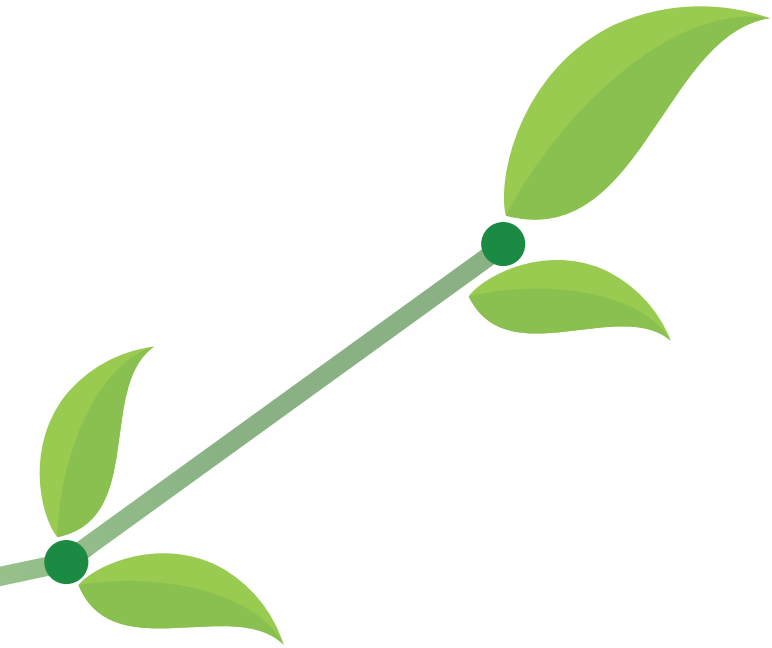

MEASURING THE BIOECONOMY

QUANTIFYING THE ARGENTINE CASE

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MEASURING THE BIOECONOMY
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"The generic feature of biobased products is both the cause of its high socio-economic potential and a major challenge for biobased products metrics." OECD, "The Bioeconomy to 2030"

Content

1. INTRODUCTION

Bioeconomy deals with the production of renewable biological resources and their conversion into food, fodder, bio-based products and bioenergy. It includes agriculture, forestry activity, fishing, food production and production of pulp and paper, as well as fractions of the chemical and energetic and biotechnological industries (health and pharmaceutical industry). Its components have a strong innovation potential, as they are used and serve as object of study in a wide range of sciences (biology, agronomy, ecology, food science and social sciences), in knowledge-intensive industries, such as biotechnology, chemistry, nanotechnology, information and communication technology (ICT) and engineering.

As indicated in the literature, there are different ways of defining the notion of bioeconomy. But the notions of biomass as a major input, production of a diversity of products, and added value is at the core of all of them.

The bioeconomy is beginning to play a significant role in Latin American economies, reflecting, mainly their competitive advantages in biomass production of a diverse type. At an early stage, this will only be represented in the development and consolidation of the biorefineries dealing with the production of biofuels (ethanol and biodiesel from different sources), but also, and increasingly, other types of products by means of cascading processes (fertilizers, bioplastics, surfactants, colorants, lubricants, etc.).

Such developments also come to light when looking at the type of employment demanded and in the generation of foreign exchange, due to the significance of export markets in the case of biofuels. However, the bioeconomy is a horizontal phenomenon running across GDP components, including not only the agricultural sector – which generates biomass, the main bioeconomy input – but also the food sector proper, together with others within the manufacturing sector, such as organic chemical products (including manures and biology-based fertilizers), the wood and paper pulp sector, the energetic sector (because of biofuels) and other biobased sectors, even those connected with the manufacturing of pharmaceutical products and medicines.

The thriving force of the bioeconomy is highly attractive for Latin American countries, where the increase in the value added to agricultural production is extremely important for the development of their economies. However, for the enhancement of its overall development, it is necessary to design strategic visions, plus a set of public policies consistent with its needs and characteristics.

Under this scenario, it is also necessary to make progress in the characterization and quantification of the bioeconomy sector:

(1) as a starting point for designing and making public and private decisions on the investment policies and programs required to promote the development of the sector; and

(2) to enable well-grounded discussions about the future growth potential of these activities, and also about the potential substitution of inputs and traditional products (fossils, non-biological products, plastics) for biodegradable alternatives, so promoting environmentally sustainable growth.

2. OBJECTIVE

The main objective of this paper is to design a general methodology for the delimitation and measurement of the bioeconomy and its contribution to GDP, and develop a pilot application for the Argentine case. This paper is intended to have as specific products:

(1) a methodology for the criteria, procedures and data bases to be used in the measurement, as an estimation guide for other countries;

(2) an overall description and quantification of the Argentine bioeconomy, including its main value chains and contributions to GDP.

3. DEFINING AND DELIMITATING BIOECONOMY

As this issue is relatively new in forums for the discussion and implementation of public policies and at an international level, there is no standard methodology allowing the international comparison of bioeconomy contribution to GDP. Furthermore, there is no international consensus on which products and activities are comprised within the so-called bioeconomy.

As described in the next section, the most commonly used classifiers of economic activity, international trade and of products at international-level (ISIC: International Standard Industrial Classification NET: Nomenclature for External Trade and CPC: Classifier per Category) are not compatible with the complexity of this sector. Additionally, the National Accounts System currently in force (SNA 08) from United Nations, which provides recommendations for measuring the nations' production and wellbeing, among other economic issues with an ensured international comparability, does not incorporate the phenomenon under analysis in this paper.

However, there is a set of alternative definitions of activities and products belonging to bioeconomy, based on the interests of countries and organizations that analyze and promote public policies fostering their development.

The existing definitions of bioeconomy can be broadly classified into two main groups: "broad" and "restrictive".

Within the first group, bioeconomy encompasses not only the sustainable use of renewable resources for the generation of "new products and inputs of biological original", but also those biobased inputs and products intended to produce food and feed. Specifically, it covers not only "new products and inputs of biological origin", such as biofuels, medical and chemical products and bioplastics, but also traditional feed and food of biological origin. Consequently, delimitating bioeconomy in a broad sense goes strictly beyond biotechnology and the products it generates.

Moreover, biochemical products produced by the chemical industry using enzymes, microorganisms and renewable resources are also included within the universe of bioeconomy. These biotechnological products referred to as "white" biotechnology can in turn be distinguished from "red" biotechnology, i.e. those used for health care (medical and pharmaceutical products) and "green" biotechnology for agriculture. Apart from the chemical and pharmaceutical industry,

primary conversion products generated in the agricultural sector through the use of biotechnology are also included. In other words, all the biomass generated by crops which is used as input of the manufacturing industry processes.

