Food and Agriculture Organization of the United Nations

International Labour Organization

A HANDBOOK ON A METHODOLOGY FOR ESTIMATING GREEN JOBS IN BIOENERGY

Tools for investigating the effects of bioenergy production on employment at provincial level

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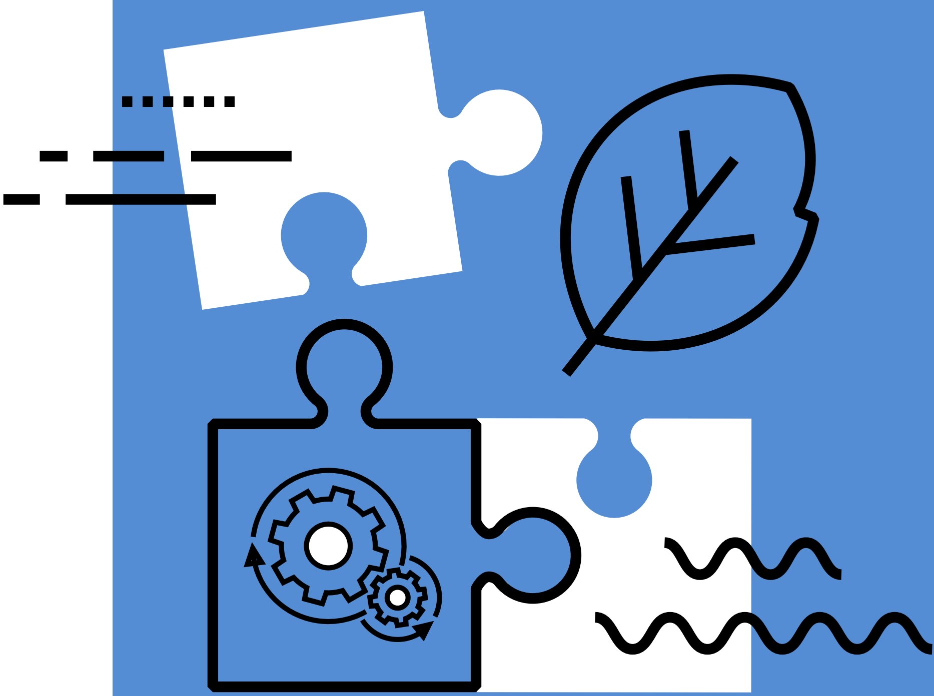

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FOREWORD

It is generally agreed that changes in technology, demographics and climate represent the greatest challenge for the future. As a result, the Leaders' Declaration of the 2018 G20 Summit held in Buenos Aires endorsed the commitment to "building an inclusive, fair and sustainable future of work by promoting decent work, vocational training and skills development (...) recognizing the importance of social dialogue".

For this reason, the report of the Global Commission on the Future of Work discussed at the 108th Session of the International Labour Conference (ILO), in the year of its centenary, focused on the great opportunities for investment and innovation still to emerge. The green economy can promote an inclusive future of work. Renewable energy, construction and sustainable environmental development have a transformative potential for creating decent work and adapting local solutions to climate change –with the impetus of the new green economies– without leaving anyone behind.

The commitment of the ILO and the Food and Agriculture Organization of the United Nations (FAO) to international cooperation clearly transcends the G20. In fact, the document establishing the FAO strategy on climate change, signed in Rome in 2017, states that "as the impacts of climate change increase and become more intense, a global transformation to sustainable agriculture must begin immediately".

Anthropogenic emissions of greenhouse gases (GHG) are historically at their highest levels, according to the latest report from the Intergovernmental Panel on Climate Change (IPCC). In the last 50 years, GHG emissions from agriculture, forestry and other land uses (AFOLU) have almost doubled and are expected to continue increasing up to 2050. With about 21% of global emissions, the AFOLU sector is the second highest contributor to GHG emissions, after the energy sector, mainly through land use, livestock production and soil and nutrient management. However, it also makes valuable contributions, i.e. forests remove GHG from the atmosphere by storing biomass and mitigate climate change.

The increased demand for energy, high dependence on fossil fuels, environmental degradation and depletion of resources are the most visible and compelling problems. Energy from renewable sources faces major challenges in order to be adopted as sustainable resources and to meet demand. In late 2015, the Argentinian government passed Law No. 27191 to encourage the share of renewable sources to reach 20% of domestic electrical energy consumption in 2025. This regulation implies a change in the country's energy matrix; which will help to increase employment in the sector and modify the labour market. Specifically, the transition to a green economy involves firstly the production of energy in environmental sectors and secondly the creation of quality jobs.

This handbook is based primarily on the experience gained in Argentina by FAO and the ILO in 2016 and 2017, concerning studies on employment in the bioenergy sector in Salta, Misiones and Santa Fe provinces. The material produced –forms and interview guides– served as a basis for this work.

These findings were obtained within the framework of the Project for the promotion of energy from biomass – UTF/020/ARG/020 (PROBIOMASA), implemented jointly by the Secretary of State of Agro-industry of the Ministry of Production and Labour, the Secretary of State of Energy of the Treasury Department, and FAO. Its main aim is to increase the production of thermal and electrical energy from local, provincial and national biomass, to guarantee an increasing supply of clean, reliable, competitive energy and, at the same time, to open new agroforestry opportunities, to stimulate regional development and to help to mitigate climate change.

In addition to the province-led analyses, the ILO and current Secretary of Employment of the Ministry of Production and Employment conducted a study to assess green jobs in Argentina, a further important input for producing this handbook. Finally, this study also used other research aimed at the analysis of green jobs throughout the economy and at other related issues, such as bioenergy or child labour, conducted by FAO, the ILO and the United Nations Children's Fund (UNICEF).

The main aim of this handbook is to provide a set of tools to facilitate the development of these studies on a provincial scale, with the aim of generating knowledge about the labour requirements and potential for the development of bioenergy at provincial level, facilitating the design of effective public employment and industrial policies. There is, in turn, an urgent need to develop these instruments based on evidence in order to tackle the challenges of climate change and the future of work.

The handbook therefore also proposes to establish the necessary conceptual guidelines for conducting studies, to set out a methodological basis which includes the necessary technical procedures, and finally to propose a planning and organization strategy. The availability of this tool will help to improve the quality of future research and build capacity at local and provincial level.

This handbook is aimed at public and private organization technicians, corporate stakeholders (cooperatives, producer associations and unions, among others), civil society and the academic world, and covers a range of issues from planning and task management to more complex conceptual and methodological aspects.

This document is part of the activities of the Joint FAO - ILO Programme in the United Nations Strategic Cooperation Framework for Development in Argentina (MECNUD) signed in December 2015. Its main aims are: i) to develop mapping of current and potential green jobs in the production and supply of energy (thermal and electrical) from biomass at provincial level; ii) to assess the quality of jobs created in bioenergy; iii) to estimate the economic characteristics of the bioenergy sector at provincial level and to analyse the impact that selected regulations or policies would have on the employment level at provincial level.

We would like to express our sincere thanks to the provincial authorities and ministries for their essential help in developing this publication. Argentina has a long tradition of various major corporate stakeholders in the business, union and civil society sector. Similarly, as demonstrated during the G20 Summit in Buenos Aires and following the MECNUD, Argentina has made a state commitment to decent work and has started on the road to Sustainable Development Goals. It is an appropriate framework for seizing the moment, relying on dialogue as a strategy for revitalizing the social contract and constructing the future of work that we want, with an agenda focused on individuals and with a clear commitment to environmental protection.

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ABBREVIATIONS AND ACRONYMS

AFOLU	Agriculture, forestry and other land use
ART	Occupational risk insurance company
BL	Backward linkages
CAMMESA	Administrator of the wholesale electricity market
CNG	New generation cooperative
CHP	Combined Heat and Power – cogeneration
CNPVyH	National census on population, housing and households
CONICET	National Research Council
ENGHo	National Survey of Household Income
EPH	Permanent Survey of Households
EAHU	Annual Survey of Urban Households
FL	Forward linkages
FLQ	Flegg Location Quotient
OFMSW	Organic Fraction of Municipal Solid Waste
GHG	Greenhouse gases
IEA	International Energy Agency
INDEC	National Institute of Statistics and Census
INTA	National Agricultural Technology Institute
INTI	National Institute of Industrial Technology
CPI	Consumer Price Index
IPCC	Intergovernmental Panel on Climate Change
IPEC	Santa Fe Provincial Institute of Statistics and Census
LQ	Location Quotients
MECNUD	United Nations Strategic Cooperation Framework for Development in Argentina
IOM	Input-Output Model
RIOM	Regional Input-Output Model
MAYDS	former Ministry of Environment and Sustainable Development of the Nation
MECON	former Ministry of the Economy of the Nation
MINAGRO	former Ministry of Agro-industry of the Nation
MINEM	ormer Ministry of Energy and Mining of the Nation
MINPROD	former Ministry of Production of the Nation
MTEySS	former Ministry of Labour, Employment and Social Security of the Nation
OEDE	Observatory of Employment and Business Dynamics
ILO	International Labour Organization
NGO	Non-governmental organization
GGP	Gross geographic product
GDP	Gross domestic product
SME	Small and medium-sized enterprises

MSW	Municipal solid waste
SAM	Social Accounting Matrix
SENASA	National Food Safety and Quality Service
MLW	Minimum living wage
DW	Decent work
UASB	Upflow Anaerobic Sludge Blanket
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
GVP	Gross production value
WISDOM	Woodfuel Integrated Supply/Demand Overview Mapping

UNITS OF MEASUREMENT

°C	degrees centigrade
m^3	cubic metre
l	litre
MW	megawatt
MWh	megawatt-hour
t	tonne
tec	tonne of coal equivalent

CHEMICAL FORMULAE

CH_4	methane
CO_2	carbon

EXECUTIVE SUMMARY

The main aim of this handbook was to provide a set of tools for conducting studies of the potential for creating bioenergy jobs at provincial level, including the related requirements for skills and capacity.

These tools resulted mainly from studies on employment in the bioenergy sector in Santa Fe, Salta and Misiones provinces. These studies were conducted by the FAO Project for the promotion of energy from biomass and the ILO in 2016 and 2017, which produced a large amount of material, such as forms, interview guides and other data-gathering instruments.

Firstly, this handbook establishes conceptual guidelines on bioenergy and green jobs; it then sets out a methodological basis which includes the necessary technical procedures to analyse a value chain, manage surveys of enterprises and workers, and use an IOM; finally it proposes a planning and organization strategy for the studies.

Methodologically speaking, specific inter-related analyses of the effects of bioenergy production on employment are proposed from different perspectives: the main characteristics of the sector and its value chain; an estimate of direct green employment in the sector; the quality of this employment; an estimate of indirect and induced employment in the sector, and the development of likely scenarios corresponding to sector policy lines, using microsimulations.

The purpose is to undertake the systematic development of studies on bioenergy employment at provincial level in order to generate useful knowledge for designing and managing local public policies. In this respect, this handbook aims to be useful for technical teams of national and provincial public and private organizations, as well as unions, employer associations, civil society and the academic world.

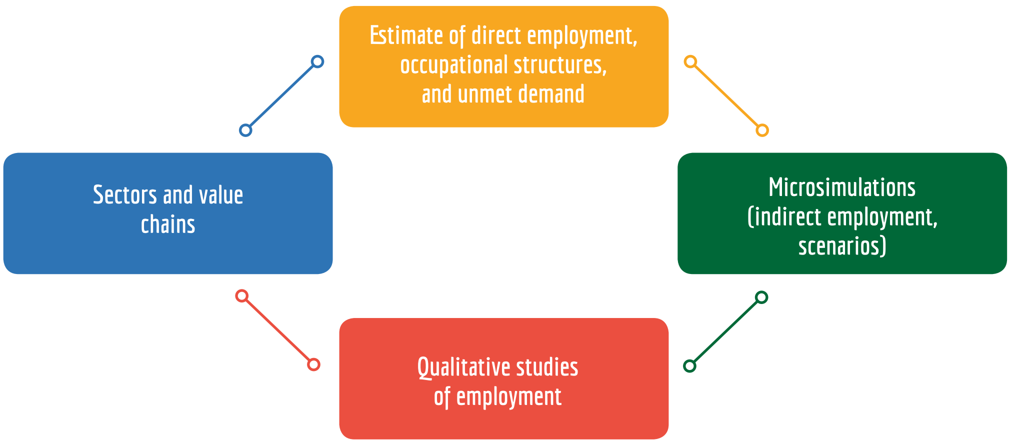
01.

Introduction

WHY A HANDBOOK ON A METHODOLOGY FOR ESTIMATING GREEN JOBS IN BIOENERGY?

The study of green jobs in the bioenergy sector at provincial level is composed of a series of specific, inter-related analyses which address the effects of this activity on employment from different perspectives: i) a description of the sector and its value chain in a given provincial context; ii) an estimate of direct green employment in the sector (formal and informal, if it exists); iii) a study of the quality of this employment; iv) an estimate of indirect and induced employment in the sector and the development of likely scenarios corresponding to sector policy lines, using microsimulations (Figure 1).

Figure 1. A study of green jobs in bioenergy and their main components



Source: Adapted from IDAE (2012).

Given its complexity, this type of study requires different research techniques, mainly analysis of value chains, development of quantitative surveys, qualitative research and use of input-output matrices (IOM) to simulate scenarios. It also uses primary and secondary information sources[1].

As bioenergy production activities are often carried out around small cities and even in rural areas, the study of its effects on employment takes place in locations where the supply of researchers with experience in the subject may be very limited.

The main goal of this handbook is to provide a set of tools to facilitate the development of these studies on a provincial scale, with the aim of generating knowledge about job creation -and requirements for skills and capacity- involved in the development of bioenergy at that level. The knowledge produced by province-based studies aims to produce information useful for policy design and management.

The handbook also has specific objectives: i) to establish conceptual guidelines; ii) to set out a methodological basis which includes the necessary technical procedures to analyse a value chain, to manage surveys of enterprises and workers, and to use an IOM; and iii) to propose a planning and organization strategy for the study.

This handbook is aimed at technical staff of national and provincial public and private organizations, corporate stakeholders (unions and employer associations), civil society and the academic world, particularly those operating at a provincial and local level. It is based mainly on the experience gained by FAO and the ILO in Argentina in 2016 and 2017 on employment in the bioenergy sector in three of the country's provinces (Santa Fe, Salta and Misiones); they produced a large amount of material, such as forms, interview guides and other instruments (FAO, 2019a; 2019b; 2019c).

The handbook contents are organized into two major thematic sections:

1. Conceptual aspects: Concepts of bioenergy –with a description of the technological, chemical and physical processes involved in its generation– and green jobs, and their relationships. The emphasis is on understanding the interdependencies between the environmental, production and social aspects, and the need to develop integrated, consistent and systemic public policies.

2. Methodological aspects: Research methods (quantitative, qualitative and development of scenarios with input-output matrices) specific to each study, in specific chapters. It includes practical examples, data-gathering instrument models, interview guides, proposals for using databases and guidelines for creating simulations with the input-output matrix, as well as issues concerning the planning and management of studies.

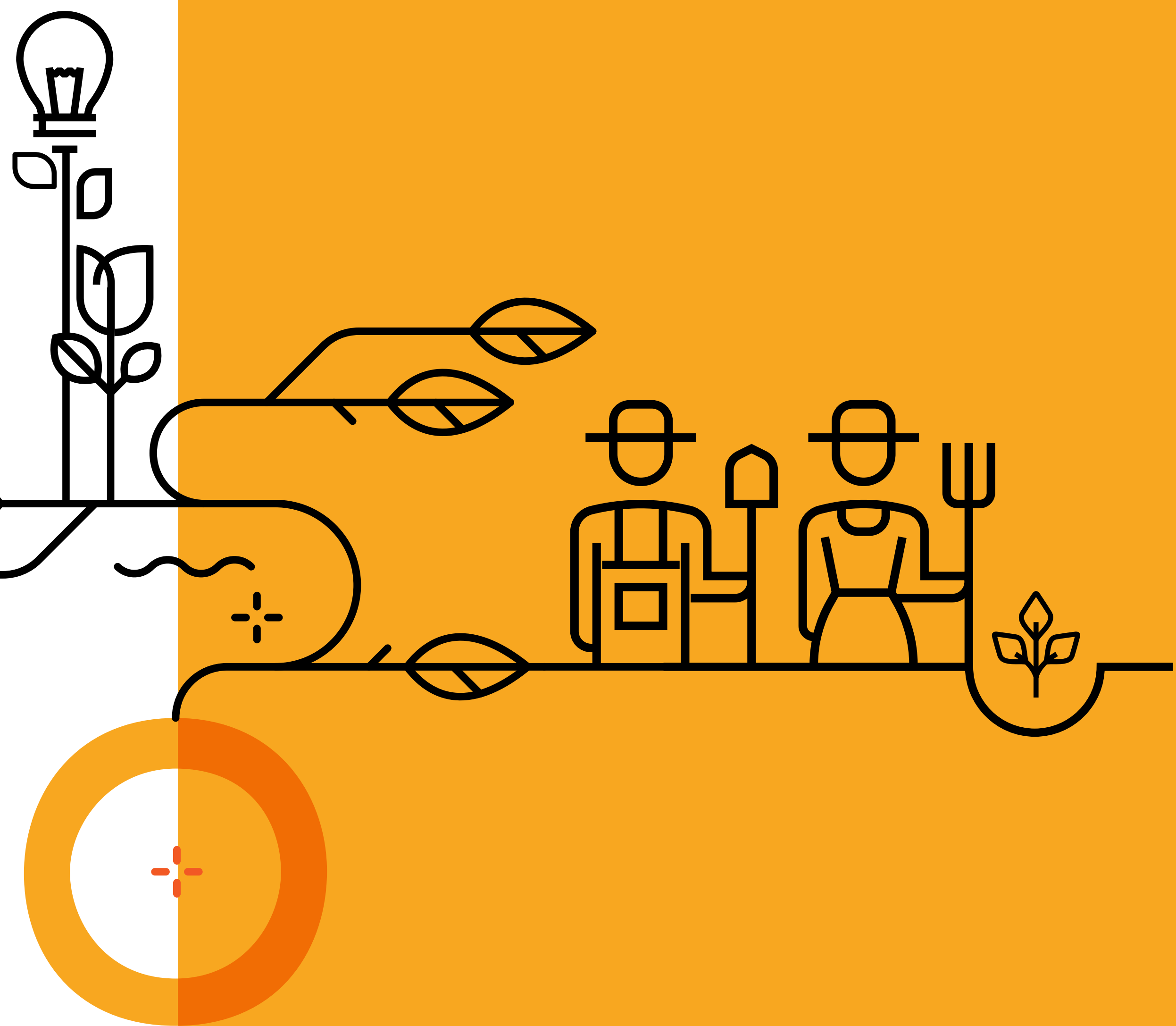
[1] Primary sources (or raw data) are: original data gathered by investigators by their own efforts. This data needs further processing, organization and/or interpretation to be used. It can be gathered using various methods, such as surveys, interviews, case studies, etc. Secondary sources are: data that has already been collected and recorded by another partner or institution, for a purpose not necessarily related to the research aim of the study being developed in the bioenergy sector. This information is generally publicly available and is usually obtained from various sources, such as census, academic articles, government publications, the organization's internal records, reports, books, and others.

Tools are also included for managing the work, in particular for developing networking between the partners involved, in Annex I.

THE MAIN AIM OF THIS HANDBOOK IS TO PRESENT A SET OF TOOLS FOR STUDYING GREEN JOBS IN BIOENERGY AT PROVINCE LEVEL, AND THUS TO GENERATE USEFUL INFORMATION FOR DESIGNING STRATEGIES AND POLICIES.

02.

CONCEPTUAL FRAMEWORK



IN THIS CHAPTER
The conceptual framework of the study is described.

Key information
/ Bioenergy.
/ Green jobs.
/ The relation between bioenergy and jobs.
/ The main economic, social and environmental effects of bioenergy.

Practical elements
/ Table describing the main employment profiles in bioenergy.
/ Table with the dimensions of decent work and operational indicators.
/ Table with the main economic, social and environmental effects of bioenergy.

Key questions that this chapter answers
/ What is bioenergy? What is meant by green jobs? What are the dimensions of decent work?

2.1 What is bioenergy?

Biomass is any material of biological origin (excluding fossil formations), such as crops, agricultural and forestry waste, manure, municipal solid waste and others that can be used as feedstock to generate bioenergy (FAO, 2004).

Biomass must be accessible in order to be converted into biofuel; in other words, it must be able to be transported and stored, to power devices and to be used to generate energy with the available resources efficiently (INTI-EU, 2015).

Biomass is a versatile energy source, which can be used to generate solid fuel (such as wood and charcoal), liquid fuel (biodiesel and bioethanol) or gas fuel (methane gas).

In Argentina, agricultural and agro-industry activities generate huge quantities of organic waste, potentially hazardous if not properly treated, which can be used to produce bioenergy as a circular economy. The organic matter wasted in farms, livestock establishments, food industries and municipal waste, for example, becomes an opportunity to conduct business and to reduce carbon emissions. These initiatives also represent an opportunity to activate agricultural production in disadvantaged areas of the country, to promote crop rotation, to revitalize soil nutrients and to generate valuable by-products that can be used as natural fertilizers (Bragachini et al., 2012).

Feedstocks that can be used in the production of bioenergy are divided into three main groups:

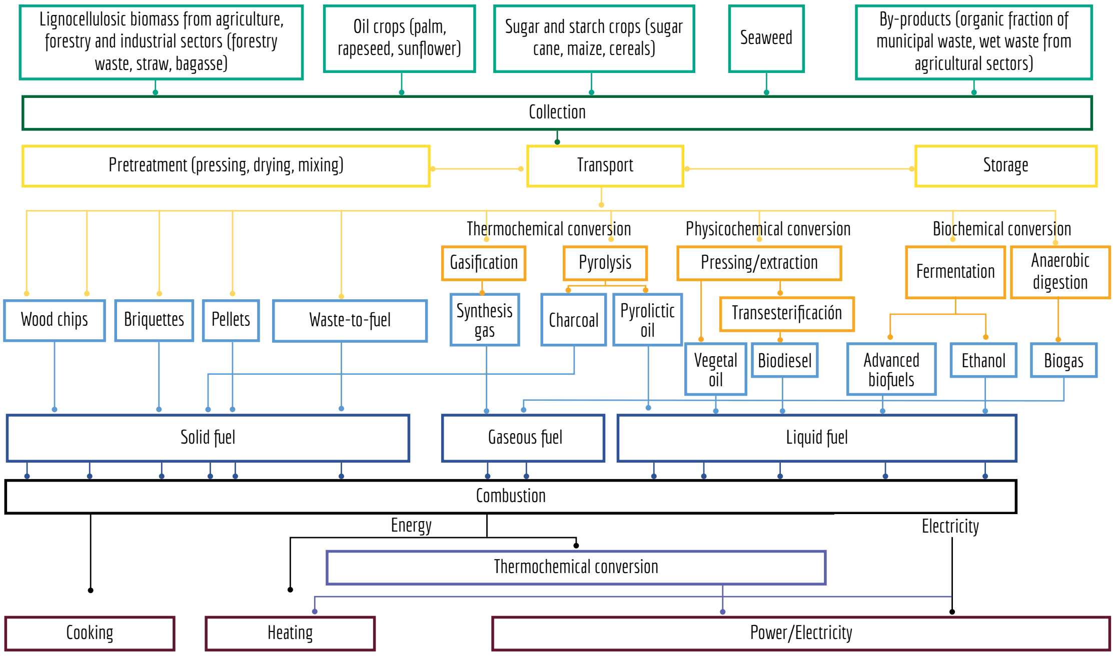
1. Woodfuel: All primary and/or secondary solid, liquid and gaseous biofuels derived from trees and vegetation from forests and forest lands (such as wood, charcoal and briquettes, among others).

2. Agrifuel: Fuel crops, animal and agro-industrial by-products.

3. Municipal by-products: Organic fraction of municipal solid waste (OFMSW) and sewage effluent.

Figure 2 shows a simplified diagram of a value chain in the production of thermal, motive and biofuel energy from various biomass sources.

Figure 2. Principal stages in the value chain for the production of thermal, motive and biofuel energy



Source: FAO (2004), IEA-FAO (2017)

Unlike fossil fuels, biomass does not take millions of years to generate, and can be considered an energy source with a potentially neutral impact. The exploitation of hydrocarbons releases quantities of carbon into the atmosphere; which, without this human intervention, would remain trapped in underground reserves. Biomass, however, eliminates, fixes and converts carbon in the atmosphere during its growth and photosynthesis, and releases it in the same quantity during energy use.

However, although bioenergy is considered renewable, its effectively neutral environmental impact depends on the sustainability of the production of the biomass used as input. The collection, cultivation and production phases are the most sensitive in terms of environmental risk: in some cases, the intensive production of the required crops has negative effects on the territory, such as soil erosion, unsustainable water use or conflicts with local communities. Furthermore, crops initially intended for food are sometimes redirected to energy production, or biomass is extracted from native forests, thus reducing the potential for absorption of greenhouse gases (GHGs) from the biosphere.

In 2006, the United Nations Framework Convention on Climate Change (UNFCCC) published criteria for distinguishing between renewable biomass and non-renewable biomass, emphasizing the sustainable use of soil and maintaining stock quantities of carbon in areas used for its cultivation (UNFCCC, 2006). Various certifications were also developed to assess the environmental and social sustainability of bioenergy production processes (Holm-Nielsen, 2016). These standards have primarily been promoted internationally by ISO standards; there are also others such as Enplus, Roundtable on Sustainable Biofuels, Sustainable Biomass Verification Scheme (World Biofuel Association) and the European Union Directive on renewable energies.

The main types of bioenergy generated in Argentina are presented below by type of biomass used (dry, agrifuel and municipal by-products), with their technical characteristics and a brief analysis of their role in the energy network of Argentina.

Energy from solid biofuels and dry biomass

Woodfuels derive directly or indirectly from trees, shrubs and sugar cane, which grow on forest and non-forest land; they are considered solid biofuels and dry biomass. In Argentina, they specifically concern lignocellulosic material from the agricultural or forestry sector, and its transformation and processing industries.

Through the processes of gasification[2], pyrolysis[3] or direct combustion (Figure 2), solid biofuels can be a source of thermal, electrical and mechanical energy. Thermal energy finds applications in the supply of heat for heating and in direct use in industrial processes. Electrical energy can be generated by itself or through combined heat and power (CHP) cogeneration systems.

The direct combustion of biomass consists of the complete oxidation of the organic matter, which gives rise to carbon dioxide, water, ash and heat. This heat has been used throughout human history in its natural state and, more recently, to generate thermal energy in high-efficiency boilers.

The CHP process is a more efficient use of the energy potential of biomass, by using the steam generated in boilers, following the combustion of biomass, sending it to turbines. This, in turn, produces mechanical energy, subsequently converted into electrical energy in a generator. Finally, steam is condensed and can be used to power a boiler or other forms (for example, the heat produced to heat a swimming pool).

Considering the availability of forest biomass resources in Argentina, the CHP process is a relatively unused bioenergy option (Griffa, Marcó and Goldstein, 2017). The traditional use of biomass to generate heat by direct combustion remains widespread, particularly inrural areas in the north of the country specialized in the production of yerba mate, tea or tobacco (products that need a calorific dehydration process), and is the main source of heating for many households.

The widespread use of solid biofuels in generating thermal and/or electrical energy in both industrial and domestic contexts prevents accurate estimates of the intensity with

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[2] Incomplete combustion, in which the biomass undergoes thermal decomposition at high temperatures, in an oxygen-poor atmosphere, from which a synthesis gas is obtained.

[3] Incomplete combustion of the biomass in the absence of oxygen, at high temperatures, from which gases, liquids and solid ash or charcoal are obtained.

which they are used or the direct jobs they generate. Just in Misiones province, there are 207 enterprises with projects to generate energy from biomass, out of which there are 144 boilers that have been recorded by the Directorate-General for Industry (FAO, 2019b). The production of thermal energy by direct combustion from biomass was identified as the only form of bioenergy in this province (FAO, 2019b). A further significant application of solid biofuels is in production chains in the paper and wood-based industries (ILO, 2019).

There is, however, a growing intent on the part of the ministries of production and energy, and of multilateral agencies associated with this topic, to quantify activities that use biomass to generate energy, and to estimate the jobs they create. According to the RenovAr4 programme (Rounds 1, 1.5 and 2), the existence of 19 biomass projects was estimated, equivalent to a provision of 203 MW of power. These projects would create 1,913 jobs in construction (temporary employment) and operation and maintenance (permanent employment) (Subsecretariat of Renewable Energies, 2018).\

Biofuels and their value chains

Biodiesel and bioethanol are the result of biochemical processes to convert biomass into liquid biofuels (equivalent, respectively, to diesel and petrol). Biodiesel is generated by the transesterification process, whereby vegetable oils are combined with alcohol (ethanol or methanol) and chemically altered, forming fatty esters which can be mixed with diesel or used directly in common engines. Bioethanol is produced from biomass with a high sugar content, such as sugar cane, sorghum and maize. Through a process that includes milling, distilling and rectifying, the sugar is converted into alcohol (ethanol), a fuel similar to petrol.

