Fact finding mission Agro-Energy-Climate NEXUS in Bolivia

Huib Hengsdijk[1], Wolter Elbersen[2] and Ria Hulsman[3]

Prepared for:
RVO
Prinses Beatrixlaan 2
2595 AL The Hague

RVO Reference: PST21BO01

[1] Wageningen Plant Research

[2] Wageningen Food & Biobased Research

[3] Corporate Strategy & Accounts/Latin America

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Stichting Wageningen Research, Wageningen Plant Research, Business Unit Agrosystems Research, P.O. Box 16, 6700 AA Wageningen, The Netherlands; T +31 (0)317 48 07 00; www.wur.eu/plant-research

Chamber of Commerce no. 09098104 at Arnhem
VAT NL no. 8065.11.618.B01
IBAN: NL20RABO0307000427, Wageningen Plant Research

Contents

Preface

The government of the Netherlands has prioritized climate change as main national policy for development and cooperation. Under this policy framework, the agro-energy-climate nexus and circular management of waste have been defined as important themes by the Dutch embassy for Peru and Bolivia in its multi-annual country strategy for 2022 - 2025.

In February 2021, the Ministry of Hydrocarbons and Energy of Bolivia (https://www.mhe.gob.bo/) approached the Dutch embassy in Peru to identify potential Dutch knowledge organizations and private parties that could be interested in cooperation on the development of a biodiesel program. The Netherlands has sound knowledge and much expertise in the field of sustainable biofuel production and supply to assist and support the Bolivian government in developing a sustainable biodiesel sector which includes and considers explicit economic, social, and environmental objectives.

In October 2021, the Rijksdienst voor Ondernemend Nederland (RVO) commissioned Wageningen University and Research (WUR) to conduct a fact-finding mission focussing on the agro-energy-climate nexus in Bolivia with specific attention to the proposed biodiesel program. This report summarizes the outcomes of that factfinding mission.

The mission to Bolivia was carried out by three staff of Wageningen University and Research at the end of November – beginning of December 2021.

The authors of the report would like to thank Rafael Valcarce, commercial attaché in Bolivia for the Netherlands embassy of Peru and Bolivia for the organisation of stakeholder meetings and his participation in the activities and meetings held by the WUR experts during the period of the mission in Bolivia.

Abbreviations

ANAPO	*Asociación Nacional de productores de oleaginosas y trigo*
CAF	Development Bank of Latin America
CANIOB	*Cámara Nacional de Industrias Oleaginosas de Bolivia*
CIAT	*Centro de Investigación Agrícola Tropical*
FAME	Fatty Acid Methyl Ester oil
GHG	Greenhouse gas
GMO	Genetically Modified Organisms
HVO	Hydrotreated Vegetable Oil
IICA	Inter-American Institute for Cooperation on Agriculture
IBIF	*Instituto Boliviano de Investigación Forestal*
INIAF	*Institute of Agricultural and Forestry Innovation*
MAS	*Movimiento al Socialismo,* the democratic socialist party
MHE	*Ministerio de Hidrocarburos y Energías* / Ministry of Hydrocarbons and Energy
MT	Metric ton (= 1,000 kg)
NDC	National Determined Contribution
UCO	Used Cooking Oil
YPFB	*Yacimientos Petrolíferos Fiscales Bolivianos*

Executive summary

In February 2021, the Ministry of Hydrocarbons and Energy (MHE) of Bolivia approached the Dutch embassy in Peru to identify Dutch knowledge organizations and private parties to cooperate on the development of a national biodiesel program. The Rijksdienst voor Ondernemend Nederland (RVO) commissioned Wageningen University and Research to conduct a fact-finding mission focussing on the agro-energy-climate nexus in Bolivia with specific attention to the proposed biodiesel program. This report summarizes the outcomes of the factfinding mission that was conducted at the end of 2021. During the fact-finding mission representatives from the public sector, private sector and civil society in Bolivia were consulted to gain information and to learn about the different opinions about the biodiesel program.

Currently, the energy market in Bolivia is governed by the state: The state imports large quantities of fossil fuel and gives significant consumer subsidies on energy. To reduce the associated high costs of imports and subsidies, the parliament of Bolivia approved legislation in 2018 making it possible to substitute fossil fuel by mixing it with renewable organic material (biofuel). As follow-up of this legislation MHE and the state-owned oil and gas company *Yacimientos Petrolíferos Fiscales Bolivianos* (YPFB) developed an ambitious plan to start producing biodiesel by the year 2025. The aim is to produce sufficient biodiesel to substitute about 40% of the diesel import in 2019, which was about 1.2 million ton. Bolivia's biodiesel program is mainly aimed at reducing the costs of diesel import and subsidies as well as increasing agricultural employment opportunities and new income generating activities to small and medium farmers by producing biofuel crops.

The biodiesel program is based on using two refinery technologies, i.e., HVO (Hydrotreated Vegetable Oil) and FAME (Fatty Acid Methyl Ester). The latter is a relatively simple technology based on the transesterification of vegetable oils, animal fats or used cooking oils with methanol resulting in diesel. HVO is based on a more complex process than FAME and is produced via hydro-treatment of oils and fats. The resulting renewable biodiesel has properties that are superior to those of FAME, such as reduced NOx emission, better storage stability, and better cold flow properties. Another advantage is that HVO can also be used as jet fuel opening the opportunity to export sustainable aircraft fuels which should have a market in many countries including the EU where a demand for these fuels is being created under new legislation.

To supply the biodiesel refineries large quantities of oil-rich feedstock are needed. The availability of the feedstock is the most uncertain factor in the biodiesel program and its sustainable supply is a big concern of MHE and YPFB. The current strategy of MHE and YPFB focusses on two potential feedstocks: i) Residues, i.e., used cooking oils (UCO) and rendered animal fats, and ii) locally produced vegetable oils. Based on the available information collected during the mission, the residue option can only provide less than 10% of the total feedstock needs. The majority of feedstock should be supplied by locally produced oil crops. Although many oil crops were mentioned by stakeholders during the mission, information and knowledge, for example on yields and oil content of crop options under the agro-climatic conditions prevailing in Bolivia are lacking (e.g., for African oil palm, *Totai* and *Pongamia*). For soybean, - the most important oil crop grown in Bolivia -, much more information and knowledge are available. However, soybean is a capital-intensive crop as it is highly mechanised and input demanding, which conflicts with one of the major goals of the biodiesel program, i.e., to provide new income generating activities to small and medium farmers. To assess the suitability and feasibility of the various crop options as feedstock an integrated assessment is needed considering the economic, social and environmental objectives of the biodiesel program in Bolivia.

Globally, replacing fossil fuels with biofuels is considered as one of the options to reduce undesirable aspects of fossil fuel production and use, especially greenhouse gas (GHG) emission. Maybe because Bolivia's position on climate change and emission calculations does not align with the dominant global carbon market policy on combatting Climate Change in the UN, the potential GHG mitigating effect of biodiesel is almost not present in the national debate on biofuels. The potential of biodiesel in combatting GHG emissions plays a minor role in governmental policies and was also little mentioned in meetings with stakeholders from both the private sector and civil society during the fact-finding mission. This poses the risk that feedstock production needed for producing biodiesel will be counterproductive with respect to the globally agreed GHG emission reduction goals at the COP 21 of

in Paris, i.e., the production of feedstock for biodiesel could increase GHG emissions instead of reducing them. Bolivia's updated NDC plan has still not been published and the role of the biodiesel program in the plan is not clear.

The productivity of currently cultivated oil crops (soybean, sunflower and groundnut) is relatively low compared to surrounding countries such as Brazil and Argentina. Causes of the lacking productivity are poorly understood but sustainable intensification of these crops is a no regret option to increase the feedstock supply. In addition, it contributes to overall improvements of the resource use efficiency including low GHG emissions per unit of vegetable oil produced. Other options to increase the feedstock supply should be based on a well thought over area expansion of oil crops. Although national land use statistics are not conclusive, large areas of temporary fallow land (in Bolivia this land is known as *barbecho*) and more permanent abandoned agricultural land (known as *tierras en descanso*) are available where oil crops can be produced with a relatively low impact or even a positive impact on the GHG emissions. In addition, large areas with pastures are available of which the low productive areas also potentially are feasible for producing oil crops. Further study is needed to assess the suitability of land with low GHG emission potential in relation to the oil crop(s) to be grown.

Based on the available information collected during the fact-finding mission it is concluded that the production target set in the biodiesel program for 2025 is ambitious and difficult to realize without intervening in the current export market of soybean (oil) and risking GHG emissions elsewhere. Considering the many knowledge questions related to the feedstock production and supply chain of other crop options it is more rational to start on a limited scale with producing biodiesel. This would justify the production of FAME biodiesel, which is a simpler refinery process and requires considerably less investments than the production of HVO. A slower but more cautious and gradual development pathway of the biodiesel program will allow to experiment with sourcing currently available feedstocks and producing feedstocks that have potential to contribute to the required feedstock in the (mid-term) future. Alternative crops of which the majority are perennial oil crops need to be assessed and evaluated carefully before start growing them at a wide scale. They need to be assessed considering the economic, social and environmental objectives of the biodiesel program in Bolivia including the explicit attention for the needs of small and medium-sized producers. Subsequently, the most promising crops need to be tested in those locations that have the greatest potential from different perspectives.

Furthermore, the report identifies various biofuel-related topics in which public and private sector of the Netherlands can cooperate with Bolivia. Some of the topics go beyond the biodiesel program itself and address alternative solutions to the high costs of Bolivia's current diesel policy, the main driver of the biodiesel program. Such solutions include development of energy saving strategies and switching to other alternative energy solutions, such as photovoltaics, wind, and biogas, all with huge potential in Bolivia considering the size of the country and its climatological and geographical characteristics.

1 Introduction

The Plurinational State of Bolivia imports large quantities of fossil diesel oil, 1.25 million ton in 2019, which represented a value of US$ 913 million (Figure 1). In 2019, the transport sector (86.5%) was the largest user of diesel oil followed by the agriculture and mining sector (7.5%), construction (4.8%) and industry sector (1.1%) [1]. Depending on the international oil price, the import of diesel oil imposes a large burden on the needs for foreign exchange of Bolivia and is expected to increase the coming decade as diesel oil is a vital part of the Bolivian economy. In addition, fossil fuels including diesel oil are subsidized to remain stable independent from international oil prices. An estimated 40% of the real cost of diesel is subsidized (Laserna, 2018), but the subsidy varies with the international oil price as domestic prices are fixed. In addition to the cost of importing and distributing diesel oil, the use of fossil diesel oil is associated with large emissions of greenhouse gasses (GHG), including CO_2, and sulphur dioxide which is a strong air pollutant.

