

Assessing the biomass potential for supplying an increased blending mandate in Argentina with a focus on food security

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Abstract

The impacts caused by the use of traditional fossil fuels on climate change have created a need to substitute these with sustainable forms of energy. In the transport industry, specifically, the use of biofuels has been employed in recent decades to reduce the reliance on fossil fuels. Blending mandates are a viable policy tool which can be used to reduce GHG emissions of the transport sector by mixing fossil fuels with a set percentage of biofuels. However, the use of food crops to generate biofuels can create competition over resources and requires a detailed assessment to safeguard food security. FAO have developed the BEFS analysis tool to assess the bioenergy potential of a country's biomass whilst ensuring that food security is not compromised. Using Argentina as a case study, this thesis applies the BEFS RA tool to analyse Argentina's existing biomass potential with an increase in blending mandate as the main consideration. The energy crops selected for analysis are sugarcane and maize for ethanol, and soybean for biodiesel. The agro-economic data for each crop were collected from a range of sources including governmental databases and agricultural reports. Assessment of potential biomass feedstock available, profit margin analysis of crop production, and financial assessment of the feasibility of construction of biofuel plants was carried out. The results provide an initial assessment of the viability of increasing the blending mandate. Although an increase in the blending mandate from energy crops is supported by this research, the economic instability of Argentina is an obstacle for the industry and governmental support for the policy must exist to ensure its viability.

Key words: Bioenergy, blending mandates, food security, BEFS, Argentina.

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Abbreviations and Acronyms

- BEFS Bioenergy and Food Security
- (BEFS) AF Analytical Framework
- (BEFS) RA Rapid Appraisal
- FAO Food and Agriculture Organisation
- GAEZ Global Agro-Ecological Zoning
- GDP Gross Domestic Product
- GHG Green House Gas
- IRR Internal Rate of Return
- LCA Life Cycle Assessment
- MMT Million Metric Tonnes
- Mtoe Million tonnes of oil equivalent
- NPV Net Present Value
- SAyDS Secretaria de Ambiente y Desarrollo Sustentable
- SVO Straight Vegetable Oil
- VAT Value Added Tax

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Chapter 1: Introduction

1.1 Background

The improvement of energy systems is an on-going process in human development. In recent history, the aim of the energy sector is to develop renewable forms of energy which help to mitigate climate change (Moomaw et al., 2011). Examples of these include solar, wind and bioenergy, amongst others (Boyle, 2004). Biofuels have long been viewed as a sustainable substitute to traditional fossil fuels, especially in the transport sector (IEA, 2018). However, bioenergy is one of the most controversial forms of renewable energy and has divided opinion of researchers (Singh et al., 2016). This is due to first-generation biofuels being produced from food crops and therefore potentially affecting food security (Fischer, 2009). The competing nature of first-generation biofuels and food prices is not unique. Similar competitive relationships exist with both water and land use and therefore these should be mitigated to ensure that the developed supply chains are sustainable (Rulli et al., 2016). Adequate assessment of the potential networks and minimising the change in land use are two of the main mitigating factors which can be undertaken (Lago et al., 2019). Furthermore, ensuring the feedstock production can be maintained year on year is also key to ensuring long-term sustainability (Bauen et al., 2009).

Argentina is an interesting case study due to the important role the bioenergy industry plays within the country, compounded by the economic volatility the country is experiencing (World Bank, 2020; Mathews et al., 2008). Recent inflation has caused manifold problems for the industry due to price freezes which have made production insolvent (Biodiesel Argentina, 2020). The current instability offers opportunities to strengthen the industry and to enact changes which will support further growth. However, any changes in the industry should be accompanied by a detailed assessment of the potential impacts on food prices, employment opportunities and the cost of fuel (Wesseler & Drabik, 2016). Given that the majority of biofuel in Argentina is produced from food crops, ensuring that sustainable practices are followed is paramount to guaranteeing that these new developments offer improvements to sustainability and lead to a reduction in GHG emissions.

1.2 Problem Statement

The importance in safeguarding food security when developing first-generation bioenergy networks is paramount (Mohr & Raman, 2013). The use of food crops to produce energy can give rise to competing interests relating to food prices, land and, water use and therefore needs to be properly considered to ensure environmental and social benefits from these developments (Janssen, 2011).

Crop management practices and complete assessments of the potential networks should be performed to guarantee that these are net positive (Lago et al., 2019).

The agriculture sector plays a key role in the Argentinian economy and the feedstock potential of the country has led Argentina to become a leader in biofuel production (Timilsina et al., 2013). A blending mandate was subsequently introduced as a policy tool to provide a national market for biofuels. This refers to the blending of biofuels with traditional fossil fuels at ratios mandated by the government. However, the current economic recession experienced in Argentina since 2018 has had detrimental impacts on the bioenergy industry. Costs have continued to increase, driven by over 50% inflation on the previous year, and the December 2019 price freeze on biofuels has led to production costs that are higher than the market price of biofuels (Joseph , 2020; World Bank, 2019). The reduced feedstock prices due to the coronavirus pandemic have alleviated the costs slightly, however, biofuel plants have been operating at a loss and the stability of the industry is at risk (Agrovoz, 2020; Biodiesel Argentina, 2019/2020). Furthermore, the law supporting the biofuel mandate is set to expire in 2021 and offers opportunities to support the struggling industry and increase the market for biofuels.

The economic uncertainty and political pressures experienced by Argentina created statistical uncertainty in the country as data were not effectively collected which can hinder the assessment and implementation of effective policy (Antón et al., 2019). However, to ensure that sustainable bioenergy networks are developed, a detailed assessment of the techno-, socio- and economic impacts of these new developments must be performed. This will help to guarantee sustainability and safeguard volatile food prices. Furthermore, this supports the objectives of the Argentinian government to strengthen the agricultural industry and improve the development of bioenergy (Gobierno de Argentina, 2016).

1.3 Research Objectives

The objective of this research is to assess the potential impacts that increasing the blending mandates for biofuels in Argentina can have on the economic, environmental, and social contexts, by using the BEFS tool to analyse the potential feedstock available and the end uses.

1.4 Research Questions

Main Research Question:

- Can an increase in the blending mandate of Argentina be supported by the available biomass feedstock whilst safeguarding food security?

Research Sub-Questions:

- 1. What are the main bioenergy and food security considerations in the country context?
- 2. Does effective crop management provide the necessary feedstock for increased biofuel capacity?
- 3. What is the current state regarding the production of biofuels in Argentina? Is increasing the production of biofuels for the transport sector a viable option? What impact has the current price freeze had on the profitability of biofuel production?

1.5 Thesis Outline

This thesis is comprised of three sections. The introduction and the literature review are presented in Chapters 1 and 2 and the research design in Chapter 3. The results obtained from the BEFS tool are presented in Chapters 4, 5 and 6 and correspond to the modules that make up the framework. Finally, the main discussion and the conclusion sections are presented in Chapters 7 and 8. The full results for the three modules are presented in the Appendices.

Chapter 2: Background Research

This aim of this chapter is to identify and review the main concepts relating to bioenergy and food security to provide the background context for the tool selection.

2.1 Bioenergy Overview

Bioenergy refers to the renewable energy which can be extracted from biomass sources. Biomass sources include oil crops and starch crops, lignocellulosic materials (residues) and wet biomass such as organic waste and manure, amongst others (FAO, 2014). This energy is derived from the sequestration of carbon in organic matter through photosynthesis. Therefore, this energy type is considered renewable as crops can be regrown to offset the carbon emitted through combustion (Dahiya, 2014). Bioenergy exists in various forms depending on the feedstock material supplied and the conversion technique used. Conversion techniques include combusting solid biomass to produce heat and/or power, generating electricity from biomass to supply rural communities with electricity, combined heat and power (CHP) and industrial biogas processes to generate power for large-scale activities, or producing liquid biofuels for the transportation sector (FAO, 2014).

2.2 Food Security Overview

The concept of food security has had a variety of definitions throughout the last 50 years. The commonly accepted definition used today was agreed at the 1996 FAO Food Summit (Upton et al., 2016). Food security exists when "all people at all times have physical, social, and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2003: 313).

Upton et al., (2016: 137) designed a set of axioms through which this definition can be visualised hierarchically using four parameters: availability, access, utilisation, and stability. The link between these four parameters and the FAO definition are detailed below:

- 1. Scale Axiom The scale required encompasses "all people".
- 2. Time Axiom The time concept relates to stability as variation exists over time and should be understood "at all times".
- Access Axiom This axiom relates to both availability as well as accessibility and depends on "physical, social and economic access".
- Outcomes Axiom This axiom refers to the concept of utilisation and is related to ensuring the available food resources for an "active lifestyle".

2.3 Bioenergy and Food Security

The production of first-generation biomass and food crops are closely related due to both industries utilising the same resources. The competing nature of these two industries creates an important nexus between energy and food which must be adequately considered to ensure novel bioenergy networks do not affect the local food supply.

2.3.1 Impacts of Bioenergy Development

The development of new bioenergy sources offers exciting possibilities for both social development as well as environmental improvements (Wu et al., 2018). The replacement of fossil fuels and the increased energy security offered by these networks are counterbalanced by issues relating to water scarcity, soil degradation and impacts on food security (Benites-Lazaro et al., 2020). The role of bioenergy can be categorised into Northern and Southern requirements. Northern economies view bioenergy as a means of reducing carbon emission, to meet decarbonisation targets, and to improve energy security and mitigate higher global oil prices. Southern economies focus on the use of bioenergy to improve rural poverty and electrification (Clancy, 2013). Although there is some overlap in uses, the contrast in the application of bioenergy between developed and developing countries demonstrates the adaptability of bioenergy networks depending on the requirements and available resources (Clancy, 2013).

Synergies of Bioenergy Production

Examples of synergies developed through bioenergy supply chains include combining the production of bioenergy with waste management techniques to improve process sustainability and to help introduce concepts of circularity (de Boer & van Ittersum, 2018). Assessing agricultural crop residues can provide the basis for the creation of new bioenergy networks (Scarlat, 2010) which can have a positive role in reducing waste and carbon emissions (Rajmohan et al., 2019). Furthermore, these new networks can produce energy sources for off-grid communities and can help to modernise energy sources in rural areas. This can greatly impact the quality of life of the local population as it offers improvements to energy consumption, food production, living conditions and job prospects (Pollock et al., 2019).

Drawbacks of Bioenergy Production

The production of bioenergy can create important drawbacks within the water-land-food nexus. To ensure sustainable development of bioenergy networks, it is of paramount importance that a detailed analysis of potential conflicts regarding resource allocation is performed to ensure the creation of sustainable energy networks (Rulli et al, 2016). Developments in bioenergy can lead to loss of

biodiversity and can greatly impact the local environment by polluting the water supply and degrading the topsoil (Wu et al., 2018). Furthermore, the increased use of food as bioenergy feedstock may impact food prices which creates important social problems. Finally, public opinion surrounding bioenergy is far from positive due to the negative media portrayal which can hinder the creation of bioenergy sources (Kline et al., 2017).

2.3.2 Sustainable Bioenergy Development

The production of bioenergy is not intrinsically positive, nor negative. The effect that developing bioenergy networks have are dependent on their implementation (Roos et al., 1999). If correctly implemented, bioenergy sources can provide positive impacts to both social and economic development and environmental improvements. However, if implemented incorrectly, these can cause permanent damage to local & global ecosystems (Wu et al., 2018). Therefore, an approach which considers the sustainability of bioenergy should be adopted to ensure first-generation biofuels are a net positive to potential bioenergy developments.

FAO (2014) has developed a systematic approach for the creation of sustainable bioenergy networks. This approach is visualised in figure 1 below and consists of various analysis tools:

- Context Analysis, Objectives and Mobilisation: this section focusses on analysing the specific country and provides a comprehensive framework to assess bioenergy development. The BEFS RA tool helps to provide a base knowledge which can be expanded upon.
- Guidelines, integrated national assessment and strategy development: this section provides further detailed analysis into risk prevention and environmental safeguarding. It can also help identify knowledge gaps which hinder the development of sustainable bioenergy.
- Assessment, evaluation, and response: this section evaluates the sustainability of the bioenergy networks and helps to finalise the creation and implementation of sustainable networks.

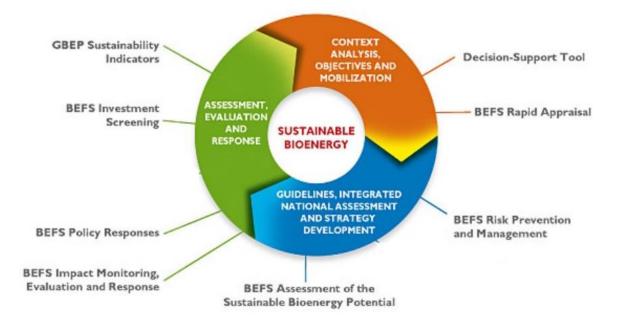


Figure 1: FAO Support Package to Decision-Making for Sustainable Bioenergy (FAO, 2014).

2.4 Bioenergy and Blending Mandates

2.4.1 Overview

Biofuels have been added to fuels to combat climate change since the early 2000s and were thought to initially provide energy security and a reduction in pollution. This was achieved through introducing blending mandates, tax breaks and investment support (FAO, 2016). Biofuel blending mandates are the major policy incentives which governments use to encourage the mix of biofuels into traditional fossil fuels for use in the transport sector (de Gorter and Just, 2009). Blending mandates are used to reduce the consumption of fossil fuels and therefore increase the sustainability of the transport sector (Bonaldo, 2020). Furthermore, the set blending mandates have provided a relatively constant demand in a constantly evolving industry (Rouhany and Montgomery, 2018). This has helped to drive investment into biofuel plants which in turn has made the production of biofuels more competitive when compared to their fossil fuel equivalent (Bonaldo, 2020). The concurrent use of both blending mandates and tax credits as bioenergy policies create limitations and reverses the potential impacts of the tax credit. This is because subsidising biofuels through tax credits ends up subsidising the consumption of fossil fuels, especially at lower blends. Blending mandates offer various advantages over tax credits and should be used as an independent policy to achieve the best results (de Gorter and Just, 2009). Interestingly, most of the biofuel production is used in the domestic market and the international trade market has remained relatively stagnant over the past decade (FAO, 2016; Rouhany and Montgomery, 2018). The reliance on food crops to supply the biofuel demand required has led countries to scrutinise the use of first-generation biofuels and has driven the creation of second- and third-generation options. This is especially true in Europe where the use of food crops to generate biofuels has been limited to encourage new generation methods and to reduce the reliance on imported biofuels (Drabik and Venus, 2019). However, first-generation biofuels are still used worldwide, and can have positive impacts if food security and food prices are safeguarded.

2.5 Biofuel Impacts on GHG

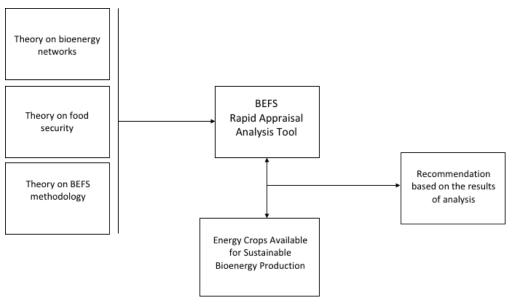
Although first-generation biofuels are considered a sustainable energy source, there is an ongoing debate to assess the impact on climate change. This is due to the competing nature of biofuels with food security, water use and changes in land use (Barnabè et al., 2012). The use of biofuels is still considered a sustainable alternative to fossil fuels, particularly in the transport sector, and the potential negative impacts on the environment should be mitigated to ensure that the maximum sustainability potential is met (Barnabè et al., 2012). The main consideration regarding the impact of biofuels on sustainability relates to changes in land use and the related GHG emissions. The production of energy crops to be used as feedstock is dependent on the land used and therefore increases in biofuels can pose serious risks to the environment (Rouhany and Montgomery, 2018). The use of existing farmland and idle cropland in the production of biomass should be selected and deforestation should be avoided due to the unsustainable nature of production. Furthermore, indirect changes in land use should also be avoided. When complete LCAs are performed on biofuels networks, the real impact of these can be properly assessed (Barnabè et al., 2012). Taking into consideration the current blending mandates of over 40 countries, Timilsina and Mevel (2013) found that the land used to produce biomass is critical to the sustainable impact of biofuels. Their study found that if the current bioenergy targets are met through first-generation biofuels, the use of forests is the critical factor in determining the sustainability of global biofuel use. If the targets are implemented by 2020, the use of forests would create a net increase in GHG until 2043. However, if only farm and croplands are used to produce the required biomass, the net increase in GHG would exist only until 2021, after which a decrease in GHG occurs (Timilsina and Mevel, 2013). Although the use of first-generation biofuels has come under scrutiny recently, the mitigation of GHG emissions in the transport sector is still a viable option to reduce emissions due to biofuels producing less pollutants than traditional fossil fuels (Rouhany and Montgomery, 2018).

Chapter 3 – Research Design & Methods

This chapter presents the overarching research design used within this report to provide answers to the formulated questions. The main objective of this section is to provide a clear outline of the data required in the research and to provide an operational framework which provides clear structure. The systematic formulation of the analytical framework provides a detailed structure to guide the progression of this project whilst adhering to the needs of the objective (Verschuren & Doorewaard, 2010). Furthermore, the analysis tool used to achieve the research objectives is presented in this section.

3.1 Research Framework

As described by Verschuren & Doorewaard (2010, p.65), "A research framework is a schematic representation of the research objective" which contains the required "steps that need to be taken in order to achieve [the research objective]". This ensures that the required knowledge to perform a successful project is systematically presented and available to the researcher. Figure 5 provides the initial research framework used in this project.





3.2 Research Strategy

The research strategy of a project aims to provide an overall plan to follow in order to achieve the research objectives. The research strategy is combined with a research method which directs the collection and analysis of data (Johannesson & Perjons, 2014). A series of conditions exists to select the appropriate research strategy. These are: how the research question is framed, the level of control

the investigator has over the events, and whether the focus is contemporary or historic (Yin, 2014). In relation to case studies, explanatory questions should be asked and the focus should be on contemporary events where the investigator has no control over the events (Yin, 2014). As defined by Yin (2015: 194), a case study is "an empirical inquiry that closely examines a contemporary phenomenon within its real-world context".

This project is focussed on a contemporary phenomenon (blending mandate policy) considered within the real-world context of Argentina, with an emphasis on food security. The research method employed is the BEFS tool created by the FAO. This tool is a valid method to achieve the research objectives as it clearly directs the collection and analysis of data with the objective of ensuring that food security is guaranteed. Due to the nature of the research objective and the question formulated, and considering the research method selected for the analysis, the use of a case study has been selected as the most appropriate research strategy. The selection of a single-case study as opposed to a multiple-case study is dictated by the research method and the scope of the research.

3.2.1 Case study credibility

The credibility of a case study can be strengthened by addressing validity and reliability. Validity refers to "identifying correct operational measure for the concepts being studied and defining the domain to which the study's findings can be generalised" (Yin, 2014: 40). In this case, as the aim of the study is framed towards ensuring food security, the selection of the analysis tool helps to support the research validity. Furthermore, the BEFS tool helps to build a chain of evidence by directing the data collection.

Reliability is defined as "demonstrating that the operations of the study can be repeated with the same results" (Yin, 2014: 40). As the BEFS tool clearly and systematically guides the user in the data collection, it can be expected, that the same results will be achieved if followed correctly. Furthermore, the previous application of the analysis tool in past research also helps to support the reliability of the tool selection and therefore the research project. Finally, the use of trusted data sources and cross-referencing data wherever possible ensure that the data collected is both valid and reliable.

Due to the specific context of this case study, the findings have limited scope to be generalized. As discussed, Argentina's complex and unique economic and geo-social situation renders it an outlier and therefore worthy of study. Valid outlying case studies may stress economic models, and so provide a beneficial feedback loop to improve their resilience. Hence, the findings from this study may, in part, be generalised by the improvement of the models used.

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3.3 Methods

3.3.1 BEFS Overview

The importance of adequately assessing the relationship between bioenergy networks and the impact on food security can be explained by the competing nature of these two factors. The FAO's mandate includes eliminating world hunger and achieving food security in developing countries (FAO, 2020). As discussed in section 2.1, bioenergy networks can have a positive impact on rural poverty and electrification, and therefore should be considered in supporting the transition to ending poverty in developing countries. To support the use of bioenergy networks and ensure that they are sustainable and coordinated with food security, FAO has developed the BEFS Approach. This approach aims to provide reliable bioenergy network assessments which consider social, environmental, and economic parameters and is especially focussed on improving rural conditions and utilising agricultural residues (FAO, 2014).

3.3.2 BEFS Analytical Framework

The overall BEFS approach consists of providing a framework which can be used by countries to analyse the development of sustainable bioenergy and can assist with rural development and policy formulation. Food security in developing countries is paramount to the development of new bioenergy networks as they may compete for the same resources. BEFS offers the user a flexible framework which can be adapted to suit the requirements or resources of the target crop or industry to be analysed. Depending on how developed bioenergy networks are or on the desired end use of the products, the framework can be tailored to individual users and provide very specific results. The analytical framework developed for this assessment tool is presented in figure 2 below.

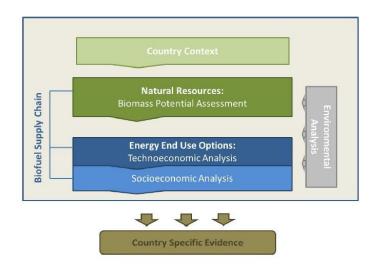


Figure 3: BEFS Analytical Framework (FAO, 2014)

The framework provided considers the unique characteristics of the country analysed and assesses the potential biomass available from the various biomass options. These are considered alongside the main food crops to ensure food security is integrated within the framework. Furthermore, environmental, economic, and social sustainability are also integrated within the framework and help ensure that a complete analysis is conducted. The analytical framework for this approach can be applied using a more simplified tool (BEFS Rapid Appraisal) or a more in-depth tool (BEFS Detailed Analysis). The BEFS Rapid Appraisal tool used in this research project will be detailed below (FAO, 2014).

3.3.3 Rapid Appraisal Analysis Tool

The Rapid Appraisal (RA) tool is the simplified version included in the BEFS AF which is used to provide an initial understanding of the potential bioenergy networks available within a country, region, or industry. Although the RA tool provides a preliminary assessment, it still supplies a complete analysis of bioenergy networks from production to use. The analysis can be performed quickly and with minimum data, is applicable to any country or region and provides an overview of the potential markets available. The tool is comprised of three modules, namely Country Status, Natural Resources, Energy End-Use, which combine to distinguish the selected bioenergy route and provide the results for it. Figure 3 below presents the BEFS AF for the RA method and the three modules relevant to this framework are described below.

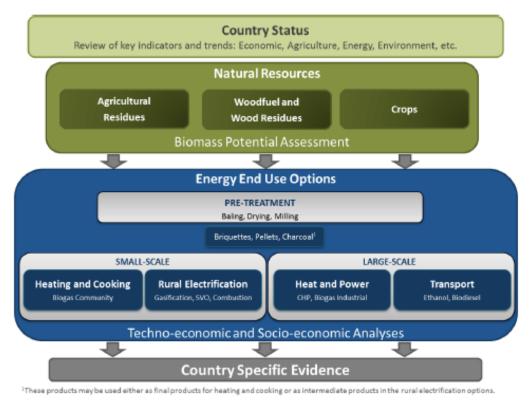


Figure 4: Analytical Framework for BEFS RA Tool (FAO, 2014).

Country Status Module

This module provides the key information concerning the food, agricultural and energy sectors and is the basis of the subsequent modules. The key information required includes the country context, key food commodities, the trade position regarding the key food crops and the overall energy consumption by sectors, in households as well as fuel consumption in the transport sector.

The required data ensures that food security is the major consideration to the results of the analysis. The energy data in this module ensures that the use of bioenergy within the country is understood and helps to identify areas which hold potential for bioenergy use.

Natural Resources Module

The second module allows the available feedstock to be quantified. This module is comprised of three components which analyse the three biomass feedstocks available. These are: Crops, Agricultural Residues and Wood Residues. This module allows the user to analyse all three components or to select the most appropriate depending on country needs.

The Crops component consists of the following tools:

- The Crop Production tool which analyses the potential production of biofuels from the various biomass feedstocks selected in the country status module.
- The Crop Budget tool which provides preliminary techno-economic information including profitability and production costs and revenues.

The Agricultural Residues component consists of the following tools:

- The Crop Residues tool which analyses the potential feedstock available from crop waste to produce solid biomass.
- The Livestock Residues tool which analyses the potential feedstock available from animal manure to produce biogas.

The Woodfuel and Wood Residues component consists of the following tools:

- The Forest Harvesting tool analyses the bioenergy potential of forest harvesting and forest residues.
- The Wood Processing Residues tool analyses the potential wood processing residues available.
- The Forest Plantations tool analyses the potential biomass resources available from bioenergy plantations and provides a cost-benefit analysis of these.

Energy End-Use Module

The final module assesses the potential bioenergy uses. The various applications are considered within the five submodules and are dependent on the previous tools. These submodules are: Intermediate or Final Products, Heating and Cooking, Rural Electrification, Heat and Power and Transport. As with the natural resources module, the submodules, can be analysed as a whole or the most relevant pathway can be selected and analysed individually.

The Intermediate or Final Products submodule analyses the potential production of solid biomass, namely, Briquettes/Pellets and Charcoal which can be used for heating or cooking.

The Heating and Cooking submodule analyses the potential biogas available at a community level. The component analyses the instalment and production of biogas using various technologies and provides techno-economic and socio-economic analysis of this installation.

The Rural Electrification submodule analyses the potential supply of electricity to off-grid rural areas. This consists of three separate components which are Gasification, SVO and Combustion.

The Heat and Power submodule analyses the potential production of heat and electricity from local biomass resources. The two components relevant to the submodule are CHP (cogeneration) and Biogas Industrial.

The Transport submodule analyses the potential for liquid biofuel production from the feedstock availability estimated in the Natural Resources module at a small, medium, or large-scale of production.

The Pre-Treatment submodule analyses the cost of preparing the biomass feedstock for the final production stage and provides added detail to the overall bioenergy network. It can be performed before the Energy End-Use submodule is selected. Both the Biogas Community and Transport components contain a pre-treatment analysis in their specific tool.

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Interlinkage between Modules

The relationships and links between the three modules are displayed in figure 4 below. As stated previously, the Country Status module helps to build the required data for the subsequent modules. Furthermore, the Natural Resources module collects important feedstock data which is utilised in the Energy End-Use module. These data are also linked to the food security analysis performed in the Country Status module and therefore ensure that the final energy module is dependent on the food security analysis performed initially.

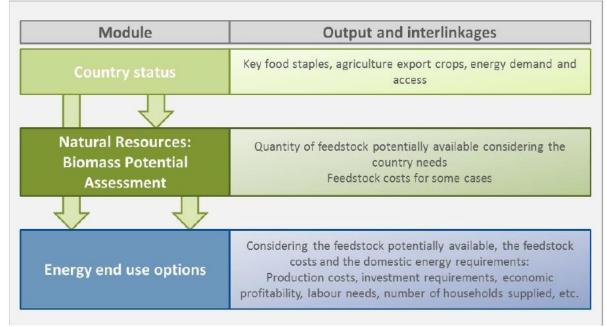


Figure 5: Interlinkage between the Rapid Appraisal modules (FAO, 2014).

Table 1 below helps to summarise the various modules, submodules, components, and tools which form the overall framework of the BEFS RA tool.

Table 1: BEFS RA module structure (FAO, 2014).

Module	Submodule	Component	Tool
Country Status		Country Status	Country Status
		Crops Agricultural Residues	Crop Production
			Crop Budget
			Crop Residues
Natural			Livestock Residues
Resources			Forest Harvesting
		Woodfuel and Wood	Wood Processing
		Residues	Residues
			Woodfuel Plantations
Briquet	Pre-Treatment	Pre-Treatment	
	Intermediate or	Briquettes	Briquettes
	Pellets	Pellets	
		Charcoal	Charcoal
	Heating &	Biogas Community	Biogas Community
Energy End-Use	Cooking		
	Rural	Gasification	Gasification
	Electrification Combustion	SVO	SVO
		Combustion	Combustion
	Heat & Power	CHP (Cogeneration)	CHP (Cogeneration)
		Biogas Industrial	Biogas Industrial
	Transport	Transport	Transport

3.4 Data Collection

The data required to answer the research questions and the source of data and accessing methods are presented in the table 2 below.

