

Science, Technology, and Innovation Policies to enhance the role of the bioeconomy as a vector of sustainable development in the Norte Grande of Argentina: a foresight study

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Summary

This report analyzes the bioeconomy potential to be the cornerstone of the sustainable territorial development process in the Norte Grande (NG) of Argentina. The trajectory of Argentine development and its regional asymmetries is studied, leading to a review of the structural problems and potentialities of the NG region. Moreover, it proposes the bioeconomy approach as a vector of sustainable regional development, focusing on the techno-productive characteristics and the scientific-technological platform of the NG region. A foresight exercise is carried out to explore the possible paths of the development process in the NG region to 2030-2040. The main conclusion of this report is related to the strategy, policy recommendations and an outline of a R&D agenda to support the development of the bioeconomy in the region.

Introduction

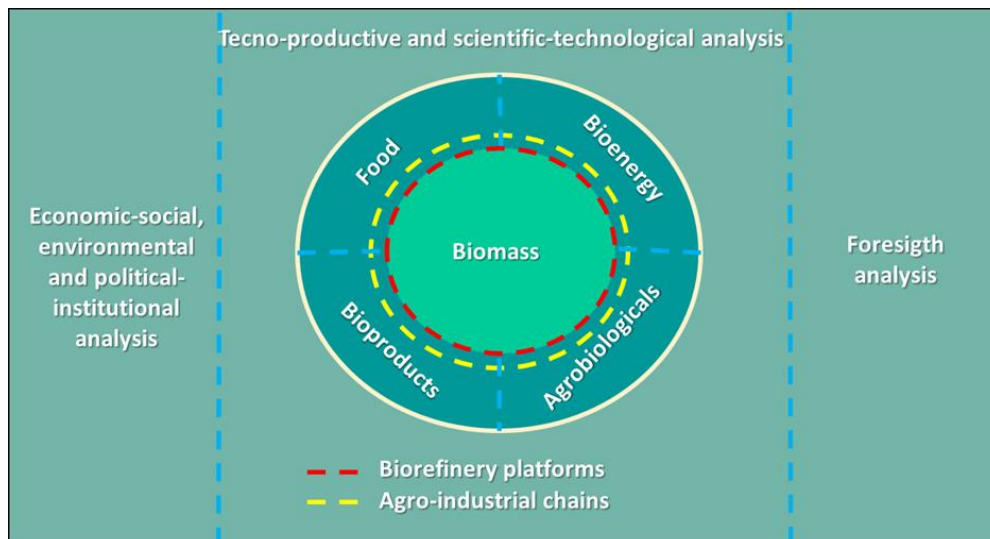
The report is based on the work carried out by the project "*The Bioeconomy of Argentina: Building a Smart and Sustainable Future for the Norte Grande (NG) Region (2030)*" (Bocchetto, R. et al., 2020, 2021)¹. This study, structured in three areas, provides the analytical framework for this report (Figure 1). The economic, social, environmental, political, and institutional area explores the conditioning factors as well as the potentialities of bioeconomy development in the NG. The techno-productive area of analysis focuses on agricultural value chains and their integration into biorefinery platforms, using biomass conversion processes for food production, bioenergy, bioproducts and agrobiologicals. Finally, the foresight area integrates all phases of the study, leading to the construction of 5 (five) scenarios about the future of the bioeconomy in the NG.

Argentina's development and its regional asymmetries

Argentina's development strategies have been historically pendular, partially due to the political divergence between the roles of the agricultural and industrial sectors. Argentina has oscillated between development models based on commodities agricultural exports, simultaneous with trade and financial liberalization and deregulation processes, and development models based on import substitution, with protectionist policies towards the industrial sector. The result has been an unfinished industrialization with a trade deficit in manufactures of industrial origin and low exportable value of manufactures of agricultural origin.

¹ This project was executed by the Consortium formed by the National Institute of Agricultural Technology - INTA, the National Institute of Industrial Technology - INTI, the National University of the Northeast - UNNE, the National University of Salta - UNSa and the National University of Santiago del Estero - UNSE, based on a competitive call issued by the National Ministry of Science, Technology and Innovation – MINCyT.