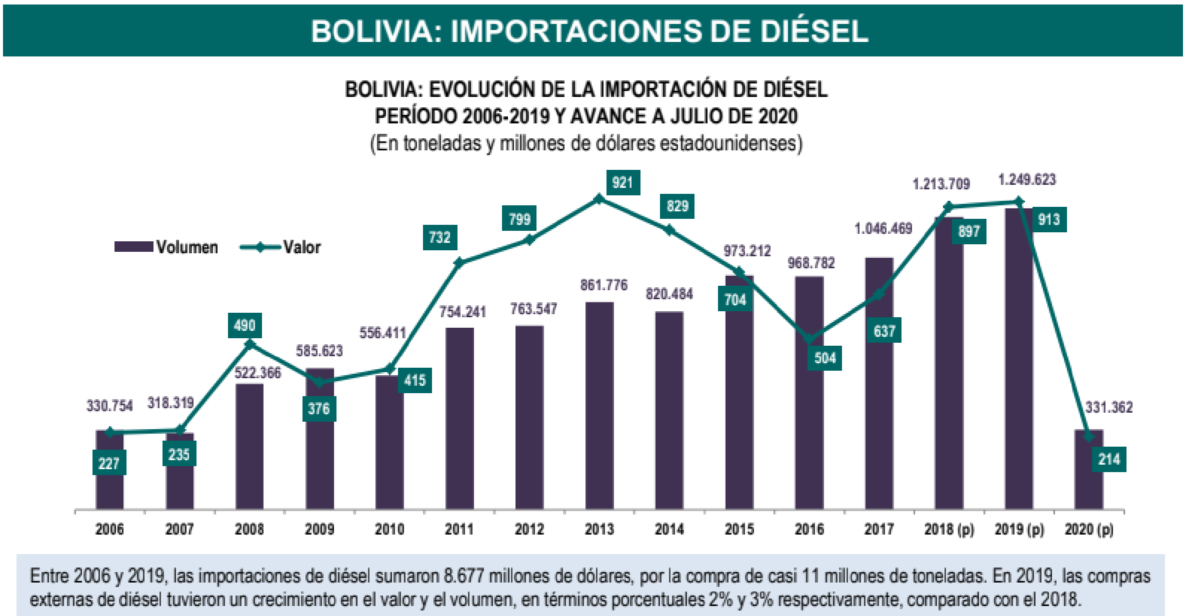

Figure 1 The import of diesel in volume (stacks) and economic value (green line) between 2006 and the first half of 2020. Source: Instituto Boliviano de Comercio Exterior (https://ibce.org.bo/publicaciones-ibcecifras-pdf.php?id=859 ;accessed November 14, 2021).

In 2018, national legislation (Ley 1098) was approved that made the production, storage, marketing and mixing of renewable organic material possible for the purpose of gradually replacing imports and of supplies and additives, and fossil-based diesel oil. Energy production and distribution in Bolivia is governed by the *Ministerio de Hidrocarburos y Energías* (MHE) and the state-owned oil and gas company *Yacimientos Petrolíferos Fiscales Bolivianos* (YPFB). MHE oversees the implementation of various biofuel programs including bioethanol and biodiesel. The government of Bolivia considers the introduction of biofuels as a policy measure to reduce the costly import of fossil fuels, and especially the subsidies it must pay. Another important objective of the biodiesel program is to stimulate rural and agricultural development by offering 60,000-day labourers and small and medium farmers an opportunity to tap into new sources of income [2]. Furthermore, the biodiesel program of the MHE

[1] Source: https://ibce.org.bo/publicaciones-ibcecifras-pdf.php?id=906 [accessed December 22, 2021]
[2] Source: http://www.endecorani.bo/images/transparencia/INFORME-RPCI-2021_17_05_2021.pdf [accessed December 22, 2021]

should contribute to Bolivia's commitment to the Paris Agreement of the COP 21 in 2015 on climate change[3] [4].

To develop an economically viable biodiesel sector the supply of sufficient feedstock is crucial. Large amounts of vegetable oil from crops and residues are needed to produce biodiesel cost-effectively. The socio-economic, technical and environmental feasibility of these feedstocks is uncertain and needs further analysis and assessment. Some of the socio-economic, technical and environmental questions that emerge are:

- What oil crops are potentially suitable to be grown or what oil-rich plants or plant parts can be collected from the wild and in which part of Bolivia? And what options exist to increase the production or collection of these oil crops/products, i.e., through land expansion, improving current crop productivity, recovering abandoned agriculture areas or a combination of these?
- What are the (potential) environmental effects associated with land expansion (e.g., deforestation, biodiversity loss, increased water use) and increasing crop productivity (e.g., emissions of fertilizer nutrients and pesticides to the atmosphere, soil and water) to improve the availability of vegetable oil feedstocks in Bolivia?
- What are direct and indirect effects of producing oil crops on the greenhouse gas (GHG) balance of Bolivia?
- How does the expansion of the agriculture area to produce oil crops affect indigenous communities?
- Can oil crops be cultivated on abandoned agricultural land and which oil crops can recover degraded (agriculture) land. What are the requirements and conditions?
- And how does a change in waste flows of used oils and animal fats as possible feedstock affect the livelihoods of those that depend currently on these flows?
- How could the production and collection of vegetable oil and fats provide a real opportunity for small and medium sized farmers and indigenous people to increase their income?

In short, the aim to produce biodiesel raises a great number of questions that need further assessment and will affect various types of stakeholders. Directly it will affect individual farmers and organized agricultural producers and other value chain stakeholders, and indirectly the local communities living in and nearby the area where feedstock is growing or will be produced. Understanding the agro-energy-climate trade-offs and an inventory of stakeholders directly involved in the biodiesel program and those that are (in)directly affected by the program is needed for proper accountability and to design support and preventive and mitigation measures. Such an assessment and stakeholder mapping are important for the Dutch embassy in Lima within its multi-annual plan that includes climate change with focus on sustainable (non-fossil) energy as a strategic topic for 2022-2025.

Therefore, a fact-finding mission to Bolivia was organised at the end of 2021 to study the key questions and considerations that need to be addressed to ensure the sustainable production of biodiesel in Bolivia. The fact-finding mission collected crucial information to enable the preparation of recommendations that will be useful for the embassy to define how, with which partners and with what approach the Dutch knowledge, innovation strength and expertise can support the Bolivian partners with implementation of the biodiesel program while preventing or mitigating any potential negative effect on climate, forestry, biodiversity, water resources and the local economy of agricultural producers.

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[4] Sources: https://www.facebook.com/Yacimientos/videos/220758266872829/?__so__=channel_tab&__rv__=all_videos_card and https://www.facebook.com/Yacimientos/videos/621730092481772/?__so__=channel_tab&__rv__=all_videos_card [accessed January 5, 2022]

1.1 Objectives of study

The purpose of the study, within the agro-energy-climate nexus to Bolivia is to gain insight into the feasibility and sustainability of the biodiesel program of MHE and the state-owned program implementing oil and gas company YPFB. In addition, the study will:

i) assess options for setting up a sustainable vegetable oil and fats supply for biodiesel production and the potential consequences on the environment and agri-food sector;

ii) map relevant stakeholders involved in or affected by this development; and

iii) identify opportunities for the public and private sector of the Netherlands and Bolivia to support this development.

1.2 Approach and activities

This report is based on a desk research and a fact-finding mission to Bolivia. The desk study was used to collect information and reference material to identify knowledge questions to be addressed during the mission to Bolivia.

The mission of three WUR staff took place at the end of November / beginning of December 2021. The first two authors of the report stayed for one week in the city Santa Cruz de la Sierra, the center of Bolivia's major agricultural production region and where the main office of YPFB is located. The third author stayed for more than two weeks and also visited other places enabling to meet with stakeholders from other parts of Bolivia, including governmental ministries in the capital La Paz that are involved in the biodiesel program. During the mission a great number of meetings were organized with stakeholders from both the public and private sector as well as civil society. See Annex I for the mission program and the stakeholders that have been met during the mission.

On December 3, the authors participated in the '*Foro de Biocombustibles*' organized by MHE to share insights of the mission with stakeholders and to address key issues for a successful implementation of the biodiesel program in Bolivia. The program of the '*Foro de Biocombustibles*' is available in Annex II and the presentation of the authors in Annex III.

1.3 General information on Bolivia

Bolivia, officially named the Plurinational State of Bolivia, is a landlocked country located in western-central South America. Its geography varies from the peaks of the Andes in the West, to the Eastern Lowlands, situated within the Amazon basin. Officially the capital of Bolivia is Sucre, but the political center and the seat of the legislative and executive government is La Paz, both cities are in the highlands of the Andes Mountain chain. The largest city and principal industrial center of Bolivia is Santa Cruz de la Sierra (estimated 1.7 million inhabitants in 2017), which is in the tropical lowlands (savannah), the mostly flat region in the east of the country (Figure 2).

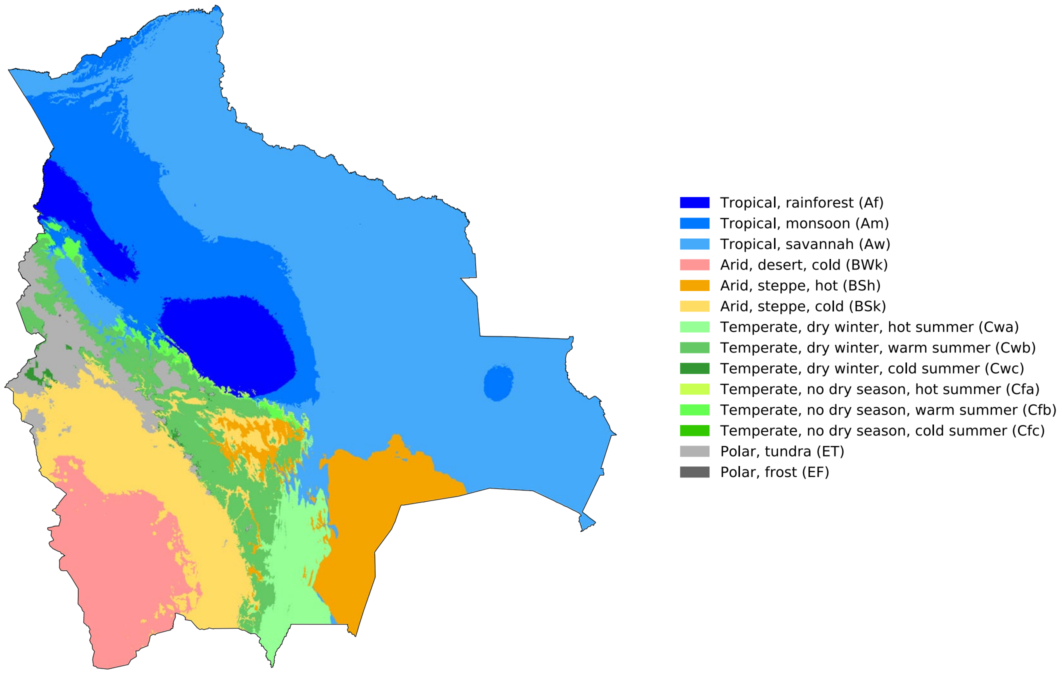

Figure 2 *Köppen-Geiger climate classification of Bolivia. Source: https://commons.wikimedia.org/w/index.php?curid=74673034 ;accessed December 1, 2021.*

Associated with the elevation, climate conditions differ widely across Bolivia. The annual average temperature in Santa Cruz de la Sierra, the capital of the main agricultural production area for soybean and livestock, is 23 °C and the annual rainfall is about 1200 mm, with a distinct wet season from November to April in which rainfed agricultural production takes place (Figure 3).