Table 2: Data Collection for each research question.

Research Question	Data Required	Sources
What are the main bioenergy and food	Country Overview: Agricultural & Energy	FAO STATS, The World Bank, Argentine Census
security considerations in the country context? (SRQ1)	Agricultural Trade	FAO STATS
	Energy Demand and Supply	IEA, Governmental Datasets
Does effective crop management provide the necessary feedstock for	Crop Production: Yields and Land Use	FAO STATS, Governmental Datasets, USDA Data, OECD-
increased biofuel capacity? (SRQ2)	Crop Budget: Prices and Costs	FAO dataset, GAEZ, Scientific Literature
What is the current state regarding the production of biofuels in Argentina? Is increasing the production of biofuels for the transport sector a viable option? What impact has the current price freeze had on the profitability of biofuel production? (SRQ3)	Industrial Production Costs and Financial Information	Governmental Datasets, BEFS RA Tool, Quiminet
Can effective energy crop management simultaneously support an increase to blending mandates and safeguard food security in Argentina? (MRQ)	Results obtained from the analysis tool	BEFS RA Modules: Country Status, Natural Resources, Energy End-Use

3.5 Data Analysis

This research project utilises quantitative methods for the data analysis.

3.5.2 Validation of Data Analysis

A variety of techniques exist to perform data validation on a research project. This project utilises existing data to perform an analysis of the bioenergy potential in Argentina. The Four Design tests can be used to validate the data; the test which is most relevant to the project is construct validity. This consists of using multiple sources and establishing a chain of evidence at the data collection phase of the project (Kidder & Judd, 1986). The selection of reliable sources of data, such as the UN or governmental datasets, is key to ensuring that the data selected are adequate for the research project.

3.5.3 Analytical Framework

The analytical framework developed in this chapter is presented in figure 6 below.

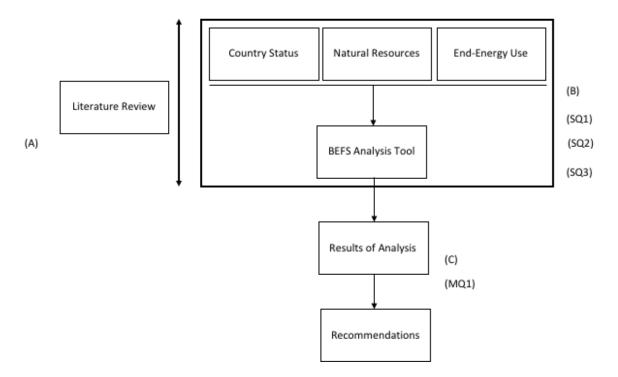


Figure 6: Analytical Research Framework.

This framework consists of four phases which are described below:

- (A) Relevant literature review to provide background to the research.
- (B) Collection of data required for BEFS analysis tool.
- (C) Assessing results from the tool.
- (D) Providing recommendations based on the result section.

3.6 Research Limitations

One of the key limitations on the study was the time available to perform the analysis. A more indepth analysis could have been undertaken with more time to assess other aspects of the bioenergy industry such as forest and crop residues or the use of sugar molasses as the feedstock for biofuels as well as other potential end use options.

Another important limitation was the data availability. Due to the country's economic volatility and high rates of inflation, there were several datasets that either were not available or were not complete. Hence, some datasets needed to be extrapolated from previous years. Although the costings of sugarcane production were adjusted for inflation, the accuracy of extrapolating the costings using only inflation raised some precision issues. Furthermore, the crop budget section of the tool created some significant limitations in the results of the research due to the required data parameters. The level of detail required was too precise when considering the scope of the project and therefore a different method had to be employed. I discuss the new method in section 5.5 of the report.

Finally, the exact blending mandates which should be adopted and the implementation of such cannot be answered by this analysis. A further survey analysis of various stakeholders, including biomass and biofuel producers, could be performed to gain further insight into the needs of the industry and the best available improvements.

Chapter 4: Country Status

The full results for this module and all the data discussed within it are presented in Appendix 1 and are summarised in this chapter.

4.1 Introduction

Bioenergy supply chains involve a variety of different sectors and requires an understanding of each one at the country level to perform a detailed analysis. The main sectors relevant to bioenergy networks are food and agriculture, energy and trade and economic indicators. The country status module helps to develop the key understandings in each area and creates a framework which ensures the focus of the analysis is based around food security. The structure of this module is depicted in figure 7, below, and shows the breakdown of the various sections.

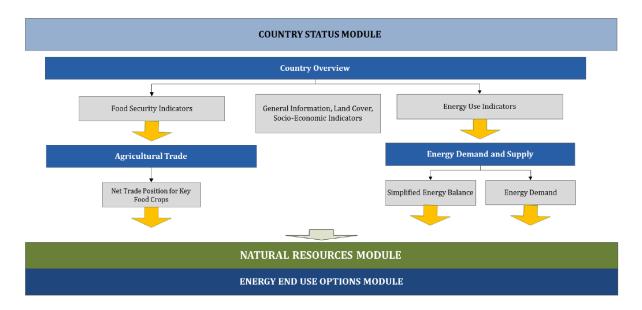


Figure 7: Structure of Country Status Module (FAO, 2014).

4.2 Scope and Objectives

The objective of this module is to provide an overview of the key sectors related to bioenergy by selecting key indicators relating to food security, agricultural trade, energy use, demand and supply and more general information regarding the country analysed.

4.3 Country Overview

4.3.1 Population

Argentina has a total population of 43,417,000 with an urban population of 92% and a rural population of 8%. The rural-urban divide in all countries is an important indicator of a country' development and industrialisation. This divide can affect the access to basic amenities such as electricity and running water and impact access to health and education (PRB, 2015). Argentina historically has had major

displacement from rural to urban zones which has led to increased centralisation around the capital, Buenos Aires, and a disparity in public funding along this divide. This has led to lower levels of access to health and education (Zapata et al., 2019) and much lower GDP in rural areas and worse infrastructure in rural areas (Verner, 2006).

4.3.2 Economic, Agricultural & Energy Indicators

The data relating to the main economic indicators are collected in this section. The main parameter which is worth considering is the inflation of consumer prices which for 2019 stood at 54% with respect to 2018. This level of rapid inflation creates major economic uncertainty and can have a significant effect on agriculture as future markets cannot be guaranteed. This creates issues for producers regarding access to capital and sale price of products which can cause a complete loss of profits (Lema et al., 2018). Furthermore, inflation can greatly affect food prices which has a critical impact on food security and affects the poorest people in the country (Antón et al., 2019). Agriculture accounts for around 7% of GDP and 54% of total land area and agriculture plays in Argentina, most significantly in rural areas which also account for the poorer regions. Other relevant indicators in this section include access to electricity as a percentage of population which is just under 100% and poverty headcount as percentage of population which is around 32%. The poverty rate indicates that the average person will be vulnerable to food price volatility.

4.3.3 Food Supply & Agricultural Trade and Production

As explained previously, this module ensures that food security is the key consideration in assessing the development of new bioenergy networks. The data collected in this section allow for a good understanding regarding the key foodstuff and the main exported agricultural goods. Table 3, below, shows the most important agricultural commodities regarding food supply to the local population. The data collated in this section ensure adequate selection of food crops to develop bioenergy networks. The most important crops relating to food supply should be avoided from selection to protect the food source of the local population and ensure food security. Regarding exports of trade commodities, soybeans, in cake, oil and raw forms, as well as maize, account for 58.2% of agricultural trade in Argentina.

Rank	Food commodity	Food supply (kcal/capita/day)	Share in total food supply
1	Wheat and Products	896	27.7%
2	Sugar (Raw Equivalent)	396	12.2%
3	Bovine Meat	337	10.4%
4	Sunflowerseed Oil	269	8.3%
5	Milk - Excluding Butter	205	6.3%
6	Poultry Meat	182	5.6%
7	Maize and Products	95	2.9%
8	Rice and products	85	2.6%
9	Pig meat	82	2.5%
10	Potatoes and products	69	2.1%

 Table 3: Food Supply and Key Foodstuff in Argentina ranked by kcal/capital/day.

4.4 Net Trade Position of Key Food

The five key foodstuffs presented in table 3 are analysed further with respect to their net trading position in this section. Assessing the export value of these crops is an important indicator to select food crops for bioenergy. This is because it provides an understanding of the excess production which is not utilised in the country as a food source. This helps to ensure that there is no overlap between food crops and energy crops and safeguards food security.

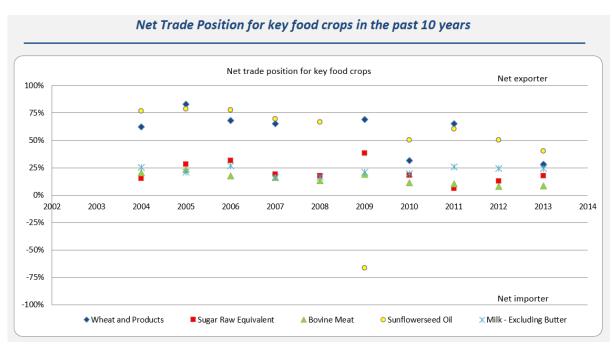


Figure 8: Net trading position of key food crops over a ten-year period.

As can be observed in figure 8 and has been previously detailed, Argentina is overall a net exporter of agricultural goods, including the main food crops produced in the country. The only instance of importing a key crop occurred in 2009 when 66.6% of sunflower seed oil had to be imported. The strength of the export percentage for these key crops suggests there is a surplus of agricultural goods and therefore there is adequate potential for bioenergy production from energy crops.

4.5 Energy Balance

This section provides an overview of the energy considerations in Argentina regarding production, consumption, and trade position for the main types. Argentina has reserves of both crude oil and natural gas and therefore produces most of its own supply with close to 100% and 80%, respectively. Overall, the main energy import for the country is natural gas which accounts for 52.9% of imports followed by oil products (petrol and diesel) which account for 29.4%. Overall final consumption is dominated by oil products and natural gas with 42.6% and 33.9% respectively. Biofuels and waste account for 4.9% of the final energy consumption in Argentina. Figure 9, below, demonstrates the dominance of natural gas in the industrial and residential sectors, whereas oil products are dominant in both the transport and agricultural sectors. Biofuels are mainly utilised in the transport and industry sectors although to a much lesser extent than traditional fossil fuels.

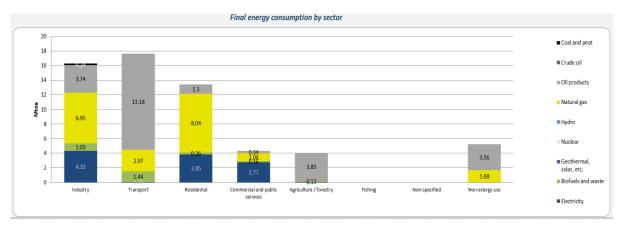


Figure 9: Final Energy Consumption by Sector in 2017.

4.6 Energy Demand

This section collects the data relevant to the fuel consumption in the transport sector. The production of both traditional fossil fuels and of liquid biofuels are assessed and compared to evaluate the overall position regarding consumption. Regarding fossil fuels used in transportation, Argentina produces 8,171 ML/year of diesel and 5,104 ML/year of petrol and imports 1,784 ML/year and 406 ML/year, respectively. Regarding liquid biofuels, Argentina produces all the biofuel it requires with 1,890 ML/year of biodiesel and 870 ML/year of ethanol. It is also one of the major exporters of biodiesel, exporting 893 ML/year. The blending mandate for both biodiesel and ethanol is also included and

stands at 10% and 12% respectively. This blending data allows an analysis of the target production of biofuels which is depicted in figure 10. As can be observed, the current targets of production to ensure blending mandates are met is currently being supplied by the biofuel production.

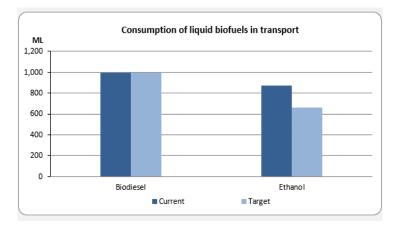


Figure 10: Biodiesel and Ethanol consumption relative to blending mandates in 2019.

4.7 Argentina Blending Mandate Policy

Historically Argentina has an important agro-industrial sector and has been a major producer of crops. The uncertainty in the aftermath of the 2001 financial crisis in Argentina and the imposition of VAT withholding on the agricultural sector created a resilient industry which combined historical expertise and the incorporation of new technologies to remain competitive in international markets (Buraschi, 2014). The adaptation to the limitation experienced by the sector form the basis for the large bioenergy potential which exists in Argentina due to significant increases in yields (Buraschi, 2014). Although the domestic market for bioenergy began in the 1970s and 1980s with the development of anhydrous ethyl alcohol, real interest in the industry began in the late 1990s with various countrywide projects. The 2001 financial crash and the subsequent rise in the price of vegetable oils (the basis of biodiesel production) led to much higher production costs and the industry became economically unsustainable (di Paola, 2013).

The SAyDS was created through the resolution 1076/2001 to orientate the production of biofuels with respect to climate change and the Kyoto Protocol. Subsequently, the resolution 1156/2004 created a new biofuel program within the Department of Agriculture which aimed to "promote the sustainable elaboration and use of biofuels" (di Paola, 2013, p. 8). In 2006, the National Law 26.093 concerning the Regulatory Regime and Promotion for the Production and Sustainable Use of Biofuels was sanctioned and was passed with the Decree 109/2007 and replaced SAyDS. This law mandated a 5% blend of both ethanol and biodiesel by 2010 (Rozemberg et al., 2009) and later, further decrees increased the blending mandate to 10% and 12% for biodiesel and ethanol, respectively. The law

26.093 was ratified for 15 years and ends in 2021 (Rozemberg et al., 2009). In 2018, Argentina entered a new economic recession and inflation more than doubled in a year leading to huge economic uncertainty. The government has tried to slow the rate of inflation via various economic policies. Regarding the biofuel industry, the government has imposed a price freeze on the consumer price of biofuels which has stood in place since December 2019 (Ámbito, 2019). This artificial manipulation of the market has led to a lack of investor confidence and has ensured that biofuel producers operate at a loss due to the rise in inflation (Campos do Prado et al., 2019).

4.8 Discussion Country Status Module

The Country Status module provides a country-wide understanding of the main industries related to bioenergy development and the key indicators relating to each one. The main findings from the module are summarised in this section and correspond to the answer to RSQ1.

What are the main bioenergy and food security considerations in the country context?

The agricultural sector plays an important role in the economy of Argentina. The industry represents 54% of the total land area of Argentina and accounts for 7% of GDP. Argentina is a major global agricultural producer and has enough produce to be a net exporter on all its key food crops. Agricultural products account for over 50% of total exports which indicates there is potential feedstock available for bioenergy processing. Although Argentina is a major food producer and food security is a secondary issue, it should still be highly regarded as 5% of the population suffer from undernourishment and changes in food crop use could lead to worsened rates. Economic uncertainty, exemplified by 54% inflation rates on consumer prices, and high levels of poverty (32% of population), are the main factors currently threatening food security in Argentina. Thus, bioenergy developments should assess the impact on food security, especially considering the high volatility of consumer prices. Furthermore, the high reliance on exports in the agricultural industry is subject to impact from export tariffs and anti-dumping regulations and changes in global food prices can also impact the agricultural industry. Although Argentina is a relatively industrialised country, a large percentage of its agricultural exports are simple raw materials and not processed products. Raw materials as an export commodity receive a lower rate of return than refined products. Furthermore, small-farm holders tend to have limited industrialisation and improvements in equipment and agricultural products such as fertiliser could improve country-wide yields in agriculture and help protect food security.

The energy sector offers areas which can support increased bioenergy development. Although Argentina is a producer of fossil fuels, a high percentage of both oil and natural gas are currently imported. The reliance on imported fuels offers an opportunity for the substitution of traditional fossil

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fuels with first- and second-generation biofuels. Furthermore, due to the increased cost of imports caused by inflation, substituting imported fossil fuels with local alternatives could safeguard energy costs and improve industrialisation. A breakdown by sector demonstrates that the transport and agricultural sectors have the highest reliance on oil whereas the industrial and residential sectors are highly reliant on natural gas. Currently, biofuels and waste account for 4.9% of the final energy consumption and the importance of biofuels in the energy mix offers room for improvements. A blending mandate for both biodiesel (10%) and ethanol (12%) exists and the production levels of biofuels meet the current requirements. This indicates that bioenergy developments in the transport sector are only viable if blending targets are increased or if biofuel exports are increased. Argentina is already a leading exporter of biodiesel globally and thus expansion of existing industry is viable as the knowledge and expertise required already exists. A focus on rural electrification is unnecessary as access to electricity is reported at 100%.

Chapter 5: Natural Resources Module

The full results for this module and all the data discussed within it are presented in Appendix 2 and are summarised in this chapter.

5.1 Introduction

As explained in Chapter 2, first-generation biofuels can be produced from multiple feedstock options including energy crops, agricultural residues and Woodfuel or residues amongst others. This module allows an overall assessment of the natural resources available for bioenergy production within the country and builds on the knowledge gained in the Country Status chapter. The three components of this module are Crops, Agricultural Residues and Woodfuel & Wood Residues and the overall structure of the module is presented in figure 5.1.

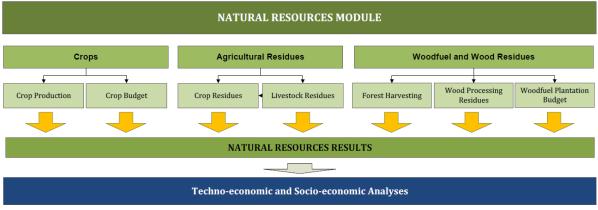


Figure 11: Structure of Natural Resources module.

The Crops component was selected for this analysis as it focusses on energy crop production and on liquid biofuel production. This component includes two tools:

- The Crop Production tool, which can be used to assess the current energy crop production and the potential for added production.
- The Crop Budget tool, which helps to assess the gross margin, production costs and profitability of crop production.

5.2 Scope and Objectives

The objective of this module is to provide an overview of the potential for energy crop feedstock production. Sustainability and food security are the main parameters considered when analysing the

potential production. The potential for additional production is assessed using intensification, extensification¹ and substitution of crop options.

5.3 Selection of Crops

The selection of bioenergy crops to be used as potential feedstock must be undertaken. This ensures that the tools in this module prioritise food security and should be considered alongside the results of the Country Status module. Key food crops considered in sub-chapter 4.3.3 should be omitted from comparison to guarantee that the potential bioenergy feedstocks are not competing with the main food resources. Furthermore, the net trade position of potential feedstocks analysed in sub-chapter 4.4 should be considered. Agricultural foods which are imported should be avoided to minimise the amount of excess imports as this ensures increased self-sufficiency. The crops selected for analysis are the following:

- Sugarcane this crop was selected as it is a key crop to generate first generation biofuels. Although the crop is the second key food supply of the country (table 3), it has also been a net export crop with approximately 20% of production being exported over a 10-year average (figure 8). Furthermore, sugar and sugar molasses are already used to produce ethanol and overall consumption of sugar in Argentina is decreasing.
- Sunflower sunflower seed oil represents the fourth key food supply (table 3) with an 8.3% share, however, it is also a major exported crop with over 50% of production exported over a 10-year average (figure 8). The excess inputs could be used to produce SVO and biodiesel.
- Maize maize is the second most exported agricultural commodity representing 11.6% of agricultural trade and only accounts for 2.9% of the share of total food supply. It is currently being used to produce ethanol and therefore offers existing potential as an energy crop.
- 4. Soybeans soybean and related products account for 46.6% of the total share of agricultural exports in Argentina and its use as an energy crop does not compete with food resources. It is currently used to produce biodiesel and therefore is a suitable crop to analyse.

Further criteria for assessment include overall energy balance and industrial capabilities. As discussed in sub-chapter 4.5, Argentina is a significant producer of energy and mainly imports natural gas and the main priorities for energy production surround the increased development of existing technologies. Regarding industry, the crops selected are currently used to produce biofuels and therefore an expansion in this production would not create major logistical and technological issues for the country.

¹ Extensification refers to increasing production by improving yield whilst keeping the agricultural area unchanged.

5.4 Crop Production Tool

5.4.1 Net Trade Position of Selected Crops

The four selected crops to be analysed for potential feedstock production are examined in this section with respect to production, domestic consumption, and trade position over a 10-year period. This analysis allows for a detailed understanding of each crop with respect to current excess feedstock and should be understood to be used later in the analysis. The graphical results of the trade position for the four crops can be visualised in figures 12 and 13 below.

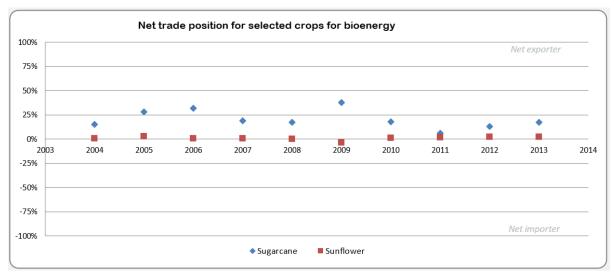


Figure 12: Trade position for Sugarcane and Sunflower over the 10-year period.

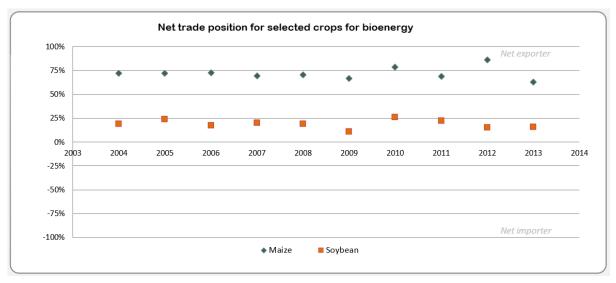


Figure 13: Net trade position for Maize and Soybeans over the 10-year period.

- Sugarcane² Over the 10-year period examined, Argentina has always been a net exporter of sugar. The exporting rate has ranged from 6.1% to 38.0% where the highest exporting rates are due to a positive stock variation from the previous year. Furthermore, the domestic consumption of sugar has increased at a relatively steady percentage from 1.5 to 1.7 MMT over the 10-year period analysed and roughly corresponds with the population growth experience over that period.
- Sunflower This crop is the only one where there is no significant net trading and most of the
 production is consumed domestically which indicates they are self-sufficient in sunflower
 production. The exporting rate ranges from 0.4% to 2.6% with 2010 being the only year where
 Argentina was a net importer with 3.7% (figure 12).
- Maize Maize shows the highest export rate over the 10-year period examined. This ranges from
 a minimum of 63.0% to a maximum of 78.7%. The production amount has more than doubled
 over the 10-year period showing a major drive towards maize production and domestic
 consumption has almost doubled from 4.39 to 7.88 MMT over the same period.
- Soybean The net trading position over the years analysed is relatively high ranging from 11.2% to 24.1% of the total production. The total production of soybeans has the largest variation year-on-year which may respond to international demand and prices or to crop rotations. It is also the most produced crop with maximum production of 52.67 MMT in 2010.

5.4.2 Intensification Option

The intensification option identifies potential increased production by increasing the overall yield of the crops. This can be achieved through the improvement of farming techniques and/or through the increased use of agricultural supplies including fertiliser or farming equipment. There are three levels of input which can be used to assess the overall yield of the selected crops. Low input level refers to rainfed production with minimum use of agricultural supplies and manual labour force. Intermediate level input refers to either rainfed production with increased use of supplies and/or mechanical labour or irrigated production with a low level of agricultural supply use. High level input refers to the irrigated production with high levels of agricultural supplies and machinery used.

The data collected on the selected crops are presented in table 4 and are used as the basis for the intensification analysis performed. The current yield and annual production are used to calculate the current production area in hectares and this figure is then used as the land area for the intensification. Appropriate potential yields should be selected considering the different inputs and land suitability.

² The trade position of raw sugar is used instead of sugarcane. This is because sugarcane is processed immediately after harvesting and raw sugar is traded as an international commodity.

Potential yields based on GAEZ data are referenced at the various input levels to guide the selection of intensified yield. The results are presented in table 4, below, and summarised for each crop. As Argentina is a semi-developed country with a strong agricultural sector and therefore a mechanised high-level input was selected for intensification of each crop. The potential production for bioenergy is presented in table 5.

		Crop 1	Crop 2	Стор 3	Crop 4
		Sugarcane	Sunflower	Maize	Soybean
Parameter	Unit		Current pr	oduction	
Current yield	t∕ha	60.00	2.00	6.30	3.20
No. of harvests/year		1	1	1	1
Annual production	tyear	22,500,000	3,300,000	32,000,000	51,000,000
Total production area	ha	375,000	1,650,000	5,079,365	15,937,500
	1	Intensified producti	on		
	(Potential production	n on the same area	with increased yie	lds)	
Water supply	Select	Irrigation 🝷	Irrigation 🔻	Irrigation 🔻	Irrigation 🔻
Input level	Select	High •	High •	High 🔻	High 🔻
Intensified yield	t∕ha	77	2.10	8.50	4.00
No. of harvests/year		1	1	1	1
Potential production	Nyear	28,875,000	3,465,000	43,174,603	63,750,000
Total production area	ha	375,000	1,650,000	5,079,365	15,937,500

Table 5: Current production for each selected crop.

Table 4: Potential feedstock production for bioenergy

Potential production for bioenergy											
		Sugarcane	Sunflower	Maize	Soybean						
Potential production	t/year	875,000	65,000	1,974,603	3,550,000						
Area of production	ha	11,364	30,952	232,306	887,500						

Sugarcane – the yield for sugarcane was found to be 60.00 t/ha in 2019 by using an OECD-FAO dataset and USDA statistics. The total production for that year was 22,500,000 tonnes. This is much lower than the FAOSTAT 10-year average and suggests a bad crop year. As previously stated, the input level selected was high and the intensified yield chosen is 77 t/ha. Although a considerable improvement on current yields, it is still well below the potential yields suggested by GAEZ for a high input level. Based on this assumed yield, the potential production was estimated at 28,875,000 tonnes using the same area of production. This allows for the potential production of 875,000 t/year to be used as bioenergy feedstock. Sunflower – the yield for sunflower was found to be 2.00 t/ha in 2018 by using USDA and national statistics and the total production for that year was 3,300,000 tonnes. This yield is comparable to the FAOSTAT 10-year average which stood at 1.73 t/ha for the period 2005-2014. As previously stated, the input level selected was high and the intensified yield chosen is 2.10 t/ha. Although a small improvement on current yields, it is in the range of moderately suitable potential yield suggested by GAEZ for a high input level. Based on this assumed yield, the potential production was estimated at 3,465,000 tonnes using the same area of production. This allows for the potential production of 65,000 t/year to be used as bioenergy feedstock.

Maize – the yield for maize was found to be 6.30 t/ha in 2018 by using national statistics and the total production for that year was 32,000,000 tonnes. This yield is comparable to the FAOSTAT 10-year average which stood at 6.61 t/ha for the period 2005-2014. As previously stated, the input level selected was high and the intensified yield chosen is 8.5 t/ha. This is a considerable improvement on current yields; however, it is within the range of moderately suitable potential yield suggested by GAEZ for a high input level. Based on this assumed yield, the potential production was estimated at 43,174,603 tonnes using the same area of production. This allows for the potential production of 1,974,603 t/year to be used as bioenergy feedstock.

Soybeans – the yield for soybeans was found to be 3.2 t/ha in 2019 by using USDA statistics and an OECD-FAO dataset and the total production for that year was 51,000,000 tonnes. This yield is higher than the FAOSTAT 10-year average but comparable to actual yields. As previously stated, the input level selected was high and the intensified yield chosen is 4.00 t/ha. Although a considerable improvement on current yields, it is much lower than the 4.90 country average yield suggested by GAEZ for a high input level. Based on this assumed yield, the potential production was estimated at 63,750,000 tonnes using the same area of production. This allows for the potential production of 3,550,000 t/year to be used as bioenergy feedstock.