First-generation biofuels come from edible agricultural products, while second-generation biofuels use other inputs not intended for food (such as crop residues, food and forestry by-products or crops specifically intended for producing energy, such as seaweed or jatropha). Finally, third-generation biofuels also come from biomass from inedible species or waste (although microalgae are also included), using advanced conversion processes, such as molecular biology processes.

Biofuel production is part of established agro-industry production chains. The cultivation of sugar cane, soybean and cereals -the main inputs for bioethanol and biodiesel- was largely developed for food. However, the expansion of bioenergy has, on the one hand, transferred food inputs to energy (FAO, 2010), on the other it has added value to these products, raising their prices and differentiating their uses.

The diversification of use of organic inputs for energy has currently increased local value addition, hence creating jobs, improving working conditions and strengthening the structure and stability of provincial economies (Goldstein and Gutman, 2010).

In Argentina, the biofuel industry has developed rapidly thanks to the development of a new regulatory framework to promote the sector around 2006. Argentinian biodiesel, produced from soybean oil, is globally highly competitive while bioethanol has a major role on the domestic market. Their respective value chains have generated new market sectors, but require logistical systems involving various provincial, national and international public and private stakeholders, and include production processes varying in complexity. These value chains are divided into three types:

- **Biomass production:** This covers the agricultural production of both oilseed (for biodiesel) and sugar cane or maize (for bioethanol). Obtaining organic feedstock is the most work-intensive phase of the chain: the labour cost of the agricultural production and transport stages represents 50% and 75% of the total production cost of bioethanol and biodiesel, respectively (Goldstein and Gutman, 2010). The processing of agricultural inputs is not always vertically integrated with the crops. In many cases, the feedstock has to travel long distances to processing plants; this makes logistics the key to developing the entire value chain. This stage also has the most temporary and unskilled jobs.

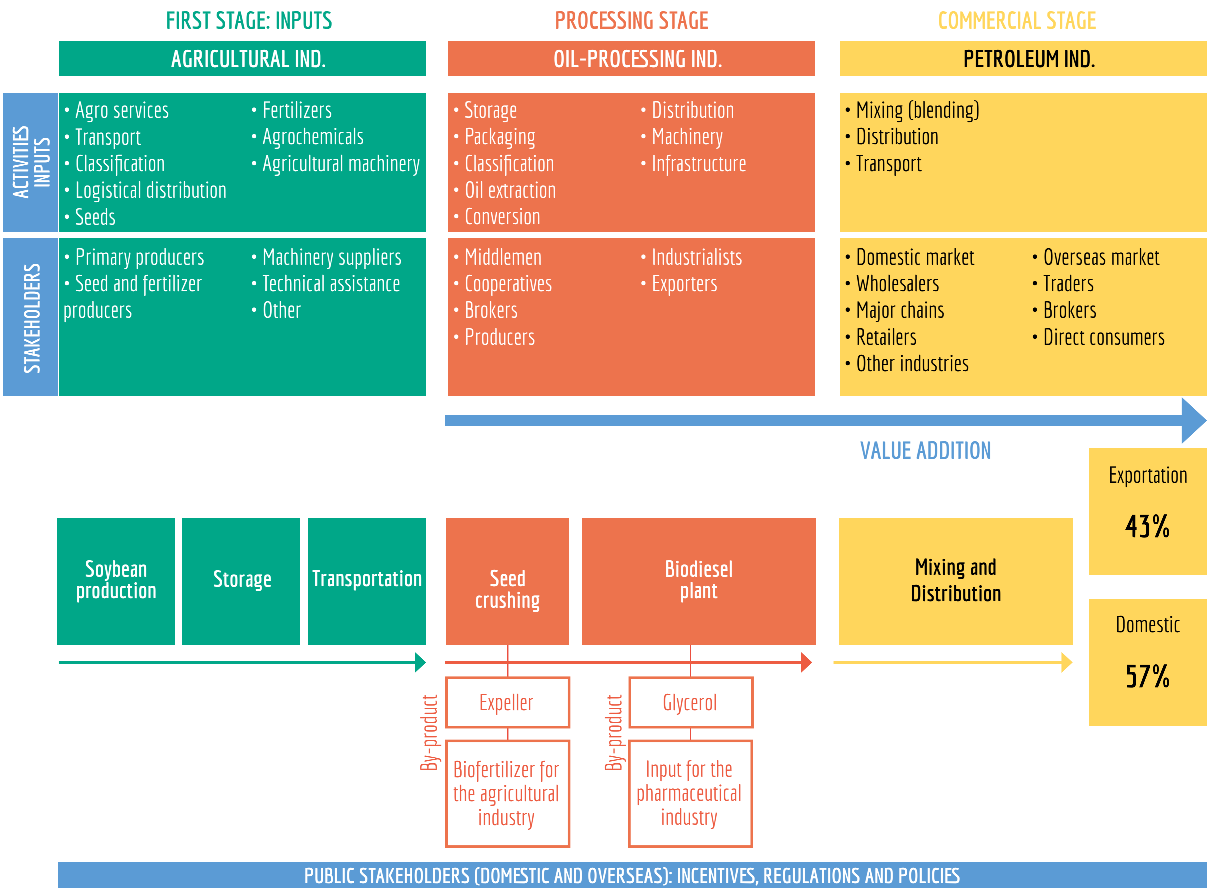
- **Oil-processing or seed-crushing and distribution:** This stage includes the storage and processing of agricultural inputs for conversion into biodiesel and bioethanol, and the extraction of by-products such as expeller and glycerine in the case of biodiesel. Once the biofuel has been produced, production companies can sell it to the petroleum industry or, if it is biodiesel, export it in its pure state. These industries have a concentration of skilled jobs owing to the need to operate the machinery, systems and technologies involved.
- **Petroleum industry and distribution:** Finally, to comply with regulations on fuel blending: in accordance with Law 26093, the petroleum industry purchases and mixes national biodiesel with gas oil, and bioethanol with petrol, to distribute them on the domestic market. The long distances between refineries and distribution terminals is a factor to be taken into consideration, particularly in a context which lacks a railway network and pipeline system. The production of biodiesel has been concentrated in Santa Fe, and it uses the Paraná-Paraguay Waterway.

Public incentives and promotion policies cut across these value chains. In this respect, both the biodiesel and bioethanol industries have used regulations relating to the compulsory blending of traditional fuels promoted by Law 26093 of 2006 (Scheme to promote the production and sustainable use of biofuels) and its subsequent amendments[4].

[4] This scheme grants a series of tax benefits for biodiesel and bioethanol producers who sell on the local market: early refund of value-added tax; accelerated depreciation allowance for income tax; exemption from tax on minimum presumed income, the water tax (5% of the purchase value of the fuel) and the fuel tax. Companies participating in the scheme are additionally assured of the purchase of all the biofuel they produce, at the price calculated by the Energy Ministry. Companies must therefore choose whether to produce for the domestic market or for export markets before creating their legal identity (Goldstein and Gutman, 2010).

Figure 3 briefly illustrates the biodiesel production cycle.

Figure 3. The biodiesel cycle



Source: Produced by the authors

In 2018, 35 biodiesel production companies were registered[5] (MINEM, 2018), with a total installed capacity of approximately 4.3 million tonnes annually (t/year), essentially in Santa Fe, and also in Buenos Aires.

Furthermore, there are 17 active registered bioethanol plants (MINEM, 2018). The majority use sugar cane and are concentrated in the north-east of Argentina, particularly in Tucumán province. The remainder produce maize bioethanol. Figure 4 gives more details and shows the provincial distribution of the plants.

6 Although the data provided is from government sources current as at the completion date of this document, there are estimated to be a larger number of unregistered biodiesel plants on Argentinian territory.

Figure 4. Location of registered biodiesel and bioethanol plants, by province

SAN LUIS	
biodiesel and bioethanol**	DIASER S.A.

JUJUY	
bioethanol*	BIO LEDESMA SA
	RÍO GRANDE ENERGÍA SA

SANTIAGO DEL ESTERO	
biodiesel	VILUCO SA

SALTA	
bioethanol*	ALCONOA SRL
	BIO SAN ISIDRO SA

TUCUMÁN	
bioethanol*	BIO ATAR SA
	BIOENERGÉTICA LEALES SA
	BIOENERGÍA LA CORONA SA
	BIOENERGÍA SANTA ROSA SA
	BIOTRINIDAD SA
	COMPAÑÍA BIONERGÉTICA LA FLORIDA SA
	ENERGÍAS ECOLÓGICAS DEL TUCUMÁN SA
	FRONTERITA ENERGÍA SA

SANTA FE		
biodiesel	RENOVA SA	ROSARIO BIOENERGY SA
	L.D.C. SA	CREMER Y ASOCIADOS SA
	PATAGONIA BIOENERGIA SA	ESTABLECIMIENTO EL ALBARDON SA
	T 6 INDUSTRIAL SA	DIFEROIL SA
	CARGILL SA	UNITEC BIO SA
	COFCO ARGENTINA SA (EX NOBLE ARGENTINA SA)	ENERGÍAS RENOVABLES ARGENTINA SA
	EXPLORA SA	BH BIOCOMBUSTIBLES SRL
	LATINBIO SA	DOBLE L BIOENERGIAS SA
		VICENTÍN S.A.I.C.
bioethanol**	VICENTÍN S.A.I.C.	

BUENOS AIRES	
biodiesel	ARIPAR SA
	BIOBAHIA SA
	BIOBIN SA
	BIO RAMALLO SA
	BIOBAL ENERGY SA
	REFINAR BIO SA
	BIOCORBA SA
	ADVANCED ORGANIC MATERIALS SA
	SOYENERGY SA
	COLALAO DEL VALLE SA
	AGRO M Y G SA

CÓRDOBA	
bioethanol**	ACA BIO COOPERATIVA LTDA
	BIOETANOL RÍO CUARTO SA
	PROMAÍZ SA

LA PAMPA	
biodiesel	PAMPA BIO SA
	ENERGÍA RENOVABLE SA

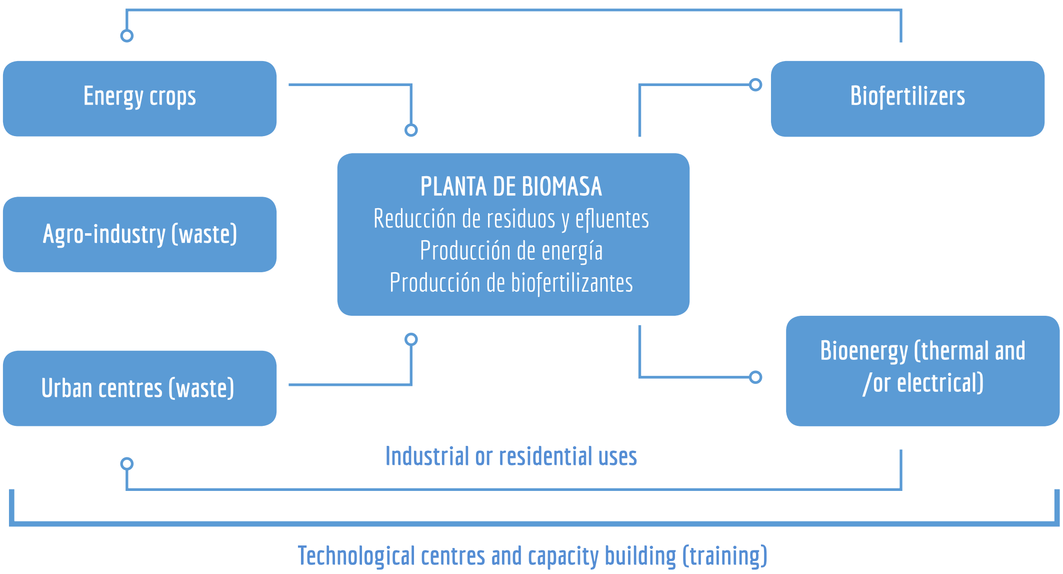
*bioethanol produced from sugar cane.
**bioethanol produced from maize.

Source: Produced by the authors based on information from MINEM (2018) and sworn declarations from the companies.

Biogas and its value chain

Biogas is generated by biochemical processes that occur during anaerobic digestion (in the absence of oxygen), in which specialized microorganisms convert organic matter into a mixture of gases. Closed units are used for this and are called biogas plants or biodigesters. The gaseous fuel generated can be used, after treatment, to generate electrical or thermal energy, and as a fuel for transport[6] (Figure 5). The typical inputs for biogas production are the organic component of municipal and industrial solid waste, manure and wastewater. Energy crops, such as maize and soybean are also used as feedstock for biogas.

Figure 5. Biomass energy production chain

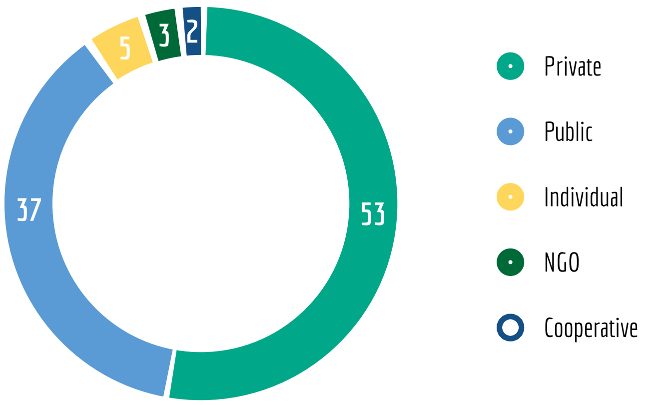


Source: OIT (2019).

A study conducted by the INTI in 2015 revealed that biodigesters in Argentina are mainly used for the purposes of sanitation, with little use of biogas as an energy source (FAO, 2019d). The type of stakeholders who manage biodigesters will help to understand this. They are mainly enterprises (53.1%) which use them as a waste and effluent treatment system (only 6% carry out energy production), and municipal districts (37.5%) which use them for sewage effluent treatment and to increase the value of the organic fraction of municipal solid waste (FORSU) for energy purposes. Cooperatives and NGOs account for 4.7% of the biodigesters recorded by the study (Figure 6).

6 This depends on the quantities of methane (CH_4) and carbon (CO_2) contained in the biogas, which can vary between 50-60% and 30-45%, respectively. Generally, 1 m^3 of biogas is equivalent to 0.6 m^3 of natural gas, 0.6 l of gas oil, 0.7 l of petrol and 0.3 tec.

Figure 6. Percentage distribution of biodigesters by ownership



Source: FAO (2019d).

As regards the location of biogas plants on Argentinian territory, 52.4% are in rural areas, 41.3% in urban areas and 6.3% in industrial districts. Their concentration in rural and urban areas is directly related to the use of biogas for water treatment or sanitation, particularly in the agro-industry and food sector. The feedstock used is accordingly agricultural, livestock, industrial and urban waste.

Finally, the technology most used in the public sector is complete mix[7], whereas in the private sector there are no major differences between complete mix, covered lagoon and UASB[8]. Nationwide almost 50% of plants are complete mix. Furthermore, only 6.3% of the total plants recorded have a high proportion of imported equipment, while 59.4% have local equipment.

According to the RenovAr programme (Rounds 1, 1.5 and 2), 36 biogas projects existed in 2018, with a provision of 64 MW of power, which would create approximately 1,040 jobs in construction (temporary employment) and operation and maintenance (permanent employment) (Subsecretariat of Renewable Energies, 2018).

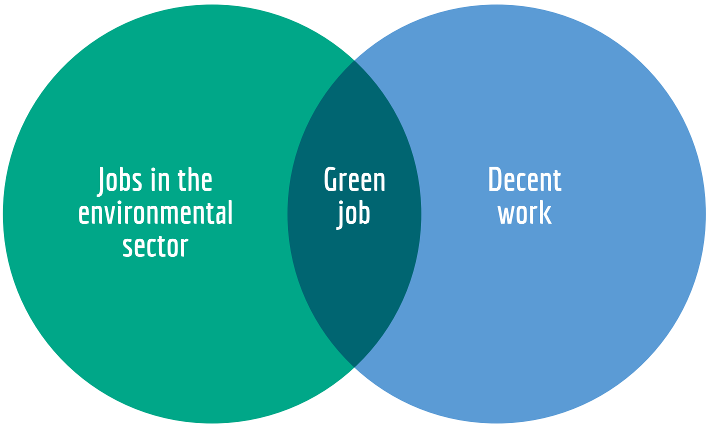
2.2 What are green jobs?

Green jobs are those that meet the standards of decent work and which involve activities that reduce the environmental impact of traditional production practices, improving their sustainability (Figure 7). Three dimensions are covered: economic, social and environmental sustainability.

7 Complete mix biodigesters incorporate mixing mechanisms –mechanical or by agitation with biogas– to keep the solids in suspension, and heating for better process control. They use mainly manure as feedstock.

8 Upflow Anaerobic Sludge Blanket.

Figure 7. Definition of green jobs



Source: ILO (2011a).

Environmental sustainability: the first condition for a green job

The first condition for a job to be considered green is for the work to be carried out in sectors[9] with environmental sustainability. This includes activities that contribute to the following:

- reducing the consumption of energy and raw materials;
- limiting greenhouse gas emissions;
- minimizing waste and pollution;
- protecting and restoring ecosystems;
- promoting adaptation to climate change.

Green jobs thus help to reduce the negative effects of economic activity on the environment, and can ultimately lead to sustainable enterprises and economies being established (ILO, 2013a; 2013b; 2013c). The concept of green jobs is closely linked to sustainable development.

Given that the set of environmental initiatives can be shaped by very heterogeneous activities, the 19th International Conference of Labour Statisticians, held by the ILO in 2013, proposed a standardized definition of green jobs that can be applied by countries. The concept of green job thus refers to the subgroup of environmental sector workers who meet the requirements of decent work.

9 The majority of environmental activities are not represented in economic classifications and statistical sources with the result that this sector lacks a descriptive framework for providing periodic information. This makes it difficult to study, evaluate and compare data on green jobs, both at national and international level. Numerous studies have tried to define, delineate and describe the environmental sector and its constituent activities; according to a "broad" definition, this report considers environmental sectors to be those that comprise "activities concerning goods and services to measure, prevent, limit, minimize or correct damage to water, air and soil, as well as problems related to waste, noise and ecosystems".

The environmental sector includes all economic units that produce, design and manufacture goods and services for the purposes of environmental protection and management of resources (ILO, 2016). This definition postulates the need to include as green jobs those created in economic sectors and green industries, environmental occupations as well as jobs created in all sectors which involve processes that respect the environment (ILO, 2013c).

Decent work: the second condition for a green job

A green job must also comply with the standards of decent work (DW). This is a concept developed by the ILO; which establishes the characteristics that a working relationship must have for work to be performed "in conditions of freedom, equity, security and human dignity" (ILO, 2002; 2012 and 2017; UNEP, 2008). From this point of view, the quality of labour integration is an inclusive, multidimensional and dynamic concept; which has several objectives, values and policies at the same time as evolving with the social and economic progress of a country (Ermida Uriarte, 2000). According to the decent work approach, the concept of quality work comprises four equally important dimensions:

- employment opportunities;
- respect for basic employment rights;
- extension of social protection and job security; and
- representation and social dialogue.

These four dimensions are inter-related and are mutually supportive as part of a balanced, integrated proposal for sustainable development with social inclusion and transition to a greener economy (ILO, 2008b; 2012). Each one can be appropriately represented by a set of indicators which can assess objective work conditions (decent and fair working day, stable working relationship, paid holidays, and others), as well as subjective assessments of what constitutes a good quality occupation (Ghai, 2003; Ermida Uriarte, 2000; Anker *et al*., 2002; Salvia and Lépore, 2008; ILO, 2016).

The first dimension, employment opportunities, examines the creation and persistence of appropriate opportunities for carrying out productive work in conditions of freedom and equity, providing a decent livelihood and allowing the development of individual abilities and performance. Access to work of sufficient quality and quantity involves, in turn, compliance with three equally important aspects, related to the possibility of:

- carrying out productive activity in the formal economic system;
- obtaining, as a result, economic independence in terms of meeting individual and family needs;
- achieving an acceptable degree of personal satisfaction and social recognition.
- This dimension aims to examine work quality objectively (access to good salaries, fair working hours, stable working relationship, among others), as well as subjective assessments regarding satisfaction. For an operational definition of a deficit of employment opportunities, a set of variables is used associated with personal satisfaction with work, the extension and intensity of the working day, job stability and

remuneration which ensures decent living conditions for workers and their families[10]. The specific value identified as decent remuneration depends on the level of economic development of a country. An alternative is to consider that a worker receives adequate remuneration when it is above or equal to the minimum living wage (MLW).

The second dimension of decent work considers whether employment opportunities correspond to the international labour standards that form the basis of the declaration on fundamental principles and rights at work, such as:

- the right to equal opportunities and treatment for women and men;
- the abolition of forced labour and child labour;
- the application of international labour standards.

The third dimension considers the extension of social protection and job security. In other words, it preserves and promotes the physical and psychological integrity of the worker. Access to adequate social protection guarantees general wellbeing, productivity and quality of life for the worker and their family in stressful, unpredictable situations. Universal social protection is a further aim of decent work, which contributes to economic growth, social peace, political integration, the engagement of citizens, the development of democracy and human wellbeing (Wingfield-Digby; Kapsos and Elder, 2008). The indicators of this third dimension usually include those related to the availability of benefits for sickness, unemployment, old age, accidents at work, family circumstances, maternity, disability and surviving spouse, making retirement contributions and payment of health insurance (social cover) by the employer.

The fourth dimension of decent work, relating to representation and social dialogue (Anker *et al*., 2002), maintains that democracy is also reflected in the opportunities for workers to express themselves freely on matters relating to their employment through a body capable of representing them and negotiating on their behalf. Social dialogue is a type of negotiation or exchange of information between governments, employers and workers, related directly to work and to social and economic policies. The freedom to join a union is therefore clearly related to social dialogue. In the majority of countries, this consists in collective bargaining between unions and employers' organizations, in the enterprise, in the sector or the country as a whole (Ghai, 2003).

Finally, with the aim of making the decent work criteria effective and verifiable, Table 1 shows the relationship between these four dimensions and the main indicators for each.

10 Salvia and Lépore (2008) consider work income to be a "constituent factor of the human and social development process, and that achieving adequate insertion in the labour market is a powerful factor of defence against poverty and a factor of social inclusion, through rolling out life projects with autonomy of agency".

Table 1. Dimensions of decent work and related indicators*

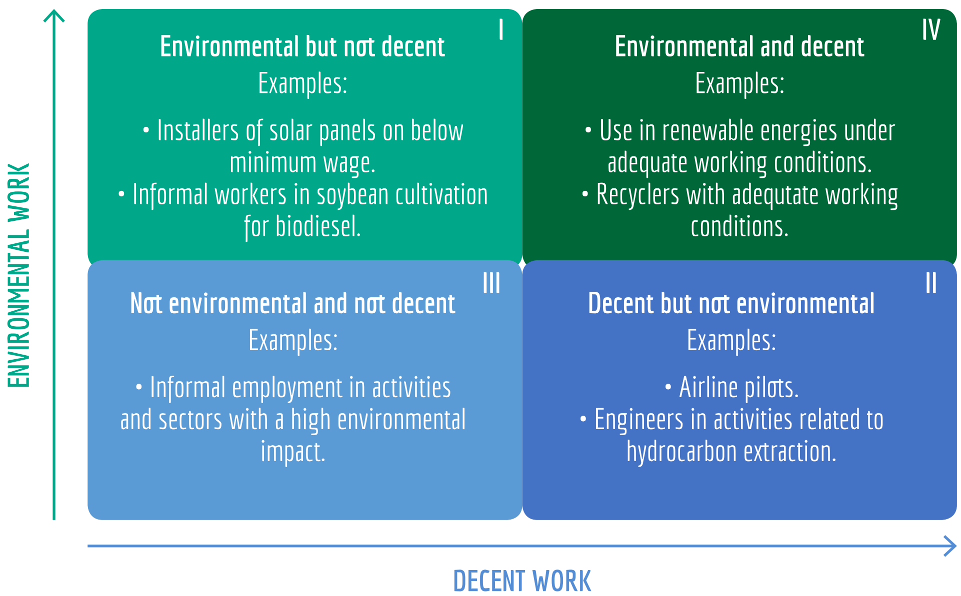
Dimensions of DW		Main indicators	
I	Employment opportunitie	Contract and stable work	Includes information on type of recruitment, the time the worker has been in this job and the recruitment habits of enterprises.
		Income and salaries	Represents the value the job has for guaranteeing meeting the material needs of the worker and their family. For example, if the MLW is achieved.
		Organization and working day	Refers to the way in which establishments organize their activity and, therefore, their employees' working day and rest periods, which influence both their health and their social life.
		Training	Accounts for a worker's opportunities for development, as it involves not only improving productivity in their tasks, but also providing new employment opportunities.
		General work satisfaction	Refers to the subjective assessment by the worker of their general working conditions.
II	Respect for basic employment rights	Gender equity and non-discrimination in employment	Examines fair treatment between women and men in the workplace and episodes of discrimination of this or another type, for example, whether the worker belongs to a demographic group or a minority group.
		Maternity protection	Refers to safeguarding the woman and her job during pregnancy and breastfeeding (Law 20744 on Employment Contracts).
		Respect for fundamental rights at work	Deals with the respect for employment rights which all employees must receive in their workstation.
III	Extension of social protection and job securit	Social security	Refers to benefits associated with social security related to work, such as social cover, bonuses and family allowances.
		Health and safety at work	Assesses whether workers are exposed to toxic or harmful substances, if they have work protection items provided, use them and have the necessary training in hygiene to carry out their tasks with occupational safety and without risk to their health.
IV	Representation and social dialogue	Union freedom and work relations	Refers to the freedom to form representative associations representativas and to carry out collective bargaining in workers' interests.

*A more detailed analysis of the ILO indicators of decent work can be found at: http://www.ilo.org/wcmsp5/groups/public/---dgreports/---integration/documents/meetingdocument/wcms_115402.pdf

Source: Produced by the authors based on FAO (2019a; 2019b).

Jobs can be classified as "non-green" and "green" based on the above definitions (Figure 8). A non-green job is one which i) is carried out in environmental sectors but does not meet the standards of decent work; ii) is carried out in adequate working conditions but in activities which do not make efforts to progress towards better environmental performance and even generate above average emissions ("brown job"), and iii) is carried out in sectors that do not meet either of the two standards examined (environmental and employment). By contrast, iv) a green job is one which meets both conditions (environmental sustainability and decent work).

Figure 8. The four work categories, according to decent work and environmental standards



Source: ILO (2011).

2.3 Bioenergy and employment

The energy sector has an important role in reducing GHG emissions, as well as in reorganizing the production and economic system to be greener, with a high job creation potential. It is therefore fundamental to the transition of the economy to a sustainable model. Global estimates indicate that energy measures aimed at holding the increase in the global average temperature to below 2°C compared with preindustrial times will generate 18 million net jobs by 2100 (ILO, 2018a).

As regards job creation, bioenergy is the main source of renewable energy (ILO, 2011a; INTI-EU, 2015) and in some cases the work needed to generate it is up to five times greater than for fossil fuels (Domac, 2002). From the agricultural stages to industrial processing and the associated services, bioenergy gives rise to agro-industrial value chains which are, moreover, driving an emerging industrial sector of capital goods directed at them.

The impacts of bioenergy activities on the economy can be classified as direct, indirect and induced. While direct effects are those that cause the development of the activity in question, indirect effects are those that occur in activities which supply goods and services to it (value chain of the activity in question). Furthermore, induced effects are those that are generated throughout the economy due to increased consumption and collection of taxes derived from greater incomes along the value chain.

In this respect, by focusing attention on the economic impacts of bioenergy on jobs, three main categories of jobs created can be distinguished:

- **Direct jobs:** These are the result of bioenergy plant activities (operation, maintenance, management, among others). In addition, they include activities carried out by bioenergy producing enterprises (for example, soybean production in integrated plants).
- **Indirect jobs:** These are jobs created along the value chain, in other words, in those sectors that supply goods or services to the bioenergy chain (production of agricultural inputs, construction of parts necessary for plant operation, outsourced activities, among others).
- **Induced jobs:** These are jobs created by purchases made by direct and indirect employees of the activity in question with the income received for their work.

Furthermore, bioenergy value chains create various jobs according to skills requirements and employment conditions (FAO, 2008), as well as with regard to the worker profile, by gender and age. It is necessary to know the quantity of jobs created in value chains and their characteristics in order to understand the sector and to establish the necessary lines of action for its development.