Biobased fuels can be sorted into three types. Primary generation biofuels: they include those originated in food crops (cereals, oilseeds, sugar cane); secondary generation biofuels: those derived from biomass not used for foods, such as lignocellulose materials (forestry sub products, cereal stubbles). Lastly, third generation biofuels, which derive from seaweed.

Alternatively, some analysts and countries, especially the United States, restrict the scope of bioeconomy. According the USDA (US Department of Agriculture), as stipulated in the definition of the "Farm Security and Rural Investment Act of 2002", biobased economy consists in the study of sectors and products of biological origin which are only intended to replace the use of fossil fuels. In this way, new products and biology-based uses are included, provided that they replace the use of fossil fuels, and "mature" products are excluded (existing before 1972), even if they have a biological origin (materials, fodder, food, textile, or, for example, corn syrup with a high fructose content), and those production processes, products and inputs which, even if they are biotechnological, do not use biomass. Consequently, both red and green biotechnology are excluded, as the substitution of fossil fuels is prioritized, thus excluding biomass destined to food and health. This means that only those to be utilized in the production of biofuels, bioenergy and biochemicals remain.

Box 1: **Definitions of bioeconomy provided by international organizations and other studies**
Narrow definitions

USDA: a biobased economy is defined as "U.S. activities related to the production and distribution of biobased products." The term "biobased product" means a product determined by the Secretary to be a commercial or industrial product (other than food or feed) that is - (A) composed, in whole or in significant part, of biological products, including renewable domestic agricultural materials and forestry materials; or (B) an intermediate ingredient or feedstock. For the purposes of this study, the definition of a biobased product is further constrained to new-use products. that have developed a market presence since 1972. Mature market products (e.g., cotton shirts) are not included in the current analysis since many do not consider these types of products as part of a new bioeconomy.

OECD: The OECD further states that the bioeconomy involves three elements: the use of advanced knowledge of genes and cell processes to design and develop *new processes* and products; the use of renewable biomass and efficient bioprocesses to stimulate sustainable production; and the integration of biotechnology knowledge and applications across a range of sectors. The OECD argues that biotechnology can offer solutions to many of the health and resource challenges facing the world, and it also proposes that the advanced bioeconomy and biotechnology will drive significant changes in the global economy over the next 30 years.

Broad definitions

EU: The bioeconomy ... encompasses 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).

In the Seventh Framework Program for Research and Technological Development (FP7) the European Commission (EC) published their strategy for "Innovating for Sustainable Growth: A Bioeconomy for Europe" in 2012. The strategy defines the bioeconomy in a broader manner than the OECD definition, since it includes all extraction of, and production from, renewable biological resources, i.e. all value adding activity connected with biological resources.) The bioeconomy encompasses the agriculture, forestry, fisheries, food and biotechnology sectors, as well as a wide range of industrial sectors, ranging from the production of energy and chemicals to building and transport.

White House: The bioeconomy is one based on the use of research and innovation in the biological sciences to create economic activity and public benefit.

All these definitions make room for discussion. The inconsistency and disparity among them, depending on the institution and/or drafting expert, may bring about problems when attempting to draw an international comparison of the importance of bioeconomy in each country.

As a step prior to measuring bioeconomy, then, it is necessary to establish its limits and scope, based on the goals of the institution, "policy maker" or country undertaking the task. The following questions are to be made:

1. Which portion of the biology-based product chain must be included in the economic analysis? For example, should the development of enzymes or the distribution system for ethanol be included? Or should the focus be on manufacturing production? (fuels, chemical products, products for the end user, etc.). Must the generation of biomass serving as input be included for the production of food and biobased products? (agricultural sector).
2. Contributions of sanitary landfilling gas and urban solid waste: should they be included within the bioenergy sector or should the emphasis be on agricultural raw materials and wood?
3. Should subproducts derived from conventional sources be included (pulp and paper mills)?
4. Should only those products considered as "new use" be measured?
5. Should a definition be made only of those biobased products based on the objective of public policy programs encouraging their use?
6. Should direct impacts be measured only, or should indirect and induced impacts be also included?

This paper intends to adopt a broad definition for the inclusion of products, inputs and bioeconomic activities based on the following criteria:

a. Use biomass as input,

b. Incorporate biotechnology as input.

c. All the products which use biomass and biotechnology as input.

Chart 1 includes a brief description on how measurement limits can be modified based on the objectives and scope of the definition of bioeconomy to be adopted:

Chart 1: Definition and alternative inclusion limits in Bioeconomy

	BIOTECHNOLOGY				
	WHITE	GREEN	RED	New Uses and Products	Mature (textile foods, etc.)
OECD	✓	✓	✓	✓	
EU	✓	✓	✓	✓	✓
Canadá	✓	✓	✓	✓	✓
USDA	✓			✓	
Grain Exchange	✓	✓	✓	✓	✓

This broad definition implies the inclusion of all biotechnology-based products and processes (red, green and white). For example, green biotechnology includes crops and food produced from transgenic and non-transgenic seeds. As part of such definition, the production of the food manufacturing sector is also included, together with the production of paper, textile products and other mature bioeconomic products, but also all those new medical products that use bioinputs.

In this way, the definition of bioeconomy adopted for this paper covers the production of renewable biological resources and their conversion into food, fodder, biology-based products and bioenergy. It also includes agriculture, forestry, fishing, food production and the pulp and paper production, as well as parts of the textile industry, chemical industry and energetic and biotechnological industries (pharmaceutical industry).

Biobased industry can be segmented into two main subsectors: biofuels, other bioenergies, biochemical inputs and end products. Biofuels can be defined as any transport fuel produced based on renewable resources of vegetal origin, specifically, ethanol and biodiesel. Other bioenergies include both the generation of electricity and the production of heat in energy plants and combined heat, whose fuel derives from biological sources: waste, biogas from sanitary landfillings, wood, waste or agricultural subproducts (biofertilizers, nonfood agricultural subproducts). Biochemical inputs are industrial subproducts derived from biomass processing. End biology-based products include all those products that are not classified as biofuels or biochemicals. These are sold directly to end consumers (selling point) or business-to-busines sales[1], etc.

4. STATISTICAL RECORDING OF BIOECONOMY - CHALLENGES

Biobased products are typically manufactured jointly, and this creates difficulties in the recording of statistics. A fundamental problem is that, within the production frontier of the central SNA 08 framework,

(1) Business-to-business sales could include transactions where only minor changes to product are made (for example, repackaging) or because of an increased distribution of end products.

statistical units are organizations classified according to the main economic activity that they develop. Such units are sorted according to a classifier, or its adaptation in each country. But when organizations and hence industries are not homogeneous within a given level of classification, these are assumed to have a main activity and one or more secondary activities. The product of these activities is determined by its nature, based on the classification of the product, but inputs of secondary activities are not separated from those of principal activities. Besides, auxiliary activities are not analyzed or classified according to their own nature, and related products are not presented as autonomous products.