5.4.3 Change of Crops

The following option to increase the amount of biomass feedstock consists of a change of crops assessment. This allows for the reallocation of existing cropland to be used to grow other bioenergy crops. The complete analysis required to accurately assess the impact of switching crops is very extensive and therefore this tool is used to provide an indication of the potential offered by the change. As this research project aims to maximise the production of sugarcane, the crops which will be compared are sugarcane as the bioenergy crop and maize as the current crop. Maize has been selected due to its high export rates which allows for a reduction in production without affecting the local production of ethanol or the food security of Argentina.

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As can be observed in table 6, below, the current production of maize has been reduced from 32 MMT to 31 MMT. Considering the average export rates of over 70%, reducing production by 1MMT is a reasonable amount which will have a minimal impact on exports. This change in crops could produce 158,730.16 ha which if used for sugarcane could support additional production of up to 9.52 MMT. Although maize and sugarcane are mostly grown in different regions, there is some overlap in the provinces of Santa Fe, Tucuman, and Salta. By increasing the production in these northern regions, the aim is to drive investment in these poorer rural areas which have suffered from centralisation and investment focussed on Buenos Aires and the surrounding provinces. This could potentially help increase local GDP levels to similar levels seen in southern provinces.

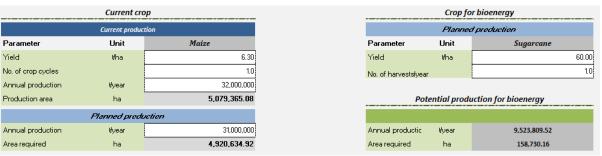


Table 6: Hypothetical change of crops from maize to sugarcane.

5.4.4 Extensification Option

The extensification option relies on increasing the overall production area of crops to increase the production of bioenergy crops. This is achieved by assessing trends in land use over time and ensures that extensification is a sustainable option considering the country-specific requirements. The historical trends in land use are presented below from the period 2004-2016 (figure 14 and table 7).

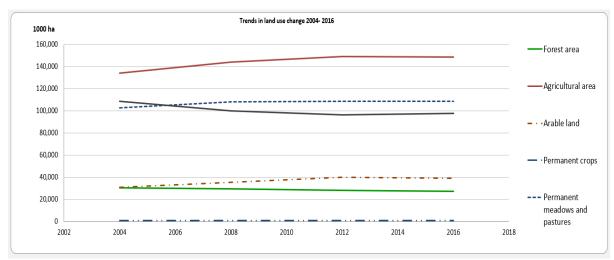


Figure 14: Trends in Land-Use by type in Argentina between 2004-2016.

Table 7: Trends in Land Use Changes in Argentina over the period 2004-2016.

Forest Area	In the period 2004-2016, a decrease of forest area was recorded. This could be an indication of deforestation at country level. Total forest area decreased
	by 3,408,800 ha, i.e. by 11.17%.
	In the same period, the total agricultural area increased by 14,355,000 ha, i.e.
Agricultural Land	by 10.69%.
Arable Land	The arable land (area under annual crops) increased by 8,425,000 ha, i.e.
Arable Land	27.38%
Grassland	Grassland area (permanent meadows and pastures) increased by 5,930,000
Grassianu	ha, i.e. by 5.78%
	Data on land use change during the period 2000-2010 indicate that the
	expansion of the agricultural area may be one of the key drivers for
Conclusion and	deforestation. Therefore, policy measures and actions aiming at the increase
Recommendations	of agricultural yields without further expansion of agricultural area is strongly
	recommended.

Table 7 is generated by the BEFS tool in the Natural Resources module and helps to understand the changes in land use over time and the impact these have on the potential expansion of production area. The main consideration for this section is the impact that agriculture and farming expansion can have on available forest area. The data in Argentina show that there has been a decrease in forest area of 11.17% between 2004-2016 and indicate that one of the key drivers for deforestation is expansion of agriculture land. Therefore, the tool recommends that increases in agricultural yields be achieved through either intensification or through change of crops and not through the expansion of agricultural land. Furthermore, the displacement of crop land by beef production should be minimised as this increases the use of forest areas for beef production.

As the extensification option has been ruled out as a viable option for Argentina, the following section of the analysis is not required.

5.4.5 Crop Production Results

The results from the additional potential production of bioenergy crops are presented below (figure 15). They include the intensification and extensification options as well as the change of crops option. As discussed in section 5.4.4, the current land use in Argentina does not support the increase of crops through extensification of production and therefore the focus is limited to intensification and change of crops.

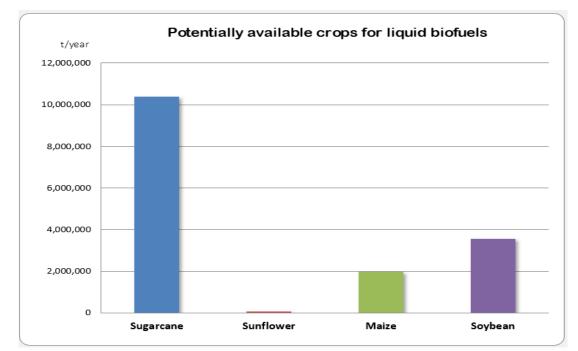


Figure 15: Potential Increase of Selected Bioenergy Crops in t/year.

As can be observed in the results in Appendix 2, the crop with the most potential for intensification is soybean. This is due to the low yields which are currently achieved from the crop relative to the potential yield, and the high proportion of cropland already allocated to soybean production. The land area used for maize production is also high and therefore intensification of yields provides a high energy crop potential. The potential crop availability of sugarcane is directly dependent on an increase in production area by changing crop production. Currently sugarcane plantations account for a small agricultural area and substituting 3.1% of maize land area with sugarcane could provide a significant increase in sugarcane feedstock available for liquid biofuel production. Overall, figure 15 shows the combined results of both the intensification and the change of crops options and it can be clearly seen that sugarcane, maize and soybean offer the most potential. However, it is worth noting that the export amounts of all crops are excluded from this analysis and therefore both maize and soybean have a much higher potential if exports are diverted to bioenergy production.

5.5 Crop Budget Tool

Results are presented in Appendix 3.

5.5.1 Crop Budget Introduction

Due to issues existing in the crop budget section of the tool relating to the data provided, the tool could not be used for the agro-economic analysis of the production options. To obtain the data required for the Energy End-Use module, a new simplified crop budget tool was created. The new tool provides an economic assessment by comparing the gross profit margin of the selected crops and extracts the required hours and costs of production for the subsequent tool. The costs are split into fixed and variable costs and are assess against the profits achieved from the crop yield to provide an indication of the production costs.

Several assumptions have been used within this tool to provide the required data for the subsequent module. These are:

- The fixed costs were assumed constant between crops when data not available.
- Linear extrapolation was assumed when gross margin yield differed from the required yield.
- UTA conversion was assumed comparable to Australian hours.
- Establishment of sugarcane plantation costs are spread equally over the lifetime of the plantation which is assumed to be 4 years.
- Intensified yields taken from available data and not as suggested by crop production tool.
- Intensified yield for soy assumed as rainfed.

5.5.2 Crop Budget Results

To make this simplified crop budget relatively comparable to the BEFS crop budget tool, an assessment of profitability on the selected crops has been performed. Although the analysis is more limited than the BEFS tool, these numbers provide an indication of the profitability of crops. It should be noted that the profitability of crops is dependent on a myriad of factors which can greatly vary between years and crop production is subsidies by government which is not included in this analysis. Furthermore, the data presented in figure 16 represents the results for the intensified yields. ³

As can be seen in figure 16, maize is the most profitable crop per hectare followed by sugarcane and soybean. The fixed costs of sugarcane are much higher compared to the annual crops due to the costs of establishing a plantation. Soybean has the lowest profitability due to the much lower yields achieved per hectare compared to maize and sugarcane. Both sugarcane and maize use irrigation which accounts for a large proportion of the variable costs and environmental impacts.

³ The units for figures 16 are USD/ha.

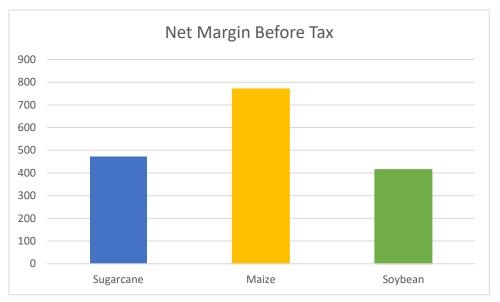


Figure 16: Net margin before tax for intensified yields.

5.6 Discussion Natural Resources Module

The Natural Resources module provides an analysis of the most important energy crops and their potential as feedstock for bioenergy developments. The information obtained in the module is summarised in this section and provides an answer to RSQ2.

To what extent can food crops supply the feedstock required for bioenergy developments? And which option is most suitable for increased production?

The viability of expanding production of energy crops to be used as feedstock has been analysed in this section by considering three separate scenarios. The first scenario focuses on yield intensification of existing crops to increase the total feedstock available whilst keeping the agricultural area constant. The current crop yields for the selected crops are lower than the potential yields for the area and therefore intensification offers potential for increased production. The potential feedstocks available through intensification for the selected crops are presented in table 4.⁴ The potential feedstock is directly dependent on the current production area and therefore improvements in soybean production yields will have the largest impact due to the size of the current production area compared to the others. The potential increase in soybean yields and production demonstrate the availability of biomass as feedstock for biodiesel production. With respect to ethanol production, both maize and sugarcane crops can supply additional feedstock for bioenergy production. Although maize offers slightly higher potential, the land area required to supply this is much larger than sugarcane due to

⁴ The planned production in table 4 should be exclusively for non-bioenergy purposes, however, to focus on the future potential production, the total current production for each crop has been used. This allows for the assessment of the feedstock available to increase biofuel production without affecting the current production used for food, bioenergy, and exports.

the much lower yield. Therefore, sugarcane crops offer increased feedstock potential when compared to maize.

The second option available is a change of crops scenario whereby an existing crop is replaced with an energy crop to increase the feedstock of the replacement crop. In this section, the crops selected are maize and sugarcane as they are both feedstock for ethanol production. The use of food crops in bioenergy developments in Argentina is not a major problem as they are net exporters of their key food crops and therefore a surplus already exists. Sugarcane has been chosen as the replacement crop due to the higher potential exhibited in the intensification option. Furthermore, as over 50% of maize produced is exported, a decrease in maize production will not affect food security and makes it a viable option. Additionally, when considering the techno-economic analysis, sugarcane shows to be more profitable than maize and therefore is a suitable replacement crop.

The final option available, extensification, assesses the viability of increasing the overall agricultural area whilst the yield remains the same. The data computed in this section are supported by data collected in the Country Status module which show that 54% of the land mass of Argentina is currently used as agricultural area and therefore the extensification option is not recommended. Further increases in agricultural land could have a detrimental effect on both biodiversity and deforestation and is therefore the least attractive option.

When considering the results of the crop budget tool, maize is the most profitable crop when comparing the intensified options. The agro-economic analysis is somewhat limited due to the nature of the simplified crop budget. This is caused by a lack of recent data and the volatile nature of the Argentine economy which complicates the comparison between maize and soybeans against sugarcane. The assumptions made are required to achieve the results necessary, however, the lack of available data is a limitation to this crop budget and current datasets would be much more useful to assess the crops analysed.

The most suitable option depends on the biofuel to be produced. Biodiesel production would benefit from intensification of soybean yields and would provide sufficient levels of feedstock considering the current land area used for production. Considering the increase in production of biomass feedstock suitable for ethanol production, the change of crops option is more suitable as sugarcane has much greater yields and would provide increased feedstock potential when compared to intensification. However, this change is limited to northern regions and therefore southern regions should consider increasing irrigation to facilitate intensification of maize to increase biomass availability.

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Chapter 6: Energy End Use Module

The full results for this module and all the data discussed within it are presented in Appendix 4 and are summarised in this chapter.

6.1 Introduction

The Energy End-Use module is the final level of analysis and consists of a techno-economic and a socioeconomic evaluation of the potential bioenergy routes available. The module consists of the following five submodules: Intermediate or Final Products, Heating and Cooking, Rural Electrification, and Heat and Power and Transport. Each submodule uses specific types of biomass feedstock and focusses on a final energy form. The overall breakdown of the module is shown in figure 18 below.

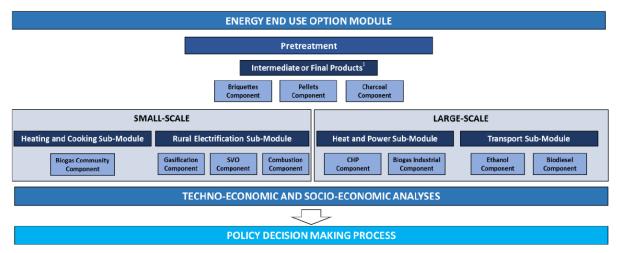


Figure 17: Energy End Use Module Breakdown.

Furthermore, since the Natural Resources module results were obtained using the Crops submodule, the submodule options for the Energy End Use are limited to either Heat and Power or Transport. Considering the country context and the current bioenergy networks available, the Transport submodule is the most relevant for Argentina. Especially when considering that maize and soy produce diesel substitutes which are primarily used as transport fuels.

The Transport submodule evaluates the potential production of biofuels from the available feedstock calculated in the Crop Production section. The production of ethanol and biodiesel are assessed using various scenarios relating to feedstock production (Own Production, Mixed and Outgrowers) and biofuel plant sizes and provide an overview to the profitability of the pathway. Furthermore, the transport submodule provides information on the most suitable plant size, feedstock type and assesses the quantity of biofuels available and the potential for job creation.

6.2 Scope and Objectives

The objective of this module is to provide a preliminary assessment of potential bioenergy pathways and the economic analysis of such a pathway. The scope of this analysis is focussed on liquid biofuels and is linked to the results obtained in the Natural Resources module. A comparison between the selected energy crops is also performed and helps to select the most suitable feedstock.

6.3 Biofuel Demand

As discussed in the previous module, Argentina already produces the biofuels required to meet the current blending mandates and is one of the world's leading exporters of biodiesel. However, the potential to expand the biofuel market exists, and the various pathways should be analysed to identify the most promising route. Furthermore, by changing the blending target in the tool, an analysis can be performed on the viability of supplying the increased mandate from the current feedstock available. These results are presented in figure 19.

	Consumption	Unit			Consumption	Unit
Diesel	9,926	ML/year	Gasoline		5,510	ML/year
Domestic blending target						
	Blending target	Biofuel demand			Blending target	Biofuel demand
Biodiesel (ML/year)	10%	993	Ethanol (ML/year)	12%	66
Biofuel production and trade						
					1	
	Domestic production	Imports	Exports	Net balance		
Biodiesel (ML/year)		Imports		Net balance 996		
·	production	•	. 893			
Biodiesel (ML/year) Ethanol (ML/year)	production 1,890 870	0	. 893	996		
Biodiesel (ML/year)	production 1,890 870	0	. 893	996		
Biodiesel (ML/year) Ethanol (ML/year)	production 1,890 870	0	. 893	996		

Figure 18: Fuel Consumption and Blending Mandates used to calculate required national biofuel volume.

Assuming blending mandates are increased to 20% for both biodiesel and ethanol, the required production would be 1,985 and 1,102 ML, respectively. Increasing the blending mandate to 20% would almost double the biofuel market and would provide additional uses for feedstocks (figure 20).

Domestic blending target						
	Blending target	Biofuel demand			Blending target	Biofuel demand
Biodiesel (ML/year)	20%	1,985	Ethanol (ML/year)		20%	1,102
Biofuel production and trade						
	Domestic production	Imports	Exports	Net balance		
Biodiesel (ML/year)		C	893 -	893		
Ethanol (ML/year)		C	0	-		
Target domestic biofuel product	ion					
Biodiesel (ML/year)	1,985					
Ethanol (ML/year)	1,102					

Figure 19: Target production at enhanced blending mandates of 20%.

6.4 Data Entry for Liquid Biofuels

This section of the tool collects the required data to perform the techno-economic and socio-economic analyses. Feedstock, labour, and land data are obtained from the Crop Budget tool and are combined with country specific data relating to costs. These include cost of utilities and chemicals, cost of transportation and storage, labour costs, and pricing for the co-products manufactured.

Due to the extreme economic situation currently experienced by Argentina, some assumptions have been made in the selection of financial parameters. These assumptions are:

- The loan interest rate and the discount rate have been assumed to minimise the impact that the exorbitant values would have on the analysis.
- The discount rate is set to 10% instead of 42% as it is a more representative for a developing country like Argentina.
- The loan interest rate is assumed to be 0%. This mitigates the current interest rate of 38%, which have been set to control inflation, and which greatly impact the profitability of financed projects. Therefore, the required capital is assumed available without the need of loans.
- The loan ratios and loan terms are also set to 0 as no loan is required.

6.5 Processing Costs

The processing costs for each energy crop analysed are calculated using the data entered in the data entry section of the spreadsheet. As discussed in the introduction, three feedstock production scenarios are considered to provide flexibility to the results; these are: Own Production, Mixed and Outgrowers. These scenarios are each assessed with respect to four differently sized process plants operating at 5, 25, 50 and 100 ML/year. Table 8, below, provides an example of the processing cost table created by the tool.

Table 8: Processing Costs for Production of Ethanol from Sugarcane Feedstock.

								Capa	citi	ies (Millic	n	litres per	ye	ar)				
				5	;			2	5			5	0			10	0	
				iting hours er year	8,	000	Ор	erating hours per year		8,000	Op	erating hours per year		8,000	Op	perating hours per year		8,000
Scenario 1: Own Production			Fil	nancial Asso (5 ML/		Sc 1		Financial Ass (25 ML				Financial Ass <mark>(50 Mi</mark>				Financial Asse (100 ML		
Scenario 2: Mixed	mario 2: Mixed (5 M			inancial Ass <mark>(5 ML/</mark>		Sc 2		Financial Ass (25 Mi				Financial Ass (50 Mi			Financial Assessment Sc 2 (100 ML/year)			
Scenario 3: Outgrowers			Fi	inancial Ass <mark>(5 ML/</mark>		Sc 3		Financial Ass (25 Mi						Financial Asse (100 ML				
Feedstock	Unit	Unit Price (USD)		uantity (Unit)		otal /year)		Quantity (Unit)		Total (USD/year)		Quantity (Unit)		Total (USD/year)		Quantity (Unit)		Total USD/year)
Sugarcane Scenario 1	t	\$ 27.19		61,728	\$	1,678,395		308,642		8,391,975		617,284		16,783,951		1,234,568		33,567,901
Sugarcane Scenario 2 Sugarcane Scenario 3	t	\$ 28.11 \$ 29.50		61,728 61,728		1,735,432 1,820,988		308,642 308,642		8,677,160 9,104,938		617,284 617,284		17,354,321 18,209,877		1,234,568 1,234,568		34,708,642 36,419,753
Total Production Costs (U	(SD/year)																	
Total Production costs (o	ob/yeary	1		Total	т	otal	_	Total		Total	:	Total	_	Total	,	Total		Total
	_			iD/year)		iD/I)		(USD/year)		(USD/I)		(USD/year)		(USD/I)		(USD/year)		(USD/I)
Scenario 1																		
Total operating costs Total fixed costs			s s	2,526,938 2,195,412		0.51 0.44	\$ \$	10,877,398 5,159,045		0.44	\$ \$	21,990,595 8,192,812		0.44	s s	44,120,332 13,838,443		0.44
Total other costs			s	132,530		0.44		235,707		0.21		411,469		0.18	s	754.649		0.14
Total production costs scenario 1 (US	SD/vear)			4,854,880			\$	16,272,150			\$	30,594,875	· · · ·		\$	58,713,424	· · · · ·	
Total production costs scenario 1 (US					ş	0.97			ş	0.65			\$	0.61			ş	0.59
Scenario 2	1																	
Total operating costs	L		\$	2,583,975	\$	0.52	\$	11,162,584	\$	0.45	\$	22,560,965	\$	0.45	\$	45,261,073	\$	0.45
Total fixed costs			\$	2,195,412	\$	0.44	\$	5,159,045	\$	0.21		8,192,812		0.16	s	13,838,443		0.14
Total other costs			\$	132,530	\$	0.03		235,707	\$	0.01		411,469	\$	0.01		754,649	\$	0.01
Total production costs scenario 2 (US			\$	4,911,917			\$	16,557,335			\$	31,165,246	_		\$	59,854,165		
Total production costs scenario 2 (US	5D/I)				\$	0.98			\$	0.66			\$	0.62			\$	0.60
Scenario 3																		
Total operating costs			\$	2,669,531		0.53		11,590,361		0.46		23,416,521		0.47		46,972,184		0.47
Total fixed costs			S	2,195,412		0.44		5,159,045		0.21		8,192,812		0.16		13,838,443		0.14
Total other costs			s s	132,530	\$	0.03	\$	235,707 16.985.113	\$	0.01	(******	411,469	Ş	0.01	\$	754,649	\$	0.01
Total production costs scenario 3 (US			Ş	4,997,473	^	1.00	\$	16,985,113	s	0.68	\$	32,020,801	s	0.64	\$	61,565,276	•	0.62
Total production costs scenario 3 (US	50/1)				\$	1.00			ş	0.68			\$	0.64			\$	0.62

Considering the trends in the three scenarios, the feedstock price is the main factor affecting the cost of production. The most profitable scenario is Own Production due to obtaining the feedstock at production cost compared to market price. On the contrary, the Outgrowers scenario is the costliest as the feedstock must be purchased at market value and transported to the processing plant. As expected, savings related to increases in plant capacity occur, and the cost per litre becomes significantly cheaper at 100 ML plants versus 5 ML plants. The operational costs have the smallest variation at higher capacities due to the feedstock price remaining equal throughout whereas the fixed costs greatly decrease at higher capacities. The data for both maize and soybeans are presented in Appendix 4.

6.6 Results Transport Submodule

6.6.1 Summary of Results by Feedstock

This section of the results provides an individual summary for each feedstock option analysed. There are three areas of analysis where results are provided. These are:

Production Cost and Investment: The production cost of biofuel is compared against the market rate price of both traditional fossil fuels and biofuels. Furthermore, the required investment for the plant and the share of production costs are also presented in this section.

Operating Results: The available feedstock is assessed in practical terms to identify the most suitable plant size and the potential each crop has, to both provide employment opportunities, and meet the blending target.

Financial Analysis: The economic feasibility of the various scenarios is compared in this section and provides a basis for identifying economically viable options. Both NPV and IRR results are presented in this section.

The results for Maize will be presented in this section of the report whilst the results for other crops will be included in appendix 4.

6.6.1.2 Maize Result Summary

Production Cost and Investment

Figure 20 shows the results relating to production cost and investment. Comparing the cost to produce ethanol to the equivalent price of gasoline, it can be observed that the production costs are higher at lower capacities and when feedstock is outgrown. With respect to the current market rate of ethanol, the cost of production is higher for all scenarios and capacities when compared to the current market rate of ethanol, this indicates that they will not provide a return on investment.

The total investment required for differing capacities is not linear and larger capacities plants are cheaper to build. This is due to the minimum costs of establishing a plant being very large compared to increasing the plant capacity. Therefore, the minimum number of viable plants should be aimed for and plant capacity should be maximised wherever possible.

The share of production costs for the three scenarios are presented below. A number of trends can be observed from the split in costs. As plant capacity increases, the cost of feedstock as a percentage also increases due to the increase in fixed costs versus operational costs. The same is true for the chemical inputs required as raw materials in the process. The share of operational costs remains relatively stable for both labour and energy costs. The greatest change in the share of prices is in the depreciation and maintenace costs as these aren't linear and therefore become cheaper at increased capacities. The trends observed are true for all three scenarios at differing capacities. As expected, the feedstock costs for the Outgrowers scenario is much higher than that of the Own Production and therefore the overall cost of production for the third scenario is always the most costly.

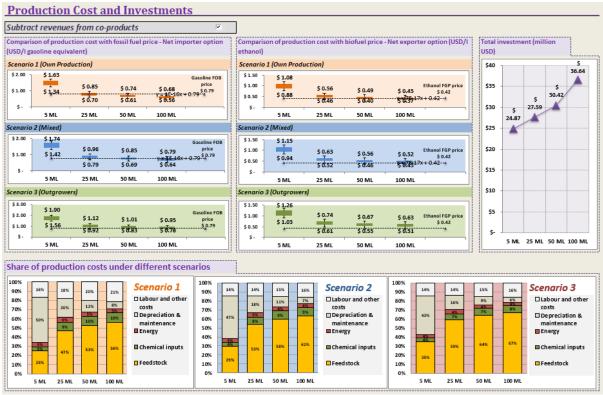


Figure 20: Production Cost and Investment results for maize.

Figure 21 compares the available feedstock with the required feedstock for the various capacities. It can be observed that there is sufficient maize biomass to supply a total of eight 100 ML capacity plants. Maximising the plant number and capacity could provide up to 800 jobs in the sector.

As shown in the biofuel demand section, the current blending demand for ethanol is met. To assess the potential of maize, the overall production of ethanol was set at zero and the blending mandate was increased to E15 (15% ethanol blend). The current available maize feedstock would be able to supply 98% of the new demand. This demonstrates the very significant biofuel potential which maize provides as sufficient feedstock potential exists to double the blending mandate. Results presented in figure 22.

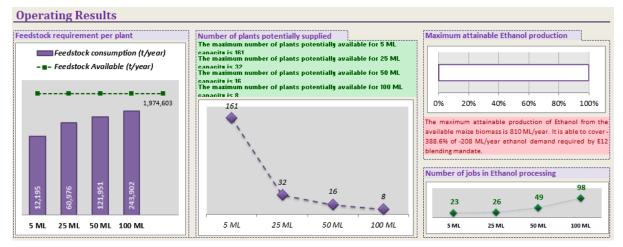
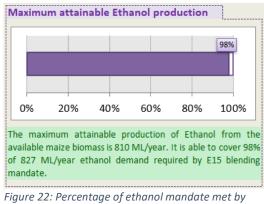


Figure 21: Operating results for ethanol production from maize feedstock.



available maize biomass

The financial results (figure 23) for maize demonstrate the current difficulty in achieving a profit due to the current prize freeze on biofuels. Under the current pricing, only a marginal profit can be achieved at 100 ML capacities in the Own Production scenarios. As the share of costs indicates, the elevated cost of feedstock is one of the main limitations to achieving profits. These results include the sale of co-products (raw glycerol and soybean meal) which provide additional funds of 0.412 \$/L.

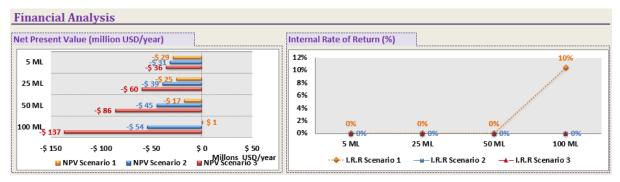


Figure 23: Financial analysis results for maize.

6.6.2 Summary of Comparative Results

The individual results presented in the previous sections are used in this section to perform a comparative analysis of the various options. By comparing these directly, a better understanding can be achieved with respect to the most suitable or promising feedstock options and the ability to meet current and future blending mandates.

Biofuel Production and Plants

For sugarcane, by considering the E12 (12% ethanol blend) blending mandate, the available feedstock could supply up to 127% of the total. Furthermore, if the blending mandate were raised to E15, the available sugarcane feedstock would be able to supply 102% of the required ethanol. Considering maize at the current blending mandate, it would be able to supply 122% of the total amount required. At an E15 blending mandate, it would be able to supply 98% of the required ethanol. The available soybeans feedstock can provide up to 65% of the current B10 blending mandate.

It should be noted that the available feedstock does not include the current feedstock used for biofuel production. Therefore, the available feedstock is being assessed at a higher capacity than required which helps to guarantee food security is safeguarded.