Although bioenergy value chains are heterogeneous, Table 2 shows the main work profiles which include: builders of processing infrastructures, suppliers of organic inputs (seeds, fertilizers, usable biomass and others), operators in the transport and storage system, stakeholders involved in the industrial processing of biomass, suppliers of machinery and technology, and distributors of the final product of these processes (Mata *et al*., 2011). The majority of work profiles required are highly (A) or partly (B) specialized. The unspecialized profiles are mainly biomass production and transport activities, which are also those with the greatest informality. The jobs are presented in order of bioenergy value chain.

Table 2. Work profiles in bioenergy [see separate file for table entries]

Link/activity	Work profile	Required skills	Informality	Employment category
Manufacture and supply of equipment	Scientists (chemical, microbiological, agricultural, materials, etc.)	A	B	Indirect
	Engineers (biological, electrical, software, manufacturing, etc.)	A	B	
	Specialists in manufacturing quality certification	A/M	B	
	Manufacturing technicians	A/M	B	
	Logistics specialists	A/M	B	
	Logistics operators	M/B	M	
	Equipment transporters	B	M	
	Storage professionals	A/M	B	
	Marketing specialists	A/M	B	
	Sales staff	A/M	B	

Link/activity	Work profile	Required skills	Informality	Employment category
Project development, construction and installatio	Project designers	A	B	Direct
	Environmental impact assessment specialists	A	B	
	Civil servants	A/M	B	
	Engineers (biological, electrical, software, manufacturing, etc.)	A	B	
	Scientists (chemical, microbiological, agricultural, materials, etc.)	A	B	
	Laboratory technicians and assistants	M	B	
	Construction professionals (architects and engineers)	A	B	
	Construction technicians (electricians, carpenters, etc.)	M	M/A	
	Labourer	B	A	
	Commercial development experts	A	B	
	Transport employees	B	M/A	
Operation and maintenance	Biochemists and microbiologists	A	B	Direct
	Laboratory technicians and assistants	M	B	
	Operation and maintenance technicians	M/B	M/B	
Biomass production	Agricultural scientists	A	B	Direct/ Indirect*
	Production managers	A	B	
	Administrative staff	M/B	M/B	
	Agricultural/forestry employees	B	A	
	Transport employees	B	A	
Other transverse activities	Policy-related civil servants	A	B	Indirect
	Profesionales gremiales	A/M	B/M	
	Union professionals	A/M	B/M	
	Trainers	A/M	B/M	
	Managers administrators	A/M	B/M	
	Public inspectors	A	B	

A: Highly skilled jobs (professional/managerial); M: Skilled jobs (technicians/skilled labourers/supervisory staff); B: Low-skilled jobs.
*The job is considered direct if biomass production is integrated in the plant.

Source: Produced by the authors based on ILO (2011a).

2.4 Bioenergy: economic, social and environmental effects

The use of biomass as an energy source not only generates new jobs directly, but also boosts the creation of specialized, quality jobs all along the value chain; this has positive economic, social and environmental impacts at both local and national level. Thanks to its ability to create jobs for different work profiles, bioenergy can have a key role in the development of rural areas where an energy shortfall and a shortage of quality job offers, are pressing problems.

Bioenergy also represents an example of the generation of "origin-based added value with local effects of redistribution of wealth which is manifested in a better standard of living –in terms of consumption levels– for households" (GBEP, 2011). This strengthens non-urban areas and helps to slow the process of rural depopulation.

Associative small- and medium-sized enterprises (SME) and new generation cooperatives (CNG)[11] have, in many cases, taken the opportunity to incorporate originally agricultural inputs by using them in bioenergy activities. Table 3 summarizes the main positive and negative economic, social and environmental effects.

Table 3. Main economic, social and environmental effects of bioenergy

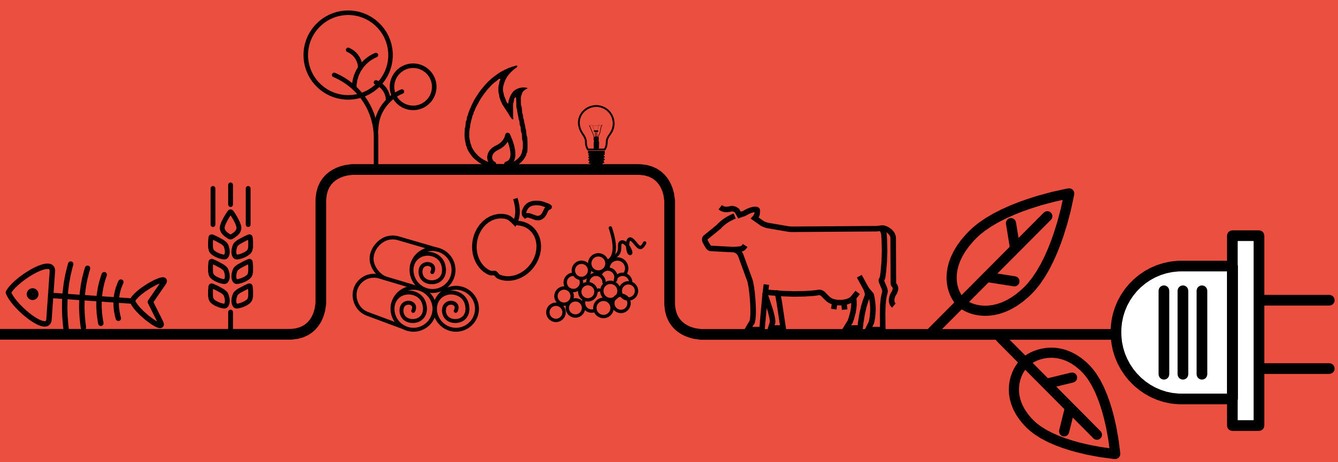
Effects	Positive	Negative
Economic	- adds value to local agricultural and forestry inputs; - improves national productivity; - generates export potential; - improves infrastructure; - generates positive effects at provincial level (consumption, production, tax revenues); - demands locally produced capital goods; develops knowledge and innovation at provincial level	- displaces agrifood inputs for the purposes of energy; - affects food safety.
Social	- creates new job opportunities rurally and in urban areas of rural zones; - generates specialized jobs; - encourages local development; - promotes provincial and national energy stability and independence; - limits rural depopulation; - boosts the generation of knowledge and new technological skills at provincial level.	- contributes to raising the prices of food products.
Environmental	- creates a destination for waste that is difficult to manage; - reduces dependence on fossil sources; - reduces GHG emissions (mitigation); promotes adaptation to climate change.	- has an impact on soil, forestry and water resources; - generates waste from bioenergy processes.

Source: Produced by the authors

11 CNG are cooperatives that seek to have a role in local and regional sustainable development, that consider the dimensions of decent work and that seek to rethink their position in agro-industrial and agrifood chains, freeing it from the single role of primary commodity distributor.

03.

BIOENERGY VALUE CHAINS AND SECTORS IN A PROVINCE



IN THIS CHAPTER

There are elements for developing the first stage of the study, which involves examining the general characteristics of the sector that produces bioenergy in the provinces and its value chain, considering how it fits into the provincial context in which it is incorporated. Guidelines are provided for the analysis of he province's socioeconomic context, the general aspects of the provincial bioenergy production sector and its value chains.

Key information

/ Economic context: job market and production system
/ Supply of biomass and regulatory and legal framework
/ The bioenergy sector in the provinces and its value chain

Practical elements

/ Example of national and provincial regulatory framework
/ Network of relevant stakeholders involved in the sector (chambers of commerce, academic sector, government areas)
/ Analysis of value chains and identification of informal segments

Main questions answered by this chapter

What is the provincial context like in which bioenergy production is being developed?
How does the provincal production context influence the development of bioenergy (supplying inputs, demanding low-cost energy)? What is the local job market like and how is it linked to the characteristics of jobs created in the sector? What is the industrial organization of the bioenergy sector in the province like? With which production sectors is it linked? Which are the main institutional stakeholders operating in the sector? What is the value chain in which it is included like? What is the level of informality in this sector?
What are its main strengths, weaknesses and opportunities like?

3.1 3.1.Production structure and jobs

The economic activities developed in a province define a given profile of production specialization, which can concern primary activities, industrial production or services, and are characterized by various levels of productivity, innovation and dynamism.

The generation of bioenergy that uses waste from primary or industrial activities as inputs often depends on the production specialization of the province, and is boosted by the energy needs of given activities. An example of this is in the brewing industry: the company Quilmes hopes to convert the energy matrix of its malting plant and achieve 100% use of green energy by 2025 (including the use of biomass by direct combustion, biodiesel and others). It will therefore use part of its organic waste to produce energy, thus also reducing its dependence on external sources, and will add value to this waste. Another example can be found in Misiones, where bioenergy production is based on the use of logging waste, central to the production structure of this province.

The most dynamic, most innovative sectors with the greatest productivity (often also exporters) are those which usually lead the way in the development of bioenergy production, seeking to improve their competitiveness and/or their environmental sustainability by selling their products on markets that value this aspect.

The demographic profile of the region is a further important element for analysis, in particular population size, urban population and town size. Urban centres are a potential source of inputs for bioenergy production, due to the waste generated by sanitation processes. The management of municipal solid waste (MSW) and liquid waste, and the type of sanitation carried out should also be considered.

The energy matrix of the province is an additional important factor, particularly the relationship between the local energy supply (from other sources) and the demands of the production and residential sector, as the incentives to develop bioenergy are greater in a context of insufficient supply and high energy costs. Box 1 summarizes the main dimensions of analysis.

The labour situation in the province is a further factor that positions the study of green jobs in its context (Box 2). How the local job market works, what are the main problems it faces and what are the most vulnerable groups are some of the questions that this study should answer. Although jobs in the energy sector in general (and the bioenergy sector in particular) in Argentina usually differ from the economic average (ILO, 2019), they can also be influenced by the general conditions of the regional economy in which they are inserted. For example, in regions with high informality or where child labour practices are observed, the recommendation is to investigate whether these situations also occur in the bioenergy sector or in any stages in its value chain. A set of traditional indicators is considered for this purpose to check how the local job market works, what are the most important problems it faces, and what are its main features: Rates of activity, employment/unemployment/underemployment and registered employment. Child labour and informal work rates are also very important aspects to take into consideration.

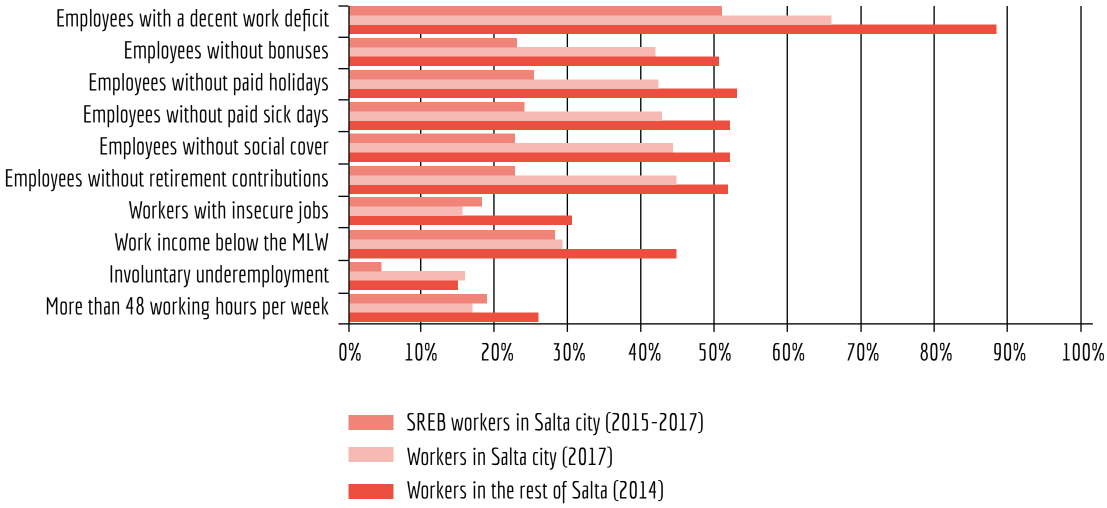
Box 1. **Production specialization in the province: main dimensions of analysis**

/ Recent dynamic provincial production structure. Main economic activities, their performance and composition of exports.
/ Population, main urban agglomerations.
/ Brief description of the MSW sector.
/ Composition of the energy matrix.

Box 2. **Features of the provincial job market: main dimensions of analysis**

/ Rates of employment, unemployment and underemployment.
/ Rate of unregistered / informal employment.
/ Composition of workers by gender, age range and educational level.
/ Vulnerable groups: the young, women and men with a low educational level,
/ Child or youth labour, forced labour.
/ Working conditions, health and safety at work, social protection and respect for employment rights.

Figure 9. Indicators of decent work deficits among workers in Salta



References

SREB: agricultural crops; energy or gas production; water harvesting, treatment and supply; sanitation services and other waste management, collection, processing and recovery services.

Source: FAO (2019b).

The main sources of secondary information for the analysis of the employment market in Argentina are the Permanent Household Survey (EPH) and the Annual Survey of Urban Households (EAHU) carried out by the National Institute of Statistics and Census (INDEC). These surveys can be used to estimate the main indicators mentioned above. However, they are limited in geographical cover or time: the EPH takes into account the main urban agglomerations, while the EAHU extends the continual recording of information by the EPH by incorporating private dwellings in villages with 2000 or more inhabitants. Bioenergy production often takes place in rural areas that are not usually covered by these surveys. Figure 9 shows an example of an analysis of a decent work deficit[12] in the case of Salta.

3.2 Bioenergy production

After defining the production context and the labour market of the province, the study should focus on the bioenergy sector and its value chain.

12 An employee is considered to have a job with a decent work deficit if they are in any of the following situations: they do not have access to social cover, they do not have paid sick days, they do not receive bonuses, they do not have retirement contributions, they receive work income below the minimum wage, they have a working day that is not decent (in other words they work for more than 48 hours a week or less than 35 hours voluntarily) or a job without a completion period.

Potential supply of bioenergy

In Argentina, the potential supply of biomass for energy purposes was estimated geospatially on a national scale by using the Woodfuel Integrated Supply/Demand Overview Mapping method (WISDOM), in a study performed by the Argentine government and FAO (FAO, 2009). This method is based on geographic information systems (GIS), a technology that helps integrate and examine statistical and spatial information on the production (supply) and consumption (demand) of biomass fuels.

The Project for the promotion of energy from biomass – UTF/ARG/020/ARG (PROBIOMASA) was set up in 2012 with the aim of increasing the production of thermal and electrical energy from biomass at local, provincial and national level, an initiative currently being taken forward by the secretaries of state for Agro-industry and Energy. The Project carried out a spatial analysis of the energy balance from biomass of eleven provinces using the WISDOM method: Tucumán, Salta, La Pampa, Mendoza, Córdoba, Corrientes, Chaco, Santa Fe, Buenos Aires, Entre Ríos and Misiones (FAO, 2016a, b and c; 2017a and b; 2018a, b, c and d; 2019a). These studies have made a major contribution in terms of strategic projections for the development of bioenergy at provincial level.

Table 4. Example: Economic sectors and their characteristics that can potentially be used for bioenergy purposes in Santa Fe

Sector	Characteristics
Production and processing of grain	The province is one of the main agricultural regions in the country: in the 2015/16 season, 14% of soybean production in Argentina, 13% sorghum, 13% wheat, 10% maize and 7% sunflower occurred there, among other crops (MINAGRO)[1].
Production and processing of cattle and pigs	It occupies the third place nationally in pig production, with approximately 20% of the country's stocks, 11% refrigerated stocks and 13% of the cold cuts industry (SENASA)[2]. In terms of beef, it has 12.4% of the country's cattle stocks, and occupies second place after Buenos Aires (SENASA)[3]. As regards industrialization, 17% of cattle slaughtering takes place in Santa Fe[4].
Dairy production	It has the highest milk production in the country, with 35% of the approximately 3926 million litres recorded in 2016, from approximately 3500 dairy farms (MECON, 2016)[5].
Municipal solid waste	It houses 8.15% of the country's population, i.e. 3 194 537 inhabitants (CNPVyH 2010, INDEC)[6], which generate 3525 tonnes of municipal solid waste per day, according to estimates by the National Observatory for the Management of Municipal Solid Waste (Ministry of Environment and Sustainable Development of Argentina)[7].

[1] http://datosestimaciones.magyp.gob.ar/. Acceso: abril de 2019.
[2] https://www.argentina.gob.ar/senasa/porcinos-sector-primario. Acceso: abril de 2019.
[3] https://www.argentina.gob.ar/senasa/mercados-y-estadisticas/estadisticas/animal-estadisticas/bovinos/bovinos-y-bubalinos-sector-primario. Acceso: abril de 2019.
[4] https://www.economia.gob.ar/peconomica/docs/Complejo_Ganadero_vacuno.pdf. Acceso: abril de 2019.
[5] https://www.economia.gob.ar/peconomica/docs/Complejo_Lacteo.pdf. Acceso: abril de 2019.
[6] https://www.indec.gov.ar/nivel4_default.asp?id_tema_1=2&id_tema_2=41&id_tema_3=135. Acceso: abril de 2019.
[7] http://observatoriorsu.ambiente.gob.ar/estadisticas.htm. Acceso: abril de 2019.

Source: FAO (2019a).

Table 4 gives an example of the results of this analysis: it shows the main characteristics of activities related to bioenergy production in Santa Fe province, stating which were the sources consulted at national level: the former Ministry of Agro-industry of the Nation (MINAGRO, the current State Department of Agro-industry), the former Ministry of Environment and Sustainable Development of the Nation (MAyDS, the current State Department of Environment and Sustainable Development), the former Ministry of Economy (MECON, the current Treasury Department), the Nacional Food Safety and Quality Service (SENASA), INDEC, the National Census on Population, Housing and Households (CNPVyH) and other documents, such as scientific articles and academic reports.

Incentives system: regulatory and legal framework of bioenergy

The development of the bioenergy sector is often promoted through public policies, i.e. by a set of incentives which can be regulatory or fiscal. An example of this concerns the production of liquid biofuels, whose development was protected by Promotion Laws 26093/2006 and 26334/2007. These constitute an emblematic case of a policy to stimulate domestic production development (Chidiak *et al*., 2014).

In Argentina, the National Constitution recognizes that provinces are the original domain of the natural resources existing in their territory. An examination of the regulatory framework for this sector therefore requires a cross-sectoral look at the various jurisdictions. In the case of Misiones, for example, given the abundance of wood energy resources, the main bioenergy generated is based on the combustion of organic waste from forestry. It is therefore essential, in order to analyse this sector, to consider the standards that regulate the production, distribution and industrial consumption of wood and charcoal originating from forests (such as Provincial Law XVI – N.º 106).

With the aim of presenting a complete picture of the regulatory and institutional framework (national and provincial) of bioenergy, it may be useful to investigate: i) what the main national/provincial laws are which specifically regulate bioenergy production in the province and what they promote, and ii) which other major public/private initiatives influence its production at provincial level. Box 3 gives an example of the regulatory framework in Santa Fe province.

Bioenergy in the province: analysis of the sector and its value chain

At this stage of the study, a diagnosis should be carried out on how the bioenergy production sector operates in the province, based on the following questions:

- What are the bioenergy production activities in the province? Are estimates available of the volume of energy/fuel produced? With which economic activities is the generation of this type of energy associated?
- What type of enterprises/institutions generate bioenergy (who are the main stakeholders)?
- How is the value chain structured? Which biomass inputs are used? Who consumes the energy generated?
- Where do they purchase capital goods? Which institutions provide support or technical assistance to the sector?
- Which are the best practices from a production perspective? Which are the main innovations, if any?

- What is the demand for skills in the sector? Are there occupations in which it is more difficult to hire staff?
- What has been the role of public policy in developing the sector?
- Are there projects for new investments or technological changes affecting the sector? What effects would they have on the demand for labour?
- What are the main strengths, weaknesses and opportunities facing the sector?
- Is there any informal work, job insecurity or child labour? In which stages and production unit types?

To answer these questions, one should consult three types of information sources:

A documentary analysis of the available studies, which can be reports from state bodies, previous investigations and studies, master's and doctoral theses, including newspaper articles and interviews by other authors with the main social stakeholders involved in the sector. The aim is to obtain qualitative information to help understand the general logic with which the sector operates at provincial level.

One should also analyse secondary statistics available on the sector (energy generated, sold on the domestic wholesale market, quantity of plants, employment, investments, among others). It is useful to compare national and provincial data with a view to identifying the level of contribution. In some cases, such as Santa Fe for example, the comparison between the production of provincial and national biofuels, according to MINEM data, shows that in 2016 79.9% of the total of national biofuels had been produced in the province.

The third approach involves carrying out interviews with key informants and is described in the next section.

Interviews with key informants: map of the network of local, provincial, regional and national stakeholders and guidelines for semi-structured interviews

Interviews with key informants are a qualitative source that helps to interpret, examine and update the information obtained from documentary and statistical sources. They also help to determine how the sector is assessed and perceived by the main stakeholders involved in it.

To plan and conduct these interviews, it is firstly necessary to map the main stakeholders relevant to the activity, including: i) government bodies which regulate and supervise the sector at national, provincial and municipal levels; ii) research institutes and universities that provide technical support or advice; chambers of commerce, trade representatives, large enterprises that are reference points in the sector at provincial level, enterprises supplying capital goods; iv) unions; v) labour inspection; vi) researchers and consultants[13]. This map will identify the persons to be interviewed, at least one reference point for each type of stakeholder (i.e. at least five interviews with key informants).

13 It is important to emphasize, in this respect, that it is not necessary to construct a directory with sector enterprises (which happens in the next stage).

Box 3. **Regulatory and institutional framework in Santa Fe**

National and provincial laws:

/ National law 26093/2006 "Programme for regulating and promoting the production and sustainable use of biofuels": It promotes compulsory minimum blending measures (compulsory mixing) of biofuels with fossil fuels, and gives tax benefits to enterprises that introduce projects for biofuel production. It also gives priority to enterprises with medium production capacity (SME) in purchasing for the supply of the biodiesel quota for the domestic market.
/ National law 26334/2008 "Programme for promoting bioethanol": It aims to include sugar refineries in bioethanol production, extending the benefits of Law 26093 to enterprises whose projects have been approved.
/ National law 27191/2016, which replaces 26093: "National programme for the promotion of the use of renewable energy sources intended for the production of electrical energy", which include biomass: It offers tax benefits for projects that produce electrical energy from renewable sources.
/ Provincial law 12692/2006 "Programme for the promotion of unconventional renewable energy": This was the first provincial law to sanction provincial measures with regard to renewable energy. It offers exemptions, reductions or deferral of provincial taxes to enterprises dedicated to producing this type of energy on provincial territory.

Other national actions aiming to promote the development of bioenergy:

/ Project for the promotion of energy from biomass (PROBIOMASA), developed by the former ministries of Agro-industry and Energy with FAO's technical and administrative assistance .
/ Policies implemented by the National Agricultural Technology Institute (INTA) and the National Institute of Industrial Technology (INTI).

Santa Fe Department of Energy has also set up a series of programmes aiming to promote the development of bioenergy:

/ Prosumers: Aims to boost the generation of renewable energy distributed, connected to the low voltage grid, by users of the Provincial Energy Company.
/ Green credit facility: Offered through Banco Municipal de Rosario, it aims to finance investments associated with the generation of renewable energy and the production of equipment or components for the generation of renewable energy and projects concerning industrial energy efficiency.
/ Financing renewable energy projects: In collaboration with the Ministry of Science, Technology and Innovation in Provincial Production, it funds projects by young enterprises and entrepreneurs in the province for technical applications, research, communication strategies, process design or construction of prototypes, and for analysis of energy efficiency.

In addition to these initiatives, there are other private initiatives combining stakeholders involved in the production of bioenergy and promoting their development, such as Argentina's Biofuels Chamber (CARBIO), Argentina's

Renewable Energies Chamber (CADER), Argentina's Oil Industry Chamber (CIARA), Argentina's Soybean Producers' Association (ACSOJA), Argentina's Maize and Sorghum Producers' Association (MAIZAR) and the Regional SME Biofuel Producers' Chamber (CEPREB).

Source: FAO (2019a)

These interviews can use the following methods: i) structured, i.e. predefined, open-ended question guides which the interviewee answers within the framework of a conversation; ii) semi-structured, i.e. based on a "script" with the themes to be addressed in a flexible order and formulation; iii) unstructured, where the conversation develops without predetermined guides.

Semi-structured interviews are recommended for this type of study as they allow the conversation to be focused on the research aims, hence giving the interviewee the opportunity to talk very freely. Although structured interviews offer the advantage of focusing the conversation on the specific information that is wanted, they limit the possibility for other related themes to emerge, not included in the original questionnaire, but which would be very relevant for the study, such as disputes or the prospects of new businesses. In some cases the existence of illegal situations, such as informal work and child labour, emerges more easily —spontaneously— in the conversation by allowing the interviewee to talk rather than questioning them directly on this theme.

Guides for semi-structured interviews will vary according to the interviewee profile. They should include the themes and sub-themes to be addressed, which depend in turn on the research aims. They provide a flexible "framework" for the conversation with the interviewee within which the theme order can be altered.

The main difficulty with this type of interview is the ability to "make the interviewee talk", achieve fluency and create a climate of trust. It should be seen not as a data gathering session but as a process of social interaction, in which empathy and ability to adapt are essential on the part of the interviewer.

It is convenient to record the interviews and then recover the aspects most important for the study (although the sector report must not contain a transcript of the interviews). Some theme guidance is given hereafter, as an example.

Representatives of enterprises and chambers of commerce:

- Economic activities with which the generation of this type of energy is associated.
- Types of enterprises/institutions that generate bioenergy.
- Structure of the value chain: inputs required and consumption of the energy generated, segments with greater levels of informality.
- Type of suppliers of the capital goods used, institutions that provide technical assistance or technology transfer to the sector.
- The role of public policy in the development of the sector.
- Demand for working capacity, profiles that are lacking.

- Main problems, opportunities and prospects for the sector (new investments or change of technology).

Unions:

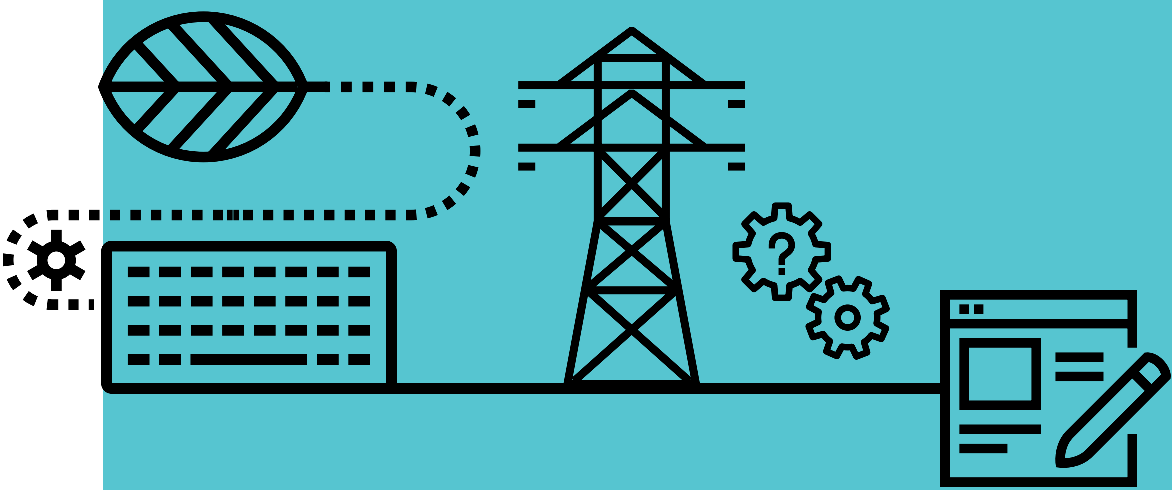
- Union presence in the sector, quantity of jobs, working conditions, health and safety at work.
- Presence of women and young people.
- Training needs.
- Level of informality of the value chain, use of child or forced labour, migrant or seasonal labour.
- Main strengths and problems.

Ministry/employment body of the province:

- Estimates of jobs created in the sector.
- Working conditions: results of health and safety labour inspection; accidents, unregistered work.
- Working conditions in the sector value chain.
- **Ministry/energy or production body of the province:**
- Types of bioenergy produced in the province, availability of specific records.
- Configuration of the value chain, main characteristics of each segment.
- Key enterprises: the most dynamic, the most productive, the most innovative.
- Province regulations and programmes to stimulate the sector.
- Key bodies and programmes in the sector.
- The role of innovation and change of technology.
- Strengths, weaknesses and opportunities of the sector in the province (including production, environmental and work aspects).

04.

ESTIMATION OF DIRECT JOBS IN BIOENERGY – ENTERPRISE SURVEYS



IN THIS CHAPTER

The activities necessary for estimating direct jobs in the bioenergy sector are described. These include: i) the study strategy, which is defined considering the available sources of information; ii) a description of the enterprise survey; iii) preparatory tasks for its application, such as developing a recording instrument, compiling a directory of enterprises and selecting cases to survey; iv) recommendations for recording data: creating databases, imputation of missing data; and v) analysis of results and producing a report.

