory spheres, which emerged in a way of ESG (Environmental, Social and Governance) concepts for reconfiguration of the business ecosystem and mapping of investments. With this, the future plans for Research, Development and Innovation (RD&I) will follow ESG concepts. In other words, the basis for projects of all companies in the fertilizer production chain will follow the target of a better agro-environmental performance of agriculture, which will be used as an instrument of foreign trade and international agreements for business with agricultural products and livestock.

Sustainable production

There is currently important convergence of the global climate challenge and the concepts of circular economy and ESG for the fertilizer sector. The European Union's Common Agricultural Policy (CAP) is structured in what is called the Green Deal, which provides for the transition to sustainable production models and to meet the objectives in combating climate change set for the EU bloc.

According to the International Fertilizer Association (IFA), in general, fertilizers account for about 2.5% of total greenhouse gas emissions to the atmosphere, resulting from the expenditure of fossil energy for the synthesis, processing and transport of fertilizers and soil reactions after use. Good fertilizer use practices in agriculture have allowed high productivity, reduced environmental pressure by avoiding the opening/ deforestation of new areas and led to high contributions of organic material, via crop residues, which will increase the carbon (C) stock in the soil.

Examples of public policies that are already underway in the country, directing both the preservation/ conservation of natural resources and the sustainable production of food and bioenergy are:

a) The Forest Code and its instruments - CAR and PRA (Law No. 12,651, of May 25, 2012)
b) The Sector Plan for Mitigation and Adaptation of Climate Change for the Consolidation of a Low Carbon Economy in Agriculture (ABC Plan, prepared in accordance with Article 3 of Decree No. 7,390/2010)
c) Climate Risk Zoning (ZARC, Decree No. 9,841 of June 18, 2019)
d) The National Biofuels Policy (RenovaBio, Law No. 13,576, of December 26, 2017)
e) The National Soil Policy (Pronasolos, Decree No. 9,414, of June 19, 2018)
f) The National Bioinsums Plan (Decree No. 10,375 of May 26, 2020).

Fertilizers account for about 2.5% of total greenhouse gas emissions

The fertilizer production sector is still under mobilized to finance actions to implement practices and processes to reduce GHG emissions. There is still limited investment and no incentives from this sector in terms of real actions to lower GHG emissions throughout the distribution and production supply chain.

Therefore, at this time, the issue of Governance greatly favours a position of the federal government with regard to the creation of a centre of excellence and strategic intelligence in fertilizers and plant nutrition in Brazil (CExFertBrasil). Something similar to the International Fertilizer Development Center (IFDC, Muscle Shoals, USA). The IFDC, was established from the National Fertilizer Development Center (NFDC) of the Tenesse Valley Authority (TVA), is an international centre for fertilizer studies. The IFDC and NFDC can be considered as the largest and most important fertilizer research institutions of all times.

The CExFertBrasil is being discussed as a modern model of public institution, with participation of the private sector. In this context, the location of the headquarters should be aligned to certain characteristics: surrounded by a powerful innovation ecosystem, a place with potential for industrial fertilizer production, a major business centre, with logistical facilities for moving people and insums, both nationally and internationally.

Strategic studies

CExFertBrasil would have regional offices, considering the vocation within the fertilizer chain and plant nutrition. For example:

- Triângulo Mineiro, in Minas Gerais, specialized in phosphate chain technologies
- Campinas, specialized in Technologies 4.0, Precision Agriculture, logistics intelligence and infrastructure
- Sergipe, specialized in nitrogen and potassium chains
- DF, specialized in emerging chains
- Pará, specialized in environmental sustainability
- Paraná, specialized in Biological Nitrogen Fixation and Biological Insums for Plant Nutrition

CEXFertBrasil would be implemented in two modules. In the beginning, it will focus on agreements and multi-level cooperation, establishing a governance structure at the tactical/ operational levels, complementing the strategic level already established in the NFP. This will occur virtually in the first years. The second module, after the construction of the headquarters and the improvement/ adaptation of regional offices, would be dedicated to the creation of an institutional arrangement in the model of a Social Organization (OS), a practice that has been very successful by the MCTI, when there is a need for technological and sectoral development in the country.

The headquarters would include laboratories specializing in technologies and strategic studies in fertilizers, administrative sector, training and pilot fertilizer production plants. It will also feature a digital version, in the form of an 'Innovation Platform', that will connect people with all possible national and international innovation hubs, both public and private. It should be deployed in a technology park to attract the RD&I structures of the world's largest companies in the fertilizer chain and, in the future, pesticides, genetic resources, information technology and others that work in agribusiness. ■