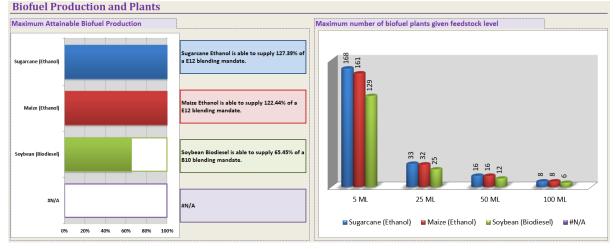


Figure 24: Comparative results for providing blending mandate and plants available.

Comparison of Economic Results

The economic results of the three feedstocks analysed are presented in figure 25 below. Only the results for the own production scenario are presented as the only feasible scenario is within these results. As was discussed in the results for maize in the previous section, the current price freeze relating to biofuels has had a large effect on the market and has limited the ability to generate a profit. Under the current pricing mechanism, only maize under the Own Production scenario at the highest capacity can generate a profit. The lack of feasible production has been warned by the major biofuels producers as the increased costs of feedstock oils and chemical inputs due to the high rates of inflation has not been addressed by the price freeze of biofuels. Therefore, although the current situation is unattainable, a detailed study of the current situation relating to costs and effective actions would

				esults														
Scenari	o 1 (ov	vn pro	ductio	n)														
Production (Costs								N	et Present Va	lue (NP	/) and In	ternal R	ate of Re	turn			
	Biodiesel F	P price		\$ 0.63	Diesel FGP	orice		\$ 0.72										
		USD/L E	Biodiesel			USD/L Diese	el Equivalent				N	IPV (Millio	n USD/yea	r)		IRR (%)	
Biodiesel	5 ML	25 ML	50 ML	100 ML	5 ML	25 ML	50 ML	100 ML		Biodiesel	5 ML	25 ML	50 ML	100 ML	5 ML	25 ML	50 ML	100 ML
3 Soybean	\$ 1.03	\$ 0.90	\$ 0.84	\$ 0.84	\$ 1.12	\$ 0.97	\$ 0.91	\$ 0.91		3 Soybean	-\$ 20.52	-\$ 66.05	-\$ 101.98	-\$ 201.64	Not feasible	Not feasible	Not feasible	Not feasibl
# #N/A										# #N/A								
	Ethanol FO	3 price		Ś 0.42	Gasoline FC	B price		\$ 0.79										
			Ethanol			JSD/L Gasoli	ne Equivaler				N	IPV (Millio	n USD/yea	r)		IRR (%)	
Ethanol	5 ML	25 ML	50 ML	100 ML	5 ML	25 ML	50 ML	100 ML		Ethanol	5 ML	25 ML	50 ML	100 ML	5 ML	25 ML	50 ML	100 ML
1 Sugarcane	\$ 0.97	\$ 0.65	\$ 0.61	\$ 0.59	\$ 1.47	\$ 0.99	\$ 0.93	\$ 0.89		1 Sugarcane	-\$ 26.93	-\$ 54.11	-\$ 87.88	-\$ 54.81	Not feasible	Not feasible	Not feasible	Vot feasibl
2 Maize	\$ 0.98	\$ 0.51	\$ 0.44	\$ 0.41	\$ 1.48	\$ 0.77	\$ 0.67	\$ 0.62		2 Maize	-\$ 28.71	-\$ 25.31	-\$ 17.30	\$ 0.99	Not feasible	Not feasible	Not feasible	10%
# #N/A										# #N/A								

change the current scenario.

Figure 25: Comparison of economic results for the feedstocks assessed.

6.6.3 Labour Analysis Results

This section of the results presents the data relevant to the socio-economic impact of the potential biofuel pathways studied. This includes the potential for job creation, the land use required, and the labour required to operate the plants.

The results presented below are for plant capacities of 100 ML and the other results are presented in Appendix 4.

Labour Results for 100 ML plants

When considering the labour requirements by plant, it can be observed that the Own Production scenario requires much lower labour intensity than the other two scenarios. Although this ensures that the price is cheapest and can be produced competitively, depending on the needs and regional situation it may be more appropriate to select scenario 2 or 3. This would help to generate additional employment which might be more significant than a cheaper production cost of biofuels. Furthermore, when comparing all the feedstocks, the production of soybean has the highest labour intensity.

As with the labour requirements, the land requirements are also much more significant in the production of soybean. This is reflected in the total country area that is planted with each crop as soybean occupies a much larger amount of agricultural land than sugarcane or maize. When comparing the ethanol-producing energy crops, it can be observed that sugarcane requires a lower land area than maize. This is due to the much higher yields that sugarcane offer, even considering that less maize feedstock is required in ethanol production.

Finally, the share of jobs in both the production and processing sections of the pathway are compared. The jobs related to processing the feedstock into biofuel remain constant at all scenarios and feedstock types. Hereby, 126 jobs are required to process the feedstock into biofuels. The main difference between the job creation is related to the feedstock-production, with the Own Production scenario requiring the least number of workers and the Outgrowers scenario requiring the highest number of workers. Furthermore, the jobs relating to feedstock-production are less technical than those of feedstock-processing. This means that independently of the scenario selected for production, the amount of technical and specialised jobs would not change significantly as most jobs are created in the feedstock production phase. It is worth noting that biofuel production is not a major job generator due to the high levels of mechanised harvesting.

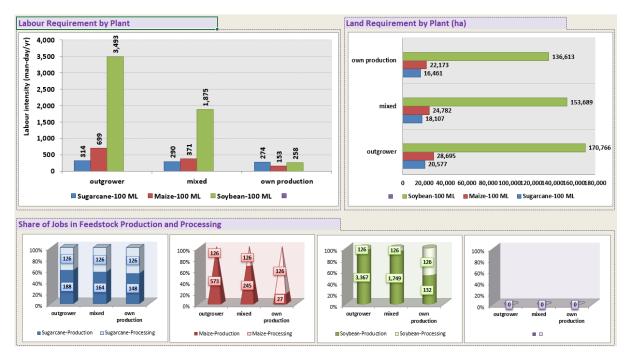


Figure 26: Comparative labour results for all feedstock options at plant capacities of 100 ML.

6.7 Discussion Energy End Use Module

The Energy End Use module provides both a techno-economic and a socio-economic analysis of the potential uses for the feedstock assessed in the Natural Resources module. The main findings from the module are summarised in this section and addresses RSQ3.

What is the current state regarding the production of biofuels in Argentina? Is increasing the production of biofuels for the transport sector a viable option? What impact has the current price freeze had on the profitability of biofuel production?

Considering the country needs, the most suitable Energy End Use option is the transport submodule, and therefore this is the pathway analysed. Furthermore, the crops data obtained in the Natural Resources module form the basis for the data required in this submodule. As was stated in the Country Status module, Argentina currently supplies 100% of the required biofuels to meet the blending mandate set by the government. Additionally, Argentina is one of the leading global exporters of biodiesel and exports just under 50% of biodiesel produced. With respect to the internal biofuel market, as discussed in Chapter 2, there has been a price freeze in place since December 2019 (recently updated in October 2020). This freeze is due to the high inflation the country is experiencing and was meant to help stabilise the economy. However, as can be confirmed in the results obtained in this section, the price freeze, coupled with rising inflation, has created an economically unsustainable situation for the producers of biofuel. As seen in the financial analysis section for each feedstock type, the current market price is not sufficient to provide a profitable scenario to produce biofuels, even considering the recent price increase. With respect to maize, a minimal profit can be obtained under the first scenario at capacities of 100 ML. The impact which the price freeze has had on the market is significant and therefore should be a main point of consideration to improve the internal biofuel market. Furthermore, Argentina has also experienced a considerable reduction in the consumption of fossil fuels due to the current global pandemic. This leads to a direct reduction in the amount of biofuel required to meet the blending mandates, which has also impacted the profitability of the industry.

The results presented in this section consider the impact that raising the blending mandates would have on feedstock availability. As can be observed in the operation results section for each feedstock, the maximum attainable biofuel production is assessed against a hypothetical blending mandate. For ethanol production, due to the availability of two feedstock options, the current production total is assumed to be zero. This helps to understand the full potential of both sugarcane and maize feedstock to produce ethanol. For sugarcane alone, a total of 102% of the E15 mandate could be achieved. For maize, a total of 98% of the E15 mandate could be supplied. The ability of both crops to supply around 100% of the total amount of ethanol required in a hypothetical E15 mandate demonstrates the

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viability of supplying an increased ethanol mandate. The maximum attainable production of biodiesel was assessed at a hypothetical blending mandate of B20, assuming the current production of biodiesel remains constant. Under this scenario, the available soybean feedstock would be able to produce up to 680% of the required blending increase (10%). Furthermore, considering that Argentina is a net importer of fossil fuels, increasing the required biofuel mandate would reduce the need to import fossil fuels and would improve the sustainability of the internal energy sector. Therefore, it can be assumed that increasing the production of biofuels in the transport sector is a viable option when considering feedstock availability and safeguarding food security. However, the increase in production would have to be accompanied by either a rise in the blending mandates (preferable) or an increase in biofuel exports (added uncertainty).

Chapter 7: Conclusion

7.1 Main Research Question

The three research sub-questions provide information relating to the results presented in Chapters 4, 5 and 6, and are included at the end of those sections. This final discussion section will aim to provide an answer for the main research question and will use the information obtained in the previous result chapters. The research objective should be met by providing an answer to the main research question.

Can an increase in the blending mandate of Argentina be supported by the available biomass feedstock whilst safeguarding food security?

The current instability in the economy, and the expiry in May 2021 of the National Law 26.093 which has regulated the bioenergy industry since 2006, offer the distinct possibility to make significant changes to the industry. One of the main policy considerations consists in the increase to the blending mandates to resemble the Brazilian model more closely. An increase in blending mandates could both improve the demand in the industry and reduce the GHG emissions from the transport sector. Furthermore, the current reliance on imported fossil fuels would be greatly minimised with a blending increase. However, a significant rise in the blending mandate could have serious impacts on food security and could have a minimum impact on GHG emissions.

In Chapter 6, the hypothetical increases in the blending mandates which might be experienced in the coming years was assessed against the existing processing technologies. The blending mandates were set at 15% and 20% for ethanol and biodiesel, respectively. The potential feedstock available in Argentina was estimated in Chapters 4 and 5 and is used as the basis for the results in Chapter 6. Using the results from the previous modules helps to ensure that the hypothetical feedstock available is safeguarded with respect to food security. This is because the net trading position and the main food crops are considered and, wherever possible, main food crops are not included in production. With respect to ethanol, there are two main crops used in Argentina in the production, sugarcane, and maize.

Considering an E15 blending mandate, both these crops can potentially supply the necessary feedstock, with maize providing 98% and sugarcane providing 102% of the total amount. As both crops are used in the production of ethanol, the impact of an increase in this blending mandate would be minimal on both food crops. Therefore, the increase of the blending mandate of ethanol could be achieved with minimal repercussions on food security. Furthermore, considering the export quantities for maize presented in Chapter 4, these alone offer sufficient feedstock to supply the increase in blending mandates. Whilst inflation makes exports more competitive, imports become more expensive. Considering that Argentina imports a significant amount of oil, substituting this with

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domestic biofuels would offer improvements in climate change mitigation and could also help to stabilise the cost of energy during this period of high inflation.

The production of biodiesel in Argentina is based on soybean oil as feedstock. The blending mandate considered for biodiesel is double the current mandate (B20). Although in practical terms blending mandates are expected to receive incremental increases, analysing the potential to deliver the B20 blend allows for a larger margin of error and is an added layer of safety against detrimental effects on food security. The current feedstock availability of soybean can supply 234% of the biomass to increase the blending mandate from 10% to 20%. Furthermore, considering the export results presented in Chapter 4, soybean is one of the major agricultural exports accounting for 46.6% of the total when all forms of soybean are considered (raw, cake and oil). The export of soybean oil demonstrates the excess feedstock available as this forms the basis to produce biodiesel. Concurrently, Argentina is a major exporter of refined biodiesel, however the recent ban in the US on Argentinian products and the limitations placed on first-generation biofuels in the European Union have caused uncertainty within key markets and may reduce available exports. Therefore, an increased blending mandate could also be supplied by existing production if international markets cannot maintain current exports.

Although second- and third-generation biomass options are preferable to the increased sustainability of the industry, the existing expertise and technologies should be considered when rapid change is desirable. The expiry of the existing law and the current issues faced by the industry offer an opportunity to increase the market share of biofuels and support the industry through increase blending mandates. An increase in blending capacity should be accompanied by a guarantee that food security will not be negatively affected. As has been demonstrated through this analysis, the effective management of food crops can guarantee both increases in biofuel blending and ensure that food prices remain relatively stable, excluding inflation. Furthermore, improvements to energy security are also possible due to the substitution of imported fuels for domestically produced biofuels.

7.2 Research Limitations

One of the key limitations on the study was the time available to perform the analysis. A more indepth analysis could have been undertaken with more time to assess other aspects of the bioenergy industry such as forest and crop residues or the use of sugar molasses as the feedstock for biofuels as well as other potential end use options.

Another important limitation was the data availability. Due to the country's economic volatility and high rates of inflation, there were several datasets that either were not available or were not complete. Hence, some datasets needed to be extrapolated from previous years. Although the

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costings of sugarcane production were adjusted for inflation, the accuracy of extrapolating the costings using only inflation raised some precision issues.

Furthermore, the exact blending mandates which should be adopted and the implementation of such cannot be answered by this analysis. A further survey analysis of various stakeholders, including biomass and biofuel producers, could be performed to gain further insight into the needs of the industry and the best available improvements.

7.3 Future Research Direction

The direction which future research could take is manifold. The BEFS detailed analysis tool would help to provide added depth to the research and would provide a more complete understanding of the most effective bioenergy pathways available. As Argentinian agriculture differs greatly between regions, ensuring a more detailed regional analysis could provide specific policy to help develop marginalised regions. This is especially important in northern rural areas where average GDP is much lower when compared to the regions closer to the capital.

An environmental assessment of the impact that a blending increase will have on GHG emission should be performed to fully comprehend the environmental benefits associated with increased capacities. This would help to ensure climate change targets are met and could help to persuade the relevant parties of the environmental impact of this policy.

Although the current bioenergy market is dominated by first-generation biofuels, the research and development of more modern options should be performed. Furthermore, incorporating new bioenergy sources into existing infrastructure would help the transition from first-generation to future biofuels. This would enable flexibility in the market and would allow for the future substitution of energy crops with more sustainable feedstocks such as residues or algae-based biofuels.

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Appendix 1

The Country Status module results are presented in full in this section and form the basis of Chapter 4.

19 19						Country	Status Module					Bioto Security								
						COUNTR	Y OVERVIEW													
	COUNTRY: A	rgentina							« BACK Start	Net Tr	NEXT≫ ade Position for Key Food	Crops								
FS Rapid Appraisal f	for		the country						Enter data i	nto white cells	Grey cells are	e calculated								
			POPULATION					ECONOMIC AND A	AGRICULTURAL IN	DICATORS										
	Parameter (unit)		Value	Year	User-defined value	Year		Parameter (unit)	Value	Year	User-defined value	Year								
(population (1000 inhab)			43,417	2015	44,781		GDP per capita (current USS)		12,449.22	2016	14,400	2019								
population(%)			8%		8%	2019	GDP per capita (constant 2010	USS)	10,148.51	2016	10043	2018								
n population (%)			92%		92%	2019	GDP/capita, PPP (const. 2011, i	nt. 5)	18,479.44	2016	20611	201								
lation density (inhab/km2	2]		15.9		16.4		Inflation, consumer prices (ann	ual %)	10.62%	2013	54%	201								
per of households					12,171,675.0		Agriculture, value added (% of	SDP)	7.56%	2016	7%	201								
households (%)						2010	Livestock, value added (% of Ag	ricultural Value Added)	33.87%	2014										
n households (%)																				
		Source:	FAO, 2017: FAOSTAT		020: UNDATA; Censo Arg	gentino, 2010: INDEC.g		Source	: The World Bank, 2	017: WDI; FAO 2017	The World Ban	ik, 2020: WDI								
		LAN	ID AND LIVESTOCK	1				FOOD SECUR	RITY AND ENERGY	USE										
Paramete	er .	1000 ha	% of land area	Year	User-defined value	Year		Parameter (unit)	Value	Year	User-defined value	Yea								
try area		278,040		2014	278,040	2020	Energy use (kg of oil eq. per cap	oit a)	2015.2	2014	2,030	201								
area		273,669	100%	2014	273,669	2020	Electric power consumption (k)		3052.4	2014	3,075	201								
ultural area		148,700	54.34%	2014	148,712	2016	Access to electricity (% of population)		100.0%	2014	100%	201								
	Arable land	39,200	14.32%	2014	39,189	2016	GDP per unit of energy use (constant 2011 PPP \$ per kg of oil equivalent)		9.3	2014	10	201								
	Permanent crops	1,000	0.37%	2014	1,095	2016	Undemounished population (%		5.0%	2015	5%	201								
t area		27,409	10.02%	2014	26,814	2016	Poverty headcount ratio at national poverty line (% of pop.)		Poverty headcount ratio at national poverty line (% of pop.)		Poverty headcount ratio at national poverty line (% of pop.)		Poverty headcount ratio at national poverty line (% of pop.)		Poverty headcount ratio at national poverty line (% of pop.)				32%	201
per 100 people, total pop	vulation (LSU)	100		2014	- AO, 2020: FAOSTAT; The	- World Bank, 2020, 114					The World Ban	k 2020 um								
		Source:		7: FAOSTAT	-so, 2020: PAUSTALI; The	worki baris, 2020: WL		Source		ank, 2017: WDI	me worte Ban	, 2020: WD								
_			WATER						WATER											
-term average precipitatio	Parameter (unit)		Value	Year	User-defined value	Year		Parameter (unit)	Value	Year	User-defined value	Yea								
-term average precipitatio Linternal rene wable water		1	591 292.0	2014 2014	591 292	2017 2017	Total area equipped for irrigation Annual freshwater withdrawais	n (1000 ha) , agriculture (% of total freshwater withdrawal)	2360.00 73.93%	2014 2014	2357 74%	201-								
		Source:	FAO, 2017. Aquastat	100400	FAD, 2020:	Aquastat			Source	FAO, 2017. Aquastat	FAO, 2020	Aquastat								
		FOOD SUPP	PLY AND KEY FOOD	STUFFS				AGRICULTURAL T	RADE - KEY COMP											
Rank	Food com			ical/capita/day)	Share in total i		Rank	Trade commodity	Export quantity (t)	Export value (1000 US\$)	(US\$/t)	Share in tota expor								
1	Wheat and F Sugar (Raw Ec	1000000		196	27.7		1	Cake, soybeans	28,255,419 23,706,382	9,081,554 3,883,602	321	27.29								
3	Sugar (Raw Ed			137	12.2		2 3	Maize Oil, soybean	4,972,587	3,883,602 3,725,822	164 749	11.6								
4	Sunflowers			169	8.35	6	4	Oil, soybean Soybeans	7,400,920	2,732,359	369	8.23								
5	Mik - Excludi	5 K.		105	6.39		5	Wheat	13,099,133	2,361,855	180	7.19								
6	Poultry Maize and P			95	5.69		6	Meat, cattle, bonciess (beef & veal)	203,825	1,282,110 806.853	6,290	3.89								
8	Rice and pr		-	85	2.99		8	Wine Oil, sunflower	224,689 758,433	602,142	3,591 794	2.49								
9	Pig me	at		82	2.55		9	Oil, sunhower Groundnuts, prepared	373,767	556,619	1,489	1.79								
10	Potatoes and			69	2.19		10	Barley	2,564,500	456,491	178	1.49								
		Subtotal Total food supply	3,5	616 239	80.8	8240)	Te	tal value of export of agricultural commodities	Subtotal	25,489,407 33,361,357		765								
Source:	FAD, 2017. FAOSTAT		1	Year:				FAO, 2017: FAOSTAT		33,301,337 Year:	201	17								
						AGRICULTU	RALPRODUCTION													
			141 - 2022-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1																	
Rank	Crop Its	m	Production Quantity (tonnes)	Area harvested (ha)	Yield (hg/ha)		Rank	Crop Item	Production Quantity (tonnes)	Area harvested (ha)	Yield (hg/ha)									
1	Maiz	·	43,462,323	7,138,620	60,883		11	Rice, paddy	1,367,968	198,170	69,030									
2 -	Soybea Sugar C		37,787,927	16,318,050 426,192	23,157		12 13	Oranges	1,005,779	46,023	218,756									
4	Sugar C	10000	19,0 99,561	426,192 5,822,173	446,737 31,805		13	Vegetables, fresh nes Groundnuts, with shell	980,810	62,910 443,864	20,755									
	Barle		5,061,069	1,209,995	41,827		15	Seed cotton	813,692	319,285	25,485									
5	Sunflower		3,537,545	1,678,031	21,082		16	Orions, dry	707,496	27,388	258,323									
6	Grape		2,573,311	218,233	117,916		17	Tomatoes	653,485	16,551	394,832									
5	20000	10	2,340,103	72,442	323,033		18	Pears	565,697	24,553	230,398									
6 7 8	Potato Lemons and	Lines	-	57.665	344,993		19		510.478	23,958	213,072									
6			1,989,400 1,563,445	57,665 437,463	344,993 35,739		19 20	Apples Oats	510,478 491,713	23,958 218,399	213,072 22,514									

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Year	Production	Import	Stock variation	Export	Domestic supply	NETTRAL	DE POSITION
							position
2004	16,139,170	8,021	- 1,266,222	10,075,576	4,805,393	62.4%	Net exporter
2005	12,721,980	6,189	2,635,039	10,536,830	4,826,379	82.8%	Net exporter
2006	14,662,940	9,398	250,000	9,988,819	4,933,519	68.1%	Net exporter
2007	16,486,530	8,400	- 808,518	10,745,811	4,940,601	65.1%	Net exporter
2008	8,508,156	7,547	6,333,744	9,992,741	4,856,706	117.4%	Net exporter
2009	9,123,399	10,365	2,079,232	6,285,092	4,927,904	68.8%	Net exporter
2010	16,067,930	8,043	- 5,847,083	5,109,964	5,118,926	31.8%	Net exporter
2011	14,683,480	7,036	- 400,000	9,575,378	4,715,138	65.2%	Net exporter
2012	8,134,409	5,289	9,272,171	12,562,944	4,848,925	154.4%	Net exporter
2013	9,315,049	3,894	- 1,453,082	2,615,156	5,250,704	28.0%	Net exporter
Source:			FAO, 2020: FAOSTAT				

Food crop 2 Sugar Raw Equivalent

L

	Production	Import	Stock variation	Export	Domestic supply	NET TRAD	DE POSITION
							position
2004	1,815,840	17,478	40,288	295,107	1,578,500	15.3%	Net exporter
2005	2,138,826	13,488	117,957	611,248	1,659,022	27.9%	Net exporter
2006	2,469,642	10,157	- 53,739	791,220	1,634,840	31.6%	Net exporter
2007	2,197,957	13,596	- 146,463	430,733	1,634,356	19.0%	Net exporter
2008	2,447,764	44,787	- 387,252	473,750	1,631,549	17.5%	Net exporter
2009	2,255,521	16,275	238,741	873,373	1,637,165	38.0%	Net exporter
2010	2,038,191	45,284	1,808	413,421	1,668,246	18.1%	Net exporter
2011	2,094,273	59,663	- 269,537	186,687	1,697,712	6.1%	Net exporter
2012	2,188,654	10,096	- 197,102	292,685	1,708,963	12.9%	Net exporter
2013	1,788,848	9,873	258,584	323,661	1,733,643	17.5%	Net exporter
irce:			FAO, 2020: FAOSTAT				

Food crop 3 Bovine Meat

Year	Production	Import	Stock variation	Export	Domestic supply	NET TRA	DE POSITION
2004	3,024,000	3,458	-	619,438	2,408,019	20.4%	Net exporter
2005	3,130,800	3,803	-	736,939	2,397,664	23.4%	Net exporter
2006	3,033,600	4,382	21	540,040	2,497,943	17.7%	Net exporter
2007	3,223,700	4,384	-	528,133	2,699,951	16.2%	Net exporter
2008	3,131,902	3,700		423,249	2,712,353	13.4%	Net exporter
2009	3,378,460	1,968	2	640,483	2,739,944	18.9%	Net exporter
2010	2,630,163	2,248	-	302,087	2,330,324	11.4%	Net exporter
2011	2,498,954	3,178	-	257,476	2,244,656	10.2%	Net exporter
2012	2,594,336	1,790		213,423	2,382,702	8.2%	Net exporter
2013	2,822,000	187	2	233,103	2,589,084	8.3%	Net exporter

	Production	Import	Stock variation	Export	Domestic supply	NET TRADE POSITION		
							position	
2004	1,208,500	1,530	125,000	925,541	409,489	76.5%	Net exporte	
2005	1,523,400	1,170	86,500	1,200,267	410,804	78.7%	Net exporte	
2006	1,579,600	176	70,000	1,228,699	421,077	77.8%	Net exporte	
2007	1,223,500	2,222	50,000	854,302	421,420	69.6%	Net exporter	
2008	1,740,060	92	- 163,000	1,155,609	421,543	66.4%	Net exporte	
2009 -	1,418,821	225	- 48,000	945,592	425,454	-66.6%	Net importe	
2010	1,127,698	67	- 110,000	567,628	450,138	50.3%	Net exporte	
2011	1,489,706	152	- 150,000	899,148	440,711	60.3%	Net exporter	
2012	1,541,580	66	- 320,000	773,858	447,788	50.2%	Net exporter	
2013	1,074,724	57	- 200,000	429,776	445,005	40.0%	Net exporter	

Food crop 5 Milk - Excluding Butter

	Production	Import	Stock variation	Export	Domestic supply	NET TRAI	DE POSITION
							position
2004	8,100,000	69,420	250	2,121,056	6,048,615	25.3%	Net exporter
2005	9,908,941	66,784	91	2,165,033	7,810,692	21.2%	Net exporter
2006	10,493,570	32,072		2,823,621	7,702,022	26.6%	Net exporter
2007	9,822,337	40,990		1,630,379	8,232,948	16.2%	Net exporter
2008	10,320,320	34,603	12 I.	1,744,157	8,610,767	16.6%	Net exporter
2009	10,366,290	40,224	8.1	2,224,410	8,182,103	21.1%	Net exporter
2010	10,307,520	44,497		2,043,321	8,308,696	19.4%	Net exporter
2011	11,206,260	40,227		2,939,047	8,307,440	25.9%	Net exporter
2012	11,238,900	95,080	14	2,839,522	8,494,458	24.4%	Net exporter
2013	11,183,750	78,588		2,781,645	8,480,693	24.2%	Net exporter
rce:			FAO, 2020: FAOSTAT				

FAO, 2020: FAOSTAT

				E	NERG	Y BALA	NCE					
Country: Arge	entina							<< BACK Net Trade Position			NEXT > Energy Der	
Rapid Appraisal fo	ır	the	country						Enter o	data into white ce	lls G	irey cells are calculated
	Toto	al primary energy	supply					Final energy	consumpt	ion		
	3.9%	1.0% 0.8%						0.4%				
	0.1%	%	Coal	and peat C	rude oil						Coal and peat	Crude oil
		31.2%	≡ Oil p	roducts <mark>=</mark> N	atural gas		4.9	18.2%	42.6		■ Oil products	Natural gas
			III Nucl	ear 📕 H	ydro				42.0		Nuclear	Hydro
	51.1%	4.0	sola	thermal, 🛛 🖷 B r, etc.	iofuels and was	te		33.9%			Geothermal, solar, etc.	Biofuels and waste
			Elect	tricity E H	eat						Electricity	Heat
				Final energ	ıy consum	ption by secto	r					
20											_	Coal and peat
16	0.24	_										Crude oil
14	3.74	_	1.3									Oil products
12		13.18	1.5									Natural gas
8 W	6.95	_	8.04								_	Hydro
6	1.03											Nudear
4 2	4.33	2.97	0.26 3.85	0.34 1.06 0.16 2.77	_	3.85				3.56	_	Geothermal, solar, etc.
0	Industry	1.44 Transport	Residential	Commercial and	oublic Ag	0.13 riculture / forestry	Fishing	Non-spe	cified	1.68 Non-energy use		Biofuels and waste
				services								Electricity