Key information

/ Green jobs and direct jobs in bioenergy production
/ Stages in the bioenergy production process
/ Directories of plants
/ Strategies for recording data
/ Creation of databases, imputation of missing data

Practical elements

/ Examples of recording instruments
/ Examples of spreadsheets for selecting enterprises

Key questions that this chapter answers

How many jobs do bioenergy producers (including enterprises, cooperatives and other corporate forms) create? How are these jobs structured by occupation, required skill level, worker gender and age? What are the present and future skills required?

4.1 Strategy for estimation

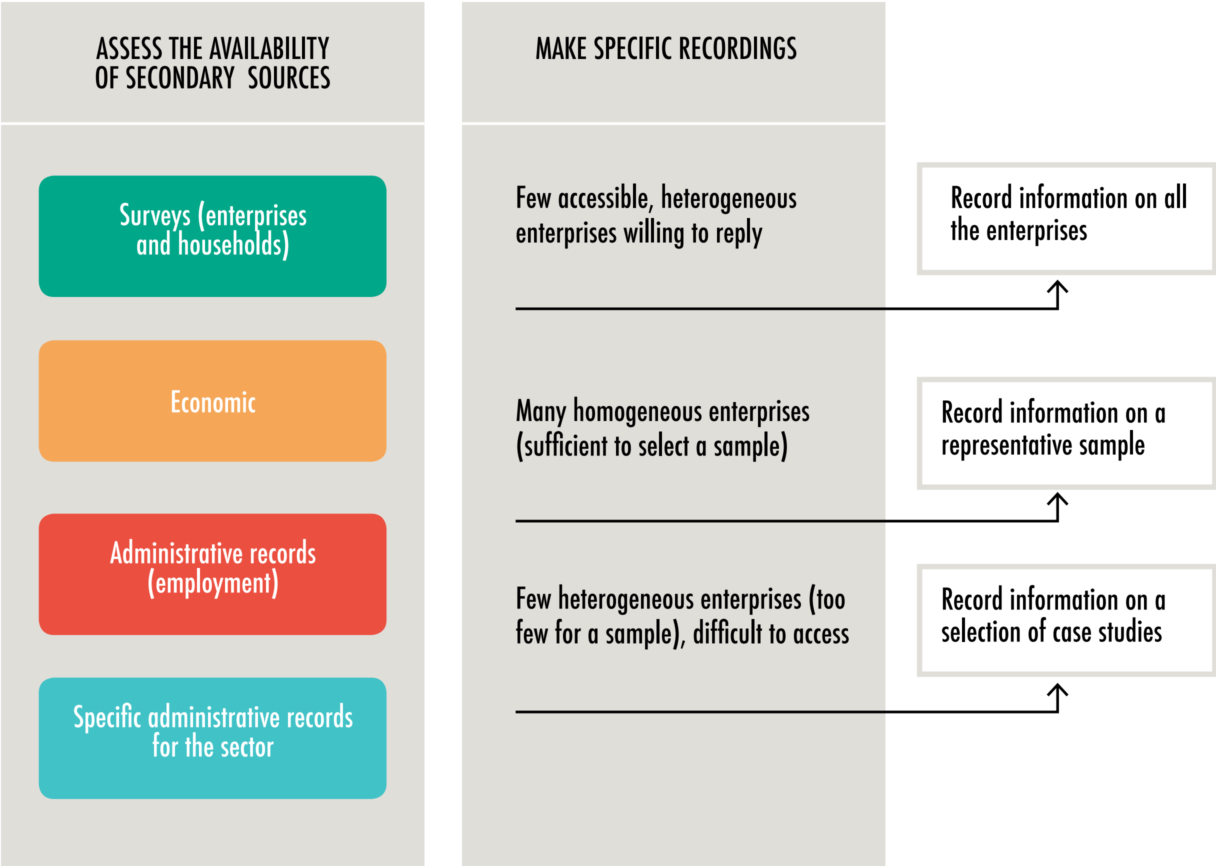
Strategies for estimating green jobs can vary with the availability of reliable information sources in the region, the configuration of activity and the availability of economic and social resources (support network) to the study.

Firstly, the study should use available sources of statistical information, where they exist. However, statistical systems -surveys, censuses and administrative records- are not always suitable sources for estimating direct jobs created in the bioenergy sector (Figure 10).

Secondly, the strategy must aim at making specific recordings: enterprise surveys, broadly speaking, including all bioenergy production units. In this case, according to the size and configuration of the sector, it may be appropriate: i) to survey all enterprises using a methodology described in this chapter (i.e. conducting a census of the sector in the province); ii) to use a representative sample, or iii) to select cases and then estimate employment in companies not interviewed.

As can be seen in the cases presented in boxes 4, 5 and 6, different strategies are adopted in practice according to the availability of information: in Misiones existing administrative records of boilers were used; in Salta social security records were used, and in Santa Fe a large number of enterprises was surveyed, with imputation of employment information for those which could not be surveyed.

Figure 10. Possible strategies for recording data



Source: Produced by the authors.

Box 4. **The recording strategy in Salta**

To estimate direct jobs in the bioenergy sector in Salta, biogas production plants were surveyed. But it was not possible to interview workers or obtain information from the employers on any of the two sugar refineries that produce bioenergy. In both cases, the information on the quantity of energy derived from the biomass they produce and on their installed capacity came mainly from the monthly report by CAMMESA and MINAGRO.

The bioenergy sector in Salta is estimated to involve 345 direct jobs, 80.6% of which are concentrated in the two sugar refineries, while the enterprises linked to biogas production account for the remaining 19.4%

Source: FAO (2019b).

Box 5. **The recording strategy in Misiones**

The estimation of direct jobs in Misiones was based on a mixed strategy, combining interview results with data from the province's Department of Industry register. It showed that there were 207 enterprises with projects involving energy generation from biomass, 144 of which were boiler plants listed by the General Department of Industry.

These enterprises are generally small plants scattered in remote areas of the province.

To estimate direct jobs in the sector, the information from the Misiones Department of Industry Boiler Plant Register was combined with the results of in-depth interviews conducted with the register authority and a series of enterprises (medium-sized yerba mate dryers, medium-sized sawmills and pulp mills).

Source: FAO (2019c).

Box 6. **The recording strategy in Santa Fe**

The plants that produce bioenergy in Santa Fe comprise very heterogeneous establishments, both in activities –and therefore in the type of biomass they use– and in size and organization. A classification of establishments was therefore created based on their distinguishing characteristics, to estimate the quantity of jobs and their quality.

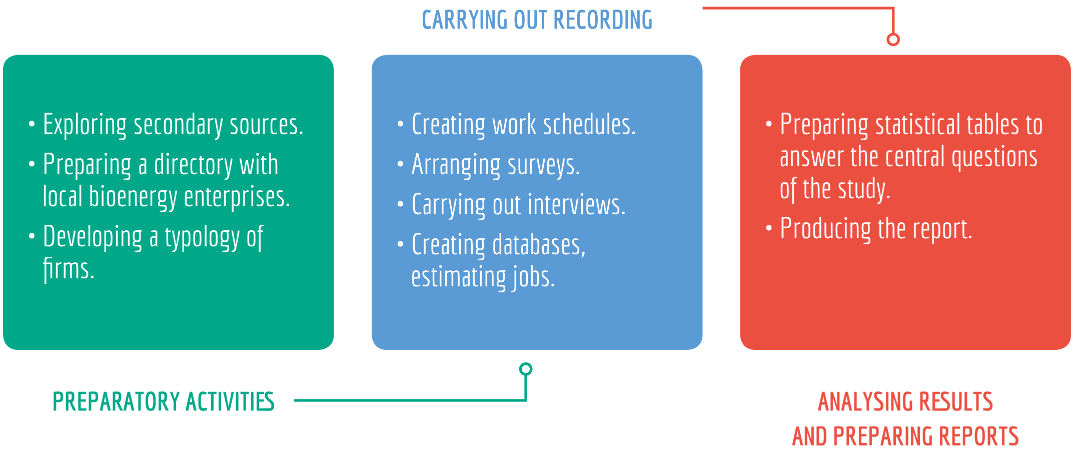
The classification was based on the identification of different processes for bioenergy production, which involved different quantitative and qualitative work requirements. Once these had been identified, cases were selected covering all the types of establishment, so that the results could be extrapolated to other similar plants, and production and employment estimated in establishments of different sizes but with comparable characteristics to those recorded. There were 51 plants installed in the province and 28 had operated in the previous year, 16 of which were interviewed.

In the case of biodiesel plants, the aim was to include at least one enterprise of each of the types identified, except in the case of large integrated factories, three of which were recorded due to the variability of scales in this segment. In the case of bioethanol production, the only plant operating in the province was visited. Considering the large quantity of biodigester types identified and, taking into account the type of substrate, scale and type of biodigester, the aim was to include in the selection all the biodigesters operating in the province.

Source: FAO (2019a).

Once the strategy has been selected and implemented, its road map comprises the steps shown in Figure 11.

Figure 11. Recording road map



Source: Produced by the authors.

4.2 Preparatory activities for recording data on jobs and production in enterprises

Exploring secondary sources

Sources of secondary information can be found in the public or private sector, in national, provincial or local jurisdictions. As mentioned above, traditional statistical surveys do not generally have the appropriate cover, as they do not obtain data representing relatively small, scattered sectors such as bioenergy production.

The experience of the study conducted by the Project for the promotion of energy from biomass (PROBIOMASA) and the INTI (FAO, 2019d) shows that administrative records can provide very useful information if combined with other sources (Box 7). Assessing the quality of these administrative records is important, particularly if they have been produced for the supervision of the sector or for the management of specific policies. Checking data consistency, the date of the last update and cover (the whole sector or a particular segment) are aspects, which should be considered before using these records.

Two techniques are usually very useful for assessing the quality of data contained in administrative records: i) interviewing the officials responsible for them to determine their update status and cover, and ii) comparing the information with other sources, and even with interviews.

Box 7. **Sources that can be useful for studying the bioenergy sector in Argentina**

At a national level, the administrative records of state bodies:

/ Secretary of State for Energy (formerly MINEM).
/ Administrator of the wholesale electricity market (CAMMESA).
/ Project for the promotion of energy from biomass (PROBIOMASA).
/ Instituto Nacional de Tecnología Industrial (INTI).
/ Observatory of employment and business dynamics (OEDE), Secretary of State for Labour and Employment of the Nation.

At a provincial and municipal level, the bodies that manage energy-related aspects, which can have very useful specific records and registers:

/ Department of Energy.
/ Subsecretariat of Renewable Energies.
/ Department of Labour.
/ Labour Inspection (provincial and national).

These bodies can have very useful specific records and registers. Available sources of municipal information should also be consulted.

In the private sector:

/ Sector chambers of commerce.
/ Enterprises which sell capital goods for bioenergy production.
/ Unions.

In addition to the bodies above-mentioned, there are academic institutions, other technical experts in the sector and, where applicable, NGOs active in the field and present in the territory.

Once the available sources have been identified and assessed, it will be clear which information has been validated, which needs to be validated (with data from a survey) and which is lacking and needs to be recorded.

The availability of secondary information and the configuration of the bioenergy production sector will indicate which is the best strategy for recording data. In other words, how the available secondary information will be supplemented with information from the enterprise survey.

Constructing the directory of production units: sampling frame of the survey

To construct the directory of bioenergy producers and their key characteristics, it is necessary to compile any existing administrative records, both national (Secretariats of State of Energy and Agro-industry, INTI), provincial and municipal.

It is important to assess whether the registered information is complete and up to date. To that effect, key informants, such as enterprises which sell capital goods (biodigesters or specific equipment for each type of bioenergy), should be consulted at local and provincial level, as well as social stakeholders in the institutional network identified in the previous stage of assessment, when in-depth interviews were carried out (i.e. chambers of commerce, state authorities and universities in the territory). Internet searches can provide some relevant information not contained in records, and email or telephone queries can confirm whether the plant is operational at the time of the study.

As mentioned earlier, the listing/directory of bioenergy-producing enterprises is the result of joint efforts by various public and private institutions which have access to activity records of enterprises. Access to this information therefore largely depends on the effectiveness of networking. Box 8 summarizes the key data that the directory should contain.

Box 8. **Key data that the directory should contain**

/ Name of enterprise and identification code.
/ Address, email, telephone, name of human resources manager.
/ Installed capacity of energy generation.
/ Type of energy produced.
/ If electrical energy is produced, whether it is sold to the wholesale market.
/ Type of bioenergy produced.
/ Type of biomass used.
/ Quantity of energy generated.
/ Type of technology used.
/ Size of enterprise.
/ Longevity.
/ Check that the plant is currently operational.

The directory of enterprises will give a clearer idea of the size of the bioenergy sector being studied, while the characterization of establishments will help to draw up taxonomies for these enterprises (or apply an existing taxonomy) considering the following dimensions:

i. Main activity of the bioenergy producer.

ii. Type of bioenergy produced and biomass used.

iii. Capacity installed (or production scale).

iv. Number of employees (if it has a source that provides preliminary data on this dimension).

Bioenergy plants are often located in enterprises which have other main activities, for example, sugar refineries in Salta and Jujuy provinces, where bioethanol production and the cogeneration of thermal and electrical energy supplement the primary activity.

As the same bioenergy can be produced from different biomass sources, it is also important to classify enterprises by the type they use. Although biodiesel produced in Santa Fe province is based on soybean, the same product can be obtained from several other feedstocks, both conventional (rapeseed or sunflower oil) and alternative (algal, safflower and other oils).

The production scale or installed capacity is usually associated with the adoption of different technologies and related labour requirements. There are classifications previously proposed by the INTI, for example, which postulate a relation between installed capacity and size of the enterprise.

It is important to note that characterization prior to data recording should generally be checked after fieldwork, which provides more accurate, up-to-date information.

Boxes 9 and 10 show some of the dimensions used to characterize plants in the Santa Fe and Misiones plants.

Box 9. **Dimensions considered in order to characterize plants in the Santa Fe study**

The plants were divided into four groups by type of bioenergy produced:

a. Biodiesel: The plants are classified by scale, and the largest of these are usually those that exclusively produce biodiesel and those involved in seed crushing and oil extraction. It is also important to take into account the type of biomass used. In Santa Fe, all the biodiesel plants are first generation, i.e. they process crops also used as food, such as soybean and maize (Goldstein and Gutman, 2010) and manufacture biodiesel from soybean oil.
b. Bioethanol: It would also be important to identify the type of biomass used and the scale, to distinguish different production processes, although there is only one plant of this type in the province, which produces bioethanol from maize.
c. Biogas: Biodigesters are usually distinguished according to the type of biomass they are supplied by (municipal waste, livestock waste, industrial waste, agricultural waste), their scale and technology type (complete mix, UASB, covered lagoon and plug flow).
d. Thermal energy from biomass: The records identified three thermal plants in Santa Fe, which operate with forestry waste and cereal processing waste. An additional criterion was added in the study, i.e. that in addition to heat/steam, they produce electrical energy. They are thus classified as large (more than 10.8 MW) and small (up to1.5 MW).

Source: FAO (2019a).

Box 10. **Typology used to characterize plants in the Misiones study**

The plants were divided into four main groups:

a. Those producing electrical energy with forestry biomass. Up to 2017, only one enterprise generated electrical energy to be injected into the wholesale electrical system; the others were involved in cogeneration for self-consumption.
b. Sawmills are forestry industries that use their waste wood to generate thermal energy and steam which they use in the wood drying process.
c. Yerba mate and tea dryers which use forest biomass to generate thermal energy to use for drying their raw materials.
d. Starch processing plants, which are beginning to generate energy through biodigesters installed in their effluent and waste treatment plants. At the time of recording, there were at least two enterprises carrying out these processes, although they are still at an experimental stage of technical development.

Source: FAO (2019c).

Selection of cases to survey

As stated earlier, when the sector consists of a few enterprises with major differences between them (technological, size or other differences), the appropriate strategy is to interview them all through a small census. By contrast, if the sector has many homogeneous enterprises, it would be advisable to work with a representative sample and to expand the results to the rest of the sector.

In practice, however, it is sometimes impossible to survey all the enterprises, for instance if some refuse to take part in the study or if there are difficulties accessing those in remote areas and they do not provide information virtually. In these cases, as many enterprises as possible should be interviewed and the missing information estimated/imputed (data imputation is summarized in the next section).

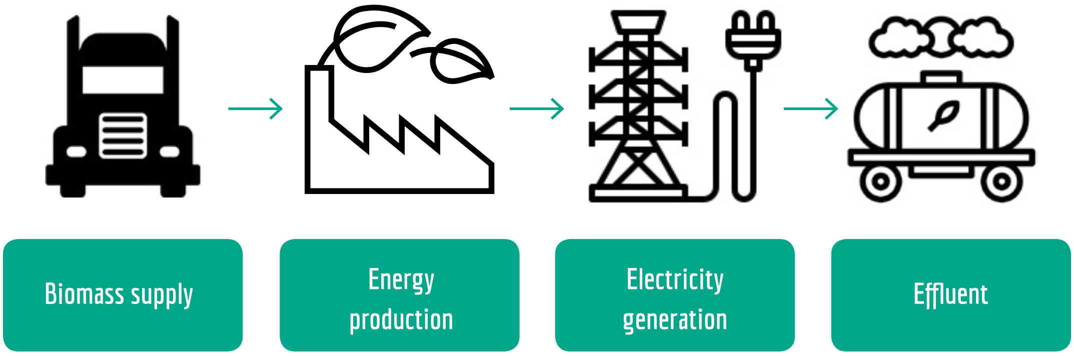
Dimensions to be recorded on enterprises and tools

The information that should be gathered on enterprises refers to the number of direct jobs that the production of bioenergy requires and its composition, as well as the income and expenditure structure. This information is necessary for estimating input-output models (IOM) at sector and province level.

Direct jobs are those created in the plant to carry out the necessary operational processes, and which persist over time (even if there may be a high turnover of persons filling the posts). This definition does not include jobs created in the construction and dismantling of plants; these are not permanent as they are created only for these stages.

For an accurate assessment of direct jobs, it is recommended that recording be structured by activities that make up the energy production process carried out in the same enterprise (the value chain is not included here): i) provision of inputs, ii) production of energy, iii) generation of electricity (if any) and iv) effluent separation and disposal (Figure 12). These activities will structure the instrument that will be used to record information which can be consulted in the annex to this handbook.

Figure 12. Stages in bioenergy production. Typical processes involved in the same production unit



Source: Elaboración propia.

For some types of bioenergy, the provision of inputs can be labour intensive. The collection, transport and treatment process can be complex and costly, and it can also create jobs. This is the case when biomass is scattered around the territory (agricultural waste or crops) and must be collected and transported to the bioenergy plant. In this case, the geographic dispersion and transport costs can be a limiting factor in the economic viability of the use of biomass for energy purposes. In the case of municipal solid waste (MSW), transport from homes to final disposal centres is not usually considered a cost attributable to energy generation (as its collection and transport are necessary in any case); however, the use of this biomass for energy purposes requires previous treatment (classification and separation) which is a specific task attributable to energy production.

The collection, transport and treatment stages are less important in other organizational models of bioenergy production (and other types of biomass), where energy plants are incorporated in the disposal of waste from production processes. Examples can be bioenergy production based on the use of industrial waste (such as beer production), animal waste on dairy farms or breeding and fattening sheds, or waste water. The production of biodiesel from soybean is another interesting case as it is usually incorporated in oil production.

As regards energy production and the generation of electricity or heat, the way in which these activities are organized depends on the type of biomass and the technology used. Four large areas of management are usually covered in production establishments: operations, maintenance, administration and environmental monitoring

En cuanto a los efluentes, una vez finalizado el ciclo se lleva a cabo su separación y disposición final. Los desechos de este proceso pueden utilizarse como fertilizantes, en modelos de economía circular.

In some cases, the energy produced is used for the generation of electricity or heat, which is used by the plant or sold –in the case of electrical energy– to the wholesale electricity market (CAMMESA).

As regards effluent, once the cycle has been completed, its separation and final disposal take place. The waste from this process can be used as fertilizer in circular economy models.

In some cases, some stages in the process can be outsourced to other enterprises or business units in the same enterprise. For example, an oil plant that also produces biodiesel might not have a specific administrative department for the biodiesel plant; in this case, if recording is limited to this plant, it will fail to pick up part of the work needed for bioenergy production, that corresponding to administrative management. To avoid a bias towards underestimating total jobs, imputation of the missing jobs is recommended, based on similar enterprises.

Similarly, in cases in which plants are integrated in other production processes, it is important to identify which jobs are attributable to the bioenergy production studied. For example, refiners can incorporate sugar-cane cultivation and the production of sugar, alcohol and paper in the same company that produces bioethanol and has a biodigester. In such cases, it is important to make an effort to determine which is the relevant job.

A form with four modules can be used for data recording; this has been used in the Santa Fe and Misiones studies (templates for the instruments can be found in Annex A2):

- First module: to determine the characteristics of the plant, its production capacity, technology, form in which inputs are supplied and waste management.
- Second module: to determine the number of workers at the plant and the production process areas, identifying skill level and gender breakdown.
- Third module: to identify demand for skills and abilities.
- Fourth module: collects information on level of activity, cost structure and links with other enterprises.

4.3 Data collection

Agreement on surveys

A critical aspect in this type of study is to ensure that enterprises agree to take part by providing information on their job allocations and data on their monetary income and expenses. If the major companies do not take part in the study, this jeopardizes the quality and relevance of the results that can be achieved.

The best way of gaining access to this information is through the explicit support of other social stakeholders (important on a national, provincial or municipal level) who might be interested in the study and have regular dialogue with enterprises, which helps to establish an appropriate framework of trust so that they answer in interviews. Energy, Agriculture, Labour and Economy bodies, provincial statistics institutes, chambers of commerce, unions and universities can be very important strategic partners.

A key strategy is to hold meetings, seminars and workshops to which the respondent enterprises and the chambers of commerce and business associations to which they belong are invited. Within the framework of these events, the importance and aim of the study must be communicated along with the fundamental role that enterprises have in it. The promotion of the study on the web pages of the institutions that support it can be an

UPPORT FOR THE STUDY FROM CHAMBERS OF COMMERCE, MINISTRIES AND OTHER KEY STAKEHOLDERS CREATES A FRAMEWORK OF TRUST AMONG ENTERPRISES WHICH CONTRIBUTES TO THE SUCCESS OF THE SURVEY.

effective way of creating confidence among the enterprises interviewed. It might also be necessary to draft a covering letter for the consultants carrying out the data collection, communicating the key aims of the study and the institutions endorsing it, signed by their representatives.

A very effective practice is for the interview schedule to be organized and managed by an institution present in the territory, which has good relations with the enterprises. In the Santa Fe study (FAO, 2019a), the Department of Energy of the province intervened in the coordination of interviews between the consultant and a group of nearby enterprises, which greatly facilitated information collection.

Data collection

Whilst it is recommended that data collection be done on site in an interview in which the consultant can also observe the plant, when the plant is located in a remote site or the interviewee is not prepared to receive the consultant, information can be collected by telephone interviews, video calls or by email.

One possible strategy, used in the Santa Fe study (FAO, 2019a) is to send the questionnaires in advance by email, so that staff can complete the employment and accounting information modules, and then to carry out the interview on site, to add the missing information. An alternative strategy, which was used in Salta (FAO, 2019b), was the opposite: first do the on-site interview and then gather the accounting data.

The experience from the Salta and Santa Fe studies shows that large enterprises prefer to complete the form and send it by email, in particular because the information required needs to be provided by two different management areas: human resources and accounts. Small enterprises, by contrast, prefer to provide the information during the on-site interview.

Data systematization and entry. Imputation of missing data

One of the advantages of gathering separate information for the various stages in the energy production process is that it helps to determine whether the sample contains enterprises that do not have complete information. This is common with multiproduct enterprises, in which it is difficult to identify management areas corresponding to energy production. In these cases, the parts of employment structures “without data” (usually support and management areas in multiproduct enterprises) must be completed by imputation of missing data based on information from similar enterprises.

Information recorded in the study for “similar” cases (similar in installed capacity, type of biomass used, energy produced, technology used) must be used for imputation of jobs in enterprises that have not been interviewed.

One way of carrying out this imputation, often used in studies of employment in renewable energy, is to use technical coefficients for jobs (ratios of jobs created to levels of energy produced or capacity installed).

4.4 Analysis and presentation of results

The information on direct jobs in the sector can be presented separately by type of energy produced, type of biomass used, technologies and size of firms. The study also shows what are the occupations of workers in the sector and the skill levels required, as well as the employment composition by worker gender and age. Table 5 shows the example of the Santa Fe study.

Table 5. Producción y empleo en el sector de bioenergías de Santa Fe en 2016

Bioenergy type	Plant size	Number of plants	Total persons employed	Total women employed	Production of bioenergy in 2016
Biodiesel		16	671	79	2 092 488 t
	Large	8	433	43	1 833 303 t
	Medium	5	205	30	226 032 t
	Small	3	33	6	33 153 t
Bioethanol		1	76	7	58 000 m³
Biogás		8	27	1	4 048 780 m³
	Large	1	1	0	409 000 m³
	Medium	4	25	1	3 626 640 m³
	Small	3	1	0	13 140 m³
Therman		3	59	1	8,2 MWh
	Large	1	16	1	5,40 MWh
	Small	2	43	0	2,75 MWh
Total		28	833	88	

Source: FAO (2019a).

The intensity of use of the labour factor can also be measured in regions with a very high density of energy plants. For example, the Santa Fe study estimated worker productivity for biodiesel plants of different sizes as well as for bioethanol plants (Table 6). This information can be used to determine employment coefficients, which could be used to make estimates about this sector in other regions with similar characteristics, starting from biofuel production volumes.

Table 7 shows another example from the Santa Fe study in which biogas production has a higher requirement for technically skilled staff, while bioethanol production has a higher demand for workers with a university education.

Table 6. Coefficients for creating jobs in biofuel production in Santa Fe

Tipo de planta	Worker productivity in 2016
Biodiesel - Large	1 job per 4 238 t/year
Biodiesel - Medium	1 job per 1 103 t/year
Biodiesel - Small	1 job per 1 005 t/year
Biodiesel - Province average	1 job per 3 120 t/year
Bioethanol	1 job per 763 m^3/year

Source: FAO (2019a).

Table 7. Level of salaried workers and skills required for the job, by bioenergy type, in Santa Fe

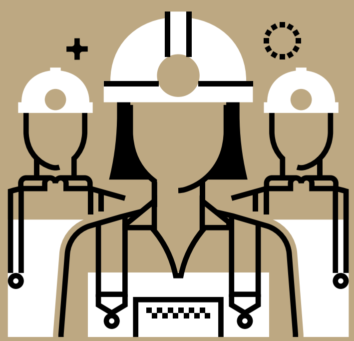
	Type of contract (%)		Skill required for the job (%)			
	Level of salaried workers	Others	Professional	Technical	Labourer	Unskilled
Biodiesel	78	22	12	50	25	10
Bioethanol	100	0	24	24	30	22
Biogas	95	5	19	71	7	1
Thermal	82	18	13	51	24	11

Source: FAO (2019a).

EMPLOYMENT STUDIES IN RENEWABLE ENERGIES USUALLY USE TECHNICAL EMPLOYMENT COEFFICIENTS FOR IMPUTATION OF MISSING DATA.

05.

ANALYSIS OF THE QUALITY OF JOBS CREATED IN THE PRODUCTION OF BIOENERGY. WORKER SURVEYS



IN THIS CHAPTER

The data collection methodologies for studying job quality in the bioenergy sector are described with the aim of assessing to what extent they meet the dimensions of decent work. Firstly, the available sources of secondary information are used and specific ways of making collections are carried out, including in-depth interviews of workers and key informants (from a qualitative point of view) and/or surveys of workers.

Key information

/ Three main sources of qualitative data (survey, interviews/observations, secondary source data)
/ Definition of the indicators of decent work used
/ Survey criteria and structure
/ Methodology for calculating the population sample
/ Method of distributing the questionnaires
/ Method of analysing and presenting the results

Practical elements

/ Table: dimensions, indicators and operational indicators of decent work
/ Formulae for calculating the population sample

Main questions answered by this chapter

What is the quality of jobs created in bioenergy production?
What are the main decent work deficits which can be observed?

5.1 Measuring job quality deficits

The aim of the study of job quality in bioenergy is to measure the main deficits in job quality and characteristics in the sector, in order to offer clear guidelines for drafting public and work policies at provincial level.

Although it targets the formal sector, this chapter also addresses the characteristics of informal work (when found), picking up the general description given in Chapter 3. The sources for determining these characteristics are consultations with key informants, such as labour inspection, enterprises in the value chain, unions and NGOs working in the region.

The work starts from the conceptual framework of decent work and aims to assess the worker's situation from a microeconomic point of view. Secondary data sources are used, where they exist, such as local and national surveys (for example the EPH), sector studies and information previously available on work quality in the sector. Specific sources of information for this study are: i) a worker survey, which is supplemented with ii) qualitative interviews with employees, human resource managers in enterprises, experts and external informants and iii) direct observations in workplaces.