Surveys and census are based on the information per each company and/or the setting of the production value, per each branch of the industry, in those principal production lines and/or products.

It is usual for statistical operations to capture the production of the main production line plus two or three lines of secondary production, which, in many cases, leaves the remaining number of products wholly unidentified within a same line. Even more, only in the event that a thorough list of input-products is required from organizations, bio-based production lines, which constitute only a small percentage of the value of production and sales, are subject to subregistration or absolute lack of reporting. The problem is compounded by the fact that the complete input-product lists are included in a second stage in the Economic Census, which in Latin America are usually conducted every ten years and only for a sub-sample of the whole universe.

Apart from that, there is a bias towards big companies in surveys conducted on the manufacturing industry, and that is the reason why a significant portion of small and medium-sized biobased companies could be excluded, and these are companies based on all segments of the bioeconomy. Additionally, the failure to update company registries and stores, combined with the reduced frequency of census could make that "new biobased products", including complete sectors remain outside standard statistics, such as the case of biofuels which appeared after the Economic Census 2004 in Argentina, and, consequently were not included in the sample base of official Industrial Surveys (and this was because the whole list of companies and stores had not been updated).

Another sort of problem, but which is still connected with the failures to capture data in standard operations, comes up when measuring industrial self-generation of energy. For example, the use of peanut shell and or rice husk in oil plants for the self-generation of energy. Self-generation, unless there is surplus energy traded in the market, does not have a market price and must be generally valued by adding costs, and these are concepts that are difficult to detect and report in a survey or general census covering several activities. (Within the concept of self-generation of energy, no inclusion is made of firewood for the generation of thermal energy, such as the case of tobacco farms, green tea fields, coffee plantations, etc.)

These problems of thoroughness, regularity and accuracy in statistics can give rise to an underestimation in the true contribution of the bioeconomy.

5. CLASSIFICATION SYSTEMS

Regardless of the universe to be measured, the information available and the classification method

must be taken into consideration. The statistical systems of each country generally adopt and adapt the International Standard Industrial Classification of the United Nations to their specific reality.

In the case of United States, Canada and Mexico, the North American Industry Classification System (NAICS) is used. In the case of EUROSTAT, NACE (National Classification of Economic Activities) is used.

Nevertheless, all these classifiers are based on the traditional ISIC and have not been conceived to classify the biobased industry. ISIC and national substitutes have been developed so that production units are grouped according to the similarity of their productive processes. Given the heterogeneous nature and variety of biobased products, the ISIC approach can prove troublesome.

1) Productive organizations are classified according to ISIC based on technology, inputs, equipment and/or similar workforce. This criterion makes no distinction into bio or not bio. For example: Biodiesel, according to Mercosur common nomenclature (ncm) 3826000, it classifies under ISIC 2429 – manufacturing of other chemical products n.c.p.
   Bioethanol (ncm 220710) is classified under ISIC 1551: destillation, rectification and mix of alcoholic beverages; production of ethyl alcohol based on fermented substances.
2) Organizations are classified in ISIC according to their main activity. Many biobased products are subproducts or secondary activities.
3) Other organizations, such as biorefineries or those dealing with the production of bioenergy, have emerged after setting the last version of ISIC. Consequently, they are not specifically classified.
4) Products can originate from biobased activities or not, depending on the disaggregation level of productive branches applied when constructing statistics. For example, the plastic product branches (branch 2520), even with a broadened scope, for example by the Central Product Classification (CPC 369 plastic materials) does not help determine if the product used bioinputs or not.
5) A similar situation is produced with bioproducts that get into the field of commerce and transport. Both CPC and ISIC of the commercial or transport section makes no distinction between the biobased origin of the product analyzed.
6) Analogously, biogas could fall within the classification of generation of energy that was not contemplated previously (n.c.p.) (ISIC 40119), which includes solar energy, wind energy, etc. or within the field of recycling of metal waste (ISIC 372), a category that integrates it with the recycling of metal waste, according to 2004 census.

This is a crucial point as it determines the estimation process ex ante. In the long run, it is necessary to redefine an economic classification system, capturing through census and surveys that make it possible to obtain production with an increased level of details for the measurement of bioeconomy in a country.

6. METHODOLOGIES FOR MEASURING A BIOECONOMY

International standards for the measurement and scopes of economic activity and its contribution to GDP are established by the National Accounts System 2008 (NAS08- for its Spanish abbreviation). The National Accounts Systems, for decades jointly developed by the Statistics Division of UN,

EUROSTAT, IMF, OECD and the World Bank intends to offer a solution that will consist in measuring the main economic variables through an integrated account system. NAS, updated according to the recommendations of the Manual of National Accounts 2008 (NAS 2008) is a standard set of internationally agreed recommendations on how to compile the measurement of economic variables according to strict accounting conventions based on economic principles.

Recommendations are expressed in terms of a set of concepts, definitions, classifications and accounting rules that make up the internationally agreed rule in order to measure not only gross domestic product (GDP), but also price indexes, income distribution, balance sheet of institutional sectors, balance of payments and net international investment position, Input-Output Matrix (I-O Matrix), social accounting matrix and other economic variables relevant for economic analysis within a unique system that ensures variables are consistent with each other.

Adopting a NAS approach will make it possible to compare the weight of the bioeconomy of each country at an international level.

Moreover, NAS approach enables a conceptual and methodological adaptation to a sector such as bioeconomy, whose definition and measurement requires a horizontal demarcation by products and activities, all of which is not necessarily compatible with the traditional GDP classification. All this is presented through the so-called Satellite Accounts. Additionally, for the purposes of measuring the likely potential impact of bioeconomy on the economic system of a given country, the so-called indirect and induced effects are simulated through the productive linkages that bioeconomy can have. Both issues are addressed below.

6.1 Satellite Account

The usual classifier of products and industries (CPC and ISIC) place all industries and products within the same hierarchical level. The National Accounts System is flexible enough to group industries and products, based on the analysis of a key sector. Thus, the customary supply and utilization charts can be estimated for the purposes of the key sector that is intended to be measured, by expanding on details that had not been previously included in the standard presentation.

Such analysis is contained in the so-called Satellite Accounts, which imply a reorganization of activities and products based on an interest which generally crosses several activities or part of them. OECD's Measuring Manuals are an example of the application of National Accounts: Education, Capital, Productivity and Environment, made with the consensus of experts from the main international organizations, which participate in work groups, such as the case of "Canberra Group II On the Measurement on Non-Financial Assets", and which are part of the ulterior recommendations of Intersecretarial Group for the National Accounts System. The most common and already executed examples at an international level have been the Satellite Tourism Account (STA), and the Health Satellite Account. Satellite Accounts related to environment present recommendations associated with biobased products. The main satellite account dealing with the environment (SEEA13), makes recommendations on how to capture and measure natural resources in keeping with the remaining National Accounts System.