Unit:	Mtoe	Coal and peat						Geothermal, solar, etc.				
Total primary ene	ergy supply	1	28	4	45	2	3	0	5	1	0	88
Production		0	28		36	2	3	0	5			74
Import		1	1	5	9					1		17
Export		0	1	2	0					0		3
Final consumptio	n	0	0	26	21	0	0	0	3	11	0	61
Industry	-	0		4	7				1	4		16
Transport				13	3				1	0		18
Residential				1	8				0	4		13
Commercial and p	oublic services			0	1				0	3		4
Agriculture / fore:	stry			4					0	0		4
Fishing												0
Non-specified												0
Non-energy use				4	2							5
Source:		EA, 2020: Sankey Dat	a	Year:	2017			•				

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BEFS Rapid Appraisal Country Status Module

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	Country:	Argentina								<< BACK Energy Balance
I	BEFS Rapid Appraisal for		the country					Enter data into	white cells	Grey cells are calculated
			CLIM	ATE PLEDGES	OF INDC/NDC					
fitigation Type fitigation Target aseline arget Year	Relative emission reduction 15% uncorditional, 30% condition BAU 2030 rce: IGES INDC & NDC Database. In	nal	Mitigation Summary		power, renewable ener /capturing GHG emission Argentina could increas financing; b) support fo	gy, and transport mo ns and associate co-l e its reduction goal u transfer, innovation	dal shift. The crit enefits, as well a nder the followir and technology	able forest management, er eria for selecting the actions s the possibility of applying g conditions: a) Adequate a fevelopment; c) support for ompared to projected BAU	s include the potenti nationally develope nd predictable inter capacity building. In	al for reducing d technologies. national n this case, a
Sou	rce: 10ES INDC & NDC Database. If	istitute for Global En	vironmental Strategies	2017-03						
			vironmental strategies	2017-03]
Fuel consumption	n in transport sector (exclu				Emort	Consumption	r			
uel consumption		iding aviation)	Production 8,170.96	Import 1,783.51	Export 28.37	Consumption 9.926.10	ML	Consumption of	f liquid biofuels in tr	ansport
uel consumption	n in transport sector (exclu		Production	Import	1		1,200	Consumption of	f liquid biofuels in tr	ansport
uel consumption	in transport sector (exclu Diesel	i ding aviation) (ML/year)	Production 8,170.96	import 1,783.51 406.00	1	9,926.10 5,510.27	1,200	Consumption of	f liquid biofuels in tr	ansport
uel consumption	in transport sector (exclu Diesel	i ding aviation) (ML/year)	Production 8,170.96 5,104.27	import 1,783.51	28.37	9,926.10	1,200	Consumption of	f liquid biofuels in tr	ansport
iel consumption	in transport sector (exclu Diesel Gasoline	l ding aviation) (ML/year) (ML/year)	Production 8,170.96 5,104.27 Production	Import 1,783.51 406.00 Import	28.37 Export	9,926.10 5,510.27 Consumption	1,200 1,000 800		f liquid biofuels in tr	ansport
uel consumption	n in transport sector (exclu Diesel Gasoline Biodiesel	(ML/year) (ML/year) (ML/year)	Production 8,170.96 5,104.27 Production 1,889.60	Import 1,783.51 406.00 Import -	28.37 Export	9,926.10 5,510.27 Consumption 996.39 869.53	1,200 1,000 800 600 400 200		f liquid biofuels in tr	aniport
	n in transport sector (exclu Diesel Gasoline Biodiesel	(ML/year) (ML/year) (ML/year)	Production 8,170.96 5,104.27 Production 1,889.60 869.53	Import 1,783.51 406.00 Import - -	28.37 Export 893	9,926.10 5,510.27 Consumption 996.39 869.53 tion (ML/year)	1.200 1.000 800 400	Consumption of	f liquid biofuels in tr	ansport

Appendix 2

The Natural Resources module results are presented in full in this section and form the basis of Chapter 5.

ood and	d Agriculture Organia nited Nations	ration												
	COUN	ITRY:	Argentina						<< BAC Crop Produ		Select an	NEXT >> Option for Additic	nal Product	tion
		BEFS Rapic	l Appraisal for:	the country					Ent	er data into white o	els	Grey ce	ils are calcu	lated
	Net Tra	ide Position for	selected crops f	or bioenergy in the	e past 10 year	3		Net	Trade Position for s	elected crops f	or bioenergy in th	ne past 10 yea	/3	
	N	et trade position 1	or selected crop	is for bioenergy					Net trade positio	n for selected or	ops for bioenergy	9		
00%						Net esp	where	100%						
75%						They eight	AUT (UP)	73%				•		
50%								50%	A		•	•	+	
25%				•				25%	100					
	•		• •	•			•		• •					
2003	2004 200	5 2006	2007 2008	2009 2010	2011 20	12 20	13 2014	0% 2008 2004	2005 2006	2007 2008	2009 2010	2011 201	2 2013	2014
25%								-25%						
50%								50%						
75N								-75%						
074							orta	-100%					Net import	
			Sugarcane	Sunflower						Maize	Soybean			
ut requ Crop 1		ugarcane	Stock variation	Excourt	Domestic supply	NET TRA	DE POSITION	Crop 3	Maize	Stock variation	Export	Domestic supply	NET TRA	DE POSITION
Crop 1	S	ugarcane Import (t]	Stock variation (t)	Export (t)	Domestic supply	NET TRA %	DE POSITION position		Maize Import (t)	Stock variation (t)	Export (t)	Domestic supply (t)	NET TRAJ	DE POSITION position
Crop 1	S	Import				% 15.3%	position Net exporter	ar Production (t) 2004 14350	Im port (t)	(t)			% 71.9%	position Net exporter
Crop 1 2004 2005	(t) 1815840 2138896	Import (t) 13478 13488	(t) 40288 117957	(t) 295107 611248	(1) 1578500 1659022	% 15.3% 27.9%	position Net exporter Net exporter	ar Production (t) 2004 14/50 2005 20/482	Import (t) 20 5900 70 5101	(t) 2000.00 0	(t) 10761896 14722042	(t) 4394824 5765629	% 71.9% 71.9%	position Net exporter Net exporter
Crop 1 2004 2005 2006	(t) 1815840 2138806 2469642	Import (1) 17478 13488 30157	(t) 40288 117957 -53739	(t) 295107 611248 791220	(t) 1578500 1659072 1634840	% 15.3% 27.9% 31.6%	position Net exporter Net exporter Net exporter	r Production (t) 2004 34550 2005 20482 2006 34645	(t) (t) 20 5900 70 5101 40 6963	(t) 200000 0 200000	(t) 10761896 14722042 10482906	(t) 4354824 5765629 5969521	% 71.9% 71.9% 72.5%	position Net exporter Net exporter
Crop 1 2004 2005 2006 2007	S Production (U) 1815800 2138206 2469642 2197957	Import (1) 17478 13458 20157 13596	(t) 40288 117957 -53739 -146463	(t) 295107 611248 791220 430733	(t) 1578500 1659072 1634840 1634336	% 15.3% 27.9% 31.6% 19.0%	position Net exporter Net exporter Net exporter Net exporter	r Production (t) 2004 34/50 2005 20482 2006 344/5 2007 221755	(t) (t) 20 5900 70 5101 40 6963 50 7181	(t) 200000 0 200000	(t) 10761896 14722042 10482906 15076044	(t) 4394824 5765629 5969621 6686697	% 71.9% 71.9% 72.5% 69.3%	position Net exporter Net exporter Net exporter Net exporter
Crop 1 2004 2005 2007 2008	S Production (t) 1815840 218805 2469642 2187057 2447264	Import (1) 17478 13488 30157 13596 44787	(t) 40288 117957 -53739 -146463 -387252	(t) 295107 611248 791220 430733 473750	(t) 1578500 1659022 1634840 1634336 1631549	% 15.3% 27.9% 31.6% 19.0% 17.5%	position Net exporter Net exporter Net exporter Net exporter Net exporter	r Production (t) 2004 34950 2005 2086 2006 14445 2007 21755 2008 22316	Im port (t) 20 5900 76 500 76 696 7181 36 780	(t) 200000 0 200000	(t) 10761896 14722042 10482906 15076044 15072042	(t) 4394824 5765629 5969521 6686497 6523438	% 71.9% 71.9% 72.5% 69.3% 70.4%	position Net exporter Net exporter Net exporter Net exporter Net exporter
Crop 1 2004 2005 2006 2007 2008 2009	5 Production (t) 1815840 2489642 2489652 249652 249	Import (t) 17478 13488 30157 13596 44787 16775	(t) 40288 117957 -53739 -146463 -387252 238741	(t) 2951.07 611248 791220 430733 473750 873373	(1) 1578500 1659072 1634840 1634336 1631549 1632165	% 15.3% 27.9% 31.6% 19.0%	position Net exporter Net exporter Net exporter Net exporter	r Production (t) 2004 14/50 2005 2066 2006 14445 2007 21755 2008 22016 2009 13121	Im port (t) 20 5900 70 5100 60 6983 60 7183 60 7280 80 4353	(t) 200000 0 200000	(t) 10761896 14722042 10482906 15076044 15501294 8752814	(t) 4394824 5765629 5969621 6686697 6523436 4372921	% 71.9% 71.9% 72.5% 69.3%	position Net exporter Net exporter Net exporter Net exporter
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				INTE	NSIFICATIO	DN					
COUNTRY:	Argentina						<< BA Crops Con		Select an Op	NEXT >> ntion for Additional	Production
	BEFS Rap	d Appraisal for:	the country					Enter data int	o white cells	Grey cells are	calculated
		Crop 1	Crop 2	Crop 3	Crop 4			Crop 1	Crop 2	Crop 3	Crop 4
		Sugarcane	Sunflower	Maize	Soybean		10-year aver	age of annual prod	luction at country le	vel	
ameter	Unit		Current pr	oduction			(±	based on FAOSTAT.	2005-2014)		
rrent yield	t/ha	60.00	2.00	6.30	3.20	Parameter	Unit	Sugarcane	Sunflower	Maize	Soybean
. of harvests/year		1	1	1	1	Yield	t/ha	72.80	1.73	6.61	2.6
nual production	t/year	22,500,000	3,300,000	32,000,000	51,000,000	Annual production	t	24,864,693	3,245,418	22,461,438	44,790,16
al production area	ha	375,000	1,650,000	5,079,365	15,937,500						
		Intensified production	n				Potential yield	is based on Global	Agro-Ecological Zo	ning	
Ø	Potential producti	on on the same area				Crop		Sugarcane	Sunflower	Maize	Soybean
ter supply	Select	Irrigation -	Irrigation -	Irrigation -	Irrigation -	Water supply		Irrigation	Irrigation	Irrigation	Irrigation
ut level ensified vield	Select t/ha	High • 77	High -	High -	High - 4.00	Input level Soil suitability class:		High	High	High	High
of harvests/year		1	1	1	1	Country average	t/ha	97.70	4.03	14.23	4.90
tential production	t/year	28,875,000	3,465,000	43,174,603		Suitable/very suitable	t/ha	111.69	4.18	14.76	5.13
tal production area	ha	375,000	1,650,000	5,079,365	15,937,500	Moderately suitable	t/ha	83.25	2.97	9.85	3.42
		on-bioenergy purpos	- 1	-		Potential yields are a					
nned production	t/year ha	28,000,000 363,636	3,400,000	41,200,000 4,847,059	60,200,000 15,050,000	- rainfed production: low - irrigated production: h					
			-,,	-,,							
	Potentia	I production for	bioenergy		<i></i>						
		Sugarcane	Sunflower	Maize	Soybean						
tential production	t/year	875,000	65,000	1,974,603	3,550,000						
ea of production	ha	11,364	30,952	232,306	887,500	Clear data					
Food and Agriculture Organ of the United Nations	nization			Natural	Rapid Appraisal Resources Modu GE OF CRO	le				(Beenry
Food and Agriculture Organ		': Argentina		Natural	Resources Modu	DPS	cc BACK	Selec	NEXT an Option for Ac		BE Beenry Security H
of the United Nations	COUNTRY			Natural	Resources Modu)PS crop	Component		rt an Option for Ac	ditional Product	_
of the United Nations	COUNTRY	': Argentina r: the country		Natural	Resources Modu)PS crop			rt an Option for Ac		_
of the United Nations	COUNTRY Appraisal fo	r: the country		Natural	Resources Modu)PS crop	Component	: cells	ct an Option for Ac	ditional Product	
of the United Nations	COUNTRY Appraisal fo	r: the country		Natural	Resources Modu	DPS Crop Enter	Component	e cells	rt an Option for Ac	ditional Product	_
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ef the United Nations BEFS Rapid Ject a current crop and I	COUNTRY Appraisal fo the crop for b Current c	r: the country ioenergy: Maize rop		CHANO	Resources Modu	DPS Crop Enter	component	rells rgy S Crop for b	Grey cell Grey cell ugarcane ioenergy	ditional Product	_
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ef the United Nations BEFS Rapid Ject a current crop and t Current crop	COUNTRY Appraisal fo the crop for b Current of Current prod Unit	r: the country ioenergy: Maize rop	Maize	Natural CHANO	Resources Modu	le DPS Crop Enter Cro Parameter	data into white	argy S Crop for b Planned pu Unit	Grey cell Grey cell Ugarcane Noenergy roduction	ditional Product	•
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	Irrigation	•	Water supply		Irrigation	
Low	Intermediate High		Input level	Low	Intermediate	High
	t/ha		Soil suitability class		t/ha	
n/a	8.63	14.23	Country average	n/a	59.38	97.70
n/a	9.86	14.76	Suitable/very suitable	n/a	72.27	111.69
n/a	6.41	9.85	Moderately suitable	n/a	52.29	83.25

Potential yields are available for:

- rainfed production: low input level and intermediate input level,

- irrigated production: high input level and intermediate input level.