Table 8. Main types of sources for measuring job quality

	Primary sources	Secondary sources
Quantitative data	Survey of workers	Statistical databases. Sector studies. EPH, EAHU
Qualitative data	Semi-structured qualitative interviews with: Human resource managers of enterprises. Labour inspection personnel. Unions, NGOs.	Reports on work and quality of work.

Source: Produced by the authors.

5.2 Worker survey

The survey of workers in their workplace aims to investigate compliance with a set of dimensions that form the concept of decent work, developed in Chapter 2 of this handbook. Due to the design of the survey (workers in their workplace), it refers to the formal sector of the economy.

This chapter provides a detailed analysis of the indicators used, the operational structure, the method of distributing the questionnaires and the methodology of organizing and presenting the results.

Definition of indicators

With the aim of measuring decent work deficits in detail, Table 9 shows the main indicators of the central dimensions of this concept, and the way in which these indicators evolve based on the worker survey proposed in this handbook.

It is important to note that, at the time of assessing work quality based on decent work indicators, there is an area of "grey" jobs existing between the extremes on the labour market: those that show deficiencies in some indicators, which can be severe or slight. Some provincial contexts show structural deficiencies in some indicators. Analysis of the labour context of a province is therefore an important preparatory activity.

Forms

The forms used in the worker survey in their workplace are aimed at obtaining the necessary information for constructing the indicators mentioned. A set of closed questions is used owing to the limits imposed by the context in which the survey is conducted (short time with the interviewee, possible presence of supervisors). It consists of an anonymous double sheet of 50 questions which are not numbered so as not to deter the respondent (the questionnaires are available in Annex A3).

The first part of the survey includes variables that characterize survey respondents (gender, place of birth, age and educational level). These will be used in the analysis to identify which are the worker groups with higher levels of vulnerability, and thus to inform policy design.

Table 9. Dimensions of decent work, main indicators and operational indicators of the work survey

Dimensions of DW		Main indicators	Operational indicators (deficits)
I	Employment opportunities	Contract and stable work	• Working hours exceeding 48 per week. • Employees with insecure jobs. • Employees without job satisfaction. • Involuntary underemployment. • Work income below the MLW. • Lack of employment contracts.
		Income and salaries	
		Organization and working hours	
		Training	
		General work satisfaction	
II	Respect for basic employment rights	Gender equity and non-discrimination	• No leave for family reasons. • No maternity/paternity leave. • No days off. • No official holidays. • No sick leave. • No family allowance. • Extra hours unpaid. • No paid sick leave. • No paid holidays. • No bonuses.
		Maternity protection	
		Respect for fundamental rights	
III	Extension of social protection and job security	Social security	• No ART (Occupational Risk Insurance). • No social cover. • No retirement contributions.
		Health and safety at work	• In contact with toxic substances. • In an environment with unpleasant smells. • Serious accidents. • In uncomfortable temperatures. • With loud noises. • Without good ventilation. • Without good lighting. • With situations of stress, aggression or abuse. • With night work. • With occupational damage to health. • Without equipment or tools with safety devices. • Without sufficient space. • Without breaks at work. • Without emergency devices or alarms. • Without protective equipment, clothing or tools.
IV	Representation and social dialogue	Union freedom and work relations	• The union cannot resolve work disputes. • Grievances or work disputes cannot be reported to union delegates. • No union representative. • No union membership. • No labour relations with the employer/boss or tense relations. • No collective bargaining.

Source: Produced by the authors based on FAO (2019a and 2019c).

The central structure of the survey seeks to gather information on the four dimensions of decent work and covers all the operational indicators presented in each. However, the questions are not structured by dimension, but are distributed at random throughout the survey. They are linked together to be able to assess the consistency of responses. For example, it is very unlikely that a worker who has a formal contract with their employer will not be registered with social security.

It should be noted that the aim of this survey is not to exclusively gather information related to the surveyed employees' work, but to obtain data on the surroundings to assess decent work deficits in the dimension of job security. Questions are also asked about the minimum age of workers in the enterprise, to detect any adolescent and child labour.

Calculation of sample size

To be able to extrapolate the results of the survey to all the workers, the number of persons interviewed must be a representative fraction of the sector as a whole; the sample must therefore be of a sufficient size (described below), and selection of cases must be carried out at random[14].

The sample size is the number of individuals in the sector who must be surveyed. The following equation shows a statistical method for determining it properly:

Determining the size of the population sample

$$\text{Sample size} = \frac{N^* (\alpha_c{}^* 0{,}5)^2}{1 + (e^{2^x} (N-1)}$$

Where:

α_c Confidence level, also called "variance" (this is the degree of certainty with which estimates are required to be made from the sample. The usual level is 95%).

e Margin of error.

N Total population size.

Source: Pérez Juste (2012).

As an example, the application of the formula to determine the population sample size in the case of a population of 500 is described (Table 10). The margin of error normally tolerated in a statistical estimate from a sample is 5.0%, which implies a level of confidence of the representative nature of the sample of 95%.

A sample size of 217 individuals is obtained, based on a population size of 500 persons with a margin of error of 5% and a confidence level of 95%. This means that 217 employees must be interviewed to obtain a statistically representative sample of the total number of employees.

14 In other words, the distribution of the surveys is the result of impartial procedures.

Table 10. Application of the formula to determine the sample from a population of 500

Margin of error (common in statistics)	5,0%				
Population size (as an example)	500*				
Confidence level (common in statistics)	95%				
Z values (confidence level value)	90%	95%	97%	98%	99%
Variance (value to be replaced in the formula)	1645	1960	2170	2 326	2576
Resulting sample sizes	81	217	341	377	475

Nota: * The population size is the total employment according to the data provided by enterprises

Source: Produced by the authors.

Once the sample size has been defined, the criteria for distributing the surveys must be established according to the characteristics of the enterprises as a whole. For this purpose, the distribution of the total employment in the sector, according to the different types of enterprise, must be considered (using the typology defined in Chapter 4), and the sample size distributed among them, respecting this structure. For example, if 20% of jobs are in small enterprises, 30% in medium enterprises and 50% in large enterprises, the distribution of cases to survey (sample) should be distributed in the same way.

The sample must reflect the internal activity structure of the enterprises and must cover all their sections. In this respect it is assumed that different sections of an enterprise employ different worker profiles with different tasks. A random distribution method must be adopted when allocating surveys to individuals. Surveyed workers should be able to fill in the surveys without pressure or control from bosses

Interpreting and presenting the results

Data gathering is a statistical task, which has the aim of channelling the results into a single database. As shown in Figure 13, the responses to each question can be converted into numerical indices for their organization.

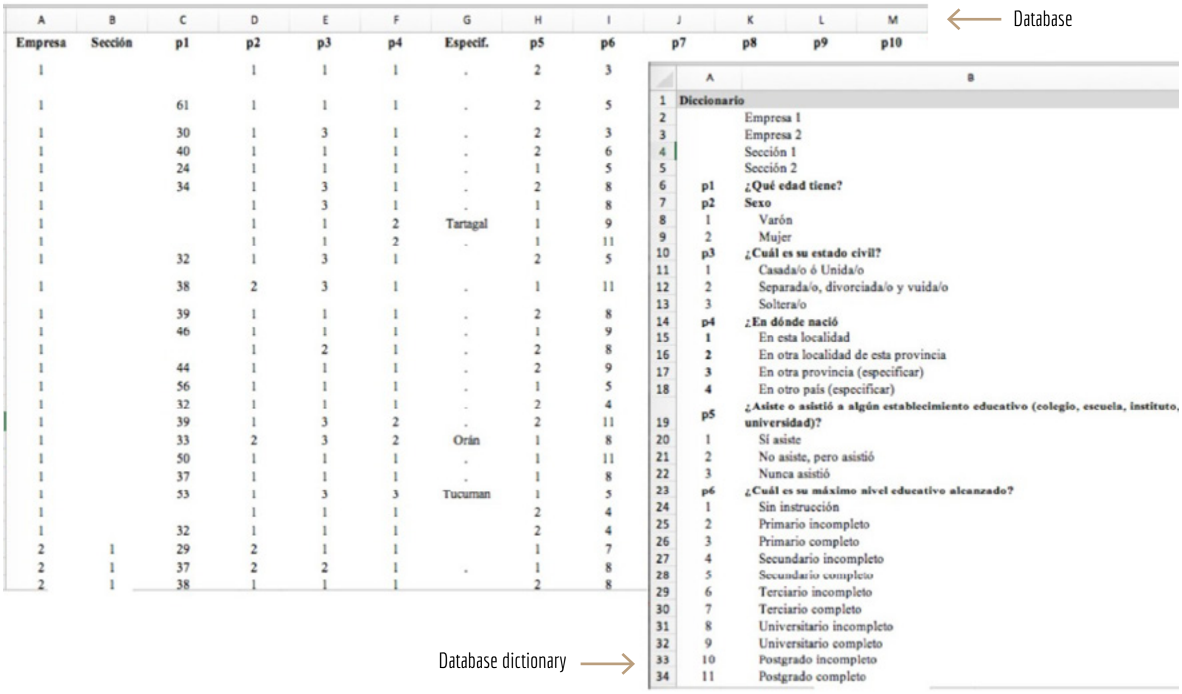
The results obtained from the survey should be analysed based on the four dimensions of decent work, with a specific examination being aimed at each of the main indicators. Figure 14 shows an example of how to present the results of the survey on work quality among biogas producers in the form of graphs in Salta.

The results obtained from the worker survey can be included with other available sources on work quality, such as interviews with experts and key stakeholders. These are presented in the following section.

5.3 In-depth interviews and workplace observations

Other methods of studying job quality in the sector include semi-structured qualitative interviews with key informants and direct observation of the workplace, and these methods were applied in the study in Santa Fe province (FAO, 2019a).

Figure 13. Organization of survey results

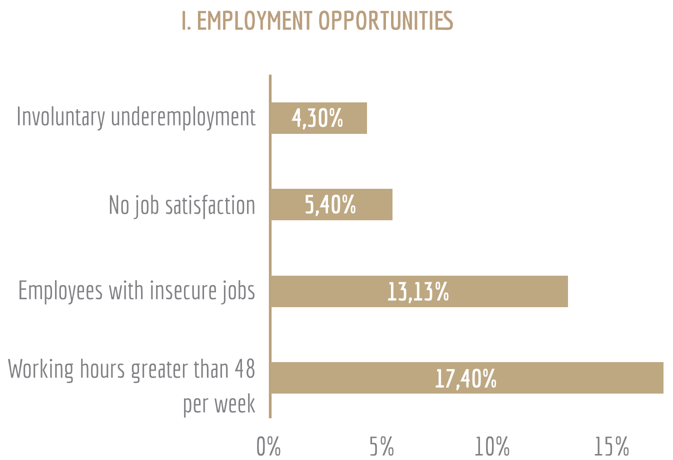


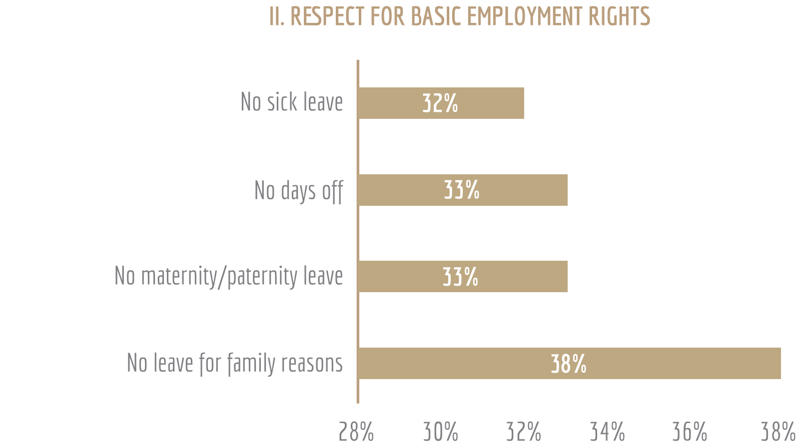
A	B	C	D	E	F	G	H	I	J	K	L	M
Empresa	Sección	p1	p2	p3	p4	Especif.	p5	p6	p7	p8	p9	p10
1			1	1	1	.	2	3				
1		61	1	1	1	.	2	5				
1		30	1	3	1	.	2	3				
1		40	1	1	1	.	2	6				
1		24	1	1	1	.	1	5				
1		34	1	3	1	.	2	8				
1			1	3	1	.	1	8				
1			1	1	2	Tartagal	1	9				
1			1	1	2	.	1	11				
1		32	1	3	1		2	5				
1		38	2	3	1	.	1	11				
1		39	1	1	1	.	2	8				
1		46	1	1	1	.	1	9				
1			1	2	1	.	2	8				
1		44	1	1	1	.	2	9				
1		56	1	1	1	.	1	5				
1		32	1	1	1	.	2	4				
1		39	1	3	2	.	2	11				
1		33	2	3	2	Orán	1	8				
1		50	1	1	1	.	1	11				
1		37	1	1	1	.	1	8				
1		53	1	3	3	Tucuman	1	5				
1			1	1	1		2	4				
1		32	1	1	1		2	4				
2	1	29	2	1	1		1	7				
2	1	37	2	2	1	.	1	8				
2	1	38	1	1	1		2	8				

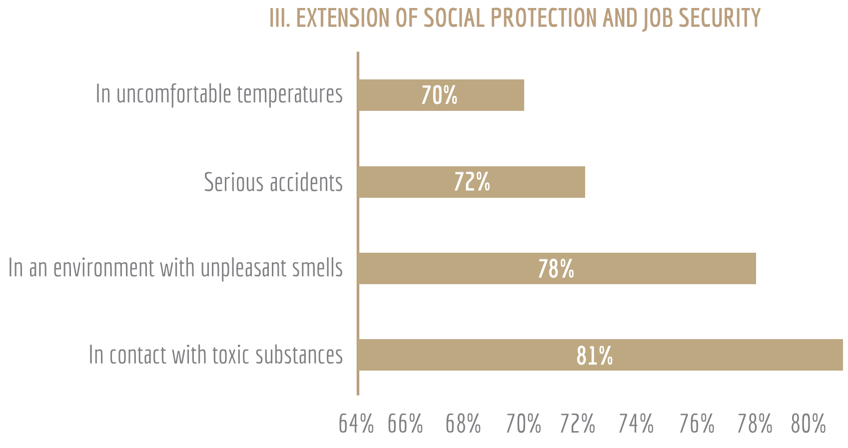
	A	B
1	**Diccionario**	
2		Empresa 1
3		Empresa 2
4		Sección 1
5		Sección 2
6	p1	**¿Qué edad tiene?**
7	p2	**Sexo**
8	1	Varón
9	2	Mujer
10	p3	**¿Cuál es su estado civil?**
11	1	Casada/o ó Unida/o
12	2	Separada/o, divorciada/o y vuida/o
13	3	Soltera/o
14	p4	**¿En dónde nació**
15	1	En esta localidad
16	2	En otra localidad de esta provincia
17	3	En otra provincia (especificar)
18	4	En otro país (especificar)
19	p5	**¿Asiste o asistió a algún establecimiento educativo (colegio, escuela, instituto, universidad)?**
20	1	Sí asiste
21	2	No asiste, pero asistió
22	3	Nunca asistió
23	p6	**¿Cuál es su máximo nivel educativo alcanzado?**
24	1	Sin instrucción
25	2	Primario incompleto
26	3	Primario completo
27	4	Secundario incompleto
28	5	Secundario completo
29	6	Terciario incompleto
30	7	Terciario completo
31	8	Universitario incompleto
32	9	Universitario completo
33	10	Postgrado incompleto
34	11	Postgrado completo

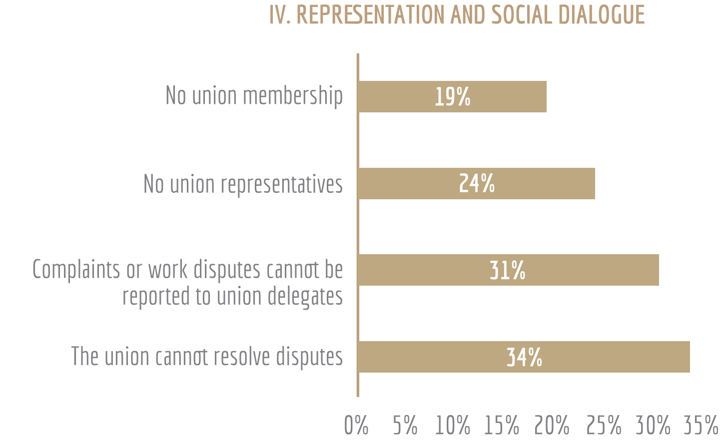
Source: FAO (2019c).

Figure 14. Presentation of some of the results of the surveys in Salta, by dimension









Source: FAO (2019b).

These interviews with key informants must use the dimensions of decent work, aiming to investigate whether interviewees find deficits in the bioenergy production sector (further details of this methodology are provided in Chapter 3 of this handbook).

- Interviews with workers must aim at capturing their own experience, but also their perception of working conditions in their workplace. They must therefore include specific questions on certain benefits as well as open-ended questions to allow them to cover questions related to the working environment and their view not only of their individual situation, but also of that of workers in the enterprise in general.
- Interviews with labour, health and safety inspection officials are an important source of information on decent work deficits for both dimensions.
- Interviews with union personnel in the area or other trade associations can reveal the main labour problems in the sector.
- Interviews with the human resource managers of enterprises can be slightly more structured, and aimed at determining the working conditions of workers, in particular the benefits they receive beyond legal obligations (corporate social responsibility policies, training programmes, children's nurseries, among others).
- It is important to note the role of observation of the working environment visited for detecting health and safety conditions, the use –in some cases– of safety equipment by workers, and other issues.

Box 11 shows two examples of the analysis of job quality in the bioenergy sector in Santa Fe for the indicators "health and safety at work" and "gender equity and non-discrimination". These are the result of in-depth interviews with employees and employers, supplemented with observations during visits to establishments.

TO STUDY JOB QUALITY, THE RESULTS OF THE WORKER SURVEY CAN BE INCLUDED WITH THOSE FROM OTHER SOURCES, SUCH AS QUALITATIVE INTERVIEWS WITH EXTERNAL EXPERTS AND OTHER KEY INFORMANTS.

Box 11. **Analysis of two job quality indicators in Santa Fe**

Occupational health and safety

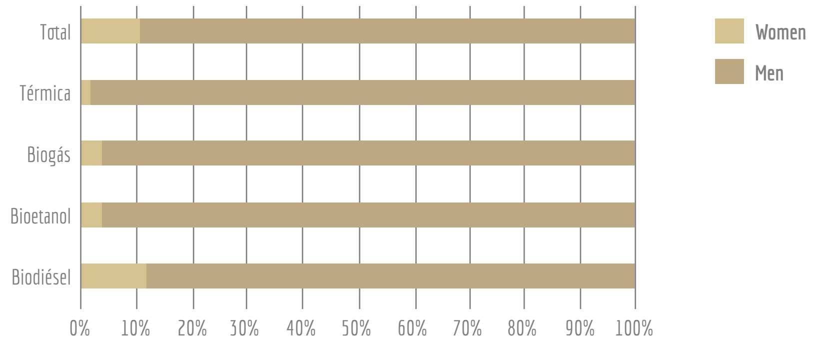
To measure occupational health and safety conditions, workers were asked about use or exposure to toxic or hazardous substances, the provision and use of protective equipment and training received in occupational health and hygiene. They were also asked about the physical conditions of the workplace. Marked differences were observed between enterprises in groups 2 and 3, which had modern facilities and were generally constructed in accordance with international safety standards, and small enterprises (group 1), whose facilities were rather insecure. It should be stated, however, that all biodiesel production plants have to undergo an annual audit on safety and hygiene. If they do not pass it, they are prevented from continuing to operate, and adjustments must be made and checked if there is a fault, as well as inspections in the event of accidents or complaints (according to information provided by the Provincial Department of Occupational Health and Safety).

A further aspect which should be emphasized is that all establishments which need to have a Joint Health and Safety Committee (according to provincial law 12913, regulated in 2009) have such a body. However, the interviews with workers revealed that several of them were unaware of the existence of this committee.

Gender equity and non-discrimination

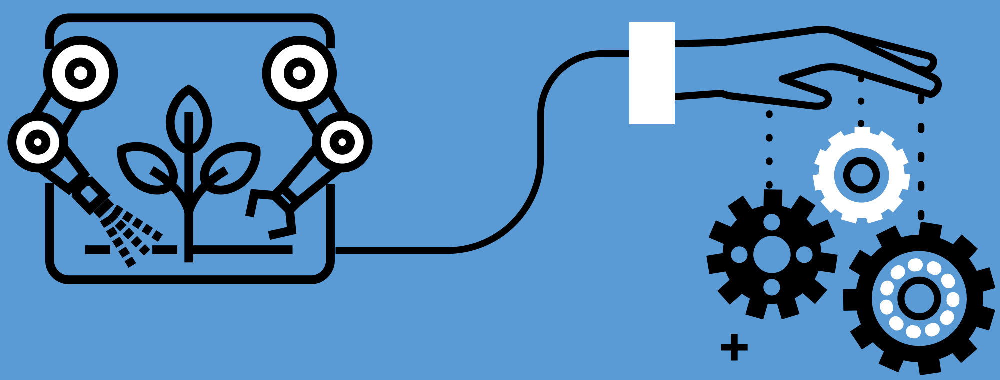
As mentioned earlier, female employment in the bioenergy sector is low, only 10.6% of the total, according to green job study data (ILO, 2019). These women worked above all in biodiesel and bioethanol plants (11.8% and 9.2%, respectively), whereas their involvement was considerably lower in biogas (3.7%) and in thermal energy (1.7%). The positions they held were mainly administrative, and none had management posts (Figure 15).

Figure 15. Involvement of female workers in the production of each type of bioenergy in Santa Fe



06.

ESTIMATE OF INDIRECT AND INDUCED JOBS AND CREATION OF JOB SIMULATIONS. APPLICATION OF IOMS



IN THIS CHAPTER

The methodologies are described for calculating indirect and induced jobs in the bioenergy sector, along with methodologies for creating job simulations.

Key information

- / Why create job simulations?
- / The main tools for calculation: input-output models (IOM) and social accounting matrices (SAM).
- / What are multipliers for and what are matrix linkages?
- / Construction of regional IOM (RIOM).
- / The use of matrices to estimate green jobs in the provinces: indirect and induced jobs.
- / Application of input-output models to simulate production shocks in bioenergy and to quantify their impact on jobs.

Practical elements

- / Examples, graph of an expanded IOM and an SAM.
- / Information and data sources used to create RIOM in cases in Misiones, Salta and Santa Fe.
- / Results of estimating indirect and induced jobs in bioenergy in Misiones, Salta and Santa Fe.
- / Detailed example of a simulation scenario in the Santa Fe study: PROD (increase in bioenergy production) and its effects by job category.

Questions answered by this chapter

What are the indirect and induced effects of an expansion in bioenergy production in terms of added value and jobs?

6.1 Main calculation tools and their scope

The study of green jobs in the bioenergy sector at provincial level proposes to provide tools, which serve as inputs to inform the formulation of labour and production development policies, and to promote the investment necessary for achieving sustainable growth trajectories in the sector.

To achieve this, the possible effects of applying the policies must be estimated, including by comparing expected results for alternative lines of action. It is important to investigate to what extent certain strategies might be effective in terms of jobs created in the short/medium/long term and their distribution according to the demographic characteristics of workers.

Input-out models (IOM) and social accounting matrix (SAM)

For an employment impact assessment, the international literature has used models based on input-out models (IOM) or social accounting matrices (SAM) and their respective multipliers (ILO, 2017a; Thorbecke, 2000; Pyatt and Thorbecke, 1976). The ILO has strongly encouraged the use of these tools.

Input-output analysis, introduced by Leontief (1970), serves to measure and analyse interdependence relationships between the various production and consumption sectors which make up the economy of a nation. With transformations, it can also be applied to the study of smaller economic systems (regional models). IOM and SAM are different tools and should be used depending on the aim of the study. An IOM is a representation of the production system, in which the economic sectors generate goods and services to be inputs for other sectors (intermediate demand) or directly for final consumption (final demand). It is basically an orderly record of these transactions. A SAM[15], however, contains detailed information on households and –probably– on the other economic agents (enterprises, government) and money transfers between them (use of income and social transfers). This is the most suitable tool for measuring the effects of the distribution of income and transfers, as well as sources of capital formation, saving and investment, and financial flows (Box 12).

Box 12. **SAM: brief description**

The SAM is an analytical tool consisting of an accounting framework, which consistently combines socioeconomic data on a specific economy, and represents its economic flow (ILO, 2011a). It reflects the production and consumption pattern of that economy and summarizes all social transactions between its agents (public sector, enterprises and households), describing its circular flow at a particular point in time (Pyatt and Round, 1985; Round, 2003). The added value of an SAM compared with an IOM is that it allows analysis of distribution effects between categories of households.
The construction of the SAM requires the collection and integration of data from different sources (Round, 2003). The integration of this information provides a complete picture of all the transactions and patterns within an economy.

IOMs and SAMs have been used in several countries[16] to estimate jobs created in green sectors, as well as the effects of any changes in the final demand for products or services on direct, indirect and induced jobs and on income distribution (ILO, 2017a; ILO, 2011b).

Both matrices can be used both to determine the impact of investment programmes or policies, in terms of jobs created (or lost) at the level of detail of worker groups affected, and to identify which sectors would be the principal beneficiaries of any programmes (ILO, 2018b).

The difference between the matrices (input-output or social accounting) and their application for developing models should be noted. Whereas matrices are simple accounting systems, models are tools for describing economic reality, in terms of structure and behaviour, with the aim of producing projections and simulations.

Models based on IOM and SAM are frequently applied to analyse the dynamics of transition to a green economy, which requires strategic investment aimed at making structural changes to the production system (ILO, 2018a). There is a growing demand for measuring the quantity (and quality) of green jobs at national level, and the potential for

[15] It should be noted that the studies estimating green jobs in bioenergy in Santa Fe, Salta and Misiones provinces did not use SAM models.

[16] South Korea, the People's Republic of China, the USA, South Africa and Mauritius, among others. See: http://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/documents/publication/wcms_176462.pdf

job creation which should have certain measures of public policy and investments (ILO, 2017a).

IOMs and SAMs have several limitations. They refer to a particular period (usually a year), so updated versions to the current year are often unavailable. Furthermore, the fact that they are accounting frameworks does not allow for the analysis of behaviour and, in their traditional form, IOMs do not allow analysis of effects on income distribution.

Open and closed models are constructed for IOMs. The simplest model is the "open model", which can be used to estimate the direct and indirect impacts of an increase in final demand on production sectors (Box 13). By contrast, a "closed model" can be generated by incorporating other accounts which provide information on final demand (consumption, expenditure, investment and exports) and can carry out analyses related to income distribution, though with lower complexity than with an SAM, which is a more complex tool in these dimensions (De Miguel and Pereira, 2011) (Box 14).

Box 13. **IOM: open model**

The open model focuses on the structure of the production system and on cross-sectoral requirements and the impacts of a given final demand. The use of an open model thus results in a multiplier effect produced by production interdependence, caused by an initial production shock in a sector, for example, an increase in the external demand for item A of 1 $ (direct effect). To meet this demand, intermediate demand for production inputs (sectors B and C) is generated, which in turn also need additional inputs to meet the new demand. This means that the final impact will be greater than $1, and the result is the multiplier effect.

The open model does not include the behavior of the final demand (private consumption, public expenditure, investments and exports), i.e. it considers it to be exogenous. This assumption implies that the increase in household income as a result of increased production does not generate additional demand for greater consumption.

Box 14. **MIP: closed model**

A closed model is one that "closes" the economic circle. While an open model ends by describing the increase in production and thus in salaries caused by a shock, a closed model extends and demonstrates what households do with the additional salary earned, and how this additional income returns to production via the consumption of goods and services. It is therefore said that the model closes with the inclusion of households as a further sector in the model, with its respective vectors of expenditure and income (for more information on closed models, see Pyatt, 2001).

The circle closed by household expenditure can be described as an additional effect, which increases the multiplier value. A type I multiplier is obtained with an open model (direct and indirect effect); a type II multiplier is obtained with a closed model, which includes not only direct and indirect jobs, but also induced jobs, which shows the effects derived from greater consumption.

However, in their simplest forms, IOMs and SAMs do not usually offer sufficiently detailed representations of economic structures to include green subsectors or to explain and present data on jobs in these. Disaggregation of bioenergy sectors and other green activities, a recently emerging factor, is in fact unusual.

Two types of changes need to be made in order to apply this tool to the estimation of indirect and induced jobs in the bioenergy sector. These are expansion and extension of the matrices.

Expansion is understood to mean opening the IOM to greater sector disaggregation, in order to model activities of interest and sectors which often do not exist in them, such as renewable energies or bioenergy. For example, an expanded dynamic SAM (DySAM) was used in Indonesia to clearly distinguish between activities benefiting from green technologies and those using brown technologies in the same sectors (Alarcón and Ernst, 2017).