The contribution of this paper is an attempt to give methodological recommendations on the measurement of bioeconomy, in compliance of fundamental principles, both NAS and SCAE (Environmental Accounts System – for its Spanish abbreviation), but an adaptation is made to the specific purposes of an accounts system applicable to the bioeconomy and its ulterior discussion and consensus with the main players and experts having an interest at a national level.

6.2 Indirect Effect and Multipliers

The indirect effects measure the likely impact on economic activity generated by consumption and investment, exports and employment of a biobased activity, not only because of its direct contribution to GDP but also because of its indirect impact through economic activity created by the linkage of this activity with the rest of the economy. These effects are usually measured through the I-O Matrix and the typical exercises generated based on Computable General Equilibrium: CGE), based on the calibration of the I-O Matrix and other parameters of the economy.

In global terms, these effects can be:

Indirect Effect or Backward Linkage: Implementing a biobased activity involves incurring in a series of expenses such as the supply of goods, services or inputs. The indirect effect of backward linkage consists in the impact of this activity on the levels of production and employment of those economic entities acting as suppliers of biobased activities, which, as any industry or segment, requires goods and services from other sectors of the economy.

Induced Consumption or Indirect Effect of Forward Linkage: Wages and compensations of employments generated by bioeconomy and its associated sectors are transferred to economy under the form of consumption goods and services. The indirect effect of induced consumption generated by the consumption of workers employed by biobased industries, is through the increased sales and employment of the domestic suppliers of those consumed goods.

Total Indirect Effect: It is the aggregate sum of the indirect effect of backward linkage and the effect of forward induced consumption. However, it is worth mentioning that very much as direct effects form part of GDP, household consumption or employment, indirect effects result from the induction on the whole economy and should then not be added to the former, nor should they be calculated as a percentage of said macroeconomic aggregates. Still, they can be compared to the indirect effect produced by other economic activities.

Apart from effects through I-O Matrix or CGE there are other beneficial effects in bioeconomy. An increase of biobased activity improves demand and the qualification of the workforce, as it is an activity with high standards of innovation and human capital. Besides, equipment and machinery requirements generates a relevant improvement of investment quantity and quality and physical capital, as well as the potential improvement of environmental sustainability in the use of natural resources, as it considers, for example, potential substitution of fossil fuels.

However, the automatic application of CGE models based on the calibration of parameters and static I-O Matrix has been widely challenged, especially when there is no regard for the specific stage of the economic cycle, the fiscal situation and the likely bottlenecks that could restrict magnitude and

duration of the impact effects in supply, that is, the effect of bioeconomy on the economy as a whole. If the economy shows a high level of utilization of its productive factors (low unemployment, a high use of installed capacity), a fiscal deficit financed through the issue of currency or through the financial system and the resulting "crowding out" of credit to the private sector, an energetic deficit, a rationing of international credit or other restrictions, the multiplying effect and the consumption induced by an increase in overall economic activity or in bioeconomy (or in any sector) will be highly reduced, and the transfer to prices will be higher than the transfer to quantities.

Admittedly, if the country is immersed in a deep recession, with low inflation and high unemployment rates and a more loosened fiscal situation, the indirect effects will have the expected "Keynesian" expansion effect. Even if that is the case, both in one situation and the other, the temporal dimension of these effects cannot be gauged accurately.

Such being the scenario, the methodology proposed in this paper is concentrated on giving recommendations on how to measure the contribution of bioeconomy to GDP, a pioneering topic both in Argentina and the world.

7. CONTRIBUTION OF BIOECONOMY TO GDP: A METHODOLOGICAL PROPOSAL

This paper intends to make an estimation of bioeconomy and its contribution to GDP, while also respecting the general principles of SNA for the calculation of GDP and internationally comparable satellite accounts. The methodology is an adaptation to the estimation made by Wierny (2013) for the WIPO (World International Property Organization), where the economic contribution of industries protected under copyright in Argentina is measured.

An inescapable stage is the estimation of added value of bioeconomy and its contribution to GDP. The most adequate indicator to measure economic contribution of an industry is added value. In fact, the idea is to make horizontal analysis, cross cutting of all sectors of the economy, in order to identify and add up the added value of products and/or biobased activities of each production branch. Furthermore, it is worth mentioning that the estimation of added value for this method is the very first step to obtain the Satellite Bioeconomy Account, which determines not only the total supply of biobased products (production value and domestic added value plus imports) but also its final destinations (consumption, investment, exports).

An initial approach is **top-down**: from industries to products

1) **Core Industries or Sectors** are those totally engaged in the production of bioproducts:
   Biodiesel
   Glycerol
   Biomaterials: lubricator, surfactants, colorants
   Bioethanol
   Biogas
   Biochemicals
   Bioplastics
   End-use Products

2) **Interdependent Industries** are those engaged in the production and sale of intermediate inputs and capital goods and the function of which consists, either totally or mainly, in facilitating the production of bioproducts:

Grains and other Crops for the Production of Food
Soy-Oil for biodiesel
Biofertilizer for biogas
Cane and grains for bioethanol
Production of specific machinery, and those of alternative use for other purposes.

3) **Industries that partially depend on bioeconomy** are those industries and/or sectors in which one portion of products is related to bioeconomy. E.g. production of plastics (ISIC25600 branch): one portion is bioeconomy: bioplastics, and the other is not, i.e. plastics manufactured from petrochemicals.

4) **Support Industries** are those industries in which part of the activities consists in facilitating distribution (commerce, transport, communications and logistics) of bioproducts and which were not included in the main industries. That is, those fractions of the commerce, transport and communication industries that operate as intermediaries of these bioproducts.

From an empirical perspective, this paper is intended to apply coefficients from I-O Matrix or from the Input-Product lists of the Economic Census or consultations made to experts to production value and added value (year 2012), which provide as estimate of the participation of bioproducts or related products in the overall production within the field.

However, several difficulties emerge in the case of bioeconomy:

1) Firstly, it is necessary to estimate Gross Value of Production (GVP) and Added Value (AV) of all those segments containing biobased products.

2) If biobased products and activities emerge after carrying out an Economic Census, and if I-O Matrix mandatorily requires to pre determine Gross Value of Production and Added value for a biobased product, to later verify its incidence. In other words, a bottom-up estimation (the most difficult one).

3) It is necessary to determine where the linkages are cut. For example, in the case of backward linkages: biodiesel uses soy oil, therefore: should soy also be measured? And in this last case: should only GM soy be included or all categories? Such difficulty has been sorted out for the purposes of this paper on the Argentine case, as the broad definition has been adopted, which in fact leads to the inclusion of the production of total biomass (agricultural sector as a whole).