Food and Agriculture Organization of the United Nations

BEFS Rapid Appraisal Natural Resources Module

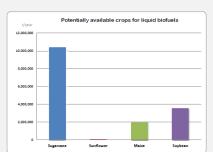
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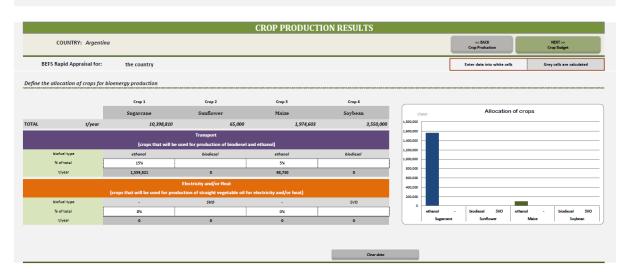
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	COUNTRY:	Argentina							Cn	<pre>ex BACK p Production</pre>		NE Results of C	XT >> rap Production	
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			nd use area (Fi	AOSTAT SDAL						nd use change				
	Year	1990	2000	2005	2012	1990-20	00	2000-20		2005-2			2000-2012	
	Land use class	1000 ha	1000 ha	1000 ha	1000 ha	1000 ha	*	1000 ha	×	1000 ha	*	1000 ha	N	Annual ra
orestarea		34,793	31,861	30,599	28,920	-2,932.00	-8.43	-1,262.00	-3.96	-1,678.60	-5.49	-2,940.60	-9.23	-0.92
gricultural area		127,565	128,510	137,798	148,791	945.00	0.74	9,288.00	7.23	10,993.00	7.98	20,281.00	15.78	1.58
	Arable land Permanent crops	26,575 1.070	27,640	32,898 1.000	39,291 1.000	1,065.00	4.01	5,257.50	19.02	6,393.50 0.00	19.43	11,651.00	42.15	4.22
Permonent mead	lows and pastures	99,970	99,870	103,900	108,500	400.00	-0.10	4,030.00	4.04	4,600.00	4.43	8,530.00	8.64	0.86
ther land		111,311	113,298	105,273	95,958	1,987.00	1.79	-8,025.00	-7.08	-9,315.40	-8.85	-17,340.40	-15.31	1.5
		(T			4000	0040					7
		1000 h 160			Iren	ias in Iana	use chi	ange 1990	- 2012			Forest		
		140										rorest	area	
		120		-	_	_						Agricu	ltural area	
		100	.000									- · · Arable	land	
		80	.000							- 270				
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			0	1990								015		
		C	1985	1990	P	935	2000	2005		2010	2	015)
				_				recommendat						
		kgricultural area Arabie <i>lond</i> Diassiend Conclusion and reco	3	fhereby, the arable and the grassland a	land (area under rea (permanent n	ural area increased annual crops) incre readows and pastor eriod 2000-2010 in crease of agricultu	by 20,281,00 ased by 11,65 res) increased		15%, by 8.64%.	tation at country le a may be one of th rail area are strongi		f deforestation. Th ed.	erefore policy	
		Arable land	3	fhereby, the arable and the grassland a	land (area under rea (permanent n ange during the p ns aiming at the in	annual crops) incre readows and pastur	by 20,281,00 ased by 11,63 res] increased dicate that th ral yields with	0 ha, i.e. by 15.78%. 1,000 ha, i.e. by 42. by 8,630,000 ha, i.e e expansion of the a out further expansic	15%, by 8.64%.			f deforestation. The ed.	erefore policy	
		Arable land	3	thereby, the arable and the grassland a Jata on land use ch reesures and actio	land (area under rea (permanent n ange during the p ns aiming at the in	annual crops) incre seedows and pastur eriod 2000-2010 is screase of agricultu	by 20,281,00 ased by 11,63 res] increased dicate that th ral yields with	0 ha, i.e. by 15.78%. 1,000 ha, i.e. by 42. by 8,630,000 ha, i.e e expansion of the a out further expansic	15%, by 8.66%, gricultural are n of agricultu		i key drivers o	d deforestation. The	erefore policy	
		Arable land	nomendations t	thereby, the arable and the grassland a Jata on land use ch reesures and actio	land (area under rea (permanent n ange during the p ns aiming at the in	annual crops) incre seedows and pastur eriod 2000-2010 is screase of agricultu	by 20,281,00 ased by 11,61 res) increased dicate that th ral yields with (user defin	0 ha, i.e. by 15.78%. 1,000 ha, i.e. by 42. by 8,630,000 ha, i.e e expansion of the a out further expansic	15%, by 8.64%, gricultural are n of agricultu	a may be one of th	i key drivers o	f deforestation. Th ed.	erefore policy 2004-2016	
		trafic land drassland Inschulen and rece statistics 2004 1000 ha	nomendations to the second sec	thereby, the arable and the grassland a lata on land use ch measures and action e orreo 2012 1000 hs	land (area under rea (permanent m ange during the p ns aiming at the lin Country 2016 1000 he	annual crops) incre readows and pastur eros 2005-2010 is crease of agricultu especific data 2004-20 1000 ha	by 20.281,00 ased by 11.6 res) hrcreased dicate that th rel yields with (user defin (user defin 08 %	ha, i.e. by 15,78%. 1,000 ha, i.e. by 42, by 8,610,000 ha, i.e. exepansion of the a exepansion of the a exepansion of the a execution of the a exe	15%, by 8.66%, gricultural are n of agricultu n of agricultu Lo 212 %	a may be one of the analysis o	e key drivers o recommend D16 55	1000 ha	2004-2016	charge
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ricultural area	Year Land use class Archite land Permanent craps	textile form Decision and union and rece 2004 1000 hs 30(351 139,455 30(755 1,000	Land use 2008 1000 ha 29,712 144,261 35,761 1,000	thereby, the acable and the grassland ad Data on land use of the acable bases and action core of the acable core of the acable core of the acable core of the acable core of the acable core of the core of the acable core of the acable core of the core of the acable core of the acable core of the core of the acable core of the acable core of the acable core of the acable core of the acable core of the acable core of the core of the acable core of the acable core of the acable core of the core of the acable core of the acable core of the acable core of the core of the acable core of the acable core of the acable core of the acable core of the core of the acable core of the acable core of the acable core of the core of the acable core of the acable core of the acable core of the core of the acable core of the acable core of the acable core of the acable core of the core of the acable core of the a	land (area under rea (permanent n ange duing the p os siming at the is country 2016 1000 he 277,112 148,700 39,200 1,000	annual crops) incre neodous na partiti errod 2005-2010 in errod 2005-2010 in errod 2005-2010 in generation of agricultur v specific data in 2006-ha 1000 ha -1,7/88.80 9,936.60 4,486.00 0.00	by 20,281,00 and by 11,63 res) increased dicate that th ral yields with (user defin) (user defin	1,00,1a, by 15,785. 1,000 ha, i.e. by 42, 1,000 ha, i.e. by 4,610,000 ha, i.e. equation of the approximation of the approximation (c) (c) (c) (c) (c) (c) (c) (c) (c) (c)	15%, by 8.64%, gricultural are n of agricultur 12 % -4.23 3.46 12.74 0.00	a may be one of th rail area are strong d use change 2012-2 1000 ha -356-00 0.00	2016 55 -3.18 -0.37 -1.39 0.00	1000 ha 3,409.80 14,355.00 8,425.00 0.00	2004-2016 55 -11.17 10.69 27.38 0.00	change -1.1 1.0 2.74 0.00
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ricultural area Permonent meod	Year Land use class Archite land Permanent craps	textile form Decision and union and rece 2004 1000 hs 30(351 139,455 30(755 1,000	Land use 2008 1000 ha 29,712 144,261 35,761 1,000	thereby, the acable and the grassland ad Data on land use of the acable bases and action core of the acable core of the acable core of the acable core of the acable core of the acable core of the core of the acable core of the acable core of the core of the acable core of the acable core of the core of the acable core of the acable core of the acable core of the acable core of the acable core of the acable core of the core of the acable core of the acable core of the acable core of the core of the acable core of the acable core of the acable core of the core of the acable core of the acable core of the acable core of the acable core of the core of the acable core of the acable core of the acable core of the core of the acable core of the acable core of the acable core of the core of the acable core of the acable core of the acable core of the acable core of the core of the acable core of the a	land (area under rea (permanent n ange duing the p os siming at the is country 2016 1000 he 277,112 148,700 39,200 1,000	annual crops) incre mesidows and particul endows and particular processes of agricultur specific data a constructure increase of agricultur specific data a constructure increase of agricultur specific data a constructure increase of agriculture increase of agriculture i	by 20,381,00 axed by 11,61 real increased dicate that the cluster definition (user definition) (user d	1) ha, i.e. by 15,78%. 1,000 ha, i.e. by 45,610,000 ha, i.e. by 5,610,000 ha, i.e. and data) 1000 ha 1,229 ki0 4,993,00 4,993,00 500,00 -3,794,00	15%, by 8.64%, gricultural are n of agricultur 12 % -4.23 3.46 12.74 0.00	a may be one of th rail area are strong d use change 2012-2 1000 ha -356-00 0.00	2016 55 -3.18 -0.37 -1.39 0.00	1000 ha 3,409.80 14,355.00 8,425.00 0.00	2004-2016 55 -11.17 10.69 27.38 0.00	charge -1.1 1.0 2.74 0.00 0.51
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ricultural area Permonent meod	Ver Land use clas Arable land Permanent crass fees and past area	People Annot Developed 2000 h 1000 hs 30,071 134,345 30,075 134,345 30,075 100,500 100,803	Land use 2008 1000 h 29,232 344,261 33,281 1,000 328,281 1,000	thereby, the arable and the grassland a data on land use of the measures and action conception conc	land (area under rea (permanent n ange during the p s arming at the in Country 2016 1000 ha 27,112 148,700 39,200 1,000 108,500	annual crops) incre mesidows and particul endows and particular processes of agricultur specific data a 1,288,30 1,288,30 4,488,50 0,00 5,480,00 4,897,20	by 20,381,00 axed by 11,61 real increased dicate that the cluster definition (user definition) (user d	1) ha, i.e. by 15,78%. 1,000 ha, i.e. by 45,610,000 ha, i.e. by 5,610,000 ha, i.e. and data) 1000 ha 1,229 ki0 4,993,00 4,993,00 500,00 -3,794,00	15%, by 8.64%, gricultural are n of agricultu 212 34. 12.74 0.00 0.46	a ray be one of th ral area are strong of Use change 1000 ha 450.40 .554.00 0.00 0.00	te key drivers o recommend 016 -3.18 -0.37 -1.39 0.00	1000 ha -3,408.80 14,455.00 8,425.00 5,530.00 -10,946.00	2004-2016 % -11.17 10.69 27.38 0.00 5.78	chang -1.1 1.0 2.74 0.00 0.58 -1.0
ricultural area Permonent meod	Ver Land use class Arable fans Permonist crass foiss and pastures	2004 2004 2004 2004 30,521 10,025 30,725 10,025 10,	Land use 2008 1000 h 29,232 344,261 33,281 1,000 328,281 1,000	thereby, the arable and the grassland a data on land use of the measures and action conception conc	land (area under rea (permanent n ange during the p s arming at the in Country 2016 1000 ha 27,112 148,700 39,200 1,000 108,500	annual crops) incre mesidows and particul endows and particular processes of agricultur specific data a 1,288,30 1,288,30 4,488,50 0,00 5,480,00 4,897,20	by 20,381,00 axed by 11,61 real increased dicate that the cluster definition (user definition) (user d	1) ha, i.e. by 15,78%. 1,000 ha, i.e. by 45,610,000 ha, i.e. by 5,610,000 ha, i.e. and data) 1000 ha 1,229 ki0 4,993,00 4,993,00 500,00 -3,794,00	15%, by 8.64%, gricultural are n of agricultu 212 34. 12.74 0.00 0.46	a ray be one of th ral area are strong of Use change 1000 ha 450.40 .554.00 0.00 0.00	te key drivers o recommend 016 -3.18 -0.37 -1.39 0.00	1000 ha 3,408.80 14,355.00 8,425.00 0.00 5,330.00 -10,346.00	2004-2016 % -11.17 10.66 27.38 0.00 5.78 -10.06	chang -1.1 1.0 2.74 0.0 0.55 -1.0
ricultural area Permonent meod	Year Land use class Arcible fant Permonent cross files and postures	2004 interference	Land use 2008 1000 h 29,232 344,261 33,281 1,000 328,281 1,000	thereby, the arable and the grassland a data on land use of the measures and action conception conc	land (area under rea (permanent n ange during the p s arming at the in Country 2016 1000 ha 27,112 148,700 39,200 1,000 108,500	annual crops) incre mesidows and particul endows and particular processes of agricultur specific data a 1,288,30 1,288,30 4,488,50 0,00 5,480,00 4,897,20	by 20,381,00 axed by 11,61 real increased dicate that the cluster definition (user definition) (user d	1) ha, i.e. by 15,78%. 1,000 ha, i.e. by 45,610,000 ha, i.e. by 5,610,000 ha, i.e. and data) 1000 ha 1,229 ki0 4,993,00 4,993,00 500,00 -3,794,00	15%, by 8.64%, gricultural are n of agricultu 212 34. 12.74 0.00 0.46	a ray be one of th ral area are strong of Use change 1000 ha 450.40 .554.00 0.00 0.00	te key drivers o recommend 016 -3.18 -0.37 -1.39 0.00	1000 ha 3,405.80 14,355.60 8,425.00 0.00 5,530.00 -10,946.00	2004-2016 55 -11.17 10.65 27.38 9.00 5.78 -10.06 Forest are Agricultur	chang: -1.1 1.0 2.7 0.0 -1.0 -1.0 -1.0 -1.0 -1.0 -1.0 -1.0
ricultural area Permonent meod	Year Land use class Arcable Land Permanent crass fores and pastares	2004 2004 2004 2004 30,521 10,025 30,725 10,025 10,	Land use 2008 1000 h 29,232 344,261 33,281 1,000 328,281 1,000	thereby, the arable and the grassland a data on land use of the measures and action conception conc	land (area under rea (permanent n ange during the p s arming at the in Country 2016 1000 ha 27,112 148,700 39,200 1,000 108,500	annual crops) incre mesidows and particul endows and particular processes of agricultur specific data a 1,288,30 1,288,30 4,488,50 0,00 5,480,00 4,897,20	by 20,381,00 axed by 11,61 real increased dicate that the cluster definition (user definition) (user d	1) ha, i.e. by 15,78%. 1,000 ha, i.e. by 45,610,000 ha, i.e. by 5,610,000 ha, i.e. and data) 1000 ha 1,229 ki0 4,993,00 4,993,00 500,00 -3,794,00	15%, by 8.64%, gricultural are n of agricultu 212 34. 12.74 0.00 0.46	a ray be one of th ral area are strong of Use change 1000 ha 450.40 .554.00 0.00 0.00	te key drivers o recommend 016 -3.18 -0.37 -1.39 0.00	1000 ha 3-408.80 8-425.00 8-425.00 5-5390.00 1-05346.00	2004-2015 5 -13.17 10.06 -7.73 -0.00 5.78 -10.06 -10.06 -7.75 -10.06 -7.75 -10.06 -7.75 -10.06 -7.75 -7.7	chang: -1.1 1.03 2.74 0.03 -1.0 -1.0 -3 -3 -3 -3 -3 -3 -3 -3 -3 -3 -3 -3 -3
ricultural area Permonent meod	Year Land use clas Arabie fane Permanent eraps	2004 inter decision of test inter- based of the second of test inter- second of test int	Land use 2008 1000 h 29,232 344,261 33,281 1,000 328,281 1,000	thereby, the arable and the grassland a data on land use of the measures and action conception conc	land (area under rea (permanent n ange during the p s arming at the in Country 2016 1000 ha 27,112 148,700 39,200 1,000 108,500	annual crops) incre mesidows and particul endows and particular processes of agricultur specific data a 1,288,30 1,288,30 4,488,50 0,00 5,480,00 4,897,20	by 20,381,00 axed by 11,61 real increased dicate that the cluster definition (user definition) (user d	1) ha, i.e. by 15,78%. 1,000 ha, i.e. by 45,610,000 ha, i.e. by 5,610,000 ha, i.e. and data) 1000 ha 1,229 ki0 4,993,00 4,993,00 500,00 -3,794,00	15%, by 8.64%, gricultural are n of agricultu 212 34. 12.74 0.00 0.45	a ray be one of th ral area are strong of Use change 1000 ha 450.40 .554.00 0.00 0.00	te key drivers o recommend 016 -3.18 -0.37 -1.39 0.00	1000 ha 3-408.80 8-425.00 8-425.00 5-5390.00 1-05346.00	2004-2016 55 -11.17 10.65 27.38 9.00 5.78 -10.06 Forest are Agricultur	chang: -1.1 1.03 2.74 0.03 -1.0 -1.0 -3 -3 -3 -3 -3 -3 -3 -3 -3 -3 -3 -3 -3
pricultural area Permonent meod	Year Land use clas Arabie fane Permanent eraps	books stand Jonatualian 2004 Jonatualian 1000 hu Jonatualian 30,521 Jonatualian 1000 hu Jonatualian 30,521 Jonatualian 100,521 Jonatualian 100,521 Jonatualian 100,521 Jonatualian 100,521 Jonatualian 100,520 Jonatualian 100,520 Jonatualian 100,520 Jonatualian 100,520 Jonatualian 100,520 Jonatualian	Land use 2008 1000 h 29,232 344,261 33,281 1,000 328,281 1,000	Creation 2014 Control of the gradient of a distance of the second of th	land Jarva under ras Bennament in ange during the bar country 2016 1000 hb 77, 112 148, 790 39, 300 108, 500 97, 857	annali crops) ecce emoloses and particular emoloses of approximation eccession of approximation eccess	by 20.261,00 and by 71,65 mill increases (<i>aser defin</i> (<i>aser defin</i> 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	0 ha, i.e. by 15 785. 1,000 ha, i.e. by 42. 1,000 ha, i.e. by 42. 1000 ha 1,222 k30. 4,493.00 4,493.00 4,493.00 3,794.00 -3,794.00 -4.2936	15%, by 8.64%, gricultural are n of agricultu 212 34. 12.74 0.00 0.45	a ray be one of th ral area are strong of Use change 1000 ha 450.40 .554.00 0.00 0.00	te key drivers o recommend 016 -3.18 -0.37 -1.39 0.00	1000 ha -3.408.80 8.425.00 8.425.00 -3.5393.00 -10.548.00	2004-2016 5 -13.12 27.33 0.00 5.78 -10.06 -7.00	change -1.12 1.07 2.74 0.00 0.58 -1.01 ral area ral area rd nt crops
pricultural area Permonent meod	Year Land use class Arable have Permonent crass (loses and pastures	2004 2004 2004 2007 2004 2007 2007 20,275 20,275 20,205 20	Land use 2008 1000 h 29,232 344,261 33,281 1,000 328,281 1,000	Creation 2014 Control of the gradient of a distance of the second of th	land Jarva under ras Bennament in ange during the bar country 2016 1000 hb 77, 112 148, 790 39, 300 108, 500 97, 857	annual crops) incre mesidows and particul endows and particular processes of agricultur specific data a 1,288,30 1,288,30 4,488,50 0,00 5,480,00 4,897,20	by 20.261,00 and by 71,65 mill increases (<i>aser defin</i> (<i>aser defin</i> 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	0 ha, i.e. by 15 785. 1,000 ha, i.e. by 42. 1,000 ha, i.e. by 42. 1000 ha 1,222 k30. 4,493.00 4,493.00 4,493.00 3,794.00 -3,794.00 -4.2936	15%, by 8.64%, gricultural are n of agricultu 212 34. 12.74 0.00 0.45	a ray be one of th ral area are strong of Use change 1000 ha 450.40 0.554.00 0.00 0.00	te key drivers o recommend 016 -3.18 -0.37 -1.39 0.00	1000 ha -3.408.80 8.425.00 8.425.00 -3.5393.00 -10.548.00	2004-2016 % 10.069 27.38 0.00 5.78 -10.06 -10.06 -10.06 -10.06 -10.06 -10.06 -10.06 -10.06 -10.06 -10.06 -10.17 -10.17 -10.17 -10.17 -10.17 -10.17 -10.17 -10.17 -10.17 -10.17 -10.17 -10.17 -10.17 -10.17 -10.17 -10.17 -10.06 -10.17 -10.06 -10.17 -10.06 -10.0	change -1.12 1.07 2.74 0.05 -1.07 -1.07
irst area priothurstarea Permanent mead her land	Year Land use class Arable have Permonent crass (loses and pastures	2004 2004	Land use 2008 1000 h 29,232 344,261 33,281 1,000 328,281 1,000	Arrest Constant of the solid of	200 has been provided in the second s	annual o cool) seco and wind 2005-3010 in wind 2005-3010 in specific dotto 2004-20 1000 ha -1,288.80 9,316.60 4,386.60 4,386.60 4,386.60 4,387.60	by 20.261,00 and by 71,65 mill increases (<i>aser defin</i> (<i>aser defin</i> 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	0 ha, i.e. by 15 785. 1,000 ha, i.e. by 42. 1,000 ha, i.e. by 42. 1000 ha 1,222 k30. 4,493.00 4,493.00 4,493.00 3,794.00 -3,794.00 -4.2936	15%, protheral are no of agrinultu 212 32 34 4.2.2 3 4.4.2.2 3.0.0 0.0.6 0.0.6 0.0.6	n ruy be ose of the rai area are strong nd use change 2012/2 100 ha 356.00 0.05 0.00 1.445.00	te key drivers o recommend 016 -3.18 -0.37 -1.39 0.00	1000 ha -3.408.80 8.425.00 8.425.00 -3.5393.00 -10.548.00	2004-2015 % 11.17 10.69 27.38 9.00 5.78 - 10.08 - Agricultar - Arable lar - Permaner	ral area nd nt crops nt meadow ires
ricultural area Permonent meod	Year Land use class Arable have Permonent crass (loses and pastures	2004 100 100 100 100 100 100 100 100 100	Land uses 2008 100 h 29,20 144,21 15,241 15,	Creation 2014 Control of the gradient of a distance of the second of th	200 has been provided in the second s	annual o cool) on co and a cool on co and a cool of a cool of a cool of a cool of a cool of a cool of a cool of a co	by 20.281,00 and by 11,62 disase that the lineased set that the (user defin) set of the set of the	0ha, i.e. by 15,785, 1,000 ha, i.e. by 42, 1,000 ha, i.e. by 42, 1,000 ha, i.e. by 42, 1,000 ha 3,725,400 4,473,00 0,00 3,784,00 4,293,60 1,000 ha 1,000 ha 1,000 ha 1,225,40 4,473,00 0,00 3,784,00 4,293,60 1,000 ha 1,000 ha 1,	15%, by 8.64%, gricultural are n of agricultu 212 34. 12.74 0.00 0.45	n ruy be ose of the rai area are strong nd use change 2012/2 100 ha 356.00 0.05 0.00 1.445.00	2016 55 53 2.13 0.00 0.00 0.00 	1000 hs -3,409.80 14,435.00 8,425.00 -3,330.00 -10,345.80	2004-2015 % 11.17 10.69 27.38 9.00 5.78 - 10.08 - Agricultar - Arable lar - Permaner	change -1.1: 1.0: 2.74 0.00 -1.0 -1.0
ricultural area Permonent meod	Year Land use class Arcoble hare Personent args fores and past area	2004	Land uses 2008 100 h 29,20 144,21 15,241 15,	e dreco 2012 2012 2012 2012 2012 2012 2012 2012 2012 2012 2014 2012 2014 2012 2014 201	the fight of provide the fight of the fight	annual o copi) on ca andreados and space and 2005-2010 in copression of agricultur r space(fic dioto r 2004-20 1000 ha - 1,2008-20 0,000 h - 1,2008-20 0,0000 0,000 0,0000 0,0000 0,0000 0,0000 0,0000 0,0000 0,0000 0,0000 0,0000 0,0000 0,0000 0,0000 0,0000 0,0000 0,0000 0,0000 0,0000 0,0000 0,000000	by 20.281,00 and by 12.62 disease that the linesase that the disease that the disease that the disease that the disease that the disease that the disease that the disease that the disease that the disease that the disease that the disease that the disease that	0ha, i.e. by 15,785, 1,000 ha, i.e. by 42, 1,000 ha, i.e. by 42, 1,000 ha, i.e. by 42, 1,000 ha 3,725,400 4,473,00 0,00 3,784,00 4,293,60 1,000 ha 1,000 ha 1,000 ha 1,225,40 4,473,00 0,00 3,784,00 4,293,60 1,000 ha 1,000 ha 1,	15%, prosthered are no of agrinotic 982 % 4.23 12.24 0.00 12.24 0.06 -3.26	n ruy be ose of the rai area are strong nd use change 2012/2 100 ha 356.00 0.05 0.00 1.445.00	2016 55 53 2.13 0.00 0.00 0.00 	1000 hs -3,409.80 14,855.00 8,425.00 -3,330.00 -10,345.80	2004-2015 % 11.17 10.69 27.38 9.00 5.78 - 10.08 - Agricultar - Arable lar - Permaner	change -1.12 1.07 2.74 0.05 -1.07 -1.07
pricultural area Permonent meod	Year Land use class Arcoble hare Personent args fores and past area	2004 100 100 100 100 100 100 100 100 100	Land use 2008 100 h 79,70 144,25 1,000 100,176 35,281 1,000 100,176	e dreco 2012 2012 2012 2012 2012 2012 2012 2014 2014 2015 20	the provide the provided of th	annual o copi) on co andicions and second and compared and compared and and compared and and compared and and compared and compared and compared and and com	by 20,281,00 and by 12,62 linesestic disestentiates that the (user definition (user definition) (user	ba, i.e. by 15.785, (100 ba, i.e. by 42, (200 ba, 65, 630, 00 ba,) (200 ba, 64, 10 bb, 1	15%, by 8.6%. protional and or of agriculture and agriculture and agriculture and agriculture and agriculture and agriculture and agriculture and agriculture agri	nd use change nd use change 2012 1000 ha 490 40 -554 00 0.00 1.445.00	 key drivers c recommind 318 -3.18 -3.19 -0.00 0.00 0	1000 hs -3,409.80 14,855.00 8,425.00 -3,330.00 -10,345.80	2004-2015 % 11.17 10.69 27.38 9.00 5.78 - 10.08 - Agricultar - Arable lar - Permaner	change -1.12 1.07 2.74 0.05 -1.07 -1.07
pricultural area Permonent meod	Year Land use clas Arabie dane Permanant orașe Seves and pesteres	2004 2 2004 2 2004 2 2004 2 2004 2 2004 2 2004 2 2004 2 2004 2 2005 2 2006 2 2007 2 2008 2 2009 2 2000 2	Lond use 2008 1000 h 29,722 144,261 39,722 144,261 39,725 30,725 39,725 30,7555 30,755 30,7555 30,7555 30,7555 30,	Creation of the graduated and the graduates and reflower a	Leng Loren ander the lorenament Country 2016 1000 ha 72,717 1144,700 1000 ha 72,717 1144,700 1000 ha 72,717 1144,700 1000 ha 72,717 1144,700 1000 ha 72,717 1144,700 1000 ha 72,717 1144,700 1000 ha 72,717 1144,700 1000 ha 72,717 1144,700 1000 ha 1000 ha 1	annali cropi) eco medioar and antic expecific data a 2004-20 1000 ha 9,255.00 4,955.00 4,955.00 4,955.00 4,955.00 7,955.	by 20.281,00 march 19 126,20 (user definition) (user definition) (ba, Le, by 15,785, . (200 ba, e. by 42, . (200 ba) (200 b	15%, by 8.6%. protional and or of agriculture and accession accesi	nd use change nd use change 2012 1000 ha 490 40 -554 00 0.00 1.445.00	 key drivers c recommind 318 -3.18 -3.19 -0.00 0.00 0	1000 hs -3,409.80 14,855.00 8,425.00 -3,330.00 -10,345.80	2004-2015 % 11.17 10.69 27.38 9.00 5.78 - 10.08 - Agricultar - Arable lar - Permaner	change -1.12 1.07 2.74 0.05 -1.07 -1.07
pricultural area Permonent meod	Year Land use class Arable hare Personent args fores and pestares	2004	Land use 2008 2008 79,70 144,25 19,000 300,176 300,176	e drea in the spin of the analysis in the spin of th	the fight of a second s	annan i orgo) on co andress end second per co andress end second per co and a construction of a gen the angle of a gen the angl	by 20,281,000 300 asade by 11,428,000 300 (asare defined in the state of the state o	ba, Le, by 15,785, 1,000 Ba, ei, by 42, 1,000 Ba, ei, by 42, 1,000 Ba, ei, by 42, 1,000 Ba, ei, by 42, 1,000 Ba, 1,272 Ki 4,993,00 4,993,00 5,00,00 5,00,00 5,784,00 4,993,00 2,012 2,20	15%, by B. 6%. cross-tored are or of aprovidu 222 3% 4.427 32.24 0.00 0.45 3.7/6 2.24 0.06 0.06 0.06 0.06 0.06 0.06 0.06 0.0	nd use change nd use change 2012 1000 ha 490 40 -554 00 0.00 1.445.00	 key drivers c recommind 318 -3.18 -3.19 -0.00 0.00 0	1000 hs -3,409.80 14,855.00 8,425.00 -3,330.00 -10,345.80	2004-2015 % 11.17 10.69 27.38 9.00 5.78 - 10.08 - Agricultar - Arable lar - Permaner	change -1.1: 1.0: 2.74 0.00 -1.0 -1.0

COUNTR	Y: Argentina							BACK fication	Results	NEXT >> of Crop Production	
BEFS Rapid	I Appraisal for:	the country						Enter data into	white cells	Grey cells are	calculated
			Calcu	lation of area nee	ded for planned prod	uction of selected crops					
		Crop 1	Crop 2	Crop 3	Crop 4			Crop 1	Crop 2	Crop 3	Crop 4
		Sugarcane	Sunflower	Maize	Soybean		10-year av	erage of annual prod	action at country lev	vel	
Parameter	Unit		Planned pro	duction				(based on FAOSTAT2	005-2014)		
Production	t/year					Parameter	Unit	Sugarcane	Sunflower	Maize	Soybean
Water supply		Select 🖕	Select 🖕	Select 🗸	Select 🖕	Yield	t/ha	72.80	1.73	6.61	
Input level		Select 🗸	Select 🗸	Select 🗸	Select 🗸	Annual production	t	24,864,693	3,245,418	22,461,438	44,790
Expected yield	t/ha						Potential y	ields based on Global	Agro-Ecological Zon	ing	
No. of crop cycles						Crop		Sugarcane	Sunflower	Maize	Soybean
Area required	ha	0.00	0.00	0.00	0.00	Water supply		Select	Select	Select	Select
		Initial land use o	lass			Input level		Select	Select	Select	Select
Idle cropland	%	100%	100%	100%	100%	Soil suitability class:					
Grassland	%					Country average	t/ha	n/a	n/a	n/a	
Sparse vegetation	*					Suitable/very suitable	t/ha	n/a	n/a	n/a	
Shrubland	%					Moderately suitable	t/ha	n/a	n/a	n/a	
Forest area	%	0%	0%	0%	0%	Potential yields are ava					
Degraded land	%					- rainfed production: low in					
Other land	%					 irrigated production: high 	input level and	i intermediate input k	evel.		
Fotal	%	100%	100%	100%	100%						

		CROP PRODU	JCTION RES	ULTS		
COUNTRY: Argentina					ee BACK Crop Production	ND(T >> Crop Budget
BEFS Rapid Appraisal for:	the country				Enter data into white cells	Grey cells are calculated
Potential production for bioenergy						

		Crop 1	Crop 2	Crop 3	Crop 4	
		Sugarcane	Sunflower	Maize	Soybean	
TOTAL	t/year	10,398,810	65,000	1,974	,603 3,550,00	0
Additional production option			Intensif	ication		
Potential production	t/year	875,000	65,000	1,97	4,603 3,550,00	•
Intensified yield	t/ha	77.00	2.10		8.50 4.0	0 12,0
No. of harvests/year	≢/γear	1	1		1	1
Area of production	ha	11,364	30,952	23	2,306 887,50	0 10,0
Additional production option			Change	of crops		8.0
Potential production	t/year	9,523,810			•	-
Yield	t/ha	60.00			•	. 6.0
No. of harvests/year		1			· ·	-
Area of production	ha	158730			•	- 4,0
Additional production option			Extensij	ication		
Potential production	t/year	0	0		0	0 2,0
Yield	t/ha	0.00	0.00		0.00 0.0	0
No. of harvests/year		0	0		0	o
Area of production	ha	0	0		0	o





Appendix 3

CROP BUDGET SOY

Assumptions (Rainfed) Yield (t/ha)

3.2 CURRENT YIELD 4 assumed intensified yield, based on GAEZ. Rainfed

				UTA (\$)	Exch.rate (March 2018)				Exch.rate (avg. 2018)
				727.96	20.3				20.3
		Inta inform	e - Marzo	Market price (\$/t)	Market price (USD/t)	Assumed i	ntensified	Market price (\$/t)	Market price (USD/t)
		2018 (5	53/85)	5,975.00	294.33	yie	ld	5,975.00	294.33
ITEM	UNIT	RATE/ha	Unit Price	\$/ha	USD/ha	RATE/ha	Unit Price	\$/ha	USD/ha
Soya grain - yield; revenue	t/ha	3.20	5,975.00	19,120.00	941.87	4.00	5,975.00	23,900.00	1,177.34
VARIABLE COSTS									
Seed	Kg	80.00	12.57	1,005.60	49.54	90.00	12.57	1,131.30	55.73
Inputs (fertilizers and agrochemicals)									
Fertilizers	kg/ha	50.00	11.76	588.00	28.97	62.00	11.76	729.12	35.92
agrochemicals (herbicides/pesticides)		15.69	107.67	1,688.80	83.19	20.00	107.67	2,153.40	106.08
Labour (prepartion of land, planting, afterplanting, harvesting)									
Land prep, planting and post planting	UTA/ha	1.00	1,747.10	1,747.10	86.06	1.00	1819.895	1,819.90	89.65
Harvesting	8% Revenue			1,529.60	75.35			1,912.00	94.19
Irrigation									
water, electricity	mm			0.00	0.00			0.00	0.00
Total Variable Costs (TVC)				6,559.10	323.11			7,745.72	381.56
FIXED COSTS									
Capital costs (land rental/interst on capital)	per ha	1.00	6,601.00	6,601.00	325.17	1.00		7,735.92	381.08
Total production costs per ha	per ha			13,160.10	648.28			15,481.64	762.64
Production costs per tonne	per tonne			4,112.53	202.59			4,838.01	190.66
					91.75				103.67
				USD/ha	293.59			USD/ha	414.6975862

CROP BUDGET SUGRCANE

Assumptions	
Yield (t/ha)	

60 CURRENT YIELD 75 GAEZ HIGH LEVEL INPUT

					Exch.rate (avg. 2015)				Exch.rate (avg. 2015)
					9				9
				Market price (\$/t)	Market price (USD/t)			Market price (\$/t)	Market price (USD/t)
		Sugarcane 201	5	265.50	29.50	Sugarca	ne 2015	265.50	29.50
ITEM	UNIT	RATE/ha	Unit Price	\$/ha	USD/ha	RATE/ha	Unit Price	\$/ha	USD/ha
Sugarcane - yield; revenue	t/ha	60.00	265.50	15,930.00	1,770.00	75.00	265.50	19,912.50	2,212.50
VARIABLE COSTS									
Seed	tonnes	12.00	240.00			12.00	240.00		
Inputs (fertilizers and agrochemicals)									
Fertilizers	kg/ha	180.00	4.41	793.80	88.20	210.00	4.41	926.10	102.90
agrochemicals (herbicides/pesticides)		7.60	68.29	519.00	57.67	8.10	67.50	546.75	60.75
extras				148.38	16.49			148.38	16.49
Labour (prepartion of land, planting, afterplanting, harvesting)									
Manual (Man-days)		0.50	367.92	183.96	20.44	0.38	547.08	207.89	23.10
Machinery (Hours)		2.50	299.23	748.08	83.12	3.00	310.14	930.41	103.38
Harvesting	\$/tonne	60.00	70.00	4,200.00	420.00	75.00	70.00	5,250.00	525.00
Irrigation									
water, electricity	mm	4.00	527.92	2,111.68	234.63	4.00	527.92	2,111.68	234.63
Total Variable Costs (TVC)				8,704.90	920.54			10,121.21	1066.25
FIXED COSTS									
Capital costs (land rental/interst on capital)	per ha			6,068.66	674.30			6,068.66	674.30
Total production costs per ha	per ha			14,773.56	1594.84			16,189.87	1740.54
Production costs per tonne	per tonne			246.23	26.58			269.83	23.21
					2.92				6.29
				USD/ha	175.1601111			USD/ha	471.9577333

CROP BUDGET MAIZE

Assumptions Yield (t/ha)

8.5/9.5 CURRENT Yı 9.50 11 GAEZ HIGH 11.00

					Exch.rate (avg. 2018) 20.3	17.3				Exch.rate (avg. 2017) 20.3
		Inta inform	e - Marzo	Market price (\$/t)	Market price (USD/t)		Inta inform	ne - Marzo	Market price (\$/t)	Market price (USD/t)
		2018 (p.	45/85)	3,583.00	176.50		2018 (p.	80/85)	3,583.00	176.50
ITEM	UNIT	RATE/ha	Unit Price	\$/ha	USD/ha		RATE/ha	Unit Price	\$/ha	USD/ha
Maiz - yield; revenue	t/ha	8.50	3,583.00	30,455.50	1,500.27		11.00	3,500.00	39,413.00	1,896.55
VARIABLE COSTS										
Seed	Bags	0.90	3,040.65	2,736.59	134.81		1.00	3,040.65	3,040.65	149.79
Inputs (fertilizers and agrochemicals)										
Fertilizers	kg/ha	170.00	9.76	1,658.40	81.69		475.00	7.42	3,523.45	173.57
agrochemicals (herbicides/pesticides)		15.60	63.87	996.40	49.08		8.60	104.30	896.99	44.19
Labour (prepartion of land, planting, afterplanting, harvesting)										
Land prep, planting and post planting	UTA/ha	1.00	1,455.92	1,455.92	71.72		1.00	1,346.72	1,346.72	66.34
Harvesting	8% Revenue			2,436.44	120.02				3,153.04	155.32
Irrigation										
water, electricity	mm	0.00	0.00	0.00	0.00		1,010.00	9.12	9,211.20	453.75
Total Variable Costs (TVC)				9,283.75	457.33				21,172.05	1042.96
FIXED COSTS										
Capital costs (land rental/interst on capital)	per ha	1.00	6,815.78	6,815.78	335.75		1.00	6,815.78	2,607.00	128.42
Total production costs per ha	per ha			16,099.53	793.08				23,779.05	1171.38
Production costs per tonne	per tonne			1,894.06	93.30				2,161.73	106.49
					83.20					70.01
				USD/ha	707.1906404				USD/ha	770.15

Appendix 4

The Energy End Use module results are presented in full in this section and form the basis of Chapter 6.