Figure 1: Analytical framework



Argentina is a highly competitive country in the production of food and agricultural *commodities*. Simultaneously, Argentina shows strong regional asymmetries in relation to its potentialities that respond to an asymmetric pattern of regional accumulation and territorial equity² (CAC, 2017).

Structural problems and potential of the Norte Grande

The NG is characterized by weak socioeconomic development, environmental fragility, a primary production matrix and recurrent socio-environmental conflicts, being the region with the most critical poverty in the country (Bolsi and Paolasso, 2009). However, the region has an immense wealth of biological resources and solid scientific-technological institutions³. The viability of bioindustrial development in the NG lies in the availability of infrastructure and logistics that facilitate a sustainable exploitation of its biological base.

Bioeconomy as a vector for sustainable regional development

In recent decades, the bioeconomy⁴ has arisen as a component of the political economy, being associated with strategies that promote economic

growth, technological innovation and environmental sustainability. Public initiatives have grown steadily and are considered essential for the fulfillment of the SDGs (National Bioeconomy Council, 2020).

Argentina has not been a passive witness to this evolution. Bioeconomic development is one of the strategic priorities of the National Science, Technology and Innovation Plan 2030 (MINCyT, 2022). In turn, innovative bioeconomic ventures have emerged throughout Argentina and provincial governments are increasingly taking a leading role in the design of public policies. Argentina is making visible progress, but there is still a long way to go for the development of the bioeconomy to become a state policy in itself.

Science, technology and innovation (STI) policies oriented to develop the bioeconomy opens the opportunity to resolve the historical political divergence. A development strategy centered in the bioindustry potential could be the key to a sustainable regional development process in the NG, integrating bioeconomy and territorial development.

² The agroindustrial sector accounts for 70% of total exports (SAGPyA, 2021), of which 78% are originated in the central region (The Pampas) (INDEC, 2021).

³ This scientific-technological structure is an important base to consolidate the capabilities required for a biological industrialization strategy.

⁴ The European Commission defines the bioeconomy as *"the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy"* (European Commission, 2012).

Techno-productive base

The techno-productive strategy involves the industrialization of renewable biological resources in the search for a circular economy that includes technological innovation, new processing routes from the available biomass, while minimizing waste. This strategy involves intensive use of knowledge and intangibles with strong value added.

In the NG region there are various sources of biomass according to the territory of origin and the productive structure. It is necessary to deepen the mapping of biomass resources and their potential for cascade use with a higher order productive objective, facilitating the transformation of value chains into biorefinery platforms.

Low-scale processes associated with the territory are also important. However, it is necessary to solve technical and management problems in order to achieve efficiency, standardization and product quality.

Most of the agriculture value chains prioritized in the study are functional to the development of the circular economy. However, they present unresolved challenges in terms of harvesting, densification, transportation and storage that should be addressed to promote integrated bioenergy. The initiatives generated by climate change open new opportunities for bioenergy production.

The country's participation in the world bioproducts market is low. However, the natural conditions and the institutional/scientific-technological capacity open possibilities for new biobased products, as well as for the development of biologicals⁵.

Scenarios

Constructing scenarios involves drawing broad outlines of possible futures, using as a starting point the most relevant megatrends and driving forces of the system and the possible combinations between their evolution. In the exercise, it is assumed that

both the State and the productive sectors play a fundamental role in the balance of the power structure that frames the configuration of future scenarios. This balance has historically been conditioned by the divergence in development strategies and the economic-social and political-institutional models in force, together with regional asymmetries and structural problems. In addition, the outbreak of the COVID-19 pandemic led to a rethinking of the starting conditions and possible future trajectories.

Five scenarios were constructed using the archetype technique (Dator, 2009): Continuity, New Equilibria (with two paths given by alternative configurations of the bioindustrial power), Collapse and Transformation. The starting point for the scenario building process are different hypotheses for the resolution of the political dispute between the competing development models.

In the Continuity scenario, it is assumed that the struggle between the agro-export and the industrial protectionist model is consolidated. In the first path of the New Equilibrium scenario, the National State and agribusiness support a new strategy that promotes greater integration between agriculture and bioindustry. In the second path of the New Equilibrium scenario, the agro-export strategy is driven by the primary sector, with limited State intervention.