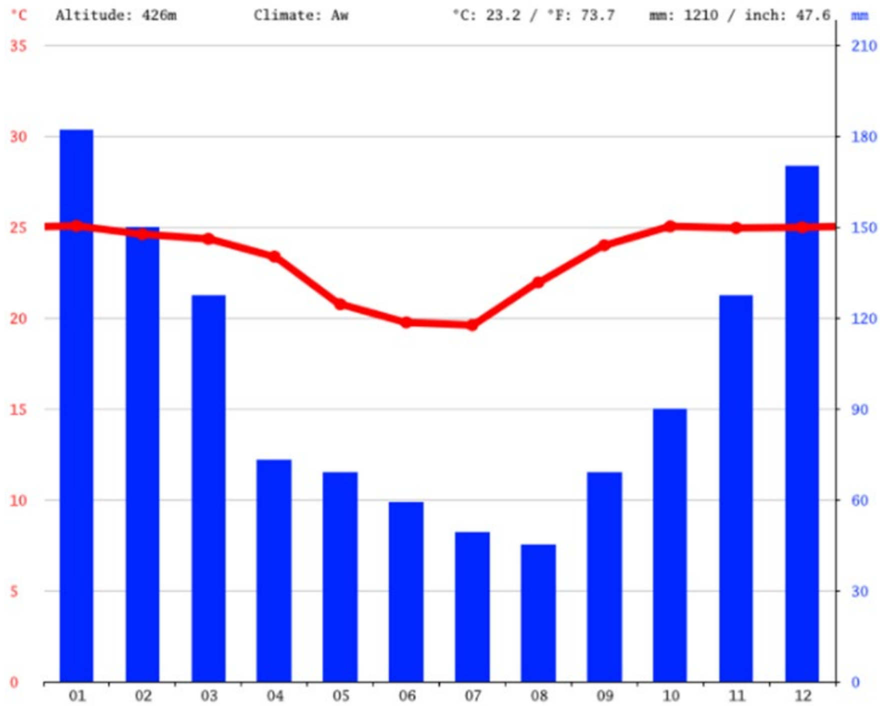

Figure 3 *Average monthly temperature (red line) and rainfall (blue bars) in Santa Cruz de la Sierra. Source: https://en.climate-data.org/ ; accessed December 1, 2021.*

The land area of Bolivia is roughly 110 million ha, about 25 times larger than the Netherlands (4.2 million ha). Recent, accurate land use statistics are lacking, but FAOSTAT estimates that in 2019 about 47% of the land was under forest. The agricultural area is dominated by extensive pastures and meadows, about 90% of the agricultural area, and the remaining is 4.8 million ha is under annual and permanent crops (Table 1). There is also a considerable category of *other land*, about 18% of the total land area, which is not further categorized but may include temporary fallow land (in Bolivia this land is known as *barbecho*) and more permanent abandoned agricultural land in various stages of secondary forest development (known as *tierras en descanso*). In the census of 2013 these two categories (*barbecho* < 1 year and *tierras en descanso* > 1 year) counted a total amount of 2,7 million ha. During the fact-finding mission, some stakeholders estimated the area with *barbecho* at 5 million ha indicating the uncertainty in the national statistical data.

Table 1 Major land use types in 2019 based on estimates of FAOSTAT. (source: https://www.fao.org/faostat/en/#data ; accessed December 1, 2021).

Land use	1000 ha
Land area	108,330
Agricultural land	37,787
Arable land	4,540
Land under permanent crops	247
Land under perm. meadows and pastures	33,000
Forest land	51,034
Other land	19,509

Bolivia has had the fastest growing economy in South America after Peru over the last five years mainly because of its revenues from natural gas and subsequence increase in public investments (Figure 4). Gas reserves are depleting and revenues from gas export are decreasing [5].

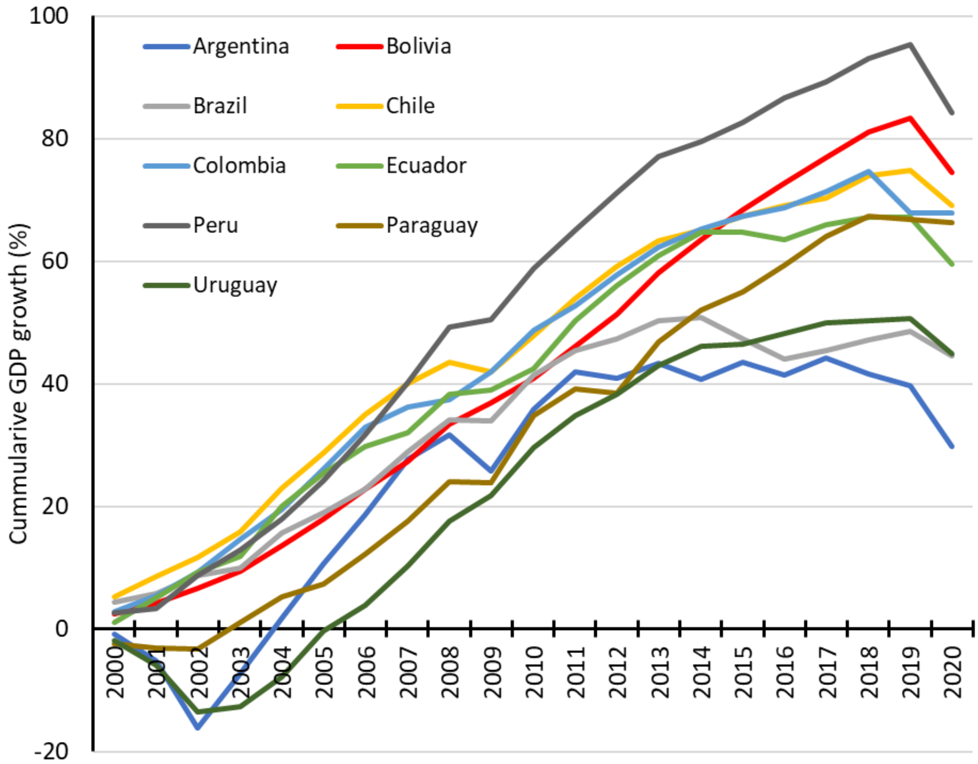

Figure 4 Cumulative GDP growth (%) over the period 2000-2021 for major economies in South America based on World Bank data. Source: https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=ZJ [visited January 5, 2022].

[5] Source: https://www.ine.gob.bo/index.php/estadisticas-economicas/comercio-exterior/cuadros-estadisticos-exportaciones/ [accessed January 5, 2022]

2 General issues and trade-offs in the biofuel debate

Replacing fossil fuels with biofuels— fuels produced from renewable organic material —has the potential to reduce greenhouse gas (GHG) emissions associated with fossil fuel production and use [6]. However, because biofuel feedstocks require land, water, and other resources, biofuels may result in undesirable effects including land use changes that may increase GHG emissions, pressure on water resources, air and water pollution, and food costs (e.g. Farrell & Brandt, 2006; Hill et al., 2006; Searchinger et al., 2008). Globally, the debate on biofuels centers on a number of these undesirable effects:

- The food versus fuel debate deals with the risk of diverting farmland currently used for food production for the production of biofuels that could affect the food supply, food prices and endanger food security. The use of bioenergy crops that are not suitable for human consumption could reduce the competition between food and fuel.
- Land use conversion for producing biofuel crops. This includes direct land use change (dLUC), e.g., forest land that is converted into land for producing biofuel crops, and indirect land use change (iLUC) induced by the expansion of cropland for biofuel production, e.g., the production of biofuel on existing crop land in one place can trigger land use conversion (e.g., deforestation) for cropland somewhere else. Both types of land use conversion, dLUC and iLUC, could lead to undesired biodiversity loss, loss of carbon stocks and could reduce or even more than neutralize net positive GHG mitigation impacts of biofuels.
- The production of biofuels requires energy such as for (mechanized) soil tillage, the production and application of pesticides and artificial fertilizers, and transport. Hence, the net positive GHG mitigation impacts of producing and using biofuels could be small (Melillo et al., 2009).

The second point above, the potential negative effect of land use conversion on biodiversity loss and GHG emission balance is especially of concern because the production of bioenergy crops requires large areas of land while one of the main motives to substitute fossil fuels with biofuels is to reduce GHG emissions. Natural ecosystems to be used for biofuel production can be major stocks of carbon stored in the soil and vegetation. Bioenergy crops could increase net GHG emissions as a result of converting such natural ecosystems into bioenergy plantations, potentially undoing the benefit of bioenergy (Searchinger et al., 2008). Therefore, the GHG mitigation potential of bioenergy crops depends on the location, land source and crop yields for newly expanding feedstock. The location and land source determine the amount of carbon stored in natural ecosystems, the carbon storage potential of bioenergy crops, and the energy yield of bioenergy crops (Gibbs et al., 2008).

The carbon payback time is a measure to compare the carbon loss of different ecosystems, net gain of bioenergy crops and avoided fossil fuel emissions from these bioenergy crops; The carbon payback time is the number of years required for avoided fossil fuel emissions from biofuels to compensate for losses in ecosystem carbon stocks during land conversion (Gibbs et al., 2008). Figure 5 illustrates the payback time for different bioenergy crops and tropical ecosystems.