4) In the case of forward linkages: Where are the linkages cut? In the first industrialization? Are the second and subsequent industrializations included as well? In this paper, our decision has been to demarcate the division in the second industrialization. For example, in the case of cotton: deforestation, fiber, cotton yarn and fabric are included. Should clothes manufacturing be included too? There is no classification covering cotton clothes only, no matter if industrial processes increasingly incorporate the mixture of fibers and synthetic filament yarn.

It goes without saying that in case a new ISIC is proposed, capturing the bioeconomy approach and opening activities according to their bio origin, it would not be necessary to apply the former coefficients.

8. METHODOLOGY MEASUREMENT FOR ARGENTINA

Measuring the value of bioeconomy for the first time in Argentina is particularly important, as this sector has been rapidly expanding over the last decade. The year elected for the measurement was 2012, basically because of the availability of information, even if bioeconomy is undergoing full expansion and its participation has increased in the last years.

The best indicator ever to measure economic contribution of an industry to GDP is the value added by the sectors producing those products, that is, biobased products. Although it is impossible to measure the likely indirect impacts on the economy through employment and economic activity, through the Input-Output Matrix o or Computable General Equilibrium Model, given all the warnings made about measuring in 6.3 above, these must be based on a detailed estimate of the importance of bioproducts in the GDP of the country under analysis.

Regardless of the fact that the quality and reliability of Argentine statistics produced by INDEC has been subject to criticism since 2007, the Argentine statistical system presents some limitations that make it difficult to identify and measure bioeconomy, such as:

a) The main statistical source of information to calculate added value per each branch of bioeconomy activity, and, broadly speaking, all sectors, is the National Economic Census 2004 (CNE04), which presents results by ISIC through different aggregation levels. There are segments showing 5 digits, others showing 4 digits and others present 3 digits. In many cases, bioproducts are within a group of 5 digits, where non-bio production exists.

b) The last economic census collects information from 2003. In order to update such data in Argentina, we cannot resort to the estimations provided by official National Accounts, as they have been distorted or biased since 2007, both in terms of current and constant prices. Consequently, alternative estimations have to be made through a traditional methodology for the measuring of GDP, which was used before the National Accounts standards began to be implemented, and which make it possible to have a thorough and reliable update of information, with highest possible breakdown level. For that purpose, the estimations classified by type of economic activity of the ARKLEMS+LAND (FCE-UBA) band was used, which follows the recommendations of SNA08 and the traditional methodology of Argentina National Accounts.

c) National Accounts in Argentina have traditionally included both the economy observed and the non-observed economy in their estimates, while the Economic Census only accounts for the former. Consequently, alternative estimates must give account of both of them.

d) The production of bio refineries and biogas, an activity that emerged after 2003, calls for a specific estimate, as the CNE04 made for 2003 did not disclose such activity, as well as other companies and businesses related with bioeconomy which also came up after 2003.

e) Lack of information. In many cases, to conduct alternative measurements, the information available is of physical quantities of products, and this makes it difficult to obtain economic estimations of such sectors. In other cases, information with a partial coverage is available.

The magnitude of the work undertaken is significant, as economic activities must be directly estimated out of the economy as whole, and this must be done with a sufficient level of details. Besides, reliable estimations must be obtained according to current prices. For such purpose, we resorted to the data base of the project mentioned above i.e. ARKLEMS+LAND from FCE-UBA for the comparable measuring of productivity together with Harvard University and University of Groningen, according to the procedures detailed below and which are in keeping with the habitual practices suggested by ONU and SNA8. All this ensures consistency of economic activity at a sector and macroeconomic level, as well as its international comparability.

Additionally, we also resorted to the calculations made as part of the AGRIKLEMS[2] project, conducted in cooperation with the Grain Exchange, el ERS-USDA and ARKLEMS, with the aim of measuring the sources of growth and productivity of the agricultural sector in Argentina.

Procedures consisted in estimating the added vale based on CNE04 standard, and adjusted by the non-observed economy according to the data base of the ARKLEMS+LAND project

The main steps followed are listed below:

1. Identification and estimation of the production value, according to the producer's prices of economic activities produced by bioproducts either as input or core activity.
2. Identification and estimation of the production value of industries utilizing bioproducts in the second stage of linkage.
3. Identification and estimation of the production value of non-bio industries, but which still produce bioproducts as a secondary or ancillary activity in a smaller proportion.
4. Compilation of thorough information based on census data and/or registered data: CEN04
5. Extrapolation to 2012 as benchmark year, through reliable price indexes and quantities, through the ARKLEMS base.
6. Explicit measuring of the production of biofuels and biogas, which were not produced in 2003 and were thus not captured in CEN04.
7. In the case of ethanol deriving from the distillation of alcohol of sugar cane (ISIC 15511), and the production of biodiesel in the ISIC 24290 segment-manufacturing of chemical products n.c.p.
8. Besides, specific estimations were also made on the production of biogas that is part of segment 37200, i.e. recycling of waste and non-metallic waste.
9. Adjustment of the billing levels of each sector for "non-registered" economy (NOE).
10. Estimation of coefficients with a biodestination for non-bio activities and minor linkages, as reported by exogenous information. Experts and informants working in strategic sectors were made, so as to ascertain the bio production within segments where there is combined production and even the main production, which is not bio. These consultations made it possible to estimate the participation coefficients of bioeconomy in these segments. In ANNEX 2, we can see all the segments within bioeconomy and the participation of bioproducts in the production of each of them.
11. Estimation of value added coefficients (va) according to census information, and adjusted through NOE

(2) See Ball, Coremberg and Costa (2011)

9. CONTRIBUTION OF BIOECONOMY IN ARGENTINA

Bioeconomy in 2012 represented 15.4% of GDP. Its added value amounted to ARS 330,000 million (around USD 72,600 million, as per the official exchange rate[3]).

According to Chart 2, primary sector presents the highest participation in the total added value of bioeconomy, accounting to 58% (8.9% of GDP), and the remaining 42% pertains to the manufacturing industry (6.5% of GDP). Moreover, not all industrial added value is generated in production of agricultural origin (MOA). Indeed, even though these sectors generate 72% of total added value of the bio industry, the manufacturing segments of industrial origin account for 28% of bio manufacturing industry.

Chart 2: Participation of sectors in Bioeconomy and GDP in*

SECTOR	Million pesos	Million dollars	TOTAL BIO	GDP
PRIMARY	**191.525**	**42.093**	**58%**	**8,9%**
MANUFACTURING INDUSTRY	**139.149**	**30.582**	**42%**	**6,5%**
MOA	100.300	22.044	30%	4,7%
MOI**	38.849	8.538	12%	1,8%
TOTAL BIO	**330.673**	**72.675**	**100%**	**15,4%**

Note: * value added to producer's Price.
Note** production of industrial origin

In some quarters, there is a tendency to consider biofuels as making the total of the bioeconomy. However, this paper shows that biofuels in Argentina supply only 3% of the total in bioindustry. Soy biodiesel generates 79.5% of that total, sugar cane bioethanol generates 12% and biogas generates the remaining 8.5%.