The expansion to other sectors involves inserting new columns and rows that disaggregate the inputs required by the new sector for other activities and the use other sectors make of these goods and services and final demand, respectively (Figure 16). Expansion thus represents the interaction of the new sector with other activities upstream and downstream in the value chain.

Figure 16. Example of expansion of the IOM to green subsectors

		Agriculture	Organic agriculture	Energy	Renewable energy	Sector 3	Sector 4	Exp. on ind. cons.	Gross private investment	Exp. on public cons.	Net exp.
Producers	Agriculture										
	Organic agriculture										
	Energy										
	Renewable energy										
	Sector 3										
	Sector 4	Workers	Compensation for workers					Gross domestic product			
	Added value	Employers	Employers' profit								
		Government	Indirect taxes								

Source: Produced by the authors based on Beyrne (2015) and ILO (2017a).

To expand the matrix, it is essential to have additional information that shows both the cost structure of the new sector and its links to the rest of the economy. For the study of bioenergy at provincial level, the information is obtained from the survey of enterprises (presented in Chapter 4 of this handbook). On the other hand, IOMs or SAMs can be extended by incorporating other satellite accounts, which can be environmental, social or employment-related (ILO, 2017a). Monetary variables of the IOM can thus be combined with real or physical variables, such as the number of workers or CO_2 emissions.

Matrices extended to non-monetary variables take the number of hybrid matrices (Miller and Blair, 2009). Job data must be compatible with the classification of IOM production data. It can include details such as worker gender, age groups, urban/rural, informal/formal and skill level, among others, which makes it possible to carry out a more detailed analysis of the impact of shocks on the job market and on specific groups of workers.

Multipliers and linkages

Matrices allow for the calculation of multipliers to simulate how changes in the production of a given industry affect others. Multipliers are coefficients that describe the impact that an increase in a unit in the final demand of one or more sectors has on each sector (ILO, 2017a).

These multipliers refer to variables such as production, income and jobs and, in turn, can refer to direct, indirect and induced effects of public policies (ILO, 2011b).

Input-output models (based on either IOM or SAM) are generally applied most commonly to simulate shocks to real demand (Thorbecke, 2000); these include, among others, public or private investment, changes in economic growth (a crisis, for example) or changes resulting from public policies or regulatory frameworks[17].

A further possible analysis using input-output models is the "production linkage" process (Hirschman, 1958; Chenery and Srinivasan, 1988). This consists in the identification of interdependence between the various sectors, understanding that a final consumption asset is the result of the transformation of a raw material via a production chain that involves activities in different sectors.

Backward linkages (BL) and forward linkages (FL) can thus be calculated. A sector that requires inputs from other sectors for its own production has BL with those supplier sectors; on the other hand, it has FL with sectors to which it sells its production as inputs. BL and FL show the degree of integration with the other sectors of the economy.

Application of the concept of linkage can distinguish four economic branch types: driving, strategic, key and independent. Driving branches are those that have a large number of backward linkages (sectors supplying inputs for the branch analysed). Strategic branches have a large number of forward linkages (sectors demanding inputs produced by the branch analysed). Key activity branches have an equal number of backward and forward linkages, as they act on cross-sectoral flows, generating significant impacts on the economy as a whole. Finally, independent branches consume few intermediate inputs and their production is aimed mainly at meeting final demand (Beyrne, 2015).

Regional IOMs (RIOMs)

To apply these tools to portions of the territory, such as the provinces, regional input-output models (RIOMs) need to be produced, which appropriately represent the real cost structure of the area in question.

To produce RIOMs, the first studies used as a starting point the national technical coefficients (each of these represents the use of input per production unit); these were adjusted to match the characteristics of the region, estimating regional technical coefficients associated with inputs purchased in the region which are not derived directly from the national IOM.

Methods are currently available for regionalizing IOMs that depend essentially on the statistics available to produce them. On the one hand, there are direct techniques which mainly use specific sectoral surveys and censuses, for which data collection is expensive.

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[17] These models are also usually used to analyse changes in the added value of sectors. They are called "price models": instead of showing changes in production, they highlight changes in the prices of sectors of the economy. Their supply capacity (and the quantities produced) is assumed to be fixed and the whole effect is felt on prices.

On the other hand, indirect or statistical techniques are based on secondary information sources, such as production value and use per branch of activity, statistical yearbooks and economic and population censuses. The drawback of indirect techniques is their lower accuracy compared with direct techniques. Finally, the hybrid focus is a mixture of the previous two; it is generally used when the focus of the analysis is a few sectors, from which information can be directly obtained.

6.2 IOMs and their application to studies of green jobs in bioenergy at provincial level

Studies estimating green jobs in the bioenergy sector in Santa Fe, Salta and Misiones provinces (FAO, 2019a; 2019b; 2019c) used RIOM models (open and closed) adapted to the provincial contexts and extended to cover the provincial bioenergy sector, along with job variables. The use of IOMs (rather than SAM matrices) was determined by the availability (restrictions) of statistical information for developing the study.

Starting from a national IOM, it was therefore necessary to carry out regionalization processes to construct regional IOMs, along with expansion/extension processes of RIOMs to incorporate bioenergy sectors and employment dimensions. These processes are described in the sections below.

Transformation of the national matrix into an RIOM

Hybrid methods were used for the regionalization of IOMs, in other words indirect methods were combined with direct methods.

Firstly, the national matrix was converted into an RIOM using statistical techniques (indirect method) by adjusting national technical coefficients, so that they represented the production structure of each region (in terms of their technology) and their relationships with all the sectors of the economy. Location quotients (LQ) were used to obtain the RIOMs, representing the relationship between the share of a sector in a specific region and its share in the national total.

Indirect methods that use LQ, in addition to the national IOM, use available statistics on employment or gross geographic product. There are many applications of these methods for countries such as Mexico (Dávila Flores, 2015), Finland (Flegg and Tohmo, 2013; Kowalewski, 2015), Greece (Kolokontes, Karafillis and Chatzitheodoridis, 2008), Germany (Kronenberg, 2009) and Argentina (Flegg, Mastronardi and Romero, 2016; Mastronardi and Romero, 2012), among others. The LQ methodology used starts from the assumption mentioned by Jensen, Mandeville and Karunaratne (1979), according to which intraregional coefficients differ from national technical coefficients only by a factor of the share in regional commerce.

The location quotients theory starts from the assumption that the technology in the region is similar to the country average. This means that the region can be distinguished, based on the chosen LQ, from self-sufficient sectors which lack regional imports and those which require them (i.e. importers in the rest of Argentina).

Furthermore, direct methods were used together with the regional transactions matrix estimated by indirect methods. In other words the information obtained as a result of the methodologies described in Chapter 4 was added to the matrix. This information, specific to the sector studied, avoids measurement errors, which would have occurred if assumptions were made only about input technologies used in each province.

With the aim of ensuring the consistency of both sets of information, matrix balancing methods were used for the final adjustment of the matrices, such as RAS or cross entropy[18].

Expansion and extension of RIOM models

To estimate indirect and induced jobs and to create simulations, the RIOM is expanded to provincial bioenergy activities, as well as to employment variables. The following are performed with this aim:

1. Expansion to local bioenergy sectors, depending on the typology generated in the province, for which primary information is required on intermediate consumption, intermediate sales and components of cross-sectoral structures of intermediate purchases.
2. Extension to employment variables, for which information is required on jobs in bioenergy-generating activities at provincial level.

The expansion and extension of RIOMs are based on information gathered at provincial level relating to cost structure and direct jobs, collected in enterprises, using the methods described in Chapter 4.

To be able to show induced effects –in addition to an open RIOM– a closed RIOM is used, i.e. one that has been "extended" to incorporate the dimensions of jobs and household expenditure. The resolution of the open regional model is identical with that of the national model (Miller and Blair, 2009). Furthermore, to close the model and make household income and expenditure endogenous, households are included as a further sector of the model (the formulas are shown in Annex A4).

The multipliers of simple and total production are obtained from the open and closed models, respectively. Moreover, the employment coefficients are obtained by changing the unit of measurement of matrix coefficients using, for example, the number of people employed per product unit. Given this change in the unit of measurement of Leontief's matrix, employment multipliers of type 1 (open model) and type 2 (closed model) are constructed to better interpret the results.

Sources of additional information

Estimating RIOMs requires solving problems related to data quality, consistency and availability. It is fairly common that the necessary information, at provincial level, is inconsistent, not updated or does not refer to production or geographical contexts other than in the area under analysis. More specifically, to estimate RIOMs, detailed information is required on: i) supply and demand in the bioenergy sector, ii) input-output relations in the provincial economy and iii) jobs and household expenditure by branch of activity.

[18] RAS, also known as the bi-proportional adjustment method, is an iterative process ,which requires knowing the row and column totals to make an adjustment of a starting matrix. The cross entropy method resolves an optimization problem which minimizes a measurement of distance between a starting matrix and various calculated matrices which comply with a given number of restrictions, both technological and transactional (Robinson et al., 2001).

The data for Santa Fe, Salta and Misiones provinces (FAO, 2019a; 2019b; 2019c) is therefore the result of several estimation and collection initiatives. The main sources of information for producing input-output tables and their corresponding direct, indirect and induced coefficient matrices were: the 2004/2005 National Economic Census (INDEC, 2005); the 2004 supply and use tables[19]; the Gross Geographic Product (separately by sector)[20]; the level of employment by activity sector of the three provinces in the 2010 Census[21] and in the 2015 Annual Survey of Urban Households (EAHU)[22]; the 1997 input-output matrix forArgentina25[23]; MINAGRO crop data by province[24], and the 2015 social accounting matrix for Argentina[25].

This information was supplemented by the results of the enterprise survey (Chapter 4); which made it possible to estimate direct jobs and to determine the cost structure of the bioenergy sector at provincial level.

Table 11 compares the production structure of Santa Fe, Salta and Misiones provinces, and presents the working hypotheses used for estimating provincial IOMs. Point B indicates the number of sectors considered by province and the data sources in each case[26]. Production disaggregation in the sectors was estimated using national weighting factors, according to the method for the regionalization of matrices developed in Mastronardi and Romero (2012). Point C refers to information sources on the production of provincial bioenergy.

Point D describes the uptake of inputs in the provincial bioenergy value chain. As regards employment, point E shows the sources used for allocating jobs by activity sector.

The transactions matrix (point F) was estimated according to the Flegg Location Quotient (FLQ) method for all sectors apart from bioenergy, using the optimal parameters obtained for Argentina from the study by Flegg, Mastronardi and Romero (2016).

The vector of household consumption (point G) was estimated based on main heading information in the National Survey of Household Income (ENGHo), for the nine chapters, and consumer price index (CPI) weighting for the Northwest of Argentina (Salta and Misiones) and Santa Fe (Santa Fe).

As a criterion of consistency (point H) to close supply and demand in each sector with the usual IOM balancing techniques, intra-provincial consumption (in Misiones) and provincial consumption (in Salta) was adjusted with the rest of the final demand. In the case of Santa Fe, exports were taken by province of origin and adjusted to consumption.

For Santa Fe and Salta, technologies in the bioenergy sectors (biodiesel, bioethanol and biogas for Santa Fe; bioethanol and biogas for Salta) were calculated in terms of technical coefficients, taking into account the cost structures of inputs and factors of the sectoral surveys carried out in both provinces. The technical coefficients of the bioenergy sectors

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[19] https://www.indec.gob.ar/nivel4_default.asp?id_tema_1=3&id_tema_2=9&id_tema_3=114 April 2019

[20] https://www.indec.gob.ar/nivel4_default.asp?id_tema_1=3&id_tema_2=9&id_tema_3=138

[21] https://www.indec.gov.ar/nivel4_default.asp?id_tema_1=2&id_tema_2=41&id_tema_3=135

[22] Extension of the ongoing Permanent Survey of Households - 31 Urban Agglomerations: https://www.indec.gob.ar/bases-de-datos.asp

[23] https://www.economia.gob.ar/peconomica/matriz/menu.html

[24] https://datos.agroindustria.gob.ar/dataset/estimaciones-agricolas

[25] http://datos.minem.gob.ar/dataset/matriz-de-contabilidad-social-para-argentina-2015

[26] As GGP information is published at chapter level, it was necessary to seek other sources to obtain greater disaggregation by sector.

TO ESTIMATE REGIONAL IOMS, DETAILED INFORMATION IS REQUIRED ON SUPPLY AND DEMAND IN THE BIOENERGY SECTOR, INPUT-OUTPUT RELATIONS IN THE PROVINCIAL ECONOMY AND JOBS AND HOUSEHOLD EXPENDITURE PER BRANCH OF ACTIVITY.

were scaled to 2015 production. For estimating sales, internal sales for blending (with fossil fuels) were considered, and the combined remainder was assigned to electricity generation and export according to 2017 data from the Department of Energy[27] and the 2015 IOM.

As regards destination, in the case of Salta, biomass sales were assigned ad hoc 70% to electricity generation and 30% to thermal generation (gas), while for Santa Fe, that not for self-consumption (mainly electrical energy) was considered market sales.

Multipliers and linkages in RIOM

Once the direct and indirect coefficient matrices (open model) and the direct, indirect and induced coefficient matrices (closed model) have been obtained, the BL and FL can be calculated. The branches of activity with the greatest multiplier effect can also be identified, along with those with the highest multipliers in terms of production and jobs.

For example, biodiesel and bioethanol in Santa Fe are "driving" branches, with an above average backward linkage, and a weaker forward linkage. These sectors therefore have relatively high production multipliers. The same applies to bioethanol and biomass in Salta. However, biomass in Misiones and Santa Fe was an "independent" branch of activity according to the same classification, given that its BL and FL were below the average for branches of production.

Furthermore, direct and total employment coefficients are calculated by activity sector, along with their respective multipliers. The direct requirement is the number of employees per gross production value (GPV) unit, and is a measure of the intensity of the use of the work factor in each activity sector. The total coefficients indicate the total number of employees resulting from increasing final demand in a given sector in a unit.

In the bioenergy sector in Santa Fe province, biodiesel and bioethanol were the two sectors with the lowest direct job requirements, which explains the particularly high value of the employment multiplier associated with them; the same applies to bioethanol in Salta.

6.3Example: estimates of direct and induced jobs and simulation results for Santa Fe, Salta and Misiones

This sections describes, as an example, results of estimates of indirect and induced jobs, and of scenario simulations carried out in Santa Fe, Salta and Misiones (FAO 2019a; 2019b; 2019c).

[27] http://datos.minem.gob.ar/dataset/estadisticas-de-biodiesel-y-bioetanol

Table 11. Information and data sources for producing RIOMs

Information		Misiones	Salta	Santa Fe
A	% of GDP of Argentina[1,2]	1,2	1,5	7,5[3]
B	Production structure: number of production sectors considered	23	28	28
C	Information sources on bioenergy production and working hypotheses	Biomass: artificial sector with a latent technology.[4] Biomass sales were assigned ad hoc 100% to electricity generation.	Bioethanol: totals obtained from MINEM information for bioethanol. Biomass: artificial sector with a latent technology.[4]	Surveys of manufacturing enterprises.
D	Uptake of value chain inputs	It was assumed that the primary bioenergy comes from mate[5] and sawmills	-	Primary production activities of maize and soybean, vegetable oils and oil refineries were identified.[6]
E	Allocation of jobs by activity secto	2010 National Census on Population, Housing and Households, adjusted to 2015.[7]	2010 National Census on Population, Housing and Households, adjusted to 2015.[8]	EAHU
F	Transactions matrix	FLQ methodology for all sectors other than bioenergy.[9]	FLQ methodology for all sectors other than bioenergy.[9]	FLQ methodology for all sectors other than bioenergy.[9]
G	Vector of household consumption	Main headings of the ENGHO and CPI weighting for the Northwest of Argentina.[10]	Main headings of the ENGHO and CPI weighting for the Northwest of Argentina.[10]	Main headings of ENGHO and CPI weighting for Santa Fe.
H	Criterion of consistency[11]	Adjustment of provincial consumption with the rest of the final demand.	Adjustment of provincial consumption with the rest of the final demand.	Exports by province of origin and adjustment of consumption.

[1] Measured at constant prices in 1993.
[2] Estimated by MINPROD based on INDEC information.
[3] Provincial Institute of Statistics and Census (IPEC, 2016). GGP Gross Geographic Product 1993-2015 Preliminary Results, Santa Fe Province, May.
[4] Similar technology was assumed with respect to the bioenergy surveys for Santa Fe province.
[5] The gross production value (GPV) was estimated for mate by taking the cost structures and sales from the supply and use tables and IOM designed by MINAGRO for 2008. Specifically, the information used was for tonnes of mate produced in 2015, at prices current as per Resolution 142/2015 of the former Ministry of Agriculture, Livestock and Fishery of the Nation, according to information from the National Mate Institute (INYM).
[6] Activities were identified based on price information from the Rosario Grain Exchange*, production data for the province** and the 2008 agricultural IOM. The GPV for these crops was estimated, taking the cost structures and sales from the supply and use tables designed by MINAGRO for 2008. Specifically, the information used was for tonnes of soybean and maize produced in 2015 and the average prices were taken from the Rosario Grain Exchange to strengthen the GPV.
[7] Observatory of Employment and Business Dynamics of the MTEySS and Annual Survey of Urban Households (EAHU).
[8] Observatory of Employment and Business Dynamics of the MTEySS.
[9] Cost structures are derived from the surveys of enterprises in Santa Fe province (FAO, 2019a).
[10] According to the August 2017 CPI methodology of INDEC.
[11] Adjustments completed to close supply with demand in each sector with the usual IOM techniques for balancing matrices.

* https://www.santafe.gov.ar/index.php/web/content/view/full/111304/(subtema)/93664
** https://www.indec.gob.ar/nivel4_default.asp?id_tema_1=3&id_tema_2=5&id_tema_3=31

Source: Produced by the authors based on FAO (2019a; 2019b; 2019c).

Indirect and induced jobs

Provincial indirect and induced jobs can be estimated using the employment indicators and calculation of direct jobs for bioenergy production.

International studies suggest that renewable energies create an even larger number of indirect than direct jobs (Lehr *et al*., 2008). This can be confirmed in the production of biofuels (biodiesel and bioethanol) inthe provinces of Argentina studied, for which estimates of direct and induced jobs are shown in Table 12.

This international study result is not, however, confirmed in the case of energy production from biomass in Misiones and Santa Fe. In these provinces, estimates showed considerably lower values for indirect jobs than direct jobs, as these activities have relatively short value chains. The use of waste (mainly agricultural) for bioenergy *in situ* does not, in fact, stimulate the development of new stages in the value chain.

In the case of Salta, however, as only MSW and waste and sewage from Salta city were considered involving treatment and processing, the analysis included collection, transport and logistics stages, which expand the value chain and create indirect jobs.

Table 12. Estimate of indirect and induced jobs in Santa Fe, Salta and Misiones, based on the calculated multipliers, in jobs and coefficients, in 2017

	Direct jobs			Mult. 1 (coeff.)			Mult. 2 (coeff.)			Indirect jobs			Induced jobs		
	Misiones	Salta	Santa Fe	Misiones	Salta	Santa Fe	Misiones	Salta	Santa Fe	Misiones	Salta	Santa Fe	Misiones	Salta	Santa Fe
Biodiesel	-	-	671	-	-	6,19	-	-	8,58	-	-	3484	-	-	1601
Bioethanol	-	278	76	-	3,58	2,54	-	4,51	3,71	-	716	117	-	260	89
Biomass	3516	67	82	1,19	3,80	1,20	1,36	4,78	1,71	677	188	17	592	65	41
Total	“	345	829	“	3,62	5,36	“	4,56	7,45	“	920	3617	“	326	1731

Source: Produced by the authors based on FAO (2019 a; 2019b and 2019c). [see separate file for table 12]

Simulation scenarios

Using the models presented, possible scenarios were simulated for the bioenergy sector of the three provinces. They include external shocks, public policies, increased investment, economic crises and others. To choose the scenarios, officials responsible for designing policies were consulted, who stated which, in their opinion, were the most relevant options, including possible impacts on courses of action planned for the sector.

The most common simulations consider scenarios in which bioenergy production is increased using largely the existing installed capacity and/or making new investments aimed at increasing production capacity. The simulations can also consider replacing the demand for conventional energy with bioenergy - in other words, an increase in bioenergy production would compensate for a reduction in fossil fuel production.

The simulation results are expressed as changes in production and in jobs (direct, indirect and induced, and by worker groups) which would occur in each scenario. The estimated demand for labour can be compared with the existing labour supply in provinces estimating gaps. This information is useful for planning occupational training policies. A further exercise is to establish the target value of jobs to be created and to estimate, using the model, how much production and/or investment should be increased to achieve this result.

The main simulation scenarios applied in the three province studies mentioned are shown below:

1. Increase in bioenergy production, using part of the idle capacity or at the expense of an increase in production capacity.
2. Increase in investments to expand the production capacity of bioenergy plants.
3. Replacement of conventional energy, such as electricity, fuel and others, with energy generated from biomass.
4. Impact of the potential energy based on biomass: by simulating scenarios, the production costs and investment necessary to expand production to the potential levels determine by the WISDOM method, are estimated.

Results obtained in the exercises carried out for Santa Fe

The results of the study of green jobs in bioenergy in Santa Fe province are shown hereafter (FAO, 2019a). The scenarios were chosen to be able to demonstrate both energy aspects (increased production) and impacts by employment category of workers (jobs by gender) of these same simulations.

a) Scenario of increased production

PROD-1 (using idle capacity): Simulates the increase in bioenergy production to achieve the full use of the installed capacity. To calculate idle capacity, annual production was compared with plant capacity, measured for biodiesel in tonnes/year (t/year), for bioethanol in cubic metres per year (m^3/year) and for biomass as the average idle capacity of biogas (m^3/year), and electrical energy in megawatts per year (MW/year). Table 13 shows the results obtained.

Table 13. Increase in production by using idle capacity (PROD-1). Direct, indirect and induced requirements for production and jobs in Santa Fe in 2015.

		ΔX					ΔL				
		Direct	Total 1	Total 2	Mult 1	Mult 2	Direct	Total 1	Total 2	Mult 1	Mult 2
Biodiesel	12,0%	2 486	5 454	6 346	2,19	2,55	268	1 662	2 302	6,19	8,58
Bioethanol	34,2%	34	54	66	1,61	1,98	8	19	28	2,54	3,71
Biomass	296,0%	111	128	157	1,15	1,41	41	49	70	1,20	1,71
Total		2 631	5 636	6 569	2,14	2,50	317	1 731	2 400	5,46	7,57

Note: ΔX: increase in production (GPV) in millions of ARS in 2015; ΔL: increase in jobs (number of employees); Total 1: Direct + indirect impact on production or employment of the open model; Total 2: Direct + indirect + induced impact on production or employment of the closed model; mult 1 and mult 2: multipliers of production or employment for the open and closed models, respectively.

Source: FAO (2019a).

In production terms, one notes that the multiplier effect for both models more than doubles the direct effect: 2.14 and 2.50 for the open and closed models, respectively. The direct requirement for jobs due to the increase in production is 317 new jobs, amounting to a total of 1731 for direct and indirect jobs (open model). If induced jobs are also considered, it amounts to 2400 employees (closed model). The employment multipliers are high, due to the effect of biodiesel, which, as mentioned earlier, has a high labour productivity.

PROD-2 (expansion of production capacity): Simulates an increase in production beyond the full use of the installed production capacity, considering the expansion in production capacity which would be achieved if a series of investment projects which are planned were carried out, identified following a consultation with social stakeholders at provincial level (FAO, 2019a). To calculate the effect of new plants, an increase in production was applied, equal to the relation between the new capacity and the existing capacity, for each bioenergy category. In other words, it is assumed that the current capacity used remains constant. Table 14 shows the results obtained.

In the case of biomass, for example, part of the 296% increase is explained by the 62 MW cogeneration facility, 25 MW of which were allocated in the second round of the RenovAr Programme.

Direct employment is higher (349) than in the previous case, as the biomass sector (cogeneration and biogas) has a higher work intensity than biofuels.

Table 14. Increase in production by increasing total capacity (PROD-2). Direct, indirect and induced requirements for production and jobs in Santa Fe in 2015

		ΔX					ΔL				
		Direct	Total 1	Total 2	Mult 1	Mult 2	Direct	Total 1	Total 2	Mult 1	Mult 2
Biodiesel	12,0%	745	1 634	1 901	2,19	2,55	80	498	690	6,19	8,58
Bioethanol	34,2%	115	184	227	1,61	1,98	26	66	96	2,54	3,71
Biomass	296,0%	656	756	927	1,15	1,41	243	292	414	1,20	1,71
Total		1 516	2 574	3 054	1,70	2,02	349	856	1 200	2,45	3,44

Note: ΔX: increase in production (GPV) in millions of ARS in 2015; ΔL: increase in jobs (number of employees); Total 1: Direct + indirect impact on production or employment of the open model; Total 2: Direct + indirect + induced impact on production or employment of the closed model; mult 1 and mult 2: multipliers of production or employment for the open and closed models, respectively.

Source: FAO (2019a).

b) Impact by employment category

The impact of PROD scenarios is analysed here in terms of their effect by employment category. These scenarios are considered to be relevant for assessing the impact in a context where potential growth is high. The results are presented in terms of employment multipliers, per million Argentine pesos (ARS) in 2015 spent on the construction of plants or increased production. The results are structured by gender, formal educational level and age.

Table 15 shows multipliers separately by gender for the two scenarios proposed. For example, for biodiesel (open model), the multiplier 6.19 can be broken down into 4.86 for men and 1.33 for women. That is, for each direct job in biodiesel production, total jobs are created of 1.33 for women and 4.86 for men.

Table 15. Employment by gender (PROD-1). Direct, indirect and induced job requirements in Santa Fe in 2015

Sector	Open			Close		
	Women	Men	Mult	Women	Men	Mult
Biodiesel	1,33	4,86	6,19	2,14	6,44	8,58
Bioethanol	0,35	2,19	2,54	0,75	2,96	3,71
Biomass	0,05	1,15	1,20	0,22	1,49	1,71
Total	1,74	8,20	9,93	3,11	10,88	13,99
	17%	83%	100%	22%	78%	100%

Source: FAO (2019a).

As regards the gender characteristics of direct jobs, employment in the sector is predominantly male: only 10.6% of jobs are held by women. Women account for 35.6% of all persons employed in Santa Fe province. The results show that the increase in production (PROD-1) creates a lower proportion of female jobs than the average for the province.

Table 16 shows the results by educational level. In Santa Fe in 2015, 36.4% of workers had completed primary education only; 28.6% had completed secondary education and the remaining 35% had received incomplete or complete higher or university education.

Table 16. Employment by educational level (PROD-1). Direct, indirect and induced job requirements in Santa Fe in 2015

Sector	Open					Closed				
	Inc.Prim	Prim.	Sec.	High/Univ	Mult.	Inc Prim	Prim.	Sec.	High/Univ	Mult.
Production Scenario										
Biodiesel	0,22	2,25	2,38	1,35	6,19	0,28	3,02	3,16	2,12	8,58
Bioethanol	0,08	1,10	0,71	0,65	2,54	0,11	1,48	1,09	1,03	3,71
Biomass	0,01	0,18	0,83	0,17	1,20	0,03	0,35	1,00	0,33	1,71
Total	0,31	3,53	3,92	2,17	9,93	0,42	4,85	5,24	3,48	13,99
	3%	36%	39%	22%	100%	3%	35%	37%	25%	100%

Note. Inc. Prim.: employees with no education or with incomplete primary education; Prim.: employees with complete primary education; Sec.: employees with incomplete or complete secondary education; High./Univ.: incomplete or complete higher or university education.

Source: FAO (2019a).

Workers in the bioenergy sector had mainly achieved complete secondary education, primarily with a technical orientation (mechanical, electrical, chemical, agricultural). Senior posts are held by persons with a university level education, mainly engineers (chemical, industrial and environmental). However, the simulation shows a demand for total labour with a formal education similar to the average for the province.

Table 17 shows the multipliers by age range. In the bioenergy sector, most jobs are concentrated between the ages of 25 and 45 years, in line with the average for the province. This job structure is also reflected in the simulation results

Cuadro 17. Empleo por edad (PROD-1). Requerimientos directos, indirectos e inducidos de empleo en Santa Fe, en 2015

Sector	Abierto						Cerrado					
	<25	25-34	35-49	50-59	>59	Mult	<25	25-34	35-49	50-59	>59	Mult
ESCENARIO PRODUCCIÓN												
Biodiésel	0,62	1,63	2,42	0,93	0,59	6,19	0,89	2,28	3,29	1,30	0,82	8,58
Bioetanol	0,23	0,68	1,03	0,32	0,28	2,54	0,36	1,00	1,45	0,50	0,39	3,71
Biomasa	0,13	0,32	0,44	0,19	0,12	1,20	0,19	0,46	0,62	0,27	0,17	1,71
Total	0,99	2,64	3,88	1,43	0,99	9,93	1,45	3,73	5,36	2,06	1,39	13,99
	10%	27%	39%	14%	10%	100%	10%	27%	38%	15%	10%	100%

Source: FAO (2019a).