[6] Source: https://www.epa.gov/environmental-economics/economics-biofuels [accessed December 22, 2021]

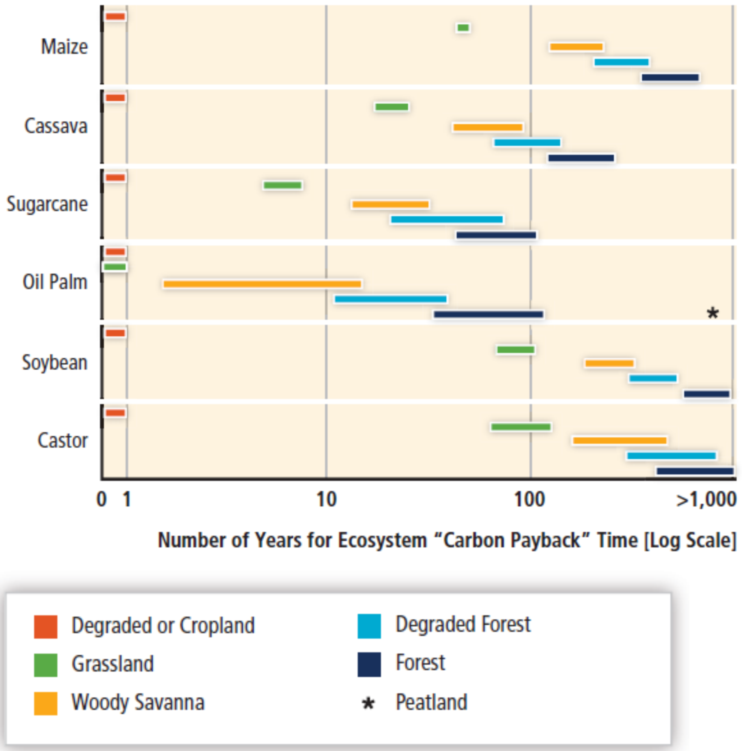

Figure 5 *The ecosystem carbon payback time for potential biofuel crop expansion pathways across the tropics comparing agricultural system yields around the year 2000. The GHG emissions associated with production and distribution of the transport fuels are neglected in these data. The asterisk represents oil palm crops grown in peatlands with payback times greater than 900 years. (Source:* Chum et al., 2012).

Main conclusions from Figure 5 are that:

- Biofuel expansion into carbon rich natural tropical ecosystems such as forests will lead to net carbon emissions for decades to centuries in most cases. Expansion of feedstocks into tropical forests will lead to net carbon emissions for ~40–120 years with the most productive biofuel crops, and for ~300–1500 years with lower yielding biofuel crops, such as maize and soybeans.
- Substantial carbon benefits after one year are possible from expanding bioenergy crops into already degraded lands or, if yields are increased, on existing land.

Obviously, replacing other arable crops with bioenergy crops may also yield carbon savings provided these croplands are not displaced into tropical ecosystems elsewhere resulting in iLUC and associated carbon losses. In addition, future carbon payback times could be reduced with higher yields of the bioenergy crops as assumed in Figure 5. Increasing the productivity of existing oil crops in a sustainable way is a no-regret options as it will result in overall improved resource use efficiency and lower GHG emissions per unit of vegetable oil produced.

Unclear from Figure 5 is how the potential by-products of biofuel crops has been accounted for, i.e., during the processing of most biofuel crops a protein-rich by-product is produced that can be used as animal feed (Popp et al., 2016). On the one hand, this by-product of oil crops could reduce the pay-back time as it would avoid its production elsewhere. On the other hand, Figure 5 is an underestimation of the real payback time because GHG emissions associated with the production and distribution of the transport fuels have been neglected.

In general, one may conclude that the production location of biofuel crops is crucial if the biodiesel program of MHE and YPFB wants to result in net carbon savings and contribute to reducing GHG emissions. Conversion of forests and other carbon-rich vegetations for the production of biofuel crops will not result in net carbon savings and reduced GHG emissions. From a GHG emission point of view it is rational to focus first on increasing the productivity of currently vegetable oils produced in Bolivia[7].

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[7] See for an overview of WUR research projects and publications on palm oil: https://perennialcrops.wur.nl/index.php/oil-palm [accessed January, 2022].

3 Situation analysis

3.1 The biodiesel program

The biodiesel program of the Ministry of Hydrocarbons and Energy of Bolivia was launched in 2018 with the approved national legislation (Ley 1098). The program is based on two technologies to produce biodiesel: HVO (Hydrotreated Vegetable Oil) and FAME (Fatty Acid Methyl Ester). The latter is a relatively simple technology based on the transesterification of vegetable oils, animal fats or used cooking oils with methanol resulting in diesel. The use of FAME biodiesel as a low-blend component in transport fuel (up to 7% in Europe) does not require extensive changes in the distribution system, therefore avoiding expensive infrastructure changes [8]. However, FAME can only replace up to 10 or 20% of diesel and some older cars require upgrades to use FAME. A byproduct of FAME production is glycerol, which after purification can be used for feed or in the food and cosmetic industries, as well as in the oleochemical industry. Glycerol is sometimes also used as a substrate for anaerobic digestion.

HVO is based on a more complex process than FAME and is produced via hydro-treatment of oils and fats. The resulting renewable biodiesel has properties that are superior to those of FAME, such as reduced NOx emission, better storage stability, and better cold flow properties. Contrary to FAME, HVO can be made from any oil or fat. HVO can be used in all diesel engines. It can also be refined to produce a (bio) jet fuel opening the opportunity to export sustainable aircraft fuels which are expected to have a great market potential in many countries, including the EU where a demand is being created under new legislation. HVO production requires a more costly refinery process compared to FAME. The total capacity of the HVO refinery in Bolivia's biodiesel program is aimed at 450,000 MT per year and the FAME refinery at 170,000 MT per year (as stated in November 2021). The amount of biodiesel produced, HVO and FAME together, would be able to substitute about 40% of the diesel import in 2019, which was about 1.2 million ton (Figure 1).

YPFB has formulated various tenders for the design and construction of the FAME and HVO refineries, while also a tender is in preparation for a study concerning the sourcing of oil-rich feedstock to supply both refineries. The planning for biodiesel program is ambitious and scheduled to start in 2025. According to information of YPFB (from August 2021), 405,000 MT of biodiesel could be produced in 2025 using a combination of nationally produced feedstocks, including oil palm, jatropha, *totai* and soybean. Oil palm and jatropha are not yet grown at a large scale in Bolivia, and the production potential of both crops still need to be proven. In addition, oil palm and jatropha need at least a 4-year lead time before starting to produce. Therefore, a very fast startup using these two crops is not possible. *Totai* is a native palm growing abundantly in the wild in Bolivia but not in a plantation form. Soybean is the most important annual oil crop currently grown in Bolivia (Chapter 3).

Because of the various interfaces of the biodiesel program with agriculture and the environment recently an inter-ministerial committee has been established by MHE to oversee and coordinate the program. In addition to MHE, the committee consists of representatives of the *Ministerio de Desarrollo Rural y Tierras* (Ministry of Rural development & Land), *Ministerio de Medio Ambiente y Agua* (Ministry of Environment & Water), and *Ministerio de Planificacion del Desarrollo* (Ministry of Productive Development and Plural Economy). This inter-ministerial committee aims to coordinate and improve the coherence in policies and actions to support the biodiesel program.

Bolivia's biodiesel program is mainly aimed at reducing the costs of diesel import and subsidies as well as increasing agricultural employment opportunities and new income generating activities to small and medium farmers by producing biofuel crops. Based on the carbon payback time analyses of a number of ecosystems and crops shown in Figure 5 it is clear that expansion of feedstock into new areas (ecosystems) should be done very carefully if biofuel production wants to contribute to net GHG

[8] Source: https://www.etipbioenergy.eu/ [accessed December 5, 2021]

emission savings. This is also important if Bolivia has the intention to export its HVO, for which there is a high global demand. The minister expressed in the Foro on Biodiesel that this global demand represents opportunities for Bolivia [9]. Recently, the EU and USA have developed strict sustainability criteria including the origin of biofuel and its production method. For example, the EU does not allow the import of biofuels from ecosystems that contain large carbon stocks such as forests, grasslands, and peatlands (EU Directive 2018/2001).

Bolivia opposes the global carbon budgets policy of the UN and developed countries (section 3.2). These carbon markets offer GHG emitting countries the possibility to pay for carbon emissions to be reduced in a second country (e.g., Bolivia); the first country can count those reductions towards its own national targets. Maybe because Bolivia's position on climate change and carbon offsetting programs does not align with the dominant global carbon market policy on combatting Climate Change in the UN, the potential GHG mitigating effect of biodiesel is not very prominent in the national debate on biofuels.

Against this background Bolivia has developed its biodiesel program, that specifically aims at reducing the costly imports and subsidies of fossil diesel, while at the same time providing opportunities for agricultural development and income generating activities for small and medium farmers. The potential of biodiesel in combatting GHG emissions plays a minor role in governmental policies and was also little mentioned in meetings with stakeholders during the fact-finding mission.

3.2 Bolivia's policy on combatting climate change

In the framework of COP 21 in Paris, Bolivia presented its intended National Determined Contribution (iNDC) [10]. At the time of ratifying the Paris Agreement in 2016, the iNDC became the Nationally Determined Contribution, assuming Bolivia to face the climate crisis by setting goals for the year 2030 in three priority sectors: water, energy, and forests and agriculture. As a legal reference, the Bolivian NDC takes the Political Constitution of the State as the basis with some specific laws (law on Rights of Mother Earth and the Law of Mother Earth and for Living well). The goals of the NDC are aligned with the pillars, goals and anticipated results of the National Plan for Economic and Social Development for the period 2016-2020.

In its NDC Bolivia proposes the **Climate Justice Index** for an equative and fair distribution of the Global Emissions budget based on historical indicators (accumulation of emission per country from 1750-2010), the ecological footprint and the capacity of development and capacity of technology of a country.

Specifically, Bolivia's NDC objectives for the forest and agriculture sector is:
- "Zero" illegal deforestation by 2020.
- The area of forested and reforested areas has increased to 4.5 million hectares by 2030.
- Forest areas with integral and sustainable management with a community focus have increased to 16.9 million hectares by 2030, compared to 3.1 million hectares in 2010.
- Environmental functions (carbon capture and storage, organic matter and soil fertility, biodiversity conservation and water availability) have been strengthened in approximately 29 million hectares by 2030.
- It has contributed to the increase in the Gross Domestic Product (GDP) to 5.4% in 2030, favored by agricultural and agroforestry production in a complementary way with the conservation.
- Extreme poverty of the population that depends on forests, approximately 350 thousand people in 2010, has been reduced to zero in 2025.
- By 2030, the net coverage of forests has increased to more than 54 million hectares, compared to 52.5 million in 2010.

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[9] Source: https://correodelsur.com/economia/20211205_el-diesel-renovable-representa-oportunidades-de-exportacion.html [accessed January 28, 2022]

[10] Source: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Bolivia%20(Plurinational%20State%20of)%20First/INDC-Bolivia-english.pdf [accessed November 12, 2021]

- The joint mitigation and adaptation capacity of the areas included in the forests and agricultural and forestry systems has been increased from 0.35 units in 2010 to 0.78 units in 2030, measured by the National Index of Sustainable Forest Life, achieving systems productive and complementary and resilient conservation.