The Collapse scenario is dominated by the economic, social and political-institutional emergency, accompanied by the prolongation of COVID-19 consequences. Finally, in the Transformation scenario, an industrialization model based on biological transformation, the reconfiguration of the STI system, carbon neutrality strategies and the integration of agro-bioindustry and territorial development are consolidated as state policies. The bioeconomy becomes a vector for national and regional development.

The methodology is described in detail in Bocchetto et al. (2020). Annex I of this report presents synthesized images of the future for each scenario, which constitute the "picture" of the bioeconomy of the NG at the end of the horizon.

⁵ Biofertilizers, bioinsecticides and biofungicides.

Strategy, public policy and R&D agenda

Developing the bioeconomy in the Norte Grande requires, as a necessary condition, that Argentina has a viable national development project that validates the energy and biological transition process at regional and provincial level. This transition will make it possible to redirect public resources towards the development of the bioeconomy.

Within this framework, the Transformation scenario is associated with the image of the desired future. It requires a national strategy that enables the creation of laws, new institutions, policies and governance schemes, together with the design of regulatory frameworks based on a new regional/territorial development dynamic.

Specifically, to promote the development of the bioeconomy of NG region, it will be necessary:

- Reevaluate the biomass wealth, adapting land use planning and the expansion of the basic regional infrastructure.
- Establish frameworks for the development of first and second transformation biorefineries.
- Ensure sustainability and carbon neutrality in the biomass transformation process.
- Strengthen the continuity of the biofuels law.
- Implement economic policies to support the biological transformation of territorial resources.
- Increase the connections and the density of the regional STI ecosystem.
- Stimulate commitment and political will at the highest decision-making levels in the region.
- Internalize the integration of agro-bioindustry and territorial development vision in the political-institutional debate.
- Take advantage of the vision and potential of regional integration.

At the regional level, it will be necessary to design a strategic plan and to stimulate the development of interinstitutional and interdisciplinary public-private platforms to support the strategy as well as R&D agenda oriented to the development of the regional bioeconomy.

Annex II presents the outline of an R&D agenda referenced by productive areas: biomass, biorefinery, food, bioproducts and agrobiologicals.

Basic reference

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Annex I: Images of the future of the regional bioeconomy

Continuidad

- The bioeconomy as an instrument of development in the NG has not been able to consolidate. There are no significant changes in the regional productive structure and only first-generation bioeconomy industries survive.
- Provincial states are not strong enough to catalyze dynamic local innovation ecosystems, prioritizing their resources to solve historical problems in terms of health, food security, employment, and poverty.
- Increased environmental fragility and reduction in the provision of ecosystem services from natural resources in the NG.
- The historical limitations in infrastructure are not resolved.
- Private job creation in the bioindustry is very limited and public employment continues to be a determining factor in the region.
- Existing regional/territorial imbalances are maintained or exacerbated.
- Family agriculture maintains a low level of technological incorporation and a significant proportion of small and medium-sized agricultural producers stays at subsistence levels.
- Significant gaps remain between formal and informal labor and there are no substantial improvements in social inclusion processes.

Nuevos Equilibrios I

- The first-generation bioeconomy industry is consolidated and the foundations are laid for a second and third-generation industries.
- The regional productive structure is slowly beginning to change, with greater preeminence of agroindustry in the region and greater diversification of productive activities.
- Asymmetries between the most competitive and least competitive producers are still very profound.
- The density and connection of local innovation ecosystems is increasing.
- New socio-environmental conflicts arise because of the expansion of agri-bioindustry in the region.
- Specific investments in infrastructure increase the competitiveness of regional agro-bioindustry.
- The historically predominant actors in the region strengthen their influence on the new value chains associated with agri-bioindustry.
- The effect on existing regional/territorial imbalances is ambiguous, depending on the location, type of investments and organizational form of the new regional agri-bioindustry.
- The gap between formal and informal labor is significantly reduced and social inclusion processes are improved.