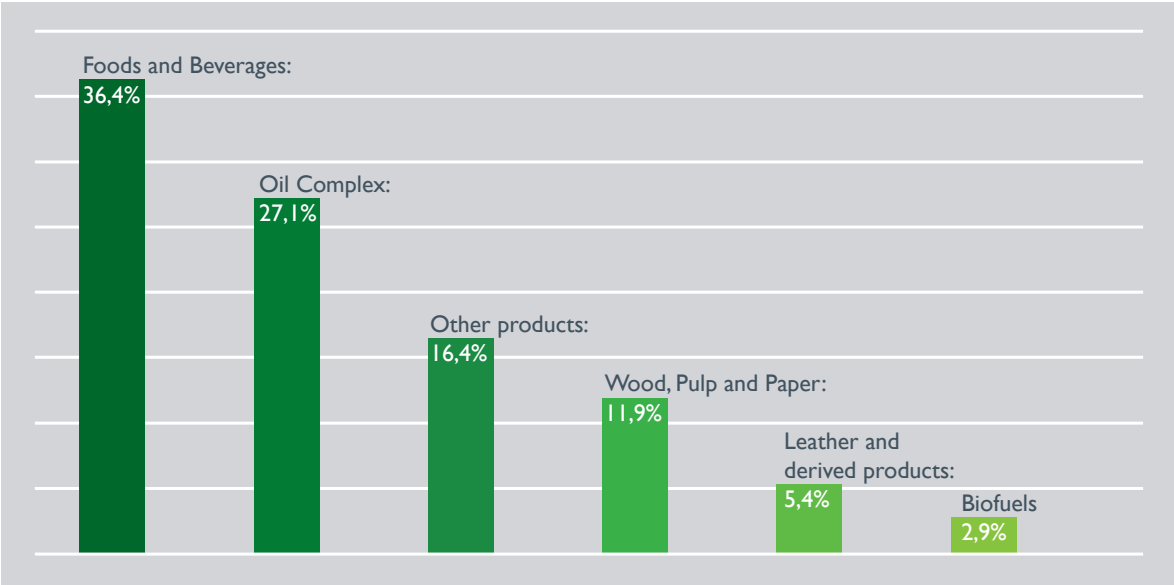
Chart 3: Added Value for Biofuels - 2012

SECTOR	Million pesos	Million dolars	Total Bio Manufactures	Total Biofuels
Manufacturing bioindustries	**139.149**	**30.582**	**100,0%**	
Biofuels	4.052	891	2,9%	**100,0%**
Soy Biodiesel	3.219	708	2,3%	79,5%
Bioethanol sugar cane	488	107	0,4%	12,0%
Biogas	345	76	0,2%	8,5%
Other Bioindustrial Products	135.097	29.692	97,1%	

A considerable percentage of total industrial added value is generated outside the biofuels sector (97%), with a highly heterogeneous set of products and activities. Details are presented in Annexes 2 and 3, where we can see that a whole group of 27 industrial activities accumulate 83.73% of bio added value. If an aggregate is made of the main productive blocks, the main bioindustrial activity is generated by the set of foods and beverages: 36.4%; 27.1% by the oil products; 16.4% by other bioindustrial products; 11.9% by the wood complex, pulp and paper; 5.4% by leather and its derived products; and 3% by biofuels.

(3) An annual average of official exchange rate during 2012: ARS 4.55 per dollar.

Figure 1. Participation of the different sector in the bio-industrial added value (as a percentage of the total)



Source: Our own calculation

10. CONCLUSIONS

Bioeconomy is beginning to play a significantly important role in the economies of the region, thus reflecting, to a considerable extent, the competitive advantages of biomass production.

Bioeconomy horizontally cuts through several sectors that make up GDP of countries, including not only the agricultural sector, which generates biomass, a principal input of bioeconomy, but also the food sector proper, plus others within the manufacturing sector, such as the chemical and organic products sector (including surfactants, lubricants, bioplastics, fertilizers and biologically-based fertilizers), the wood and paper pulp sector, the energy sector (biofuels) and other biologically-based sectors, including those related with the manufacturing of pharmaceutical and medical products.

The new opportunities offered by bioeconomy are being reflected not only in the development and consolidation of bio-refineries sector, engaged in the production of biofuels (ethanol and biodiesel from different sources), but also and increasingly, in the production of different types of additional products through biorefineries (bioplastics, fertilizers, bioplastics, etc.). Such development is also evidenced in the employment requested, as well as the generation of foreign exchange, thanks to the importance of export markets as destiny of the country's biofuels production.

The development of bioeconomy is highly attractive for Latin American countries, where the increase in the value added to agricultural production is crucially important for the sustainable development of the economies in terms of the demand of employment and the generation of foreign exchange. This double advantage is further emphasized in view of the externalities and strategic complementarities it generates, given its knowledge-intensive nature: qualified employment and a powerful R&D. The sectors included in bioeconomy have a strong potential to generate dynamic

productivity gains, which together with static productivity gains resulting from productive specialization, could result in significant improvements in the country's insertion in international trade. As far as the Argentine economy is concerned, the dynamic competitive advantages generated in the production of biomass are a key potential attraction for direct foreign investment, which could promote a more effective integration of the Argentine economy into the world economy, through high value linkages, such as biobased products. However, for the economy to be developed fully, it is necessary to design strategic visions and a whole framework of public policies in keeping with its characteristics and needs.

This paper proposes a quantification methodology consistent with international recommendations for measuring GDP. It has become evident that, given the heterogeneous nature of bioeconomy, the measuring task requires a cross-cutting approach through activities and products so as to reflect the nature and fully capture the components of bioeconomy. Additionally, it is necessary to define the scopes and limits of sectors and products that are comprised within bioeconomy. For such purpose, a widened scope is adopted: the inclusion of all products and processes based on biotechnology (red, green and white). Thus, the definition of bioeconomy adopted in this paper includes the production of renewable biological resources and their transformation into food, feed, biobased products and bioenergy. It also includes agriculture, forestry, fishing, food production and pulp and paper production, as well as those parts of textile and chemical industry, and energetic and biotechnological industries (health and chemical industry).

An approach by means of the Satellite Account of Bioeconomy is valid, as it enables to gain flexibility, by relying on the SNA08 standard, which enables its inter-sector and international comparison.

However, the difficulties and complexities presented when measuring are common both to developed and developing countries.

Biobased products are generally a secondary activity of major production sectors so these are not always captured in surveys and traditional census. Furthermore, the traditional classification systems of economic activity and products (even the recent ISIC, rev. 4), are not prepared for the level of detailed capture that the sector requires.