<< BACK Start	Liquid Biofuel	s Process Descript	ion				NEXT >> Data Entry
Domestic fossil fuel c	onsumption						
		Consumption	Unit			Consumption	Unit
Diesel	[9,926	ML/year	Gasoline		5,510	ML/year
Domestic blending ta	rget						
		Blending target	Biofuel demand			Blending target	Biofuel deman
Biodiesel (ML/year)	Į	10%	993	Ethanol (ML/year)	12%	66
Biofuel production ar	d trade						
		Domestic production	Imports	Exports	Net balance		
				1			
3iodiesel (ML/year)	[1,890	0	893	996		
			0		996 870		
Ethanol (ML/year)	el productio	1,890 870					
Ethanol (ML/year)	iel productio	1,890 870					
Biodiesel (ML/year) Ethanol (ML/year) Target domestic biofu Biodiesel (ML/year)	iel productio	1,890 870					





BEFSRA_TRANSPORT TOOL RESULTS REPORT

ACK Load Default	t Values clu	ear Data	Liquid Biofuels Pro	ocess Bio	fuel Demand
Start			Description		guer Demana
Use white cells to input data	Grey cells are use	d for calculations]		
Feedstock Availability and C	ost				
		Feedstock 1	Feedstock 2	Feedstock 3	Feedstock 4
		Ethanol -	Ethanol -	Biodiesel -	Please Select
Feedstock		Sugarcane	Maize 🚽	Soybean 🗸	
Feedstock potential (t/year)		10,398,810	1,974,603	3,550,000	
Feedstock cost (cost of production) - Own Feedstock cost (market price) - Outgrower		\$ 27.19		\$ 190.66	
Feedstock cost (market price) - Outgrower Feedstock storage cost (USD/t)	losolul	\$ 5.00		\$ 294.33	
		Storage Calculator 1	Storage Calculator 2	Storage Calculator 3	Storage Calculator 4
		Production Cost 1	Production Cost 2	Production Cost 3	Production Cost 4
Biofuel Production Cost and	Financial Parame	eters			
Chemical inpute*					
Chemical inputs* Biodiesel inputs	USD/t	Ethanol inputs	USD/t	Ethanol inputs	USD/t
Methanol		Ammonia	\$ 570		\$5
Sodium hydroxide	\$ 380	Yeast		Alpha-amylase	\$ 3,00
Hexane http://www.icis.com/chemicals/channel-info		Sulfuric acid	\$ 200	Glucoamylase	\$ 3,00
Utilities		Unit			
Heat carrier		USD/t steam			
Water Electricity		USD/m ³ USD/kWh			
nection	50.0	Joseykwin			
Labour		Unit			
Unskilled worker		USD/person-hour	Working days per year		260
Skilled worker	\$ 3.00	USD/person-hour			
Miscellaneous cost (%)		5			
Transportation		Unit			
Feedstock (farm to plant)	\$ 0.07	USD/t/km			
Storage		Unit			
Biodiesel storage cost Ethanol storage cost) USD/I/year) USD/I/year	Storage rate of biodiesel Storage rate of ethanol		209
0.1			-		
Other costs Maintenance (%)	10%	3			
	15%	-			
Plant overhead (%)		6			
Plant overhead (%)	6%	-			
Plant overhead (%) General and administrative (%)		Unit			Unit
Plant overhead (%) General and administrative (%) Price of co-products Raw glycerol	\$ 800.00	USD/t	DDGS	\$ 90.00	
Plant overhead (%) General and administrative (%) Price of co-products Raw glycerol Meal	\$ 800.00 \$ 355.00	USD/t USD/t			USD/t
Plant overhead (%) General and administrative (%) Price of co-products Raw glycerol Meal http://www.icis.com/chemicals/channel-info	\$ 800.00 \$ 355.00 -chemicals-a-z/	USD/t USD/t http://www	DDGS tindevanundi.com/comm		USD/t
	\$ 800.00 \$ 355.00 -chemicals-a-z/	USD/t USD/t Unit		odities/?commodity=s	USD/t





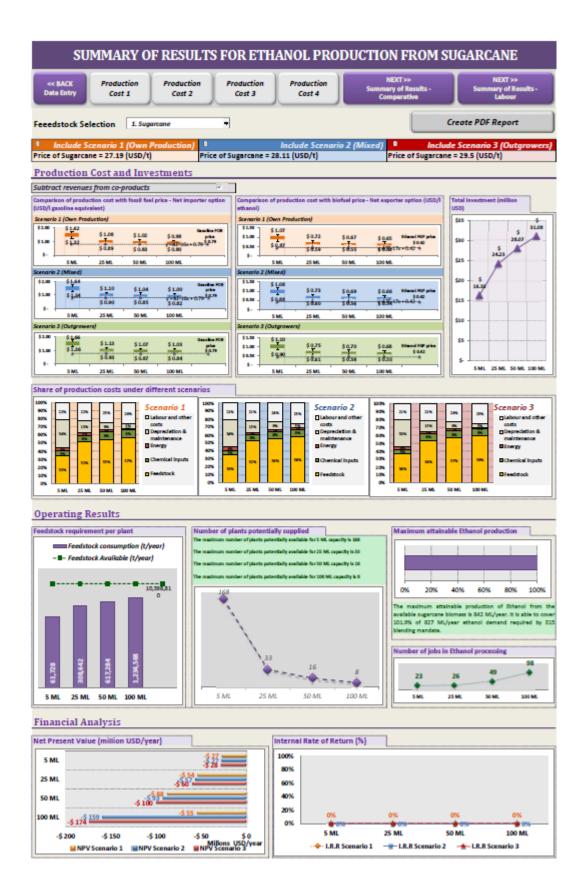
BEFSRA_TRANSPORT TOOL RESULTS REPORT

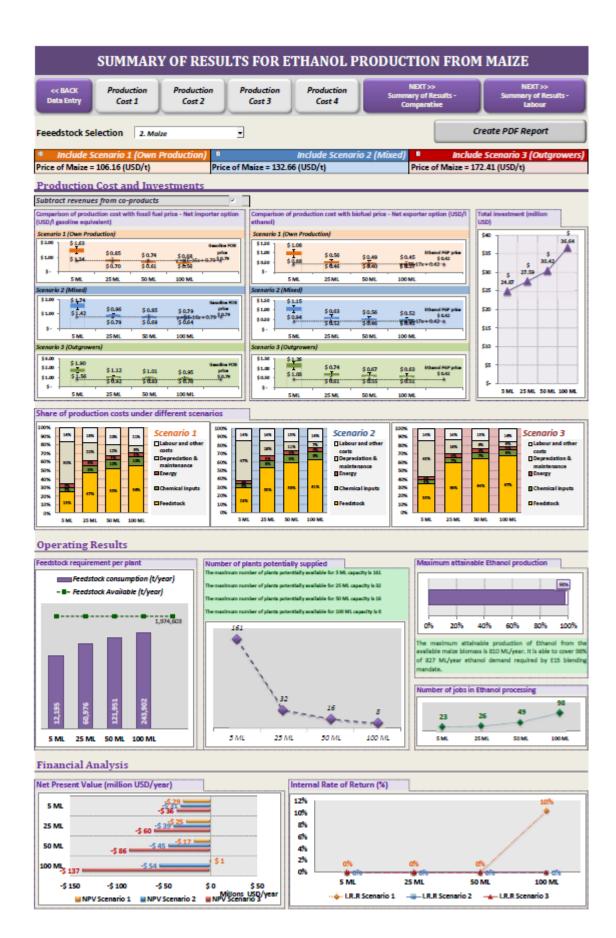
Gasoline FOB price	\$ 0.79	USD/I	Ethanol FGP price	\$ 0.4	12 USD/I
Financial parameters			Investment cost (update	
Discount rate (%) Loan interest rate (%) Loan term (years)	10%		Plant Cost Index during 1 http://base_intratec.us/b		160.00
Loan ratio					
5 ML/year 25 ML/year 50 ML/year					
100 ML/year					
Labour and Land Paramete	rs				. <u> </u>
		Sugarcane	Maize	Soybean	
Crop yield (t/ha)	Outgrowers	60.00	8.50	3.20	
Labour manual (person-day/ha)	Outgrowers	1.80	5.00	5.00	
Labour machinery (person-hour/ha)	Outgrowers	4.60	1.50	1.00	
Crop Yield (t/ha)	Own Production	75.00	11.00	4.00	
Labour manual (person-day/ha)	Own Production	1.70	0.00	0.00	
Labour machinery (person-hour/ha)	Own Production	5.10	2.50	2.00	
Sur	NEXT >> nmary of Results - Comparat	ive Summary	NEXT >> of Results - by Feedstock	Summary	NEXT >> of Results - Labour

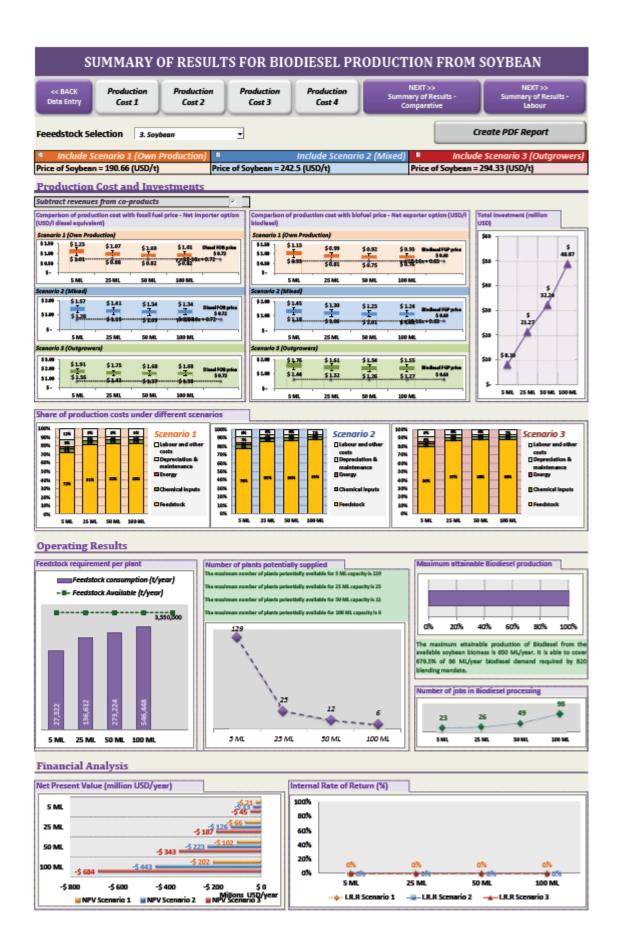
PROCESS	SING	CUSIS	FURE		LFKUD	00110	IN FROM			
<c back<br="">Data Entry Biofuel De</c>	emand		fuels Process cription		VEXT >> lesults - Comparati	ve Sumr	NEXT >>> mary of Results - by	Feedstock	NEXT: Summary of Res	
Use white cells to input data	Grey c	cells are used for o	calculations							
Summary of Feedstock and Sto	orage		Financial Par	ameters			Investment Co	st Update		
rechtock available (t/year)	10,398,810		Discount rate (%)	and created and and and and and and and and and an	10%		Plant Cost Index duri		160	
thanol storage cost (USD/I)	\$0.30		Loan interest rate (1	%)	0%		(FINE COLL HORE COLL	1.111010	100	
torage rate of ethanol redstock storage cost (USD/t)	20% \$ 5.00		Loan term (years)		0					
Storage Calculator 1	75.00									
ransport Distance of Feedsto	ck	Transport (Juantity							
stance SIZE 1 (5 ML) (km)	10	Size 1 (t/year)		61,728						
stance SIZE 2 (25 ML) (km)		Size 2 (t/year)		308,642						
istance SIZE 3 (50 ML) (km)		Size 3 (t/year)		617,284						
istance SIZE 4 (100 ML) (km)		Size 4 (t/year)		1,234,568						
eedstock Production Scheme	5									
cenario 1: Own Production		r Scenario 1	Scenario 2: Mio		Exclude	Scenario 2	Scenario 3: Out	growers		Scenario 3
scription: 100% of Sugarcane feedstock	33%		Description: 60% of produced directly by		-		Description: 100% of Su	garcane feedstock is	130%	
aduced directly by processing plant	58 -	100	40% provided by outgro		30% -	Modify Rotice	provided by outgrowers.	at market price.	N/N 10	
edatock Price = 100%*Production Cost			Feedstock Price = 60%	*Production Cost +	675	1 F	Feedstock Price = 100%	and the second		
editock Price = 100% "Production Cost	Distance (N)	Dulgeren (N)	40% "Market Price		Canada Cana	Outgrower (N)	Peeditocs Price - 100%		Dis.	Dulgrower (%)
\$ 27.19	_			\$28.11				\$ 29.50		
					Canaci	tioc (Millic	n litror por i	lace		_
			5	5	Capaci 25		on litres per y 50		10	D
	_		Operating hours per year	5					10 Operating hours per year	D 8,000
icenario 1: Own Production			Operating hours	8,000 esument Sc 1	25 Operating hours	8,000	50 Operating hours	8,000	Operating hours	8,000 ament Sc 1
cenario 1: Own Production	_		Operating hours per year Financial Asso (5 ML/	8,000 essment Sc 1 /year) essment Sc 2	25 Operating hours per year Financial Assess	8,000 sment Sc 1 sear) sament Sc 2	50 Operating hours per year Financial Asse:	8,000 sament Sc 1 year) sament Sc 2	Operating hours per year Financial Asses	8,000 ament Sc 1 year) ament Sc 2
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cenario 2: Mixed	Unit	Unit Price	Operating hours per year Financial Asso (5 ML/ Financial Ass (5 ML/ Financial Ass	8,000 essment Sc 1 /year) essment Sc 2 /year) essment Sc 3 /year) Total	25 Operating hours per year Financial Asses (25 ML/) Financial Asses (25 ML/) Financial Asses	8,000 sment Sc 1 sment Sc 2 reor) sment Sc 3 reor) Total	5C Operating hours per year Financial Asse (SO ML/ Financial Asse (SO ML/ Quantity	a,000 ssment Sc 1 year) ssment Sc 2 year) ssment Sc 3 year) Total	Operating hours per year Financial Asser (100 ML/ Financial Asser (100 ML/ Quantity	8,000 sment Sc 1 year) ument Sc 2 year) sment Sc 3 year) Total
icenario 2: Mixed icenario 3: Outgrowers eedstock	Unit	(USD)	Operating hours per year Financki Ass. (5 ML/ Financial Ass (5 ML/ Financial Ass (5 ML/ Quantity (Unit)	8,000 essment Sc 1 /year) essment Sc 2 /year) essment Sc 3 /year)	25 Operating hours per year Financial Assect (25 ML/) Financial Assect (25 ML/) Financial Assect (25 ML/) Operating (Unit)	8,000 sment Sc 1 ear) sment Sc 2 year) sment Sc 3 year)	5C Operating hours per year Financial Asse (SO ML/ Financial Asse (SO ML/ Guantity (Unit)	B,000 ssment Sc 1 year) ssment Sc 2 year) ssment Sc 3 year)	Operating hours per year Financial Asser (300 ML/ Financial Asser (100 ML/ Financial Asser (100 ML/ Quantity (Unit)	8,000 sment Sc 1 year) ument Sc 2 year) ument Sc 3 year) Total (USD/year
cenario 2: Mixed cenario 3: Outgrowers eedstock groupe Senario 1 groupe Senario 2	t t	(USD) \$ 27.19 \$ 28.11	Operating hours per year Financial Ass (5 Mil) Financial Ass (5 Mil) Financial Ass (5 Mil) Quantity (Unit) 61,720 61,720	8,000 essment Sc 1 (year) esament Sc 2 (year) esament Sc 3 (year) S 1,572,55 \$ 1,752,433	25 Operating hours per year Financial Asses (25 ML/) Financial Asses (25 ML/) Quantity (Unit) 300,642 300,642	8,000 sment Sc 1 sment Sc 2 rear) Total (USO/year) 6 8,00,775 6 8,07,775	5(Operating hours per year Financial Asse (50 ML/ Financial Asse (50 ML/ Financial Asse (50 ML/ Gasetity (Unit) G17,244 617,724	8,000 8,000 sament Sc 1 year/ sament Sc 2 year/ sament Sc 3 year/ (USS/year) 5 16,713,951 5 17,554,321	Operating hours per year Financial Asser (100 ML) Financial Asser (100 ML) Financial Asser (100 ML) Quantity (Unit) 1,234,560	8,000 ament Sc 1 year) ament Sc 2 year) ament Sc 3 year) Total (USD)year (33,507 ; 33,507 ; 34,700
cenario 2: Mixed cenario 3: Outgrowers edstock garane Senario 1 garane Senario 2 garane Senario 3	t t	(USD) \$ 27.19	Operating hours per year Financial Ass (5 Mil) Financial Ass (5 Mil) Financial Ass (5 Mil) Quantity (Unit) 61,720 61,720	8,000 esament Sc 1 /year) ciament Sc 2 /year) ciament Sc 3 /year) Total (USD/year) \$ 1,670,395	25 Operating hours peryear Finandial Assee (25 ML/) Financial Assee (25 ML/) Financial Assee (25 ML/) Operating (Unit) 300,642	8,000 sment Sc 1 ear) sament Sc 2 rear) sament Sc 3 rear) Total (USD/year) 5 8,301,275	50 Operating hours per year Financial Asse (SO ML/ Financial Asse (SO ML/ Guantity (Unit) 617,254	B,000 sument Sc 1 year) sument Sc 2 year) sument Sc 3 year) Total (USS/year) 5 16,77.0,551	Operating hours per year /Inancial Asse: (100 ML/ /Inancial Asse: (100 ML/ Quantity (Unit) 1_234,550	8,000 ament Sc 1 (year) ament Sc 2 (year) ament Sc 3 (year) Total (USD)yea (USD)yea (33,050)
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Summary of Feedstock and S	Financial Par	ameters			Investment C	ost Update					
eetbitock eveilable (t/year)	1,974,603		Discount rate (%)		10%	1	Plant Cost Index du	ring 11/2020	160		
thanol storage cost (USD/I) torage rate of ethanol	\$ 0.30		Loan interest rate () Loan term (years)	8	0%						
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scription: 100% Mabe feedstock produce	100%			of Malas Seedlack	100%		Description: 100% of	f Make Redstock is	100%		
rectly by processing plant.			produced directly by 40% provided by outgr	processing plant, and owers at market price.		Modity	provided by outgrower			LUPA .	
editock Price = 100%*Production Cost			Feedrack Price = 60%	*Production Cost +	-	4.8	Feedback Price - 300	Contract in the		1911	
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FRUCESSI	NG COS	TS FOR I	BIODIE	SEL PR	ODUC	TION F	ROM	SOYBEA	٩N		
< BACK Data Entry Biofuel De	emand Liq	uid Biofuels Process Description		NEXT >> Results - Comparat	ive Sumr	NEXT >> mary of Results - by	Feedstock	NEXT> Summary of Res			
Use white cells to input data	Grey cells are u	sed for calculations									
Summary of Feedstock and Sto		Financial Pa	arameters			Investment Co	stUndate				
Feedstock available (t/year)	3,550,000	Discount rate (N		10%		Plant Cost Index dur		160			
Ethanol storage cost (USD/I)	\$0.30	Loan interest rat	= (%)	0%		(FIGHE COLE HOLE OUT	ng 11/2020	160			
Storage rate of biodiesel Feedstock storage cost (USD/t)	20% \$ 5.00	Loan term (years	0	0							
Storage Calculator 3											
Transport Distance of Feedsto	ck Trans	port Quantity									
Distance SIZE 1 (5 ML) (km)	5 Size 1 (t/	year)	27,322]							
Distance SIZE 2 (25 ML) (km)	10 Size 2 (t/		136,612								
Distance SIZE 3 (50 ML) (km) Distance SIZE 4 (100 ML) (km)	20 Size 3 (t/ 30 Size 4 (t/		273,224 546,448								
Feedstock Production Scheme				,							
	_	o 1 Scenario 2: N		_				_			
Scenario 1: Own Production	10%				Scenario 2	Scenario 3: Out	-	Exclude Scenario 3			
Description: 100% of Soybean feedstock produced directly by processing plant.	108 - 108	produced directly	of Soybean feedstock by processing plant, and tgrowers at market price.		Modify Retion	Description: 100% of 1 provided by outgrowers		xa - 10			
Feedstock Price = 100%*Production Cost		S0% "Market Price	0%*Production Cost +	50K		Feedstock Price = 100%	"Market Price				
\$ 190.66	Diatory (N) DOutgrou	- (N)	\$ 242.50	Bistory (N	Outgrower (%)		\$ 294,33	Efectory (N)	Culgrower (%)		
Show Costing Details											
	_		Capacities (Million litres per year)								
			5	25	5	50)	100			
				Operating hours per year	8,000	Operating hours per year	8,000	Operating hours 8,000			
						i ber year		per year			
Scenario 1: Own Production			ssessment Sc 1 N/year)	Financial Asses (25 ML/)		Financial Asse (50 ML/		Financial Asses (100 ML/)	sment Sc 1		
Scenario 1: Own Production Scenario 2: Mixed		(5 M Financial A	AL/year) Assessment Sc 2	(25 ML/) Financial Asse	year) ssment Sc 2	Financial Asse (50 ML/ Financial Asse	year) sument Sc 2	Financial Asses (100 ML/ Financial Asses	sment Sc 1 year) sment Sc 2		
Scenario 2: Mixed		(5 N Financial A (5 N Financial A	AL/year) Assessment Sc 2 AL/year) Assessment Sc 3	(25 ML/) Financial Asse (25 ML/) Financial Asse	year) ssment Sc 2 year) ssment Sc 3	Financial Asse (50 ML/ Financial Asse (50 ML/ Financial Asse	year) ssment Sc 2 year) ssment Sc 3	Financial Asses (100 ML/ Financial Asses (100 ML/ Financial Asses	sment Sc 1 year) sment Sc 2 year) sment Sc 3		
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Scenario 2: Mixed Scenario 3: Outgrowers Feeddook	Unit Unit	(5 N Financial A (5 N Financial A (5 N Price 0) Quantity (Unit)	RL/year) Issessment Sc 2 AL/year) Assessment Sc 3 AL/year) Total (USD/year)	(25 ML/) Financial Asse: (25 ML/) Financial Asse: (25 ML/) Quantity (Unit)	rear) ssment Sc 2 year) ssment Sc 3 year) Total (USD/year)	Financial Asse (S0 ML/ Financial Asse (S0 ML/ Financial Asse (S0 ML/ Quantity (Unit)	year) sament Sc 2 year) sament Sc 3 year) Total (USG/year)	Financial Asses (200 ML/) Financial Asses (200 ML/) Financial Asses (200 ML/) Quantity (Unit)	sment Sc 1 year) sment Sc 2 year) sment Sc 3 year) Total (USD/year)		
Scenario 2: Mixed Scenario 3: Outgrowers Reedstock Soybean Scenario 1	(U)	(5 N Financial A (5 N Financial A (5 N (5 N (5 N (5 N (5 N))) (0 n) (0 n	R/year) Assessment Sc 2 R/year) Assessment Sc 3 R/year) Total (USD/year) 2 5 5,209,290	(25 ML/) Financial Asse: (25 ML/) Financial Asse: (25 ML/) Quantity (Unit) 156,612	rear) sament Sc 2 year) sament Sc 3 year) Total (USD/year) \$ 26,046,448	Financial Asse (SO ML/ Financial Asse (SO ML/ Financial Asse (SO ML/ Quantity	year) sument Sc 2 year) sument Sc 3 year) Total (USD/year) \$ 52,002,896	Financial Asses (200 ML/) Financial Asses (200 ML/) Financial Asses (200 ML/) Quantity (Unit) 546,445 (3	sment Sc 1 year) sment Sc 2 year) sment Sc 3 year) Total		
Scenario 2: Mixed Scenario 3: Outgrowers Feedstock	t (US	(5 N Financial A (5 N Financial A (5 N Price 0) Quantity (Unit)	R/year) suessment Sc 2 R/year) suessment Sc 3 R/year) Total (USD/year) 2 5 5,200,290 2 5 5,205,566	(25 ML/) Financial Asse: (25 ML/) Financial Asse: (25 ML/) Quantity (Unit)	rear) ssment Sc 2 year) ssment Sc 3 year) Total (USD/year)	Financial Asse (50 ML/ Financial Asse (50 ML/ Financial Asse (50 ML/ Quantity (Unit) 273,224	year) sament Sc 2 year) sament Sc 3 year) Total (USG/year)	Financial Asses (200 ML/) Financial Asses (200 ML/) Financial Asses (200 ML/) Quantity (Unit)	sment Sc 1 year) sment Sc 2 year) sment Sc 3 year) Total (USD/year) 104,185,700		
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Scenario 2: Mixed Scenario 3: Outgrowers Feetstock Soyban Sonario 1 Soyban Sonario 2 Soyban Sonario 3 Total Production Costs (USI	t t t	(5 A Financki / (5 A Financki / (5 A Financki / (5 A Financki / (5 A (5 A) (5	R/year) suessment Sc 2 R/year) suessment Sc 3 R/year) Total (USD/year) 2 5 5,200,290 2 5 5,205,566	(25 ML/) Financial Asse: (25 ML/) Financial Asse: (25 ML/) Quantity (Unit) 136,612	rear) sament Sc 2 year) sament Sc 3 year) Total [USD/year) \$ 26,046,448 \$ 33,127,732	Financial Asse: (50 ML/ Financial Asse (50 ML/ Financial Asse (50 ML/ Quantity (Unit) 273,224	pear) sament Sc 2 year) sament Sc 3 year) Total (USO/year) \$ 52,092,896 \$ 66,255,464	Financial Asses (200 ML/) Financial Asses (200 ML/) Financial Asses (200 ML/) Generity (Unit) 546,448 3 546,448 3	sment Sc 1 sment Sc 2 year) sment Sc 2 year) Total (USD/year) 100,105,70,92		
Scenario 2: Mixed Scenario 3: Outgrowers Feedstock Soybean Scenario 1 Soybean Scenario 2 Soybean Scenario 3	t t t	(5 A Financial A (5 A Financial A (5 A (5 A (5 A (5 A (5 A (5 A (5 A (5	#L/year) Lasessment Sc 2 ML/year) Lasessment Sc 3 ML/year) Total (USD/year) 2 \$ 5,20,300 2 \$ 0,622,546 2 \$ 0,622,546 2 \$ 0,622,546 2 \$ 0,622,546 2 \$ 0,622,546 2 \$ 0,622,546 2 \$ 0,622,546 2 \$ 0,622,546 2 \$ 0,622,546 2 \$ 0,622,546 2 \$ 0,622,546 2 \$ 0,622,546 2 \$ 0,622,546 2 \$ 0,622,546 2 \$ 0,624,640 1 \$ 0,624,640	(25 ML/) Financial Asse (25 ML/) Financial Asse (25 ML/) Guanthy (Unit) 136,612 136,612 136,612 136,612 136,612 136,612	rear) sement Sc 2 year) sement Sc 3 year) Total (USD/year) \$ 30,107,408 \$ 30,107,408 \$ 30,107,408 Total Total	Financial Asse (S0 ML/ Financial Asse (S0 ML/ Guantity (Until 273,224 273,224 273,224 Total (USD/year)	rear) sament Sc 2 pear) sament Sc 3 pear) Total (USD/year) \$ 52,002,896 \$ 66,255,464 \$ 66,255,464 Total Total	Financial Asses (200 ML/) Financial Asses (200 ML/) Financial Asses (200 ML/) Quantity (both) 546,443 (5 546,443 (5) 546,443 (5) 546,453 (sment Sc 1 (1997) sment Sc 2 (1997) Total (1997) Total (1997) 190,195,00 Total (1997) 190,195,00 Total (1997)		
Scenario 2: Mixed Scenario 3: Outgrowers Feedstock Soyban Sonario 1 Soyban Sonario 2 Soyban Sonario 3 Total Production Costs (US) Scenario 1 Total Seconts	t t t	(5 A Financial / (5 A Financial / (5 A Financial / (5 A (5 A) (5 A (5	#L/year) Lassesament Sc 2 #Lyear) Lassesament Sc 3 #Lyear) Total (USD/lyear) 2 2 2 3 4 2 4 2 5 2 4 1 1 1 1 1 1 1 2 5 1 <	(25 ML/) Financial Asse (25 ML/) Financial Asse (25 ML/) Guanthy (Unit) 136,612 136,61	rear) ssment Sc 2 year) ssment Sc 3 year) Total (USD/year) \$ 26,046,488 \$ 30,209,016 Total (USD/i) \$ 1,13 \$ 1,13 \$ 0,15 }	Financial Asse. (S0 ML/) Financial Asse. (S0 ML/) Financial Asse. (S0 ML/) Guantity (Use) 273,224 273,224 Total (USD/year) \$ 56,227,228 \$ 6,62,97,228	pear) sument Sc 2 year) sament Sc 3 year) Total (USD/year) \$ 00,418,023 Total (USD/year) \$ 00,418,023 \$ 0,13	Financial Asses (100 ML/) Financial Asses (200 ML/) Financial Asses (200 ML/) Quantity (Une) 546,445 546,455 546,455 546,455 546,455 546,455 546,455 546,455 546,455 546,455 546,455 546,455 546,455 546,455 546,455 546,455 546,455 546,455 546,455546 546,455 546,455 546,455 546,455546 546,455 546,455 546,455 546,455546 546,455 546,455 546,455 546,455 546,455 546,455546 546,455 546,455 546,455546 546,455 546,455 546,4555546 546,4555 546,455556 546,455556565656565656565656565656565656	sment Sc 1 (vear) sment Sc 2 (vear) sment Sc 3 (vsD/year) 30(,185,79 105,185,00 Total (uSD/) 11 (uSD/) 11 (11 (11)		
Scenario 2: Mixed Scenario 3: Outgrowers Feedstock Software Senario 1 Software Senario 2 Software Senario 2 Total Production Costs (USI Scenario 1 Total Spenting costs Total famed costs Total famed costs	Unit (ut t t D/year)	(5 A Financial A (5 A Financial A (5 A Financial A (5 A) (5 A (5 A) (5 A) (#L/year) kssessment Sc 2 #L/year) Sissessment Sc 3 #L/year) 2 Socostation 2 4,050/year) 2 5 2 4,050/year) 2 5 6,525,546 6 122 6 122 6 122 6 122 7 7	(25 ML/) Financial Asse: (25 ML/) Financial Asse: (25 ML/) Quantity (Unit) 136,612 136,612 136,612 136,612 136,612 136,612 136,612	rear) ssment Sc 2 vear) ssment Sc 3 vear) Total (USD/vear) 5 20,046,448 5 33,127,732 5 40,200,016 Total (USD/t) 5 1.13	Financial Asse. (S0 ML/ Financial Asse. (S0 ML/ Financial Asse. (S0 ML/ Quantity (Unti) 273,224 273,224 273,224 273,224 273,224 273,224 273,224	year) sament Sc 2 year) sament Sc 2 year) Total (050/year) 5 5 0,02,056 5 6 0,410,033 Total (US0/t) 5 1,13	Financial Asses (100 ML/) Financial Asses (200 ML/) Financial Asses (100 ML/) Quantity (Unit) S46,443 \$ 546,443 \$ 546,444 \$ 546,443 \$ 546,443 \$ 546,443 \$ 546,443 \$ 546,443 \$ 546,444 \$ 546,446 \$ 546,446 \$ 546,446 \$ 546,446 \$ 546,446 \$ 56	sment Sc 1 (vear) sment Sc 2 (vear) sment Sc 3 (vsD/year) 30(,185,79 105,185,00 Total (uSD/) 11 (uSD/) 11 (11 (11)		
Scenario 2: Mixed Scenario 3: Outgrowers Feedstock Soyban Sonario 1 Soyban Sonario 2 Soyban Sonario 3 Total Production Costs (USI Scenario 1 Total operating cost Total operating cost Total operating cost Total operating cost Total production costs scenario 1 (USD	Unit (ut t t D/year)	(5 A Financial / (5 A Financial / (5 A (5 A) (5 A (5 A) (5 A)	#L/year) kssessment Sc 2 #L/year) Sissessment Sc 3 #L/year) 2 Socostation 2 4,050/year) 2 5 2 4,050/year) 2 5 6,525,546 6 122 6 122 6 122 6 122 7 7	(25 ML/) Financial Asse: (25 ML/) Financial Asse: (25 ML/) Quantity (Une) 136,612 136,	rear) ssment Sc 2 year) ssment Sc 3 year) Total (USD/year) \$ 26,046,488 \$ 30,127 \$ 40,209,016 Total (USD/t) \$ 1.13 \$ 0.15 }	Financial Asse. (S0 ML/ Financial Asse (S0 ML/ Financial Asse (S0 ML/ Quantity (Uset) 273,224 273,224 273,224 273,224 273,224 273,224 273,224 273,224	pear) sument Sc 2 year) sament Sc 3 year) Total (USD/year) \$ 00,418,023 Total (USD/year) \$ 00,418,023 \$ 0,13	Financial Asses (100 ML/) Financial Asses (100 ML/) Financial Asses (100 ML/) Gesetity (Uote) 346,443 (546,443 (546,443 (546,443 (546,443 (546,443 (546,443 (546,443 (546,443 (512,474,404 (sment Sc 1 seers) sment Sc 2 year) Total (USD/year) 100,185,00,90 Total (USD/) Total (USD/)		
Scenario 2: Mixed Scenario 3: Outgrowers Feedstock Soybean Sonario 1 Soybean Sonario 2 Soybean Sonario 2 Total Production Costs (USI Scenario 1 Total Spectrum Total production costs scenario 1 (USD Total production costs scenario 1 (USD Scenario 2	Unit (ut t t D/year)	(5 A Financial / (5 A Financial / (5 A Financial / (5 A (5 A) (5 A (5	A(/year) Lasessment Sc 2 A(/year) Lasessment Sc 3 A(/year) Total (USD/)ser) 2 \$ 5,200,300 2 \$ 6,625,346 2 \$ 6,625,346 2 \$ 0,212 7 \$ 0,020 8 \$ 1,45	(25 ML/) Financial Asse: (25 ML/) Financial Asse: (25 ML/) Quantity (Unit) 136,612 13	rear) sament Sc 2 year) sament Sc 2 year) Total (USD/year) \$ 26,046,488 \$ 33,127 \$ 40,209,016 Total (USD/i) \$ 1.13 \$ 0.15 \$ 0.01 \$ 1.28 }	Financial Asse. (S0 ML/ Financial Asse (S0 ML/ financial Asse (S0 ML/ Quantity (Unit) 273,234 274,2344 275,234,2344 275,2344 275,2344 275,2344 275,2344 275,23	pear) sument Sc 2 year) sament Sc 3 year) Total (USD/year) \$ 00,410,023 Total (USD/N) \$ 1.13 \$ 0.13 \$ 0.13 \$ 0.01 \$ 1.27	Financial Asses (100 ML/ Financial Asses (200 ML/ Financial Asses (200 ML/ Financial Asses (200 ML/ Quantity (Une) 546,443 546,445 546,445 546,445 546,445 546,4455577,4045 546,445 546,445 546,445 546,4455577,4045 546,4557677,4045 546,45576776,455767767767767767767767777777777	sment Sc 1 year) sment Sc 2 year) Total (USD/year) 304,182,77 332,510,92 Total (USD/) 1.1 1.0 1.0 1.2 5 1.2		
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Scenario 2: Mixed Scenario 3: Outgrowers Feedstock Sryban Senario 3 Total Production Costs (USI Total operating costs Total production costs scenario 1 [USD Scenario 2 Total operating costs T	(ur t t D/year))/year))/year)	(5 A Financial / (5 f) Financial / (5 f) Financial / (5 f) Financial / (0 et) (0 et) (K/year) Issessment Sc 2 Kssessment Sc 2 Ksyessment Sc 3 (USD/year) 2 \$ 5.30,230 2 \$ 6.22,546 2 \$ 0.041,000 6 \$ 1.22 7 \$ 0.02 8 3 2 \$ 1.45 2 \$ 0.21 7 \$ 0.02 8 3 2 \$ 0.21 7 \$ 0.02 8 3 2 \$ 0.21 7 \$ 0.02 8 3	(25 ML/) Financial Asse: (25 ML/ Financial Asse: (25 ML/ Gasethy (Unit) 106,612 106,6	rear) ssment Sc 2 year) ssment Sc 2 year) Total (USD/year) \$ 25,046,448 \$ 33,127,25 \$ 40,209,016 Total (USD/t) \$ 1,13 \$ 0,15 \$ 0,15 \$ 0,01 \$ 1,28 \$ 1,41 \$ 0,15 \$ 0,15 }	Financial Asse. (S0 ML/ Financial Asse (S0 ML/ Gasettry (Unt) 273,224 273,224 273,224 273,224 273,224 273,224 273,224 273,224 273,224 273,224 273,224 5 6,207,203 5 6,207,203 5 6,207,203 5 6,207,203 5 6,207,203 5 6,207,203 5 6,207,203 5 5,207,203 5 5,207,203	pear) sament Sc 2 year) sament Sc 3 year) Total (USD)/paar) \$ 52,002,396 \$ 66,255,464 \$ 66,255,464 \$ 60,410,039 \$ 1.13 \$ 0.13 \$ 0.13 \$ 1.27 \$ 1.41	Financial Asses (100 ML/) Financial Asses (200 ML/) Financial Asses (200 ML/) Financial Asses (200 ML/) Gazetty (Uota) S46,443 3 S46,443 3 S46,443 3 S46,443 3 S46,443 3 S46,444 3 S12,674,004 5 S2,376,573 5 S 125,560,966 S 140,990,540 5 S 140,990,540 5 S 140,990,540 5 S 140,990,540 5 S 120,704,754 5	sment Sc 1 verr) sment Sc 2 verr) ment Sc 3 verr) Total (USD/ver) 100,185,70 100,195,70 100,100,100,100,100,100,100,100,100,10		
Scenario 2: Mixed Scenario 3: Outgrowers Feedstock Sophan Sonario 1 Sophan Sonario 2 Sophan Sonario 3 Total Operating costs Total operating costs Total operating costs Total production costs scenario 1 (USD Total production costs scenario 1 (USD Total production costs scenario 1 (USD Scenario 2 Total operating costs Total operat	/year) //year)	(5 A Financial / (5 A (5 A) (5	K/year) Issessment Sc 2 Kssessment Sc 2 Ksyessment Sc 3 (USD/year) 2 \$ 5.30,230 2 \$ 6.22,546 2 \$ 0.041,000 6 \$ 1.22 7 \$ 0.02 8 3 2 \$ 1.45 2 \$ 0.21 7 \$ 0.02 8 3 2 \$ 0.21 7 \$ 0.02 8 3 2 \$ 0.21 7 \$ 0.02 8 3	(25 ML/) Financial Asse: (25 ML/) Financial Asse: (25 ML/) Quantity (Unit) (156,612 136,612 1	rear) ssment Sc 2 year) ssment Sc 2 year) Total (USD/year) \$ 25,046,448 \$ 33,127,25 \$ 40,209,016 Total (USD/t) \$ 1,13 \$ 0,15 \$ 0,15 \$ 0,01 \$ 1,28 \$ 1,41 \$ 0,15 \$ 0,15 }	Financial Asse. (S0 ML/ Financial Asse (S0 ML/ Financial Asse (S0 ML/ Financial Asse (S0 ML/ Financial Asse (S0 ML/ 273,224 273,224 273,224 273,224 273,224 273,224 5 6,600,149 5 85,300,676 5 85,300,676 5 70,420,269 5 77,471,244	pear) sument Sc 2 year) sament Sc 3 year) Total (USD/year) \$ 52,092,866 \$ 60,255,466 \$ 00,418,025 Total (USD/year) \$ 0,418,025 \$ 0,13 \$ 0,12 \$ 1.27 \$ 1.41 \$ 0,13	Financial Asses (100 ML/) Financial Asses (200 ML/) Financial Asses (100 ML/) Financial Asses (100 ML/) Gasetty (Uok) 546,48 546,48 546,48 546,48 546,48 546,48 546,48 512,376,404 5 122,376,615 5 125,350,346 5 140,990,540 5 121,276,615	sment Sc 1 veer) ment Sc 2 veer) Total (USD/year) 100,857,0592 100,857,0592 100,857,0592 100,85,05 111,059 100,85,05 1,22 1,23 1,24 1,25 1,25 1,25 1,25 1,25 1,25 1,25 1,25		
Scenario 2: Mixed Scenario 3: Outgrowers Feedstock Soyban Sonario 1 Soyban Sonario 2 Soyban Sonario 3 Total Production Costs (USI Scenario 1 Total operating costs Total operating costs Total and costs Total production costs scenario 1 (USD Total frand costs Tetal operating costs	/year) //year)	(5 A Financial / (5 f) Financial / (5 f) Financial / (5 f) Financial / (0 et) (0 et) (Total (Jyear) Sasesament Sc 2 (Jyear) Total (USD/year) 2 2 3 4,025,946 2 4,025,947 2 5 5 1,22 6 7 2 8 2 2 3 1,45 2 2 3 1,22 4 1,22 5 1,22 6 1,22 5 1,22 5 1,22 6 0,21 7 0,02 5	(25 ML/) Financial Asse: (25 ML/) Financial Asse: (25 ML/) Quantity (Unit) (156,612 136,612 1	rear) sament Sc 2 vear) sament Sc 2 vear) Total (USD/vear) \$ 32,046,448 \$ 32,127,722 \$ 40,209,016 Total (USD/t) \$ 1.13 \$ 0.15 \$ 0.01 \$ 1.28 \$ 1.41 \$ 0.15 \$ 0.01	Financial Asse. (S0 ML/ Financial Asse (S0 ML/ Financial Asse (S0 ML/ Financial Asse (S0 ML/ Financial Asse (S0 ML/ 273,224 273,224 273,224 273,224 273,224 273,224 5 6,600,149 5 85,300,676 5 85,300,676 5 70,420,269 5 77,471,244	pear) sament 5c 2 year) sament 5c 3 year) Total (US50/year) \$ 52,002,396 \$ 66,253,464 \$ 90,410,035 \$ 0,135 \$ 0,135 \$ 0,13 \$ 1.27 \$ 1.41 \$ 0,13 \$ 0,13 \$ 0,13	Financial Asses (100 ML/ Financial Asses (100 ML/ Financial Asses (100 ML/ Financial Asses (100 ML/ Classifier (Unit) 546,443 546,443 546,445 546,445 546,445 546,445 546,445 546,445 5123,356,355 5123,356,345 5123,356,356 5123,	sment Sc 1 veer) ment Sc 2 veer) Total (USD/year) 100,857,0592 100,857,0592 100,857,0592 100,85,05 111,059 100,85,05 1,22 1,23 1,24 1,25 1,25 1,25 1,25 1,25 1,25 1,25 1,25		
Scenario 2: Mixed Scenario 3: Outgrowers Feedstock Softwan Scenario 1 Softwan Scenario 2 Softwan Scenario 2 Total Production Costs (USI Total operating cost Total and costs Total production costs scenario 1 (USD Scenario 2 Total production costs scenario 1 (USD Scenario 2 Total production costs scenario 2 Scenario 2 Total production costs scenario 2 Scenario 2 Total production costs scenario 2 Scenario 3 Total production costs scenario 2 Scenario 3 Total operating costs	/year) //year)	(5 A Financki / (5 A Financki / (5 A Financki / (5 A Financki / (5 A Financki / (5 A (5 A) (5 A (5 A) (5 A) (8(/year) kssessment Sc 2 fl/year) kssessment Sc 3 fl/year) 2 \$ 5,50,200 2 \$ 6,22,546 2 \$ 0,225,546 2 \$ 0,225,546 2 \$ 0,225,546 2 \$ 0,225,546 2 \$ 0,225,546 2 \$ 0,221 7 \$ 0,020 8 \$ 1,222 8 \$ 1,223 8 \$ 1,455 9 \$ 1,73 9 \$ 1,775 9 \$ 1,775 1,77	(25 ML/) Financial Asse. (25 ML/ Financial Asse. (25 ML/ Gasethy 106,612 136,	rear) sament Sc 2 year) sament Sc 3 year) Total (USD/year) \$ 26,046,448 \$ 33,127,732 \$ 26,046,448 \$ 33,127,732 \$ 1,13 \$ 26,040,209,016 \$ 1,13 \$ 0,15 \$ 0,01 \$ 1,28 \$ 1,41 \$ 0,015 \$ 0,01 \$ 1,28 \$ 1,41 \$ 0,015 \$ 0,01 \$ 1,28 \$ 1,41 \$ 0,015 \$ 0,01 \$ 1,28 \$ 1,41 \$ 0,015 \$ 0,01 \$ 1,28 \$ 1,41 \$ 0,015 \$ 0,01 \$ 1,28 \$ 1,57 \$ 0,01 \$ 1,57 \$ 0,01 }	Financial Asse. (S0 ML/ Financial Asse. (S0 ML/ Financial Asse. (S0 ML/ Quantity Quantity Quantity 273,224 273,224 273,224 Total (USD/year) \$ 56,207,728 5,660,349 \$ 302,129 \$ 302,129 \$ 50,207,928 \$ 53,308,676 \$ 70,420,056 \$ 5,600,349 \$ 77,471,244 \$ 77,471,244	pear) sament Sc 2 year) sament Sc 3 year) Total (USD(year)) \$ 52,09,286 \$ 66,255,464 \$ 0,410,035 \$ 1.13 \$ 0,133 \$ 0,133 \$ 0,133 \$ 0,201 \$ 1.27 \$ 1.27 \$ 1.27 \$ 1.27 \$ 1.27 \$ 1.27 \$ 1.27 \$ 1.27 \$ 1.27 \$ 1.27	Financial Asses (100 ML/) Financial Asses (200 ML/) Financial Asses (200 ML/) Financial Asses (200 ML/) Casetty (Unit) S46,440 3 S46,440 3 S46,440 3 S122,776,613 3 S122,776,613 5 S122,776,613 5 S122,776,613 5 S122,776,613 5 S123,786,946 3 S140,999,540 5 S123,786,745 5 S140,999,540 5 S140,999,540 5 S140,999,540 5 S123,990,062 3 S153,990,062 3	sment Sc 1 year) ment Sc 2 year) Total (USD/year) 300,185,75 100,185,75 100,185,75 100,185,05 100,185,05 100,185,05 11 11 11 11 12 12 12 12 12 12 12 12 12		
Scenario 2: Mixed Scenario 3: Outgrowers Feedstock Soyban Senario 1 Soyban Senario 2 Soyban Senario 2 Total Production Costs (USI Scenario 1 Total operating costs Total operating costs Total production costs scenario 1 (USD Scenario 2 Total production costs scenario 1 (USD Scenario 2 Total production costs scenario 2 (USD Total production costs scenario 1 (USD Scenario 2 Total operating costs Total production costs scenario 2 (USD Total production costs scenario 2 (USD Total production costs scenario 2 (USD Scenario 2 Total operating costs Tota	/year) //year)	(5 A Financial / (5 A Financial / (5 A Financial / (5 A Financial / (5 A Financial / (5 A (5 A) (5 A)	R_/year) sassament Sc 2 R_/year) sassament Sc 3 R_/year) Total (USD/year) 2 \$ 5,200,300 2 \$ 6,625,900,300 2 \$ 6,625,900,300 2 \$ 6,625,900,300 2 \$ 6,625,900,300 2 \$ 6,625,900,300 2 \$ 6,625,900,300 2 \$ 6,625,900,300 2 \$ 6,021,800 5 1.222 5 1.232 6 \$ 0.212 5 1.73 9 \$ 1.773 9 \$ 1.773	(25 ML/) Financial Asse (25 ML/) Financial Asse (25 ML/) Gasothy (Unit) 136,612	rear) sament Sc 2 year) sament Sc 2 year) Total (USD/year) \$ 25,046,448 \$ 33,127 \$ 40,209,016 Total (USD/h) \$ 1,13 \$ 0,15 \$ 0,15 \$ 0,01 \$ 1,28 \$ 1,41 \$ 0,15 \$ 0,01 \$ 1,28 \$ 1,41 \$ 0,15 \$ 0,01 \$ 1,57 \$ 1,69 \$ 1,57 \$ 1,69 \$ 0,15 }	Financial Asse (S0 ML/ Financial Asse (S0 ML/ Financial Asse (S0 ML/ Quantity (Ust) 273,234 273,234 273,234 273,234 273,234 273,234 273,234 273,234 273,234 273,234 273,234 5 5 6,600,340 5 5 5 6,600,340 5 5 5 77,471,244	pear) sument Sc 2 year) sament Sc 3 year) Total (USD/year) \$ 00,412,025 \$ 00,412,025 \$ 00,412,025 \$ 00,412,025 \$ 00,412,025 \$ 00,412,025 \$ 0,412,025 \$ 0,412,025 \$ 0,13 \$ 0,13 \$ 1,41 \$ 0,01 \$ 1,55 \$ 1,69 \$ 1,69 \$ 1,69	Financial Asses (100 ML/) Financial Asses (200 ML/) Financial Asses (100 ML/) Financial Asses (100 ML/) Financial Asses (100 ML/) States (100 ML/)<	sment Sc 1 very ment Sc 2 very Total (USD/ver) 120(115,77 120(115,77 120(115,77) 120(11		
Scenario 2: Mixed Scenario 3: Outgrowers Feedstock Sophan Senario 3 Sophan Senario 3 Total Production Costs (USI Scenario 1 Total operating cost Total production cost scenario 1 (USD Scenario 2 Total production cost scenario 1 (USD Scenario 2 Total production cost scenario 2 (USD Scenario 2 Total production cost scenario 2 (USD Total production cost scenario 2 (USD Scenario 3 Total production cost scenario 2 (USD Scenario 3 Total production cost scenario 2 (USD Scenario 3	/year) //year) //year)	(5 A Financki / (5 A Financki / (5 A Financki / (5 A Financki / (5 A Financki / (5 A Financki / (5 A (5 A (5 A (5 A) (0et) (0	8(/year) Lasessment Sc 2 (//year) Lasessment Sc 3 (USD/year) 2 5 5.20,200 2 5 6.22,546 2 5 0.22 5 0.021 (USD/) 6 5 1.22 6 5 0.22 8 0 9 1.45 9 1.45 9 1.75 9 5 1.77 9 5 0.22 9 5 0.21 9 7 5 0.02 9 7 7 5 0.02 10 7 7 7 7 5 0.02 10 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	(25 ML/) Financial Asse. (25 ML/ Financial Asse. (25 ML/ Gasethy 106,612 136,	rear) sament Sc 2 year) sament Sc 2 year) Total (USD/year) \$ 25,046,448 \$ 33,127 \$ 40,209,016 Total (USD/h) \$ 1,13 \$ 0,15 \$ 0,15 \$ 0,01 \$ 1,28 \$ 1,41 \$ 0,15 \$ 0,01 \$ 1,28 \$ 1,41 \$ 0,15 \$ 0,01 \$ 1,57 \$ 1,69 \$ 1,57 \$ 1,69 \$ 0,15 }	Financial Asse. (S0 ML/ Financial Asse. (S0 ML/ Financial Asse. (S0 ML/ Quantity Quantity Quantity 273,224 273,224 273,224 Total (USD/year) \$ 56,207,728 5,660,349 \$ 302,129 \$ 302,129 \$ 50,207,928 \$ 53,308,676 \$ 70,420,056 \$ 5,600,349 \$ 77,471,244 \$ 77,471,244	pear) sument Sc 2 year) sament Sc 3 year) Total (USD/year) \$ 00,412,025 \$ 00,412,025 \$ 00,412,025 \$ 00,412,025 \$ 00,412,025 \$ 00,412,025 \$ 0,412,025 \$ 0,412,025 \$ 0,13 \$ 0,13 \$ 1,41 \$ 0,01 \$ 1,55 \$ 1,69 \$ 1,69 \$ 0,01	Financial Asses (100 ML/) Financial Asses (200 ML/) Financial Asses (200 ML/) Financial Asses (200 ML/) Guarding 54,442 S46,443 546,443 S46,444 5 S122,776,613 5 S122,776,613 5 S122,776,613 5 S122,776,613 5 S122,776,613 5 S122,776,613 5 S123,706,623 5 S120,990,540 5 S123,900,062 3 S125,300,304,062 3	sment Sc 1 vear) mment Sc 2 vear) Total (USD/year) i 300,485,70 Total (USD/) i 100,485,00 i 100,485,000 i 100,485,000,485,000,485,000 i 100,485,		