The example given shows the value of this type of analysis for informing the design of public policies. For the three provinces studied, the simulations confirm the potential offered by bioenergy both for achieving greater regional economic integration and for creating new jobs. The exercise actually made it possible to determine what would be the demand for job profiles corresponding to different scenarios of sector expansion defined based on public policy actions planned by policy makers at provincial level.

The results showed that, in addition to production, policies for sector expansion, labour policies must be designed and implemented to facilitate the inclusion of women and young people in this value chain. They also showed the type of professional skill that would be required, which may not be present in the region and which might even be a factor limiting local sector expansion in the future. This information provides a valuable opportunity for reviewing professional expertise and technical college curricula.

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ANNEXES

ANNEX 1 – ACTIVITIES AND USEFUL TOOLS FOR MANAGING THE STUDY

Planning and organization prior to field tasks are key to achieving the results expected of the study. As its aim is to take a snapshot of employment in bioenergy in a province at a given time, the study must be conducted quickly and effectively. Based on the experiences accumulated in the Santa Fe, Salta and Misiones studies, a series of practical guidelines is proposed here, including a possible table of contents, a timetable and further information relating to data sources which can be used to enhance the analysis.

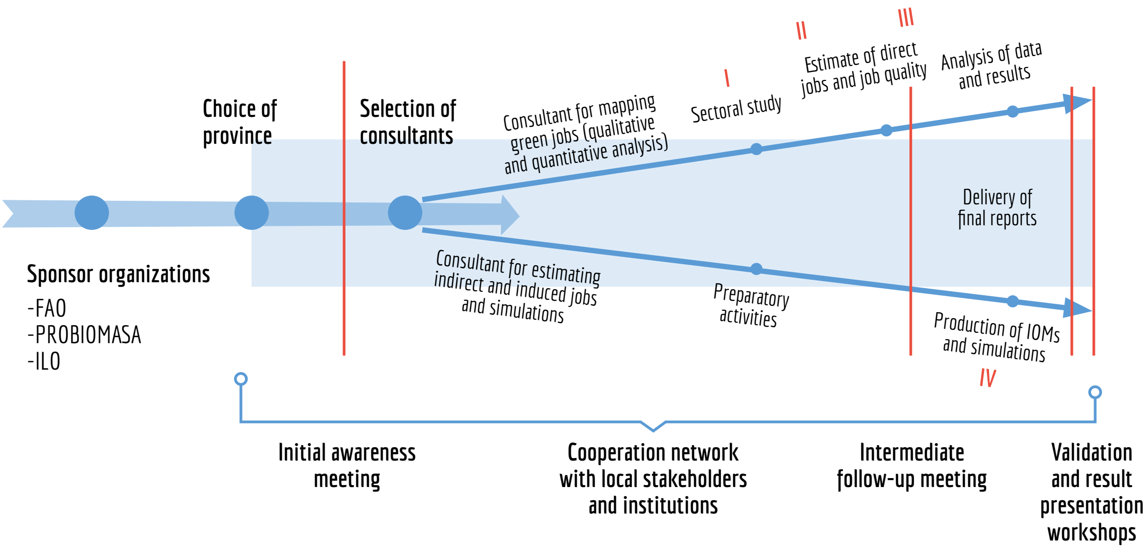
The key stakeholders in provincial bioenergy and the importance of networking

The following figure summarizes the main stages in the study of green jobs in the bioenergy sector at provincial level. The numbers in red represent the four main components: i) sectoral study, ii) estimate of direct jobs, iii) study of job quality and iv) simulations.

The red vertical lines represent study phases when it is advisable to hold coordination meetings, to strengthen the cooperation network and to improve the quality of the work. From the selection of the province and the consultants up to the presentation of the results, the cooperation and communication network between the various stakeholders and institutions has a cross-cutting role throughout the study. The aim of this network is to connect all the parties –both public and private– associated with the sector.

ORGANIZING COORDINATION MEETINGS BETWEEN THE VARIOUS STAKEHOLDERS AND INSTITUTIONS STRENGTHENS THE COOPERATION NETWORK AND IMPROVES THE QUALITY OF THE WORK.

Figure A1.1 Main stages of the province-based study of green jobs in bioenergy



Source: Produced by the authors

An effective cooperation network offers: i) the opportunity to progress the studies, incorporating interdisciplinary knowledge and specific information sources which the different social stakeholders involved could contribute; ii) agreement beforehand which increases the validity of the study results when they are presented and discussed, and iii) orientation of the study according to the requirements of its possible users.

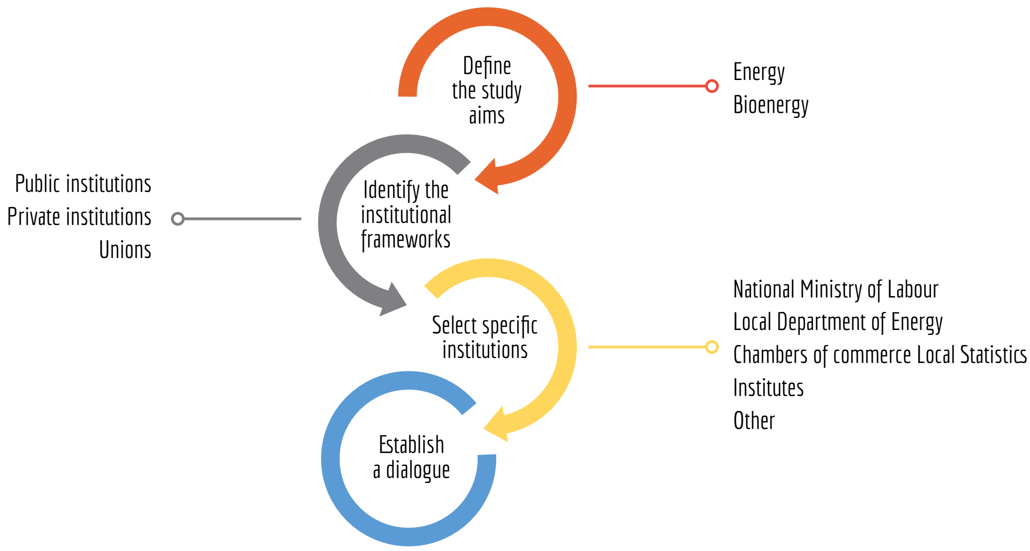
The aim of the cooperation network is to involve the most relevant stakeholders (ministries, employers, unions, academics and others) in the development of the province-based studies. This involvement will not only improve the quality and technical validity of the study, but also make the results more useful to public institutions.

The first stage in constructing a cooperation network involves informing provincial stakeholders that the study is being conducted. This firstly requires identifying the main institutions involved, and secondly developing a schedule of events (for example, meetings and presentations) to be attended by representatives of the institutions.

The following guidelines may help in selecting the institutions which should be involved in this network: the first stage is to outline the study themes; the second is to identify the institutional frameworks operating in the themes identified; the third is to select the institutions specifically concerned with the study themes; and the fourth and most important is to establish a dialogue with the representatives of the institutions, with the aim of presenting the study to them.

It is also important to identify at this stage which are the main obstacles and risks in developing the study. Labour disputes in the sector, adverse climate events (floods or droughts) or situations of high political unrest are a few examples.

Figure A1.2 Stages in constructing a networking strategy



Source: Produced by the authors

In particular, cooperation with provincial departments –mainly of Energy and Labour– is key to achieve some of the main aims of the study (see Chapter 4).

Once the cooperation network has been established, the participatory monitoring of the study can be planned. This involves smooth communication between the parties aimed at enhancing the work in terms of material and information, as well as obtaining help if barriers and challenges are encountered during the study. Finally, the last stage involves organizing two workshops –one for validation of the results and one for their presentation– with the key social stakeholders involved in the sector and with experts. Both workshops aim to carry out a critical analysis of the results obtained, and thus guarantee a validation process.

It is then important to have a dissemination strategy aimed at increasing the social value of the study conducted.

Proposed table of contents

The province-based studies of green jobs in the bioenergy sector seek to generate a series of studies that are comparable with one another. It is therefore important that not only do they use the methodologies and conceptual criteria presented in chapters 3 to 6, but that they also contain a given number of sections so that they are similar in structure.

A table of contents based on the structure of the study of green jobs in the bioenergy sector in Santa Fe is proposed below (FAO, 2019a). It should be noted that the contents proposed in the following table are linked to chapters 2 to 6 of this handbook[28].

[28] It is important to note that, although the methodological and conceptual aspects do not vary between provinces, they must be included in each report to facilitate their interpretation, in case they are disseminated separately.

Figure A1.3 Proposed table of contents

LIST OF TABLES
FOREWORD
1. INTRODUCTION
2. METHODOLOGICAL AND CONCEPTUAL ASPECTS
2.1.Definition of bioenergy and its main characteristics
2.2. Bioenergy and its presence in the national and provincial system
2.3. Definition of green employment
2.4. Bioenergy and employment
3. BIOENERGY SECTORS AND VALUE CHAINS IN THE PROVINCE
3.1.Production characteristics of the province
3.2. Labour situation in the province
3.3. Potential supply of biofuels at provincial level
3.4. Regulatory and legal framework of bioenergy in the province
3.5. Bioenergy in the province: general information, key stakeholders
3.6. Informality in the sector and its value chain
4. MAPPING GREEN EMPLOYMENT IN THE BIOENERGY SECTOR IN THE PROVINCE
4.1. Direct jobs in the bioenergy sector
4.2. Occupational structure by bioenergy type
4.2.1. Example: Liquid biofuels
4.2.2. Example: Biogas
4.3. Skill requirements in the sector
4.3.1. For personnel
4.3.2. Profiles with unmet demand
4.4. Final comments
5. ESTIMATING INDIRECT JOBS AND SIMULATION SCENARIOS
5.1. Regional input-output models
5.2. Estimating IOMs in the province
5.3. Estimating indirect and induced jobs
5.4. Background and scenarios
5.5. Results of simulations
5.6. Conclusions and extensions
6. JOB QUALITY IN BIOENERGY IN THE PROVINCE
6.1. Analytical scope and methodology
6.2. Job quality in bioenergy in the province based on decent **WORK INDICATORS**
6.2.1. Formalization and stability
6.2.2. Social security
6.2.3. Other factors
6.3. Final comments
7. POLICIES FOR INCREASING GREEN EMPLOYMENT IN THE BIOENERGY SECTOR IN THE PROVINCE
8. CONCLUSIONS
BIBLIOGRAPHY
ANNEXES

Source: Produced by the authors based on the table of contents in FAO (2019a).

Proposed timetable

The time factor is key when progressing the study. Choosing the most suitable period for conducting it can facilitate the field study. The strategy involves an analysis of the province and sector circumstances, including those conditions which affect the efficiency of the main institutional partners involved in the study. For example, carrying out the recording proposed in chapters 4 and 5 during a period of tension between social partners, or at times of administrative change, can be counterproductive for the study aims. It is therefore important to identify an appropriate time.

In order to facilitate the organization of the work, a timetable is proposed below which can serve as a basis. Firstly, the preparatory activities described in Chapter 2 of this handbook, which include an analysis of the characteristics of the sector, the employment framework of the province and the regulatory and legal context, should cover the first two weeks of the study. Secondly, it is calculated that, owing to its dependence on the sources used, the characterization of stakeholders in bioenergy is an activity that cuts across the whole timetable, with two particularly important weeks (week 1 and week 6). Thirdly, recording –the data gathering stage– is the phase that requires the most time (60% of the total). Finally, the phases of data analysis and production of the qualitative and quantitative results are planned to cover the remaining two weeks of the study.

Figure A1.4 Proposed study timetable

Activity*		Estimated time	Timetable (in weeks, based on 45 actual working days)						
Preparatory activities	Analysis of legal and regulatory framework	2 weeks	1	2	3	4	5	6	7
	Analysis of sector characteristics	2 weeks	1	2	3	4	5	6	7
	Analysis of employment framework	2 weeks	1	2	3	4	5	6	7
	Characterization of stakeholders in bioenergy	2 weeks	1	2	3	4	5	6	7
Data gathering	Recording of qualitative and quantitative data	4 weeks	1	2	3	4	5	6	7
Data analysis and discussion	Quantitative analysis	2 weeks	1	2	3	4	5	6	7
	Qualitative analysis	2 weeks	1	2	3	4	5	6	7
	Estimate of indirect and induced jobs and employment simulations	Parallel with the other activities	1	2	3	4	5	6	7

* The consultants who carry out the qualitative/quantitative analyses and the estimate of indirect and induced jobs will not necessarily be the same.

Data collection can be considered to be finished when the results are sufficiently complete to cover or be extended to the plants as a whole. As necessary conditions for the study to be considered complete, the following information has been added:

- the bioenergy enterprises as a whole have been contacted and possibly recorded;
- all the existing data has been analysed;
- experts in bioenergy and employment have been interviewed;
- the technical representatives of the sponsor institutions have approved the start of the study.

The province-based study of green jobs in the bioenergy sector requires the extensive management of primary and secondary sources. The efficient use of secondary data available prior to the field studies provides guidelines for orienting the study, delimiting it and serving as a supplement to the primary data.

THE TIME FACTOR IS KEY WHEN PROGRESSING THE STUDY. CHOOSING THE MOST SUITABLE PERIOD, WHICH WILL FACILITATE THE FIELD WORK, INVOLVES ANALYSING THE PROVINCE AND SECTOR CIRCUMSTANCES, INCLUDING EVERYTHING AFFECTING THE EFFICIENCY OF THE INSTITUTIONS INVOLVED.

ANNEX 2 ENTERPRISE SURVEY FORM

General information

GENERAL INFORMATION

1) Name of the bioenergy generating plant:
2) CUIT (single taxpayer identification code):
3) Location:
4) Main activity of the enterprise which has the plant:
5) Type of energy produced:
6) Installed capacity:
7) Is it involved in any other activity?

SUPPLY OF INPUTS

1) What type of biomass is used?
2) Where is it obtained from?
3) How often is biomass received (daily, weekly, monthly)?
4) How is it transported?
5) In which province does the shipment transaction end, where income is generated?
6) What volume is received each time (m3)? What volume should be received for plants to operate at maximum capacity?

THE BIOENERGY PLANT

1) What does your plant produce (gas, electricity, fertilizer, etc.)?
2) Level of activity in the last year (as a percentage of installed capacity).
3) Installation date of the plant.
4) Last major modification: what was done?
5) Uses of the production: to whom is the energy and fertilizer sold? Is there any self-consumption?
6) What technology is used?
7) Is the supplier of the technologies used in the province/in the country or in another country?
8) Is it a turnkey plant? Which enterprises were involved in construction/commissioning the plant?
9) Is the technical service in the province? Is it national or in another country?
10) How many technical service hours were needed in the last year?
11) How many hours of external maintenance were needed in the last year?
12) Where is information obtained about obtaining technological improvements?
13) For recruiting personnel for your plant, do you liaise with universities or technological centres?
14) And for training personnel?
15) How many work shifts per day does the operation of the plant require?

ELECTRICITY GENERATION

1) Does your plant generate electricity?
2) Using what technology?
3) For what it is used? To whom is it sold?

EFFLUENT

1) What type of effluent is generated?
2) What is done with the effluent?
3) Is it treated?
4) Is there a separation process?
5) What is it used for?

Employment structure

Figure A2.1 Form for recording employment structure

Activity	Position	Responsibility	Number of workers					How many women work?	Level of training required			
			Salaried	Freelancer	Contracted	Other	Total		Professional	Technical	Operational	Unskilled
B3. ENERGY GENERATION (marcar) THERMAL ☐ ELECTRICAL ☐ COGENERATION ☐												
1- Operations												
2- Maintenance												
Total												
B3. ENERGY GENERATION (marcar) THERMAL ☐ ELECTRICAL ☐ COGENERATION ☐												
1- Operations												
2- Maintenance												
Total												
B3. ENERGY GENERATION (marcar) THERMAL ☐ ELECTRICAL ☐ COGENERATION ☐												
1- Operations												
2- Maintenance												
Total												
B5. EFFLUENT												
1- Separation												
2- Disposal												
Total												
B6. OTHER NOT PREVIOUSLY CLASSIFIED												

Demand for skills

1. TRAINING REQUIREMENTS FOR PERSONNEL

Please state which topics you think you would need to train your staff on, either to improve their performance (productivity), to incorporate new technologies or to improve safety aspects. They can be referred to specific technical aspects or to general knowledge (such as mathematical calculations, language and communication, etc.).

Subjects	Profiles or occupations that need training
Subject 1	
Subject 2	
Subject 3	

2. DIFFICULTY RECRUITING CERTAIN WORK PROFILES

Please state whether you have had difficulty recruiting workers in the last year. Specify the occupations of these workers and the main skills and abilities required.

Occupations	Main skills and abilities required
Ocupation 1	
Ocupation 2	
Ocupation 3	

Expenses and revenue

Figure A2.2 Form for recording expenses and revenue

C1. OUTGOINGS	AMOUNT (in pesos)	DETAIL				
Includes the current expenses of this plant for the year XXXX (paid or not). They should be valued at the current price at the time they were added to the production process, excluding deductible VAT.						
1.1. Spending on wages						
(Gross wages, employers' contributions and payments which do not generate social contributions. Includes meals, paid transport and other benefits.)						
1.2. Cost of materials for provision of services						
(Includes non-durable goods consumed in the production process, other than feedstock.)						
1.3. Cost of feedstock and materials consumed in production						
(Fill in the names of the feedstock in order of importance.)						
	Total	Same province	Rest of Argentina	Rest of the world	Quantity	Origen
Feedstock 1:						
Feedstock 2:						
Feedstock 3:						
Feedstock 4:						
1.4. Industrial jobs carried out by third parties						
(Fill in the names of the jobs in order of importance)						
	Total	Same province	Rest of Argentina	Rest of the world	Quantity	Origen
Services 1:						
Services 2:						
Services 3:						
Services 4:						
1.5. Contracting construction work, refurbishing or repair of equipment or infrastructure 1.6. Services provided by third parties 1.7. Contracted freight services 1.8. Electrical energy, fuel and lubricants (also for self-consumption) 1.9. Taxes						
(Includes provincial taxes -including gross revenue-, national and municipal taxes. Excludes deductible VAT, internal taxes on fuel, income and all specific taxes on goods and services.)						

1.10. Depreciation		
(Assets with more than one year of useful life corresponding to the biofuel plant, electricity generation plant or plant associated with the use of the biodigester.)		
1.11. Other current expenses		
(Including rent, IT, legal, accounting, personnel management, cleaning, security, packaging and interest expenditure.)		
TOTAL EXPENSES		
(Total of 1.1 to 1.11)	0,00	

C2. REVENUE		DETAIL
Includes the sale of goods and/or services and other current revenue of these premises corresponding to XXXX (covered in this year or not). The amounts should not include internal taxes, fuel taxes or VAT.		
2.2. Sale of goods produced by the plant		
(Includes gas, electricity, fuel and by-products.)		
	Total	
Raw material 1:		
Raw material 2:		
Raw material 3:		
Raw material 4:		
2.3. Industrial work performed by third parties		
(Includes revenue from industrial work carried out on raw material from third parties.)		
2.4. Repairs to machinery and equipment belonging to third parties		
2.5. Production for self-consumption in the enterprise (value at market prices)		
Gas		
Fuel		
Electricity		
Inputs		
Others: ________________		
2.6. Provision of services not previously classified		
Service 1: Production services		
Service 2: ________________		
2.7. Refunds and subsidies		
2.8. Other current revenue		
TOTAL REVENUE		
(total of 2.1 to 2.8)	0,00	

C3. CHANGE OF STOCKS				
Stock at the beginning and end of the period				
	Stock at XXXX		Stock at XXXX	
Raw materials and other materials		Detail:		Detail:
Finished and in-process products		Detail:		Detail:
TOTAL	0,00		0,00	

ANNEX 3 WORKER SURVEY FORM

Figure A3.1 Worker survey form

Part 1

How old are you?

Sex

Male

Female

What is your marital status?

Married or with unmarried partner

Separated, divorced or widowed

Single

Where were you born?

In this locality

In another locality in this province

In another province (specify)

In another country (specify)

Are you attending or have you attended an educational establishment (college, school, institute, university)?

Yes, I am attending one

No, I am not attending one, but I have done

I have never attended one

What is the highest educational level you have reached?

No formal education

Incomplete primary

Complete primary

Incomplete secondary

Complete secondary

Incomplete higher

Complete higher

Incomplete university

Complete university

Incomplete postgraduate

Complete postgraduate

At home

You are the main income provider (head of the household)

You are the child of the head of the household

You are the spouse of the head of the household

You have another kinship relation with the head of the household

You are not related to the head of the household

Would you like to work more hours?

Yes

No

How many hours per day do you work in this enterprise?

How many days per week do you work in this enterprise?

In addition to this job, do you have (tick all the options that apply to you)

Other work on your own account

Other work as an employee or worker

Other family work

How much take-home (net) salary did you receive last month?

When you work, or worked, overtime

You are paid for it

You are not paid for it

You did not or do not work overtime

For how long have you been working in this enterprise?

Less than one year

From one to five years

More than five years

In this enterprise, you currently

Are a regular or contracted employee (with an open-ended or permanent contract)

Are on a fixed-term contract

Are doing an internship or trial period

Are personnel of another enterprise/agency

Do not have a contract

For how much time is this work?

Less than 30 days

Less than 12 months

From one year to five years

More than five years

Do you have paid holidays in this work?

Yes

No

Do you have bonuses in this work?

Yes

No

Do you have paid sick days in this work?

Yes

No

Have you been on strike or had grievances working in this enterprise?

Yes

No

Can you take breaks during working hours?

Always

Sometimes

Never

In this enterprise

Have you ever changed to a better job (job advancement)?

Have you ever changed to a worse job?

Have you changed job several times?

Have you never changed job?

Does the enterprise provide, or has it provided, any training courses?

Yes and they are or were held during working hours

Yes and they are or were held outside working hours

No

Do you perform tasks in this enterprise which require

Professional knowledge (managerial, legal, engineering, accounting, etc.)

Technical knowledge (of mechanics, electricity, plumbing, etc.)

Knowledge to operate machines/tools/vehicles, etc.

None of the above

What do you do or what is your job in this enterprise?

Part 2

Are you satisfied with your employment in this enterprise?

- Yes
- No

In this job do you have (tick all the options that apply to you)

- Days off
- Holidays
- Sick leave
- Maternity leave
- Family leave

The age of the youngest workers at this enterprise is about

- 5 to 14 years
- 15 to 17 years
- 18 to 24 years
- Over 25 years

Do you have any medical or social cover for which deductions are made in this job?

- Yes
- No

Do you have retirement deductions for this job?

- Yes
- No

Retirement deductions are made at this enterprise

- When you join the company
- After a period
- Never

Do you have family allowances in this enterprise?

- Yes
- No

Did you sign a written contract with your employer in this enterprise?

- Yes
- No

Do you have ART/occupational risk insurance in this enterprise?

- Yes
- No

In this job do you have (tick all the options that apply to you)

- Good lighting
- Good ventilation
- Sufficient space to work
- Tolerable, low or imperceptible noise
- Comfortable temperatures
- Environment without unpleasant smells
- None of the above

Are there workers at this enterprise exposed to situations of stress, aggression or abuse?

- Always
- Sometimes
- Never

Does the employer give you equipment, clothing or tools for your protection to do this work?

- Yes
- No

Does the enterprise have emergency or alarm devices?

- Yes
- No

Do you work at night at this enterprise?

- Yes
- No

Can you take breaks during your working hours at this enterprise?

- Always
- Sometimes
- Never

Have there been serious accidents at this enterprise?

- Yes
- No

Do the machines or tools you use at this enterprise have safety devices?

- Yes
- No

Are you near to substances that are toxic or harmful to your health in this job?

- Yes
- No

Have you suffered any damage to your health or physical injury while working at this enterprise?

- Yes
- No

Are you covered by a collective labour agreement?

- Yes
- No

Are you a member of a union?

- Yes and I contribute or have reductions on the union fees
- Yes and I do not contribute or have no reductions on the union fees
- No

Can you inform union delegates of your grievances or work disputes?

- Yes
- No

How would you describe work relations between you and your employer or boss?

- Very good
- Good
- Tense
- There are no work relations

Are there union representatives in the enterprise?

- Yes
- No

Has the union resolved disputes at this enterprise?

- Always
- Sometimes
- Never

ANNEX 4 IOM METHODOLOGY AND FORMULAE FOR ESTIMATING GREEN JOBS IN SANTA FE, SALTA AND MISIONES

This annex expands on the conceptual explanation presented in Chapter 6, incorporating algebraic developments which may be useful for readers more advanced in the use of input-output matrices and SAM.

Open and closed models

The resolution of the regional model is identical with that of the national model (see Miller and Blair, 2009). The open regional model is:

(1) $x^r = (I - A^{rr})^{-1} f^r = L^{rr} f^r$

Where, x^r is the production vector of the region, I is the identity matrix, A^{rr} is the technical coefficient matrix of the region; f^r is the vector of final demand of the region, which includes purchases from other regions of the country and L^{rr} is the Leontief matrix (of direct and indirect coefficients).

The (open) model considers all final demands to be exogenous: private consumption, public expenditure, investment and exports. On this assumption, the increase in household income as a consequence of the increase in production does not generate additional demand due to greater consumption. To resolve this, the model can be closed making household income and expenditure endogenous, i.e. including households as a further sector in the model. The model is modified as follows:

(2) $\bar{x}^r = (I - \bar{A}^{rr})^{-1} \bar{f}^r = \bar{L}^{rr} \bar{f}^r$

Where $\bar{A}^{rr}$ is the matrix of technical coefficients whose last row is household income and the right-hand column household expenditure; $\bar{x}^r$ is the production vector of the region, which includes household income in the last row; $\bar{f}^r$ is the vector of remaining final demand (without the regional household consumption) and $\bar{L}^{rr}$ is the Leontief matrix (of direct, indirect and induced coefficients).

Production and employment multipliers

In addition to the simple product multipliers obtained from the open model (type I multipliers) and total product multipliers obtained from the closed model (type II multipliers), employment multipliers are estimated. Simple and total production multipliers are calculated by adding together the coefficients in each column in the Leontief matrix.

(3) $m(o)_j = \sum_{i=1}^{n} l_{ij}$

(4) $\bar{m}(o)_j = \sum_{i=1}^{n+1} \bar{l}_{ij}$

For each sector j, the first expression is the simple multiplier of output $(m(o)_j)$ and the second the total multiplier $(\bar{m}(o)_j)$, with l_{ij} and $\bar{l}_{ij}$ being the coefficients of the Leontief matrices of the open and closed model, respectively.

The employment coefficients are obtained by changing the unit of measurement of the coefficients of matrices $\bar{L}^{rr}$ and $\bar{L}^{rr}$, , using, for example, the number of persons employed per product unit. For this, the row vector must first be obtained with the number of employees per activity sector: h'. The associated coefficient is then calculated, $h'_c = h'\hat{x}^{-1}$. Finally, these coefficients are used to weight each row in the Leontief matrix. In algebraic notation, the simple and total employment multipliers are:

(5) $m(h)_j = \sum_{i=1}^{n} h_{c,i} l_{ij}$

(6) $\bar{m}(h)_j = \sum_{i=1}^{n+1} h_{c,i} l_{ij}$

To interpret the results better, given the change in unit of measurement of the Leontief matrix, type 1 (open model) and type 2 (closed model) multipliers are constructed.

(7) $m(h)_j^1 = \frac{m(h)_j}{h_{c,j}}$

(8) $\bar{m}(h)_j^2 = \frac{\bar{m}(h)_j}{h_{c,j}}$.

Methodology for estimating regional IOMs

Three major groups of methods are considered to regionalize matrices. The criterion for selecting the most suitable method in specific cases will depend on the availability of statistics to perform the study.

- Direct techniques need to have surveys and specific sectoral information so that coefficients can be estimated at regional level. These techniques are costly, as they require special data gathering or economic censuses, and usually take a long time to process.
- Indirect techniques or statistics use available secondary statistics such as statistical yearbooks and economic and population censuses. In comparison with direct methods, indirect techniques are less accurate, although they may be faster and cheaper to perform.
- The hybrid approach combines elements of the previous techniques, and is used when a few sectors need to be studied for which primary information can be produced directly.

The following sections contain a more detailed description of the last two methods.

a) Indirect methods based on Location Quotients

To convert the national matrix into a RIOM using statistical techniques, adjustments are made to the national technical coefficients, so that they represent the production structure of the region (in terms of its technology) and its relationships with other sectors of the economy.