This paper presents a quantification for the Argentine case. The bioeconomy in Argentina represents 15.4% of GDP for 2012: 58% is generated by the agricultural sector (biomass) and the remaining 42% by the industry of biobased products. However, the recent dynamism evidenced by the biofuels sector (biogas, cane ethanol and oilseed biodiesel) is only 3% of the total biobased industry (oilseed biofuels makes up 80% of that total). The remaining 97% presents a high heterogeneous nature: 36.4% for foods and beverages; 27.1% for oil products; 16.3% for other bioindustrial products; 12% for the wood complex, pulp and paper; and 5.4% for leather and its derived products.

All in all, the bioeconomy in Argentina, according to the methodology proposed, accounts for 15.4% of GDP. A significantly higher figure than that traditionally allocated to agriculture and the agroindustrial sector in its traditional sense. It is nonetheless necessary to highlight that this estimation, because of the specific reasons and circumstances addressed in this paper, does not include the

set of machinery and equipment used for the generation of bioproducts and services, and the logistics activated around these sectors of the economy. And these are sectors with a significant potential in the generation of added value, qualified employment, technological innovation and genuine competitive improvements, as well an important potential in the net generation of currencies.

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ANNEX 1: General Guide for Procedures and Methods for Estimating the Contribution of Bioeconomy to the Economy.

Considering the experience described in this paper, the following procedures are recommended in order to compile and estimate the contribution of bioeconomy to a country's economy.

Estimating the Contribution of Bioeconomy to GDP

1. Identification and estimation of the gross production value (GPV) and added value (AV) of the economic activities that produce bioproducts as principal activity or input.

2. Identification and estimation of the gross production value (GPV) and added value (AV) of the industries that utilize bioproducts as second or third linkage.

3. Identification and estimation of the gross production value (GPV) and added value (AV) of non-bio industries that nevertheless produce bioproducts as secondary or ancillary activity on a small scale.

4. Compilation of thorough information based on census data and/or records.

5. Estimation of bio target ratios for non-bio activities and minor linkages according to exogenous information and consultation with experts.

6. Adjustment for "non-registered" economy to the invoicing levels of each sector.

7. Estimation of the added value ratios (AV) according to census data and NOE adjustment.

8. Estimation of the Influence of Bioeconomy on the Household Consumption and the Final Demand.

9. From step 3 (GPV), market and transport margin adjustment in order to value at purchase prices.

10. Addition of imports by area, with a prior adjustment for intermediation margin and customs clearance charges.

It is worth observing that, unlike the Argentine case, the possibility of assessing the final demand of bioproducts at consumer prices is also suggested, so as to broaden the estimation of the possible SC of bioeconomy in the future, and observe its influence on Household Consumption and the Gross Domestic Investment.

ANNEX 2: Activities Considered to Estimate Bioeconomy

Contribution of Bioeconomy to the Added Value of Each Activity (business item). Year 2012

ISIC Rev3	Description	Participation %
Letter A	Agriculture, ranching, hunting and forestry	100
Letter B	Fishing	100
Letter D	Bio manufacturing industry	
15111	Livestock slaughter, production, processing and conservation of beef, pork, lamb, hare and other animal meat, except poultry	100
15112	Manufacture, processing and conservation of poultry	100
15113	Manufacture of cold meat	100
15120	Manufacture and conservation of fish and fish products	100
15130	Manufacture and conservation of fruits and vegetables	100
15140	Manufacture of vegetable oil and fat	100
15200	Manufacture of dairy products	100
15311	Wheat milling	100
15312	Preparation of rice	100
15313	Legumes and cereal milling (except wheat)	100
15320	Manufacture of starches and starch products	100
15330	Manufacture of prepared animal feeds	100
15411	Manufacture of cookies and pastries	100
15412	Industrial manufacture of bakery products, except cookies and pastries	100
15419	Manufacture of other bakery products n.e.c. (not elsewhere classified)	100
15420	Manufacture of sugar	100
15430	Manufacture of cocoa, chocolate and sugar confectionery	100
15441	Manufacture of fresh pasta	100
15442	Manufacture of dry pasta	100
15491	Spices and coffee roasting and grounding	100
15492	Manufacture of tea leaves	100
15493	Manufacture of yerba mate	100
15499	Manufacture of other food products n.e.c.	100
15511	Distilling of ethyl alcohol (ETHANOL)	100
15512	Distilling, rectifying and blending of spirits	100
15521	Manufacture of wine	100
15529	Manufacture of cider and other fermented but not distilled alcoholic beverages	100
15530	Manufacture of beer, malt and malt liquors	100
15542	Manufacture of soft drinks, except soda water	25
15549	Manufacture of ice, packaged fruit juice and other non-alcoholic beverages	100
16001	Preparation of tobacco leaves	100
16009	Manufacture of cigarettes and other tobacco products	100
17111	Preparation of textile vegetable fibers (including cotton ginning)	100
17112	Wool scouring	100

17113	Textile fibers spinning	100
17114	Manufacture of textile fabrics (including integrated spinning mills)	100
17120	Finishing of textile products	50
17210	Manufacture of made-up textile articles, except apparel	50
17220	Manufacture of carpets and rugs	50
17230	Manufacture of cordage, rope, twine and netting	50
17290	Manufacture of other textile products n.e.c.	50
17301	Manufacture of socks	50
17302	Manufacture of sweaters and similar knitted articles	50
17309	Manufacture of knitted fabrics and other knitted articles	50
18101	Manufacture and tailoring of apparel and accessories, except leather	50
18102	Manufacture and tailoring of apparel and accessories, leather	100
18200	Finishing and dyeing of furs; manufacture of articles of fur	100
19110	Tanning and finishing of leather	100
19120	Manufacture of luggage, handbags and the like, saddlery and leather articles n.e.c.	100
19201	Manufacture of leather footwear	100
19202	Manufacture of footwear of textile materials, plastic and other materials (except asbestos and orthopedic footwear)	50
19203	Manufacture of parts of footwear	50
20100	Sawmilling and planing of wood	100
20210	Manufacture of veneer sheets; plywood and other panels and boards	100
20220	Manufacture of builders' carpentry and joinery	100
20230	Manufacture of wooden containers	100
20290	FManufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials	100
21010	Manufacture of pulp, paper and paperboard	100
21020	Manufacture of corrugated paper and paperboard, and paper and paperboard containers	100
21091	Manufacture of paper and paperboard products for household, hygienic and sanitary use	100
21099	Manufacture of other paper and paperboard products n.e.c.	100
23200	Manufacture of refined petroleum products (blends with biodiesel)	2
24112	Manufacture of natural and synthetic tanning agents	25
24113	Manufacture of basic coloring materials, except prepared pigments	25
24210	Manufacture of pesticides and other agro-chemical products	25
24231	Manufacture of pharmaceutical preparations for human use and pharmaceutical products	10
24232	Manufacture of pharmaceutical preparations for veterinary use	25
24239	Manufacturing of pharmaceutical products; medicinal chemicals and botanical products n.e.c.	25
24241	Manufacture of soaps and cleaning preparations	50
24249	Manufacture of cosmetics, perfumes and other hygiene and toilet products	25
24290	Manufacture of chemical products n.e.c. (BIODIESEL)	100
36101	Manufacture of furniture and furniture parts, mainly made of wood	100
37200	Recycling of non-metal waste and scrap	100