SUMMARY OF RESULTS COMPARATIVE																	
<< BACK Data Entry	Produ	ction Cost 1	Υ	ction Cost	Y	uction Cost 3	Y.	oduct	tion Cost 4	Sum		NEXT>>			N Summary o	IEXT >> f Results - I	abour
Create PDF Report																	
Biofuel Production and Plants																	
Maximum Attain	able Biofuel Pr	oduction						Ma	dimum num	ber of bi	ofuel plar	its given	feedstoc	k level		1	
Sugarane (Ithanol)	Sigerane (Ittano)					Supercare Ethanol Is able to supply 127.09% of a E12 blending mandeta. Maita Ethanol Is able to supply 122.44% of a E12 blending mandeta.											r.
Mabe (Ithanol)										81							
Soybean (Biadiesel)				Soybean Bloc B30 blending		o supply 65.45%	iofa				Ħ	32		12	-00	ی تھ	
en/A				m/A					5 N	4	2	5 ML		50 ML		100 ML	
	N 20% 40%	50% X	N 500%						Suga	arcane (Et	thanol)	Maize	(Ethanol) 🖬 Saybi	ean (Biodies	el) ∎≠N	/A
Compariso	on of Econ	omic Re	esults														
Scenario 1	(own pro	duction	1)														
Production Cost								Net	Present Va	lue (NPV) and inte	mai Rate	of Retur	m		1	
Bicc	lesel FGP price USD/1	Diodiesei	\$0.63	Dissel FGP pr	USD/L Diesel	Equivalent	\$0.72				NPV (Million	USD/year)			RR	15	
Diodesel	ML 25 ML	50 ML	100 ML	SML	25 ML	50 ML 1	00 ML		Diodiesel	SML	25 ML	SOML	100 ML	SML	25 ML	S0 ML	100 ML
3 Soybeen S # #N/A	1.09 \$0.90	\$0.04	\$ 0.0H	\$1.12	\$ 0.97	\$ 0.91	\$0.RI	3	Soybean eN/A	420.52	-\$ 66.05	-\$ 101.98	-\$ 201.64	Not feedble	Not feasible	Not feasible	Not feasible
		LEthenol	\$0.42		ISD/L Gesolin		\$ 0.79				NPV (Million	USD/year)			RR	15	
1 Sugarcane S 2 Malze S	0.97 \$ 0.65 0.98 \$ 0.51	50.ML 50.61 50.44	100 ML \$ 0.59 \$ 0.41	5 ML \$ 1.47 \$ 1.48	25 ML \$ 0.99 \$ 0.77	\$ 0.90	00 ML \$0.89 \$0.62	1	Ethanol Sugarcane Maize	5 ML -\$ 26.90 -\$ 28.71		50 ML -\$87.88 -\$17.30	100 ML -6 54.81 \$0.99		25 ML Not feesible Not feesible		100 ML Not feasible 10%
e m/A									m\/A								
Scenario 2	(Mixed)																
Production Cost	1							Net	Present Va	lue (NPV) and inte	mal Rate	of Retu	m		1	
Bioc	level FGP price USD/1	Dicclesel	\$0.63	Diesel FGP pr	USD/L Diesel	Equivalent	\$0.72				NPV (Million	USD/year)			RR	14	
Dicdesel	ML 25 ML	S0 ML	100 ML	SML	25 ML	50 ML 1	00 ML		Diodiesei	SML	25 ML	SOML	100 ML	5 ML	25 ML	50 ML	300 ML
3 Soybeen S # #N/A	1.31 \$1.18	\$ 1.12	\$1.13	\$1.40	\$1.28	\$1.22	\$1.22	3	Soybean mi/A	-\$ 32.50	-6 126.33	-6 222.55	-\$ 442.79	Not feedble	Not feasible	Not feasible	Not feasible
Dete	nol FOB price USD/	LEthanol	\$0.42	Gesoline FOB	i price ISD/I. Gasoline	e Equivalent	\$ 0.79				NPV (Million	USD/year)			RR	14	
1 Sugarcane \$	ML 25 ML 0.98 \$ 0.96	50 ML \$ 0.62	100 ML \$ 0.60	5 ML \$ 1.49	25 ML \$1.00	\$ 0.94	00 ML \$0.91	1	Ethanol Sugarcane	5 ML -\$ 27.41	25 ML -\$ 56.54	50 ML -\$92.74	100 ML -\$159.04		25 ML Not feesible	S0 ML Not feasible	
2 Malze S	1.04 \$ 0.58	\$0.51	\$0.07	\$ 1.58	\$ 0.47	\$ 0.77	\$0.72	2	Mabe mi/A	-5 31.46	-6 39.07	-\$44.82	-6 54.04	Not feedble	Not feasible	Not feasible	Not feasible
Scenario 3	Scenario 3 (Outgrowers)																
Production Cost								Net	Present Va	lue (NPV) and inte	mal Rate	of Retur	m		1	
Bio	lesel FGP price	Dicdistel	\$0.63	Diesel FGP pr	tso/L Diesel	Easteriest	\$0.72				NPV (Million	USD/wert				151	
Diodesel	IML 25 ML	SO ML	100 ML	SML	25 ML		00 ML		Diodiesel	SML	25 ML	SOML	100 ML	SML	25 ML	50 ML	100 ML
3 Soybeen S	1.50 \$ 1.45	\$ 1.40	\$ 1.41	\$ 1.73	\$1.59	\$1.52	\$1.50		Soybean MI/A	-\$ 44.54	-\$ 186.62	4340.13	-5 683.94	Not feedble	Not feedble	Not feesible	Not feesible
Dita	nol FOB price USD/	LEthanol	\$0.42	Gesoline FOD	i price JSD/L Gasolini	e Equivalent	\$0.79				NPV (Million	USD/year)			RR	N	
1 Sugarcane \$	ML 25 ML 1.00 \$ 0.68	50 ML \$ 0.64	\$0.62 5.0.77	5 ML \$ 1.51	25 ML \$ 1.00	\$0.97	00 ML \$ 0.90	1	Ethenol Sugarcane Maha	5 ML -6 28.14	25 ML -\$ 60.18	50 ML -\$ 100.02		S ML Not feedble Not feedble	25 ML Not feasible Not feasible	SO ML Not feasible	100 ML Not feasible
2 Malze S	1.14 \$0.67	\$ 0.61	\$0.57	\$1.73	\$ 1.02	\$ 0.92	\$0.86	2	Mabe mi/A	-\$ 35.99	-6 59.71	-9 86.09	-9 136.58	Aut teadble	Not feasible	Not teacible	NOT WARDS