The NDC objective for the Energy sector is to 'Increase electricity generation capacity through renewable energies for local and regional development' with the following targets:
- The share of renewable energies has increased to 79% by 2030 compared to 39% in 2010.
- It has been possible to increase the participation of alternative energies and other energies from 2% in 2010 to 9% in 2030 in the total electricity system, which implies an increase of 1,228 MW by 2030, compared to 31 MW in 2010
- The electricity sector has increased to 13,387 MW by 2030, compared to 1,625 MW in 2010.
- The Unsatisfied Basic Needs for electricity coverage have been reduced from 14.6% in 2010 to 3% in 2025.
- The export potential of electricity has been developed, generated mainly by renewable energies, reaching an estimated 8,930 MW to export in 2030, increasing the State's energy income.
- Moderate poverty has been reduced to 13.4% by 2030 and extreme poverty eradicated by 2025, due to the impact of energy generation and coverage, among others, including the increase, distribution and redistribution of energy income.
- Contribution to the growth of Gross Domestic Product (GDP) to 5.4% in 2030 due to the impact of the energy sector.

The institutional structure for the implementation of the NDC and specifically the *Plan de Desarrollo Economico y Social* (PDES) lies in the Interinstitutional committee formed by seven Ministries headed by the Ministry of Planning and Development and supported by the National Statistics Institute (INE).

A recent analysis of the implementation of Bolivia's NDC plan showed moderate progress in the water and energy sector and the need to rethink and specify actions, goals and indicators for the forest sector and agricultural production (Cristián Retamal & Gutiérrez, 2020). The state prioritized food security over environmental management which promoted the agriculture expansion in the lowlands at the expense of forests. This places Bolivia in controversial situation regarding its commitments to achieving climate goals as prioritized in the NDC (Cristián Retamal & Gutiérrez, 2020). The role of the biodiesel program in the NDC is unknown as the moment of writing this report the revised NDC was in its final stage.

In the run-up to the 26th UN Climate Change Conference in Glasgow Bolivia started to revise its NDC, which needs to be updated each five years. At the time of the conference in Glasgow and at the time of writing this report the revised NDC of Bolivia was not available yet. In Glasgow, Bolivia joined and leaded Like-Minded Developing Countries (including India) in their attempt to change the context of the provision of finance under the Paris Agreement and holding strong to its position to apply the **Climate Justice Index** based on principals of equity and common but differentiated responsibilities (recognizing historical responsibility of developed countries and compensating climate-vulnerable developing countries on loss and damage). In an article with the newspaper the Guardian the spokesman explains: "*We reject the narrative that the market is the solution. We want to focus on strengthening direct cooperation from developed countries to developing countries. They only want to talk about loans, but we want direct aid and the transfer of knowledge and technologies. They don't want to discuss loss and damage, only mitigation through forests which will serve as an instrument for carbon credits*." [11]
Bolivian's position in Glasgow is controversial as national legislation in the past years has let to deforestation and conversion of forest to agriculture land under the pretext of agriculture development / expansion making Bolivia the second largest country in South America that contributes to deforestation rates in Latin America in 2020 [12].

[11] Source: https://www.bbc.com/mundo/noticias-59241453 [Accessed January 6, 2022]
[12] Source: https://research.wri.org/gfr/forest-pulse?utm_medium=media&utm_source=article&utm_campaign=globalforestreview [accessed January 28, 2022]

The expected update of Bolivia's NDC should promote alignment and integration of the current National Plan for Economic and Social Development 2021-2025. This current National Plan "*Rebuilding the Economy to Live Well, Towards Industrialization with Import Substitution*" follows earlier policies of the MAS aimed at greater sovereignty in several sectors among others food and energy. The plan assumes the international commitment to the Peoples of the World to preserve the integrity of Mother Earth, being a Party to the Paris Agreement. Nevertheless, no further mentioning or reference of the NDC of Bolivia is made [13]. Of the 10 axes of the Plan, one is worth mentioning in the context of this report which is the policy line 2.1 "*Promote new industries of strategic products focused on substitution of imports that allow to reduce our dependency on external production (imports)"*. Under this line the development of renewable diesel (HVO), biodiesel and synthetic diesel for import substitution is mentioned with a target of having at least two plants producing annually 723.4 MT, which would substitute 43% of the fossil diesel imports (MPD, 2021).

3.3 Potential sources for producing biofuel

MHE and YPFB aim at using two flows of feedstock to supply the biodiesel refineries, i) Residues, i.e., used cooking oils (UCO) and rendered animal fats, and ii) locally produced vegetable oils.

According to information of MHE from August 2021, the amount of feedstock that can be supplied through the collection of used vegetable oils and animal fats in Bolivia is estimated at about 36,000 MT, i.e., about 11,000 MT from UCO and 25,000 MT from rendered animal fat. This could supply in total about 8% of the feedstock needed for the HVO refinery. Currently, two rendering companies operate in Bolivia that processes offal from ruminants, poultry and pork slaughtering. FRIDOSA, a meat processing company in Santa Cruz de la Sierra that was visited during the fact-finding mission, estimated that about 5 kg of fat per processed animal (cattle) is available. With about 1.4 million processed ruminants per year about 6,000 MT is available from ruminants only. FRIDOSA did not know about the number of processed poultry and pork, but YPFB's estimate of 25,000 MT rendered animal fat is in the high range of what in practice is available and can be collected cost-effectively in Bolivia. Currently, offal collected from FRIDOSA is used for the soap industry and animal (non-ruminant) feed industry.

Considering the small amounts of UCO and animal fats available for feedstock it is clear that the majority of the feedstock should be provided by vegetable oil crops. During the mission, stakeholders mentioned many crops that could be considered, ranging from crops that currently are already produced in Bolivia such as soybean, sunflower, and groundnut to a great number of alternative crops and native wild plants that are not yet produced as an agricultural crop at a wide scale (in Bolivia), including the African Oil palm (*Elaeis guineensis*), Jatropha (J*atropha curcas;* Figure 6), Castor bean (*Ricinus communis*), Pongamia (*Millettia pinnata*), Royal palm (*Roystonea regia*), Babassu or *Cusi* palm (*Attalea speciosa*), *Totai* palm *(Acrocomia totai*), Moringa (*Moringa oleifera*), Motacu (*Attalea phalerata*) and Rapeseed (*Brassica napus*). For many of these crops and plants important production characteristics such as yields and oil content under the various agro-climatic conditions prevailing in Bolivia are lacking. For some plants it is even unknown whether homogenic varieties exist and uniform and sufficient seed stock is available to plant large areas

[13] Source: http://www.planificacion.gob.bo/uploads/Presentacion_PDES_2021-2025.pdf [Accessed December 22, 2021]


Figure 6 Unripe Jatropha fruit.

Globally the major oil crops, African oil palm, soybean, rape seed and sunflower are also the major feedstocks used for producing biodiesel. However, many countries in Europe such as the Netherlands use mainly biodiesel produced from residues such as UCO, animal fat, fat from bleaching earth, tall oil, corn oil (a by-product from corn ethanol production) and other more exotic oil and fat containing residues. Many of these residues are sourced from far away.

To assess the suitability and potential of the various crop options as feedstock, criteria need to be defined considering the economic, social and environmental objectives of the biodiesel program in Bolivia (Chapter 1). Subsequently, these criteria need to be used to evaluate spatially explicit each crop option within the prevailing agro-ecological conditions and current ecosystem of a given potential production location of feedstock.

Economic criteria include, for example:
- Production costs per hectare.
- Production costs per kg produced oil.
- The extent of suitable land for a crop.
- Properties of the oil for biodiesel.

Social criteria include, for example:
- Requirements of qualified labor.
- Labor productivity (net returns per working day).
- Technology/knowledge needs and capacity/skills of producers.
- Suitability for small or large producers (e.g., level of mechanization needed).

Environmental criteria include, for example:
- Capacity to capture carbon.
- Effect of the crop cultivation on biodiversity.
- Effect of the crop cultivation on deforestation.
- Effect of the crop cultivation on GHG emissions.

Although the focus of identifying a proper feedstock supply will be on oil-rich biomass, the production of oil-rich crops offers additional opportunities and risks. Perennial oil crops offer opportunities for intercropping with annual crops in the first plantation years when resource competition with the growing oil crop is still limited. In later stages of such plantations, the perennial crops offer options for integrating crop and livestock production in silvopastoral systems, for example cattle grazing between mature oil palms. Another opportunity is offered by the byproducts of many oil crops (after milling), which is a protein-rich cake or flour with high feeding value for animals. This provides opportunities for the export of nutritive animal feed or for the further intensification of the domestic livestock sector. In this context it is important to mention that 40-50% of soy producers in Bolivia are also cattle producers. After the harvest of the winter season cattle enter the fields to eat the crop stubbles. Increasing the soybean production (or other oil crops) will result in a higher availability of protein-rich animal feed, probably against a lower price than the current price level, which could benefit the chicken and pork industry. In addition, both intercropping and the production of animal feed potentially contribute to reducing the carbon payback time of biofuel production (Chapter 2).

An important risk of all crop options is the oversupply of markets with byproducts of oil crops and indirect increased agricultural production of non-oil crops associated with the expansion of the production area for oil crops. For example, soybean is commonly grown in Bolivia during the summer season (November-February), typically followed by a cereal crop (maize, wheat or sorghum) in the winter season (February-May). This means that expansion of the soybean area for biodiesel production may result in an expansion of the area and production of cereals. The amount of additionally produced cereals will need a market outlet without disturbing current market prices. During stakeholder interviews it was stated that currently not much land is cultivated in the winter because of the low profitability of cereals.

Last but not least, considering the long-term investments associated with the production and distribution of biofuels the performances of potential oil crops need to be assessed under changing climate conditions. It may well be that future temperature and rainfall regimes are less suitable for crops that show promising performances under prevailing climate conditions. But also the opposite may be true, i.e., crops that show poor performance under current climate conditions may show a better performance under expected climate conditions in the future.

4 Stakeholder mapping and analysis

The production of biodiesel touches upon various policy areas ranging from agriculture, environment, legal land ownership issues to the national finance of Bolivia. During the mission, we engaged with a great number of stakeholders from the public sector, private sector as well as civil society to gain insights in the diverging opinions about the biodiesel program. See Annex I for the list of stakeholders that have been interviewed during the mission.

An overall observation is that the stakeholders showed a certain degree of susceptibly about the governmental plans and the eventual role of the institutions and private actors mainly because they were poorly informed about the details of the biodiesel plans. The 'Foro de combustible' organized by MHE on December 3, 2021 at the end of the mission provided a first public platform on the biodiesel program with national and international guest speakers (Annex II). The platform offered the authors of this report the possibility to share first findings of the mission and recommendations (Annex III).