ANNEX 3: Added Value of Bioeconomy In Million Dollars. Year 2012

ISIC Rev3	Activity	Description	Million dollars
		Total Bioeconomy	**72.668**
Letter A		**Agriculture, ranching, hunting and forestry**	**41.439**
11		Growing of crops	23.905
1111		Cereals	8.699
1113		Seeds and oil products	11.258
Other 11		Other crops	3.947
12		Farming of animals	13.654
14		Agriculture and animal services, except veterinary and other activities	3.881
Letter B		**Fishing**	**654**
Letter D		**Bio Manufacturing Industry**	**30.582**
151	Food and beverages	Production, processing and preservation of meat, fish, fruit, vegetables, oils and fats	3.170
1514	Oil industry	Manufacture of vegetable oils and fats	8.275
152	Food and beverages	Manufacture of dairy products	435
153	Food and beverages	Manufacture of grain mil products, starches and starch products, and prepared animal feeds	1.008
154	Food and beverages	Manufacture of other food products	3.942
155	Food and beverages	Manufacture of beverages	2.539
15511	Biocombustibles	Distilling of ethyl alcohol (ETHANOL)	107

ISIC Rev3	Activity	Description	Million dollars
160	Food and beverages	Preparation of tobacco leaves, cigarettes and other tobacco products	1.945
171	Other bioindustrial products	Spinning, weaving and finishing of textiles	604
172	Other bioindustrial products	Manufacture of other textiles	151
173	Other bioindustrial products	Manufacture of knitted and crocheted fabrics and articles	126
18	Other bioindustrial products	Manufacture and tailoring of apparel and accessories	336
19	Leather and derived products	Tanning and finishing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	1.788
20	Wood, pulp and paper	Manufacture of wood and other products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	2.854
21	Wood, pulp and paper	Manufacture of paper and paper products	1.492
232	Biofuels	Manufacture of refined petroleum products (blends of biodiesel)	100
241	Other bioindustrial products	Manufacture of basic chemicals	150
2429	Biofuels	Manufacture of other chemical products n.e.c. (BIODIESEL)	708
Other 242	Other bioindustrial products	Manufacture of other chemical products	489
361	Other bioindustrial products	Manufacture of furniture and furniture parts, mainly made of wood	288
372	Biofuels	Recycling of non-metal waste and scrap (BIOGAS)	76

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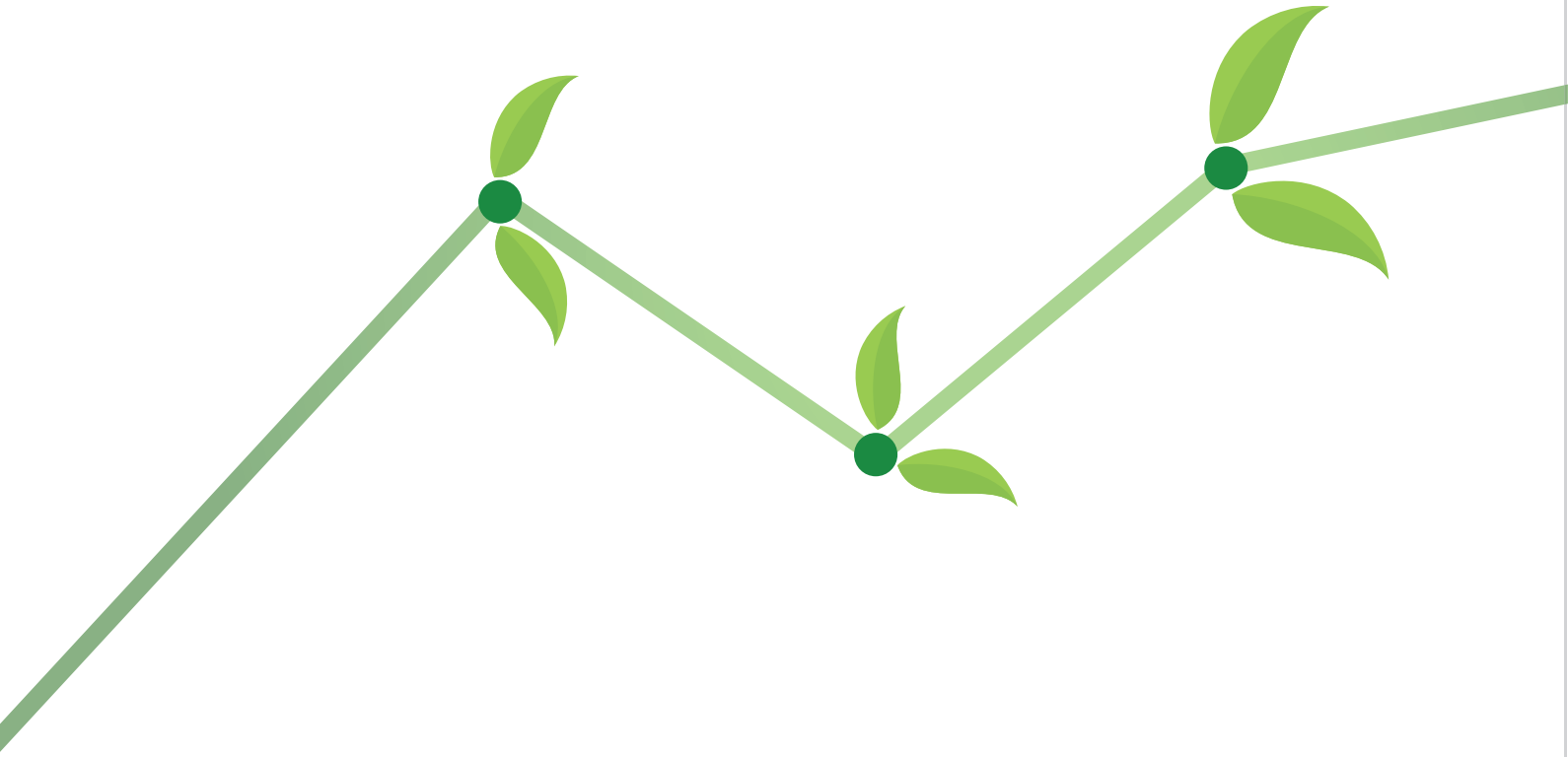

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