Nuevos Equilibrios II

- The bioeconomy as an instrument for development in the NG has a limited scope, driven only by some developments oriented to the primary sector.
- Asymmetries between the most competitive producers and the less competitive ones are becoming more acute and the primary sector is gaining relative weight in the region.
- State investments in basic science and research is limited, compromising the density and network of science and technology in the region.
- The expansion of the agricultural frontier exacerbates socio-environmental conflicts in the region and the provision of ecosystem services is reduced due to the lack of specific policies for this purpose.
- There are specific investments in infrastructure aimed at increasing the competitiveness of the primary sector.
- The historically predominant players in the region are losing relative influence in regional value chains.
- Existing regional/territorial imbalances are worsening.
- Productivity levels in the primary sector and production concentration levels increase. A significant proportion of small and medium-sized agricultural producers abandon farming activities.

Colapso

- The bioeconomy as an instrument of regional development is not viable. The lack of policies towards the sector generates the disappearance of most of the companies in the regional bioeconomy, except for isolated cases of success, associated to external niche markets.
- Expansion of the agricultural frontier which temporarily increases production in the NG but, at the same time, increases the fragility of regional ecosystems and compromises the quantity and quality of the natural capital of the NG for future generations.
- Disarticulation and loss of density of the regional innovation system, with little adoption and/or national and regional development of technologies.
- Decapitalization and weakening of regional infrastructure, reducing the competitiveness of the economies of the NG.
- The historically predominant actors in the region strengthen their influence on regional value chains.
- Destruction of private employment and increase in public employment in several provinces of the NG.
- Existing regional/territorial imbalances deepen, and socio-environmental conflicts become more acute.
- Food security is significantly compromised in multiple dimensions, especially in the most vulnerable areas of the NG region.

Transformation

- The bioeconomy is becoming a vector of structural change in the region and a driving force for regional economic development.
- The expansion of the agricultural frontier is very limited, within the framework of land-use planning processes and public policies that preserve the ecosystem services of natural resources.
- A new industrial policy that overcomes the historical rural-industrial antinomy consolidates as a state policy.
- Transformation and value-adding processes are gaining strength with biorefinery platforms of different scales.
- The reconfiguration of the innovation system at the national level generates a critical mass of resources and capabilities at the regional level, increasing the density of research and technological developments in agroindustry and bioeconomy, oriented to the problems of the NG region.
- The predominant players in the region are seeing their primacy challenged by the emergence of new regional and extra-regional players.
- The creation of private and formal employment increases along with the growth of the service sector associated with industries.
- Food security and food sovereignty levels improve substantially, both in terms of access and in terms of the variety of foods available based on the region's traditions and culture.
- Small and medium-sized producers and family farming are undergoing a period of conversion to become suppliers of fresh and healthy foods for the domestic market, mainly in local markets, increasing their levels of technological adoption and competitiveness.

Annex II: Outline of R&D Agenda

A survey of work areas, critical technologies, the need for studies and project ideas to solve existing problems and to anticipate future demands for the development of the bioeconomy in the NG is presented.

Biomass	<ul style="list-style-type: none">•Technologies for quantification, characterization, stabilization and utilization in high value-added bioproducts.•Improvement of herbaceous and forest biomass species for the production of biofuels and second generation biomaterials.•Development of a green balance label for biomass production versus consumption of fossil fuels.
Biorefinery	<ul style="list-style-type: none">•Application of available agroindustrial technologies, generating greater standardization and efficiency in production processes.•Development and application of biotechnology to all biomasses, aimed at obtaining high value-added products.•Application of modeling and data science for the study, deepening and scaling of biorefinery processes.
Food	<ul style="list-style-type: none">•Adoption and adaptation of new technologies for food safety assurance and shelf-life extension.•Use of agro-industrial wastes to obtain high-value food compounds.•Development and adaptation of technological tools for food traceability.
Bioenergy	<ul style="list-style-type: none">•Study and development of technologies related to the use of agricultural and agro-industrial wastes for energy purposes based on the most developed crops.•Environmental evaluations of bioenergy alternatives as an intangible value addition to all productions of biomass origin.•Studies and development of complementary biorefinery technologies that allow self-supply and energy export.
Bioproducts	<ul style="list-style-type: none">•Technological strategies for the development of bio-based bioplastics.•Production of renewable monomers.•Development of technologies and bioprocesses for the production of biolubricants.
Agrobiologicals	<ul style="list-style-type: none">•Development of slow release biofertilizer formulations.•R&D of microbial consortia for arid and semi-arid zones.•Development of efficient and economical fungal biofungicides and bioinsecticides.