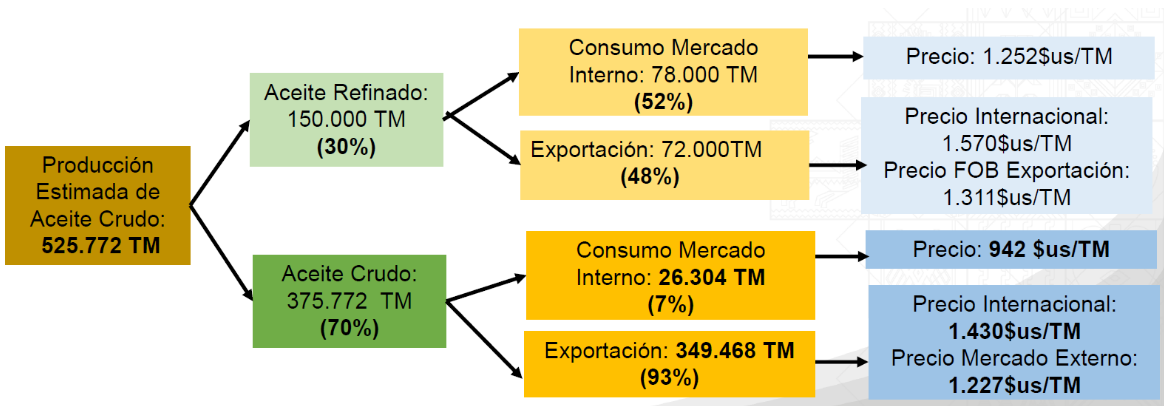
Main stakeholders from the **private sector** are the producers of the oil crops united in the *Asociación de productores de oleaginosas y trigo* (ANAPO) and the oil millers united in the *Cámara Nacional de Industria Oligeanosas de Bolivia* (CANIOB). Both are key partners in the vegetable oil supply chain to deliver sufficient feedstock to the biodiesel refineries (Figure 7). Smaller players in the oil feedstock supply chain are industrial meat processers such as FRIDOSA, the rendering companies and some pioneering entrepreneurs processing palm products like NATUR SRL (Freeze Drying amazon fruits), Organic Oils (*Cusi* oil) and Agroseller SRL (superfoods).

ANAPO represents the 18,000 oilseed and wheat producers of which about 80% are considered small producers (<50 ha). The majority of the soybean production (80%) is produced by the 20% large member producers. Currently, soybean is by far the most important oil crop grown for commercial purposes in Bolivia. About 35% of the arable land area is cultivated with soybean, in total 1.4 million ha of which just over 1 million ha in the summer season (November-March) and 0.3 million ha in the winter season (February - May) producing on average a total of 2.8 million tons of soy per year. The cultivated areas of sunflower and groundnut are much smaller with in total about 130,000 ha. Soybean productivity per hectare is low (2.2 ton/ha) compared with soy production in the neighboring countries Argentina and Brazil (3.8 and 3.5 ton/ha, respectively). According to the Tropical Agriculture Research Centre (CIAT) in Santa Cruz de la Sierra, the low productivity in Bolivia is associated with the predominant smaller producers and poor crop management. ANAPO gave as reason the ban on genetically modified soybean in Bolivia.

Figure 7 Typical soybean storages nearby Sant Cruz de la Sierra.

CANIOB represents six (of total nine) national oil crop millers that are important to process oil seeds, mostly soybeans. During the milling process of soybean, protein-rich soybean cake or flour is produced and soybean oil. The cake and flour are used as feed source in the livestock industry. The soybean oil is used for human consumption, but also other uses including biofuel (such as in Brazil). In contrast to Brazil, where soybean is mainly produced for the export of soybean cake, in Bolivia the soybean oil is the main export product, most likely because the price of cake cannot compete with that produced in other countries of South America. Figure 8 shows the destination of the produced soybean oil in Bolivia. The majority of the crude soybean oil is exported, about 422,000 MT (80%) of the total available crude soybean oil of 526,000 MT goes abroad as refined or crude oil.

Figure 8. The destination of Bolivian soybean oil to national and export markets mid-2021. Source: MHE.



Both ANAPO and CANIOB confirm that the production and milling of soybean for the biodiesel program is feasible if the price paid for the oil is competitive with the export price. Currently, the milling capacity of the CANIOB members is only used for about 50%, i.e., about twice as much crude soybean oil can be potentially milled as shown in Figure 8. This amount would be about sufficient for the planned HVO refinery plant (section 3.1). Soybean producers indicate that soybean production can be increased by expanding the agricultural area and increasing the current (low) soybean yields. ANAPO is a staunch advocate for the admission of genetically modified soybean varieties in Bolivia to increase the soybean productivity. Currently, only the genetically modified roundup-ready soybean is allowed in Bolivia, while there is a national ban on other genetically modified organisms (GMO).

The major stakeholders in soybean supply chain, ANAPO and CANIOB, acknowledge the potential benefits of the biodiesel program for their members. At the same time, both ANAPO and CANIOB are concerned that once the biodiesel program is implemented the government of Bolivia will interfere in the market. The export market is especially of interest for both ANAPO and CANIOB members: Figure 8 shows that the export prices of both refined and crude soybean oil are both much higher than the prices at the national market. Because most of the soybean and soybean oil is for export purposes, regulation of the export market, for example, through export bans and taxes would hit both soybean producers and soybean millers.

Another feedstock source for producing biodiesel is animal fat (section 3.3). According to FRIDOSA, there are two rendering companies in Bolivia, collecting animal fat (mainly cow, pig and chicken). The rendered fat is currently used by the soap/detergent and pet feed industry. Currently, FRIDOSA sells its fat for 0.25 Euro/kg to the rendering companies. At higher animal fat prices FRIDOSA would consider investing in its own rendering factory.

Also belonging to the private sector are some smaller pioneers/entrepreneurs that do see potential (of oil extraction) of local/native palms such as, *Cusi (Attalea speciosa)* and *Totai (Acrocomia aculeata)*. Earlier studies suggest that the climate conditions of many Santa Cruz departments are not very suitable for growing the most oil-dense crop African oil palm (*Elaeis guineensis*) due to the average low temperature, extreme low temperatures, and low rainfall in the period from May to September (Escobar & Peralta, 2010; NN, 2007). Local palm varieties that currently grow in the wild like *Motacú*, *Cusi* and *Totaí* seem better adapted to the prevailing agro-ecological conditions of Santa Cruz, although their production potential is yet unknown. They may offer better opportunities to be cultivated as agricultural crops in the future and serve as feedstock for the biodiesel program. Such local palms need to be part of the screening procedure for potential oil crops as described in section 3.3.

Some pioneer entrepreneurs in the vegetable oil industry are Agroseller SRL, Organic Oils SRL and NATUR SRL. The company Agroseller is specialized in the production, trading and logistics of agriculture products among other 'super oils' for which it sources from independent producers. Recently, the company started a 'energy & power' company specialized in the production of alternative green energy. Agroseller has not much confidence in the biodiesel program of MHE and considers it only a way to control the (vegetable oil) market in Bolivia. Agroseller shared a first design/idea of a project to produce vegetable oil for biodiesel at community level.

Organic Oils has recently started a plant to clean, peal and break the fruits of the *Cusi* palm with a capacity of 6 tons per day. The project is in its first phase but is projected to produce 10 million liters of biodiesel in its 3rd phase besides other by-products like starch, animal feed, vegetable charcoal and activated carbon.

NATUR SRL is a company specialized in freeze-drying of fruits, especially the fruit of the native palm a*çaí (Euterpe precatoria).* The company exports 99% of the products in bulk packages for resale. Importers produce energy drinks, food supplements, cosmetics and other products. Although the company is not producing vegetable oil, the way NATUR SRL is working with local communities is worth taking as a model of inclusiveness working with small collectors that traditionally extract/collect from the rainforest and are less focused on agriculture. Now 62 collectors collect açaí from açaí palm trees in the wild and 38 employees process the açaí to puree in small community facilities. NATUR SRL buys the puree from the communities giving added value to the products and benefiting in total 600 smallholders. The extraction and processing of (oil) products from the forest has the potential to increase the economic value of the forest and could therefor contribute to prevent deforestation.

The main stakeholders from the **public sector** are those operating under the different ministries. An important player is the state-owned oil/gas company YPFB formally placed under the responsibility of MHE. YPFB is the intellectual owner of the biodiesel program and the construction and execution of the biodiesel installations for FAME and HVO are placed under its institutional structure. As described in section 3.1, on initiative of MHE and YPFB an inter-ministerial committee (CMiB) has been formed to coordinate the biodiesel program consisting of MHE, and the ministries of Rural development & Land, Productive Development and Plural Economy and the Ministry of Environment & Water.

A preliminary and quick study on feedstock for biodiesel had been commissioned to the National Institute of Agricultural and Forestry Innovation (INIAF for its abbreviation in Spanish), an institution under supervision of the Ministry of Rural Development & Land. In principle, INIAF focuses on food crops mainly for small producers. The quick study focused on four potential oil crops: jatropha, African oil palm, *pongamia* and rapeseed and considered three scenarios: 1) a monoculture crop concentrated in a specific area, 3) introduction of oil crops in family farming systems (integrated), and 3) identification of oil producing wild species (*totaí*, *cusi*, etc.). According to this study, some spots in the north of Bolivia are potentially suitable for the cultivation of African oil palm. However, African oil palm is a non-native plant species in Bolivia and not yet formally registered in Bolivia. It should first pass through a registrations process by the National Service of Agricultural Health and Food Safety which would take up to two years before being able to have seedlings in Bolivia. Another challenge is the pollinization of the African oil palm as pollinizers apparently have reduced significantly in Bolivia. Therefore, different crops and scenarios should be further analyzed before being able to enter in conclusions. INIAF mentioned a meeting with the Inter-American Institute for Cooperation on Agriculture (IICA) which has biofuels on its agenda with the Development Bank of Latin America (CAF) and INIAF would prefer to implement follow-up studies jointly with WUR, YPFB, IICA and CAF.

The Ministry of Rural Development and Land under which INIAF operates had a more rigorous and optimistic vision: If MHE would give the ministry 7 USD per small producer for 100,000 ha of oil palm (and jatropha in the dryer regions of the south) and 60,000 ha of *totaí* including some oil extraction machinery, the work could already start in 2022. As described before, earlier studies indicated that agro-climatic conditions for growing oil palm maybe less suitable in large parts of the department of Santa Cruz because of the average low temperature, low minima temperature and low rainfall in the period from May to September (Escobar & Peralta, 2010; NN, 2007). Basic data on the performance and management of jatropha and *totai* are lacking which makes early investments in both crops very risky.