To obtain the RIOM of Santa Fe, location quotients (LQ) are used. Indirect methods which use LQ, in addition to the national IOM, use available statistics on employment or Gross Geographic Product. There are many applications of these indirect methods for countries such as Mexico (Dávila Flores, 2015), Finland (Flegg and Tohmo, 2013; Kowalewski, 2015), Greece (Kolokontes, 2008), Germany (Kronenberg, 2009) and Argentina (Flegg, Mastronardi and Romero, 2016; Mastronardi and Romero, 2012), among others.

The LQ methodology used starts from the assumption mentioned by Jensen, Mandeville and Karunaratne (1979). According to this, intraregional coefficients (a_{ij}^{rr}) differ from national technical coefficients (a_{ij})only by a factor of the share in regional commerce regional (lq_{ij}), as shown by equation (9).

(9) $\mathbf{a_{ij}^{rr} = lq_{ij}\, a_{ij}^{\square}}$

The sub-indices i and j refer to seller and buyer sectors, respectively, a_{ij}^{rr} is defined as the quantity of input i produced in the region which is required to produce one unit of product j, and is known as the "regional purchase coefficient".

The location quotients theory starts from the assumption that the technology in the region is similar to the country average. This means that the region can be distinguished, based on the chosen LQ, from selfsufficient sectors which lack regional imports and those which are not self-sufficient (i.e. importers from the rest of Argentina).

(10) $\begin{cases} \mathbf{a_{ij}^{rr} = lq_{ij}\, a_{ij}^{\square}} & \mathbf{si\ lq_{ij} < 1} \\ \mathbf{a_{ij}^{R} = a_{ij}^{N}} & \mathbf{si\ lq_{ij} \geq 1} \end{cases}$

In the first case, when the location quotient is less than one, the regional coefficient is a proportion (less than one) of the national coefficient, and the region is not considered to be self-sufficient and therefore has to import from other regions. In the second case, when the location quotient is greater than one, the regional coefficient is equal to the national coefficient; the region is self-sufficient and does not therefore need to import the input from other regions. The criterion causes a degree of sensitivity in self-sufficient and importer sectors, and the choice of disaggregation level to use is therefore very important and should be as great as possible.

The factor of the share in regional trade $(\boldsymbol{lq_{ij}})$ has evolved over time. The simple location quotient (SLQ) and the cross-industry location quotient (CILQ) are presented below. The former compares the share of a sector in the region with the same sector in the country.

(11) $\boldsymbol{SLQ_i = \dfrac{PBG_{i,r}/PBG_r}{PBI_i/PBI_{\square}}}$

Where $\boldsymbol{PBG_{i,r}}$ is the gross geographic product of sector $\boldsymbol{i}$ in region r, $\boldsymbol{PBG_r}$ is the total gross geographic product of region r, $\boldsymbol{PBI_i}$ is the gross product of sector $\boldsymbol{i}$ in the whole of the country, and $\boldsymbol{PBI_{\square}}$ is the gross domestic product of the country.

The cross-industry location quotient aims to measure the importance of a seller industry $\boldsymbol{i}$ in relation to the buyer industry $\boldsymbol{j}$, in a given region.

(12) $\boldsymbol{CILQ_{ij} = \dfrac{PBG_{i,r}/PBI_i}{PBG_{j,r}/PBI_j} = \dfrac{SLQ_i}{SLQ_j}}$

These coefficients usually overestimate regional sectoral multipliers as they tend to underestimate imports from other regions (Flegg, Mastronardi and Romero, 2016).

With the aim of resolving the drawbacks of SLQ and CILQ, Flegg and Webber (1997) proposed a new location quotient, the FLQ (Flegg Location Quotient), which explicitly takes account of region size. It postulates an inverse relation between region size and the tendency to import from other regions. The following formulae express how the quotient is calculated.

(13) $\boldsymbol{FLQ_{ij} = \dfrac{PBG_{i,r}/PBI_i}{PBG_{j,r}/PBI_j} \cdot \lambda^* = CILQ_{ij} \cdot \lambda^*}$

(14) $\lambda^* = \left[log_2\left(1 + {}^{PBG_r}/_{PBI_{\square}}\right)\right]^{\delta}, 0 \leq \delta \leq 1$

The FLQ is determined by the cross-industry location quotient ($CILQ$) and by a new factor, $\boldsymbol{\lambda^*}$, que pondera el tamaño (importancia) de la región en el país. which weights the size (importance) of the region in the country. This factor is determined by the base two logarithm of the quotient between the $\boldsymbol{PBG_r}$ and the $\boldsymbol{PBI}$.[29] The calculation of factor $\boldsymbol{\lambda^*}$ adds the involvement of another parameter, $\boldsymbol{\delta}$, which is related to interregional imports. When this parameter is close to one, interregional imports are greater, whereas if it is equal to zero, it is a special case in which FLQij is equal to CILQij.

b) Hybrid methods

Field recording of biomass production branches serves to estimate intermediate consumption totals, intermediate sales totals and, due to the characteristics of the surveys carried out, several of the inter-sectoral structure components of intermediate buying. This avoids measurement errors resulting from making assumptions about input technologies used in the province.

This information is therefore used in conjunction with the regional transactions matrix estimated by indirect methods. With the aim of ensuring the consistency of both sets of information, matrix balancing methods are used for the final adjustment of the matrices, such as RAS or cross entropy. RAS, also known as the bi-proportional adjustment method, is an iterative process which requires knowing the row and column totals to make an adjustment of a starting matrix (Bacharach, 1970). The cross entropy method resolves an optimization problem which minimizes a measurement of distance between a starting matrix and various calculated matrices which comply with a given number of restrictions, both technological and transactional (Robinson et al., 2001). This method is more flexible as it allows the inclusion of restrictions on regional technical coefficients, so that the estimate can be carried out with approximately the same information as the RAS method. McDougall (1999) shows that RAS is a specific example of the entropy method.

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[29] The essence of the logarithm base is that factor $\boldsymbol{\lambda^*}$is always between 0 and 1. If the region has the same size as the nation, the factor would be one and if not it would be zero.

Estimate of transaction matrices and technical coefficients

Table A4.1: Share of local and imported inputs, production structure and employment by sector in Misiones, 2015

Sec.	Description	Share IB Misiones (%)	Share IB Rest of country (%)	Share IB Imports (%)	VA FC (million $)	Struc. VA FC (%)	Employment (quantity)	Employment structure (%)
s1	Agriculture, forestry and fishing	15,2	13,1	2,5	3 208	3,9	38 327	10,6
s2	Yerba Mate	13,6	16,0	2,4	1 397	1,7	20 300	5,6
s3	Mining and quarrying	22,9	13,0	2,0	118	0,1	258	0,1
s4	Food products, beverages and tobacco	48,7	8,2	1,5	3 294	4,0	10 026	2,8
s5	Textiles and leather	21,6	7,9	4,3	153	0,2	863	0,2
s6	Paper, wood and publications	16,0	23,4	6,0	6 299	7,7	23 985	6,6
s7	Chemicals and petrochemicals	24,5	24,9	9,5	183	0,2	1 898	0,5
s8	Biomass	14,9	25,2	0,0	363	0,4	3 516	1,0
s9	Non-metallic minerals	21,3	13,0	3,8	209	0,3	397	0,1
s10	Base metals and metal products	21,0	18,5	6,7	159	0,2	1 067	0,3
s11	Machinery, equipment and precision mat.	32,5	9,1	10,1	185	0,2	466	0,1
s12	Motor vehicles and transport equipment	29,5	7,5	14,4	33	0,0	59	0,0
s13	Other manufacturing industries	17,6	0,0	0,0	675	0,8	4 383	1,2
s14	Rep., Maint. and inst. of machines and equipment	17,2	10,8	7,6	67	0,1	345	0,1
s15	Electricity gener. and distrib.	7,3	29,4	10,7	1 679	2,0	1 336	0,4
s16	Water prod. and distribution	26,8	17,4	2,7	109	0,1	1 130	0,3
s17	Construction	11,3	23,6	7,8	6 843	8,3	32 074	8,9
s18	Wholesale and retail trade	8,0	14,9	2,1	23 185	28,3	67 763	18,7
s19	Restaurantes and hotels	38,8	19,0	1,7	1 388	1,7	15 630	4,3
s20	Transport	20,4	25,6	5,0	1 992	2,4	13 409	3,7
s21	Communications	32,9	12,7	4,5	641	0,8	2 437	0,7
s22	Financial and business activities	15,5	7,4	2,0	11,308	13,8	20 184	5,6
s23	Public admin. and education	7,8	8,3	0,0	12 980	15,8	74 401	20,5
s24	Health and social services	26,0	14,5	0,0	5 534	6,7	27 422	7,6
	TOTAL	**17,9**	**14,7**	**2,8**	**82 004**	**100,0**	**362 408**	**100,0**

Note. IB: intermediate buying for Misiones, Rest of country and imports, as % of GPV; VA: variable; Struc. refers to the % of the corresponding variable with respect to the total; FC: factor costs; employment is measured in quantity of employees.

Table A4.2: Share of intermediate buying, production structure and employment by sector in Salta, 2015

Sec.	Description	Share IB Salta (%)	Share IB Rest of country (%)	Share IB Imports (%)	VA FC (million $)	Struc. VA FC (%)	Employment (quantity)	Employment structure (%)
s1	Agriculture, livestock and fishing	24,9	12,9	2,3	7 423	8,8	29 656	7,3
s2	Forestry	1,9	22,2	3,4	225	0,3	1 117	0,3
s3	Mining	10,1	20,6	0,3	6 995	8,2	1 896	0,5
s4	Food products, beverages and tobacco	50,8	2,3	1,7	3 832	4,5	21 792	5,4
s5	Sugar	45,5	7,4	1,7	295	0,3	1 851	0,5
s6	Textiles and leather	35,2	7,7	3,9	456	0,5	3 572	0,9
s7	Wood	22,0	9,8	4,7	209	0,2	2 573	0,6
s8	Paper and publications	26,9	15,0	5,7	163	0,2	1 572	0,4
s9	Biodiesel	0,0	0,0	0,0	0	0,0	0	0,0
s10	Bioethanol	62,6	0,4	0,0	127	0,1	152	0,0
s11	Biomass	69,4	0,0	0,0	27	0,0	204	0,1
s12	Oil refineries	51,4	0,8	1,3	2 127	2,5	259	0,1
s13	Rubber, chemicals and petrochemicals	32,5	6,9	3,8	174	0,2	2 817	0,7
s14	Base metals and metal products	19,4	14,7	6,7	212	0,3	2 315	0,6
s15	Machinery, equipment and precision mat.	23,3	13,2	8,3	312	0,4	858	0,2
s16	Motor vehicles and transport equip.	28,0	6,4	13,6	78	0,1	471	0,1
s17	Other manufacturing industries	0,1	0,1	0,0	1 371	1,6	5 534	1,4
s18	Rep., Maint. and inst. of mach. and equip.	24,3	7,9	7,6	37	0,0	6 564	1,6
s19	Electricity gener. and distrib.	11,5	1,0	59,8	1 578	1,9	2 677	0,7
s20	Gas distribution	67,6	23,6	34,4	19	0,0	66	0,0
s21	Water prod. and distribution	13,2	19,6	2,7	308	0,4	1 289	0,3
s22	Construction	11,4	28,9	7,8	6 421	7,6	44 780	11,0
s23	Trade, restaurants and hotels	22,3	12,7	2,0	13 395	15,8	106 317	26,1
s24	Transport	36,9	10,7	5,0	2 596	3,1	15 894	3,9
s25	Communications	33,9	11,7	4,5	1 034	1,2	4 405	1,1
s26	Financial and business activities	18,3	10,2	2,0	13 211	15,6	29 501	7,3
s27	Public admin. and education	11,5	13,8	0,0	14 695	17,3	81 935	20,1
s28	Health and social services	11,5	10,2	0,0	7 486	8,8	36 712	9,1
	TOTAL	**24,6**	**11,9**	**2,9**	**84 808**	**100,0**	**406 779**	**100,0**

Note. IB: intermediate buying for Salta, Rest of country and imports, as % of GPV; VA: variable; Struc. refers to the % of the corresponding variable with respect to the total; FC: factor costs; employment is measured in quantity of employees.

Table A4.3: Share of local and imported inputs, production structure and employment by sector in Santa Fe, 2015

Sec.	Description	Share IB Santa Fe (%)	Share IB Rest of country (%)	Share IB Imports (%)	VA FC (million $)	Struc. VA FC (%)	Employment (quantity)	Employment structure (%)
s1	Agriculture, forestry and fishing	24,1	19,1	2,3	43 677	12,2	28 767	2,5
s2	Maize	21,6	21,5	2,3	1 934	0,5	1 274	0,1
s3	Soybean	19,7	23,4	2,3	8 698	2,4	5 728	0,5
s4	Mining and quarrying and non-metal mining.	73,4	2,2	0,7	359	0,1	1 863	0,2
s5	Food products, beverages and tobacco	57,8	6,2	1,7	28 939	8,1	36 944	3,1
s6	Vegetable oils	61,8	2,2	1,7	4 647	1,3	5 935	0,5
s7	Textiles and leather	43,9	6,5	4,1	3 944	1,1	15 015	1,3
s8	Paper, wood and publications	37,5	11,2	6,2	3 664	1,0	22 245	1,9
s9	Biodiesel	63,5	8,6	0,0	407	0,1	671	0,1
s10	Bioethanol	44,3	12,0	0,0	134	0,0	76	0,0
s11	Biomass	11,2	1,4	0,0	194	0,1	82	0,0
s12	Oil refineries	2,3	34,5	8,0	8 560	2,4	536	0,0
s13	Rubber, chemicals and petrochemicals	82,5	4,6	1,0	1 378	0,4	20 623	1,8
s14	Base metals and metal products	27,6	25,8	6,8	13 559	3,8	45 627	3,9
s15	Machinery, equipment and precision mat.	25,1	23,6	10,0	11 346	3,2	10 285	0,9
s16	Motor vehicles and transport equip.	41,0	14,3	14,3	4 969	1,4	8 334	0,7
s17	Other manufacturing industries	2,1	0,4	0,8	4 491	1,3	13 699	1,2
s18	Rep., Maint. and inst. of mach. and equip.	19,5	12,8	7,6	731	0,2	5 816	0,5
s19	Electricity gener. and distrib.	12,1	6,9	58,4	2 618	0,7	7 920	0,7
s20	Gas distribution	13,0	79,8	40,9	101	0,0	709	0,1
s21	Water prod. and distribution	25,2	16,3	2,7	844	0,2	659	0,1
s22	Construction	21,9	21,8	7,8	20 137	5,6	123 820	10,6
s23	Trade, restaurants and hotels	40,3	3,1	1,9	32 784	9,2	309 381	26,4
s24	Transport	35,0	15,5	5,0	12 197	3,4	69 925	6,0
s25	Communications	37,6	8,7	4,5	6 645	1,9	13 972	1,2
s26	Financial and business activities	21,6	4,6	1,9	54 443	15,2	120 558	10,3
s27	Public admin. and education	16,1	7,9	0,0	56 443	15,8	182 599	15,6
s28	Health and social services	28,8	8,0	0,0	30 250	8,4	119 934	10,2
	Total	**35,0**	**11,5**	**3,5**	**358 089**	**100,0**	**1 172 997**	**100,0**

Note. IB: intermediate buying for Santa Fe, Rest of country and imports, as % of GPV; VA: variable; Struc. refers to the % of the corresponding variable with respect to the total; FC: factor costs; employment is measured in quantity of employees.

Source: FAO (2019a)

Estimate of Leontief multiplier matrices

Table A4.4: Forward linkages (FL) and backward linkages (BL) by sector in Misiones, 2015

Sec.	Description	Open model		Closed model	
		BL1	FL1	BL2	FL2
s1	Agriculture, forestry and fishing	1,189	1,536	1,912	2,899
s2	Yerba mate	1,162	1,208	1,770	1,666
s3	Mining and quarrying	1,274	1,079	1,648	1,083
s4	Food products, beverages and tobacco	1,603	1,522	2,208	5,640
s5	Textiles and leather	1,270	1,040	2,267	1,131
s6	Paper, wood and publications	1,190	1,430	1,673	1,612
s7	Chemicals and petrochemicals	1,301	1,129	1,776	1,225
s8	Biomass	1,191	1,192	1,740	1,295
s9	Non-metallic minerals	1,266	1,053	1,841	1,079
s10	Base metals and metal products	1,258	1,113	2,142	1,132
s11	Machinery, equipment and precision mat.	1,402	1,051	2,045	1,100
s12	Motor vehicles and transport equip.	1,364	1,007	2,168	1,013
s13	Other manufacturing industries	1,212	1,052	3,069	1,248
s14	Rep., Maint. and inst. of mach. and equip.	1,217	1,020	1,638	1,028
s15	Electricity gener. and distrib.	1,085	1,135	1,865	1,202
s16	Water prod. and distribution	1,319	1,006	1,991	1,048
s17	Construction	1,130	1,105	2,189	1,171
s18	Wholesale and retail trade	1,094	2,383	2,393	3,650
s19	Restaurants and hotels	1,540	1,300	2,136	1,780
s20	Transport	1,246	1,572	2,378	2,673
s21	Communications	1,410	1,140	1,875	1,475
s22	Financial and business activities	1,186	2,037	1,948	3,884
s23	Public admin. and education	1,097	1,009	3,465	1,270
s24	Health and social services	1,325	1,208	2,707	2,824

Note. BL1 and BL2: Backward linkages, type 1 and 2 models, respectively. FL1 and FL2: Forward linkages, type 1 and 2 models, respectively.

Source: FAO (2019c)

Table A4.5: Forward linkages (FL) and backward linkages (BL) by sector in Salta, 2015

Sec.	Descripción	Open model		Closed model	
		BL1	FL1	BL2	FL2
s1	Agriculture, livestock and fishing	1,358	2,517	1,987	4,656
s2	Forestry	1,027	1,103	2,779	1,107
s3	Mining	1,125	2,645	1,709	2,992
s4	Food products, beverages and tobacco	1,715	1,406	2,348	5,437
s5	Sugar	1,660	2,410	2,267	2,627
s6	Textiles and leather	1,502	1,129	2,452	1,498
s7	Wood	1,286	1,068	2,157	1,091
s8	Paper and publications	1,369	1,037	2,109	1,071
s9	Biodiesel	1,000	1,000	1,680	1,000
s10	Bioethanol	2,029	1,002	2,532	1,016
s11	Biomass	2,116	1,249	2,669	1,258
s12	Oil refineries	1,608	1,818	1,996	2,496
s13	Rubber, chemicals and petrochemicals	1,420	1,048	2,058	1,069
s14	Base metals and metal products	1,261	1,095	2,242	1,112
s15	Machinery, equipment and precision mat.	1,315	1,060	2,048	1,099
s16	Motor vehicles and transport equip.	1,374	1,011	2,233	1,022
s17	Other manufacturing industries	1,001	1,059	3,126	1,251
s18	Rep., Maint. and inst. of mach. and equip.	1,326	1,012	1,813	1,016
s19	Electricity gener. and distrib.	1,147	1,178	1,793	1,271
s20	Gas distribution	1,932	1,012	2,826	1,020
s21	Water prod. and distribution	1,181	1,008	1,824	1,071
s22	Constrution	1,145	1,120	2,129	1,223
s23	Trade, restaurants and hotels	1,312	2,601	2,456	4,441
s24	Transport	1,537	1,707	2,741	2,945
s25	Communications	1,454	1,201	1,937	1,668
s26	Financial and business activities	1,232	2,175	1,972	4,815
s27	Public admin. and education	1,152	1,010	3,374	1,400
s28	Health and social services	1,316	1,215	2,805	3,153

Note: BL1 and BL2: Backward linkages, type 1 and 2 models, respectively. FL1 and FL2: Forward linkages, type 1 and 2 models, respectively.

Source: FAO (2019b)

Table A4.6: Forward linkages (FL) and backward linkages (BL) by sector in Santa Fe, 2015

Sec.	Description	Open Model		Closed model	
		BL1	FL1	BL2	FL2
s1	Agricultural, forestry and fishing	1,361	2,982	1,928	5,142
s2	Maize	1,333	1,436	1,887	1,454
s3	Soybean	1,300	1,823	1,837	1,913
s4	Mining and quarrying and non-metal mining.	2,279	1,251	2,911	1,288
s5	Food products, beverages and tobacco	1,917	2,031	2,393	6,607
s6	Vegetable oils	1,873	2,086	2,401	2,300
s7	Textiles and leather	1,741	1,311	2,543	1,798
s8	Paper, wood and publications	1,655	1,400	2,279	1,544
s9	Biodiesel	2,193	1,060	2,552	1,090
s10	Bioethanol	1,606	1,018	1,976	1,026
s11	Biomass	1,153	1,136	1,412	1,141
s12	Oil refineries	1,033	1,528	1,225	1,739
s13	Rubber, chemicals and petrochemicals	2,582	2,317	3,208	2,858
s14	Base metals and metal products	1,403	1,828	1,869	1,968
s15	Machinery, equipment and precision mat.	1,387	1,141	1,796	1,355
s16	Motor vehicles and transport equip.	1,652	1,361	2,138	1,580
s17	Other manufacturing industries	1,035	1,063	3,150	1,204
s18	Rep., Maint. and inst. of mach. and equip.	1,296	1,038	1,693	1,051
s19	Electricity gener. and distrib.	1,152	1,243	1,757	1,309
s20	Gas distribution	1,165	1,032	1,619	1,038
s21	Water prod. and distribution	1,386	1,018	2,062	1,039
s22	Construction	1,365	1,119	2,353	1,167
s23	Trade, restaurants and hotels	1,678	2,403	2,680	3,437
s24	Transport	1,503	1,893	2,628	3,125
s25	Communications	1,554	1,340	2,024	1,954
s26	Financial and business activities	1,316	2,522	2,009	3,746
s27	Public admin. and education	1,242	1,012	3,581	1,309
s28	Health and social services	1,468	1,235	2,942	2,301

Note. BL1 and BL2: Backward linkages, type 1 and 2 models, respectively. FL1 and FL2: Forward linkages, type 1 and 2 models, respectively.
Source: FAO (2019a)

Table A4.7: Direct, indirect and induced employment multipliers, by sector in Misiones, 2015

Sec.	Description	Direct req.	Total requirement		Employment multiplier	
			type 1	type 2	type 1	type 2
s1	Agriculture, forestry and fishing	7,406	8,075	9,160	1,090	1,237
s2	Yerba mate	8,833	9,602	10,515	1,087	1,190
s3	Mining and quarrying	1,331	1,849	2,410	1,389	1,810
s4	Food products, beverages and tobacco	0,746	3,872	4,779	5,189	6,405
s5	Textiles and leather	2,846	3,804	5,300	1,337	1,863
s6	Paper, wood and publications	1,822	2,294	3,019	1,259	1,657
s7	Chemicals and petrochemicals	3,416	4,122	4,836	1,207	1,415
s8	Biomass	4,887	5,828	6,651	1,192	1,361
s9	Non-metallic minerals	1,082	1,600	2,463	1,479	2,277
s10	Base metals and metal products	3,343	3,920	5,246	1,173	1,569
s11	Machinery, equipment and precision mat.	0,972	1,905	2,870	1,960	2,951
s12	Motor vehicles and transport equip.	0,569	1,473	2,680	2,591	4,713
s13	Other manufacturing industries	4,568	5,057	7,843	1,107	1,717
s14	Rep., Maint. and inst. of mach. and equip.	3,100	3,588	4,220	1,157	1,361
s15	Electricity gener. and distrib.	0,806	1,106	2,277	1,373	2,826
s16	Water prod. and distribution	4,577	5,277	6,286	1,153	1,373
s17	Construction	2,615	2,881	4,471	1,102	1,710
s18	Wholesale and retail trade	2,169	2,343	4,292	1,080	1,979
s19	Restaurants and hotels	3,210	4,560	5,455	1,420	1,699
s20	Transport	2,885	3,393	5,092	1,176	1,765
s21	Communications	1,514	2,293	2,991	1,514	1,976
s22	Financial and business activities	1,184	1,538	2,682	1,299	2,265
s23	Public admin. and education	4,804	5,013	8,566	1,044	1,783
s24	Health and social services	2,589	3,302	5,375	1,276	2,076

Source: FAO (2019c)

Table A4.8: Direct, indirect and induced employment multipliers, by sector in Salta, 2015

Sec.	Description	Direct req.	Total requirement		Employment multiplier	
			type 1	type 2	type 1	type 2
s1	Agriculture, livestock and fishing	2,108	2,766	3,598	1,312	1,707
s2	Forestry	3,285	3,358	5,679	1,022	1,728
s3	Mining	0,181	0,389	1,163	2,150	6,430
s4	Food products, beverages and tobacco	1,486	3,160	3,998	2,127	2,691
s5	Sugar	1,645	3,064	3,869	1,863	2,352
s6	Textiles and leather	2,967	4,240	5,499	1,429	1,853
s7	Wood	7,156	8,156	9,310	1,140	1,301
s8	Paper and publications	4,605	5,667	6,648	1,230	1,443
s9	Biodiesel	0,108	0,108	1,008	1,000	9,339
s10	Bioethanol	0,390	2,260	2,927	5,795	7,505
s11	Biomass	2,291	4,437	5,170	1,937	2,257
s12	Oil refineries	0,022	0,306	0,821	13,765	38,876
s13	Rubber, chemicals and petrochemicals	8,360	9,271	10,117	1,109	1,210
s14	Base metals and metal products	6,015	6,889	8,189	1,145	1,361
s15	Machinery, equipment and precision mat.	1,239	2,248	3,219	1,815	2,599
s16	Motor vehicles and transport equip.	2,184	3,565	4,703	1,633	2,154
s17	Other manufacturing industries	3,439	3,442	6,256	1,001	1,819
s18	Rep., Maint. and inst. of mach. and equip.	98,302	99,317	99,963	1,010	1,017
s19	Electricity gener. and distrib.	1,311	1,434	2,290	1,094	1,746
s20	Gas distribution	1,311	2,305	3,490	1,757	2,661
s21	Water prod. and distribution	2,326	2,746	3,598	1,181	1,547
s22	Construction	3,515	3,965	5,267	1,128	1,499
s23	Trade, restaurants and hotels	4,705	5,419	6,936	1,152	1,474
s24	Transport	2,531	3,390	4,986	1,339	1,970
s25	Communications	1,700	2,853	3,492	1,678	2,054
s26	Financial and business activities	1,345	1,937	2,917	1,441	2,169
s27	Public admin. and education	4,155	4,547	7,489	1,095	1,803
s28	Health and social services	2,888	3,758	5,730	1,301	1,984

Source: FAO (2019b)

Table A4.9: Direct, indirect and induced employment multipliers, by sector in Santa Fe, 2015

Sec.	Description	Direct req.	Total requirement		Employment multiplier	
			type 1	type 2	type 1	type 2
s1	Agriculture, forestry and fishing	0,312	0,607	1,014	1,946	3,247
s2	Maize	0,312	0,650	1,047	2,081	3,353
s3	Soybean	0,312	0,583	0,968	1,866	3,100
s4	Mining and quarrying and non-metal mining	1,200	3,591	4,045	2,992	3,369
s5	Food products, beverages and tobacco	0,193	0,733	1,074	3,797	5,566
s6	Vegetable oils	0,193	0,831	1,211	4,309	6,274
s7	Textiles and leather	1,140	2,047	2,622	1,795	2,299
s8	Paper, wood and publications	2,332	3,632	4,080	1,558	1,750
s9	Biodiesel	0,108	0,668	0,926	6,192	8,578
s10	Bioethanol	0,226	0,574	0,840	2,537	3,710
s11	Biomass	0,370	0,445	0,632	1,204	1,707
s12	Oil refineries	0,018	0,049	0,187	2,718	10,349
s13	Rubber, chemicals and petrochemicals	1,604	4,121	4,570	2,570	2,850
s14	Base metals and metal products	1,202	1,837	2,172	1,529	1,807
s15	Machinery, equipment and precision mat.	0,288	0,912	1,206	3,170	4,191
s16	Motor vehicles and transport equip.	0,237	1,018	1,366	4,287	5,753
s17	Other manufacturing industries	2,504	2,569	4,086	1,026	1,632
s18	Rep., Maint. and inst. of mach. and equip.	4,438	4,974	5,258	1,121	1,185
s19	Electricity gener. and distrib.	2,153	2,344	2,779	1,089	1,291
s20	Gas distribution	2,153	2,284	2,610	1,061	1,212
s21	Water prod. and distribution	0,367	1,100	1,585	3,002	4,324
s22	Construction	2,886	3,498	4,207	1,212	1,458
s23	Trade, restaurants and hotels	4,551	5,234	5,953	1,150	1,308
s24	Transport	2,205	2,920	3,727	1,324	1,690
s25	Communications	0,823	1,753	2,090	2,131	2,541
s26	Financial and business activities	1,263	1,825	2,322	1,444	1,838
s27	Public admin. and education	2,454	2,877	4,556	1,172	1,856
s28	Health and social services	2,226	3,081	4,139	1,384	1,860

Source: FAO (2019a)

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