The Ministry of productive development has done a quick study on the potential available offal and UCO in the four main cities of Bolivia. The study reveals that 11,863 TM offal and UCO from Santa Cruz and 25,971 from the other bigger cities (La Paz, Cochabamba and Oruro) could be collected. However, these numbers are overestimations as there are many obstacles in place for a cost-effective collection (regulations, collections and logistics). The Ministry is in favor of promoting small-scale regionalized collection enterprises for offal and UCO.

In general, the **Civil Society** organizations met during the fact-finding mission were poorly informed about the biodiesel program and were beforehand critical. Maybe because recent experiences with state-owned enterprise have shown that some are economically not viable, for example, the urea plant in Bulo bulo. NGOs are very concerned about the weak institutions on land registration and enforcement.

The Bolivian Institute of Forest Research (IBIF) also indicate that the institutions on agriculture and forest research and extension are weak and it fears uncontrolled exploitation of native palms and deforestation if, for example, Africa oil palm is introduced. Nowadays there are 5 million ha of forest with concessions to exploit timber. Nevertheless, the wood harvest intensity and the volume of extracted timber is low, bureaucracy is high and there is no institutional/governmental support to the indigenous communities who own large, forested areas. Collection of native palm fruits for its oil content would need a forest management plan. Some palms grow in large spots with a high density while others grow more dispersed and would require regulations to prevent overexploitation. With respect to degraded and abandoned land IBIF recommends reforestation of these areas for productive purposes (productive restauration/forest enrichment/assisted regeneration). An example is the integration of '*nuez de chiquitania*' mixed with traditional food crops. The system is successfully recovering degraded and abandoned areas in the Chiquitania region. The same could work by introducing agroforestry systems including native oil producing palms like *cusi* and *totaí* in degraded and abandoned areas.

5 Opportunities for Dutch organisations and companies

Bolivia wants to reduce its imports of diesel oil to reduce costs. Diesel is subsidized considerably, thereby insulating diesel users from fluctuations on the international petroleum market. The cost for subsidies is especially high for the government when petroleum prices are high, as is currently the case (2021/2022). As diesel is subsidized incentives to use diesel efficiently or implement alternatives are difficult to implement.

Though statistics on this are hard to access, diesel oil is now used mainly in the transport sector but also in off-the-grid electricity production. The current focus is on replacing imported diesel oil by biodiesel based on locally produced waste/residue oils and fats and on vegetable oils. The plan is to build FAME and HVO factories to convert vegetable oil to diesel for local use.

Though the focus is on biodiesel there are other options to reduce the subsidy expenditures. They include reducing the need for diesel especially for stationary uses. This can include a switch to other renewables such as photovoltaic solar energy, wind, biogas to electricity and biomass-based cogeneration (heat and electricity). Bolivia has made a started with some hybrid project (photovoltaic solar) in the North of the country [14]

Other areas where Bolivia could find solutions would be to produce diesel from natural gas, a technology well known to Dutch companies and which has been implemented by Shell in Bintulu (Malaysia) and Bahrain.

In interactions with government officials the ambition has been expressed to become an exporter of biodiesel, especially HVO diesel, which can also be used (after distillation) as a jet fuel. There is an understanding that this will also require conforming to sustainability standards. Officials indicated that discussion have been in place to assess the needs to certify sustainable biofuels for export. Dutch companies are involved in certification (quality and sustainability) of the entire chain.

The Netherlands is a large importer of biofuels for the EU market. Bolivia has been an exporter of ethanol to The Netherlands before, at least till 2014 (Goh et al., 2016). Export opportunities of biodiesel (and derived products) to the EU through The Netherlands are an opportunity for Bolivia and Dutch companies.

In the Netherlands a number of companies are involved in production of HVO and bringing the products from this process to market. They include HVO diesel but also Bio-naphtha and Bio-LPG. As they are biobased this opens opportunities in bioplastics (e.g., Neste oil).

Diesel is being produced in Bolivia in different refineries. Domestic production of petroleum has declined, increasing the need for importing diesel [15]. Using pyrolysis oil produced from wood (saw dust plus off-cuts) and other biomass (e.g., shells from Brazil nut growing in the north of Bolivia) may be an option for increasing domestic diesel production. Several companies in The Netherlands (i.e., BTG-Bioliquids) are involved in pyrolysis oil production. This pyrolysis oil can then be used in oil refineries to produce fuels (diesel)[16]. Pyrolysis oil can also be used in stationary electricity production thereby replacing fossil diesel for this application.

[14] Source: https://energypedia.info/wiki/Renewable_Energies_in_Bolivia [accessed January 28, 2022]
[15] Source: https://www.eia.gov/international/analysis/country/BOL [accessed January 7, 2022]
[16] Source: http://biomassmagazine.com/articles/18093/preems-refinery-in-lysekil-begins-producing-renewable-gasoline (accessed 7 January 2022)

Another area of bilateral or multilateral cooperation may be on policy support: The development of effective biofuel policies is complicated and will remain very dynamic because of the international agreements on biofuels and land use such as decided upon in the recent COP 26 in Glasgow. In the Netherlands much experience exists on developing and implementing biofuel policies both at local level and EU but also in other countries. This opens opportunities for Dutch consultancies and also for setting up Government to Government projects.

In the production of biodiesel, a whole range of opportunities arise for involving Dutch companies. The large-scale production of (new) oil crops may require developing new genetic seed stocks (breeding) and starting material as well as improving production methods and educating farmers. This may need the involvement of NGO's and local and international knowledge institutes. Especially for new crops (*Jatropha*, *Totai*, *Cusi*, *Pongamia*, etc.) this will require developing of processing (seed crushing) and applications for the (high protein) residues. This may offer opportunities for animal feed companies (e.g., De Heus).

Distribution of FAME Biodiesel requires adapted distribution networks and infrastructure. Methods are needed to make sure quality is maintained. Experience in rolling this out in the Netherlands can be useful for Bolivia. Related to the logistical needs, the collection of UCO and converting it into FAME of HVO will require specific purification and logistics and storage and Dutch companies have experience in this.

When producing FAME, glycerin is a coproduct which can be used for low value energy (biogas) or feed applications but can also be used for high value pharmaceutical uses and production of chemicals. In the Netherlands experience exits in using glycerin from FAME production.

6 Conclusions

The biodiesel program of MHE and YPFB is born out of the need to reduce the cost of importing and subsidizing fossil diesel oil and to change Bolivia's energy matrix. In addition, the Government of Bolivia considers the biodiesel program as an opportunity to create new income-generating activities for small and medium farmers and to spur overall rural development. At the same time Bolivia is eager to reach a higher industrialization level regarding the processing of natural resources (gas, vegetable oil, etc).

The potential contribution of biodiesel in reducing GHG emissions plays a less prominent role in the national debate. This poses the risk that feedstock production needed for producing biodiesel will be counterproductive with respect to the globally agreed GHG emission reduction goals at the COP 21 of in Paris, i.e., the production of feedstock for biodiesel could increase GHG emissions instead of reducing them. Bolivia's revised NDC plan has still not been published and the role of the biodiesel program in the plan is until now unclear.

The production of biofuels should have a net positive effect on GHG emissions compared to using fossil diesel, especially if Bolivia wants to export biodiesel to the EU or USA in the future [17]. This can be achieved by:

- Overall efficient chain management with low GHG emissions;
- Increasing yield of the currently produced oil crops (sustainable crop intensification);
- Increasing oil crop production on degraded/ fallow land, i.e., ecosystems with low carbon stocks;
- Minimising the risk of causing indirect land use change (iLUC), i.e., not diverting the current export of soybeans and soybean oil to biodiesel as this may elicit new soybean production somewhere else resulting in land use conversion and deforestation and associated GHG emissions.

The productivity of currently cultivated oil crops (soybean, sunflower and groundnut) is relatively low compared to surrounding countries such as Brazil and Argentina. Though reasons for the lacking productivity of oil crops in Bolivia are poorly understood, sustainable intensification of these crops is a no regret option to increase the feedstock supply and to contribute to overall improvements of resource use efficiency including low GHG emissions per unit of vegetable oil produced. Other options to increase the feedstock supply should be based on a well thought over area expansion of oil crops into areas with low carbon stocks in vegetations and soils. Although national land use statistics are not conclusive, large areas of temporary fallow land (in Bolivia this land is known as *barbecho*) and more permanent abandoned agricultural land (known as *tierras en descanso*) are available where oil crops potentially can be produced with a relatively low impact on the GHG emissions. In addition, large areas with pastures are available of which the low productive areas also potentially could be used for oil crop production. Further study is needed to assess the suitability of land with low GHG emission potential in relation to the oil crop(s) to be grown.

The program goal to produce 405,000 MT of biodiesel by 2025 is ambitious and difficult to realize without intervening in the current export market of soybean (oil) and risking iLUC. By the time of writing this report the tenders on the technical design of the biodiesel refinery were declared inconclusive because 'the proposals/bids would not have met the requirements of the Base Contract Document'. This will delay the implementation of biodiesel program but may also indicate at a change in the plans. Considering the many uncertainties in the supply of feedstocks, GHG balance of the entire program, benefits for small and medium farmers, cost price of production, needs for an enabling environment and stronger institutions, etc. it would be sound to downscale ambitions in the

[17] In the EU (and The Netherlands) methods have been developed to assess the GHG performance of biodiesel production chains. RVO and others have developed the Biograce model (https://www.biograce.net) that can help calculate this performance. The model follows the widely recognized methods described in the EU REDII directive (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001&from=EN) p 179.

short term. It is more rational to start on a limited scale with producing FAME biodiesel, which involves a less complex technical refinery process than the production of HVO. Therefore, the investments to produce FAME biodiesel are much lower than to produce HVO biodiesel. A slower but more cautious and gradual development pathway of the biodiesel program will allow to experiment with sourcing currently available feedstocks and producing feedstocks that have potential to contribute to the required feedstock in the (mid-term) future. Soybean oil, UCO and rendered fat waste flows are currently best available and could be sourced in the short term. However, soybean production is highly mechanised, and the majority is produced by large scale producers, which would conflict with one of the original goals of the program, i.e., to provide opportunities for small and medium-sized producers. Alternative crops of which the majority are perennial oil crops need to be assessed and evaluated carefully before start growing them at a wide scale. They need to be assessed considering the economic, social, and environmental objectives of the biodiesel program in Bolivia including the explicit attention for the needs of small and medium-sized producers. Subsequently, the most promising crops need to be tested in those locations that have the greatest potential from different perspectives.

Furthermore, the report identifies various biofuel-related topics in which public and private sector of the Netherlands can cooperate with Bolivia. Some of the topics go beyond the biodiesel program itself and address alternative solutions to the high costs of Bolivia’s current diesel policy, the main driver of the biodiesel program. Such solutions include development of energy saving strategies and development of other alternative energy solutions, topics that were little addressed by stakeholders during the mission.

References

Chum, H., Faaij, A., Moreira, J., Berndes, G., Dhamija, P., Dong, H., Gabrielle, B., Eng, a G., Cerutti, O. M., Mcintyre, T., Minowa, T., Pingoud, K., Seyboth, K., Matschoss, P., Kadner, S., Zwickel, T., Eickemeier, P., Hansen, G., & Kingdom, U. (2012). SRREN - Chapter 2 - Bioenergy. In *Bioenergy* (Issue In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation).

Cristián Retamal, & Gutiérrez, E. (2020). *Análisis del estado de situación de la implementación de la Contribución Nacionalmente Determinada (NDC) de Bolivia y recomendaciones para su actualización*.

Escobar, R., & Peralta, F. (2010). *Desarollo de la industria de la palma aceitera en Bolivia. Propuestra para el establicimento proyecto piloto de 1,000 ha en la provincia Iturralde, Departmento de La Paz*.

Farrell, A. E., & Brandt, A. R. (2006). Risks of the oil transition. *Environmental Research Letters*, *1*(1). https://doi.org/10.1088/1748-9326/1/1/014004

Gibbs, H. K., Johnston, M., Foley, J. A., Holloway, T., Monfreda, C., & Ramankutty, N. (2008). *Carbon payback times for crop-based biofuel expansion in the tropics : the effects of changing yield and technology*. https://doi.org/10.1088/1748-9326/3/3/034001

Hill, J., Nelson, E., Tilman, D., Polasky, S., & Tiffany, D. (2006). Environmental, economic, and energetic costs and benefits of biodiesel and ethanol biofuels. *Proceedings of the National Academy of Sciences*, *103*(30), 11206–11210. https://doi.org/10.1073/PNAS.0604600103

Laserna, R. (2018). *Energy Dividends in Bolivia: Are There Any Alternatives to Price Subsidies? Vol. CGD policy*. www.cgdev.orgwww.cgdev.orgwww.cgdev.org

Melillo, J. M., Reilly, J. M., Kicklighter, D. W., Gurgel, A. C., Cronin, T. W., Paltsev, S., Felzer, B. S., Wang, X., Sokolov, A. P., & Adam Schlosser, C. (2009). Indirect emissions from biofuels: How important? *Science*, *326*(5958), 1397–1399. https://doi.org/10.1126/science.1180251

MPD. (2021). *PLAN DE DESARROLLO ECONÓMICO Y SOCIAL 2021-2025. Reconstruyendo la Economía para Vivir Bien, Hacia la Industrialización con Sustitución de Importaciones.*

NN. (2007). *Proyecto de Palma Aceitera en el municipio de Puerto Villarroel. Estudio de Factibilidad Técnica y Económica.*

Popp, J., Harangi-Rákos, M., Gabnai, Z., Balogh, P., Antal, G., & Bai, A. (2016). Biofuels and Their Co-Products as Livestock Feed: Global Economic and Environmental Implications. *Molecules 2016, Vol. 21, Page 285*, *21*(3), 285. https://doi.org/10.3390/MOLECULES21030285

Searchinger, T., Heimlich, R., Houghton, R. A., Dong, F., Elobeid, A., Fabiosa, J., Tokgoz, S., Hayes, D., & Yu, T. (2008). *Emissions from Land-Use Change*. *423*(February), 1238–1241.

Annex I Mission program and meetings

When	Who
November 23	Arrival of three author and Rafael Valcarce in Santa Cruz
November 22	YPFB (Raul Pablo Mujica, Laura Churra, Cesar Duran and Afredo Duran) CIAT (Edgar F. Talavera, Research director and Julio Mérida director of production) ANAPO (Jaime Hernandez Zamora general manager; Fidel Flores Arizaga, president; Guillermo C. Rocco C., agriculture manager and one staff) Fundación Tierra (Gonzalo Colque, responsible for research and Alcides Vadillo, director) Agroseller S.R.L. (Emilio Pualuan Ver, Project Manager, Freddy Fuentes, Walter Samiento, staff and producers) James Johnson (consultant), Ingo Betram (Dutch consul and owner of El Tulipán), Peter O'Tool (Irish consul) and colleague
November 23	Field visit to experimental station of CIAT in Saavedra, North of Montero with two CIAT staff (Edgar Talavera and Julio Cesar. General manager of CIAT Station in Saavedra; Fatima Vaquero) YPFB (Luis Marcelo Arce Mosqueira)
November 24	Fridosa (Jaime Barrenechea, Marcelo Lara Godoy and Julio dos Santos CANIOB (David Oscar Diez Canseco Oliva, statistics and information) IBIF (Nataly Ascarrunz, director and Humerto Gómez Cerveró, researcher) FAN (Natalia Calderón and two staff)
November 25	Roberto Unterladstaetter (Retired professor of Univ Gabriel Rene Moreno and owner of AgroLife) James Johnson (consultant and specialist on agroforestry, owner CANAVALIA) University of Gabriel Rene Morena (Rector and staff) Franklin Molina, Minister of MHE and Luis Marcelo Arce Mosquiera (YPFB)
November 26	YPFB (Raul Pablo Mujica and three staff) Ingo Bertram (Dutch consul)
November 27	Departure of two authors
November 29	PROINPA in Cochabamba (Rolando Oros, general manager and Ximena Cadima coordinator agrobiodiversity and Climate Change) Universidad Publica de El Alto (UPEA) Daniel Condori Guarachi, director Agriculture faculty and Edwin Guarachi Laura, coordinator Research & extension and Postgraduate Agronomy)
November 30	Universidad Mayor de San Andres, food chemistry (Mauricio Penarrieta and Oscar Miguel Rollano Penaloza) Instituto Nacional de Innovacion Agropecuaria y Forestal (INIAF), Pedro Azuga, director of production. Marcelo Colloa Grandi, independent consultant, working among other for FAO)
December 1	Ministerio de Desarrollo Productivo, Alejandro Durán, DG desarrollo industrial, Garin Tintaya and Hugo Torres. Banco Desarrollo Productivo (BDP); Ariel Erwin Zabala David, General manager, Carmen Tapia Gemio, manager technical assistance and productive innovation
December 3	Forum on Biocombustles; short conversations with among others Pedro Ribeiro, Total Energies, Gabriela Vinales, Investancia (Pongamia production in Chaco, Paraguay),
December 5-6	Ana Lucia Reis, mayor of Cobija, Bolivia
December 7	Tjalle Boorsma, Fundación Armonia and alumnus of WU (ecology)
December 8	Natur S.R.L. Andre Luiz Nápravnik, General Manager
December 9	Andre Viscarra, local representative of Agriterra in Bolivia. FEGASACRUZ (Federacion de Ganaderos de Santa Cruz), Javier Landivar Mercado, General Manager, Saul Molina Gomez, projects and statistics, Emilio Pena Hasbun, Director

Annex II program of *Foro Biocombustibles*, December 3

PROGRAM
Salón Chiquitano, Fexpocruz
Santa Cruz, Bolivia - 3 de diciembre, 2021

HORARIO	ACTIVIDAD
08:00 - 08:30	Recepción y registro de participantes
08:30 – 08:45	**Palabras de Circunstancia** **Wilson Zelaya Prudencio** Presidente de YPFB
08:45 - 09:00	**Palabras de Bienvenida** **Franklin Molina Ortiz** Ministro de Hidrocarburos y Energías
09:00 - 09:30	**Palabras de Inauguración** **Luis Alberto Arce Catacora** Presidente del Estado Plurinacional de Bolivia
DESARROLLO NACIONAL DE BIOCOMBUSTIBLES	
09:30 - 09:45	**Presentación:** Programa de Biocombustibles **Yacimientos Petrolíferos Fiscales Bolivianos**
09:45 - 10:00	**Presentación:** Reforestación y Cambio Climático **Ministerio de Desarrollo Rural y Tierras**
10:00 - 10:15	**Presentación:** Desarrollo productivo y generación múltiple de empleos **Ministerio de Desarrollo Productivo y Economía Plural**
10:15 - 10:30	*Refrigerio*
TECNOLOGÍA Y COMBUSTIBLES VERDES	
10:30 – 11:00	**Presentación:** La experiencia brasileña en biocombustibles y la inclusión de Diésel Renovable en la matriz de combustibles Donato Aranda **Especialista - Universidad Federal de Rio de Janeiro y Unión Brasileira de Biodiesel y Bioquerosen, Brasil**
11:00 – 11:30	**Presentación:** Beneficios de la Tecnología Flex Fuel Fernando Badia y Maria Stelzer. **Especialistas** **Volkswagen, Brasil**
PRETRATAMIENTO Y MATERIAS PRIMAS	
11:30 - 12:00	**Presentación:** Sistema de pretratamiento de materia prima para producir Diésel Renovable Priscilla Costa **Sales & Business Development - Renewable Diesel CROWN**
12:00 - 12:30	**Presentación:** Diseño y Características de Unidades de Pretratamiento Higor Ribeire y Bent Surap **Especialistas - ALFA LAVAL**
12:30 - 13:00	**Presentación:** Materia prima para biocombustibles: aspectos de sostenibilidad económica, social y medio ambiental Ria Hulsmann **Regional Manager Latin America & the Caribbean - Universidad de Wageningen, Países Bajos**
RECESO	

14:30 - 15:00	**Presentación:** INVESTANCIA Paraguay: produciendo Pongamia en el Chaco Paraguayo Gabriela Viñales **Country Manager – INVESTANCIA, Paraguay**
15:00 - 15:30	**Presentación:** Rigor Técnico para el Desarrollo de Proyectos de Cultivos de Especies Oleaginosas para el Suministro Sostenible de Materia Prima para Fábricas de Biocombustibles Romano Luis Diel **Director Ejecutivo – EFISA, Paraguay**
IMPLEMENTACIÓN DE BIOCOMBUSTIBLES	
15:30 - 16:00	**Presentación:** Experiencias en el uso de biodiésel de palma en Colombia y perspectivas futuras Mónica Cuéllar Sánchez **Líder Desarrollo de Nuevos Negocios - FEDEPALMA, Colombia**
16:00 - 16:30	**Presentación:** HVO - Ciclo del Negocio Pedro Ribeiro **Director Bolivia - TotalEnergies, Francia**
16:30 - 17:00	*Refrigerio*
TECNOLOGÍA FAME	
17:00 - 17:30	**Presentación:** FAME Miguel Ivan la Cerda de Oliveira (POR CONFIRMAR) **Ex Director de Biocombustibles - Ministerio de Minas y Energías, Brasil**
TECNOLOGÍA PIRÓLISIS	
17:30 - 18:00	**Presentación:** Sustitución de las importaciones de Diésel, con producción en base a residuos. Francisco Xavier Iturralde **Director - Ecoearth, Bolivia**
REGULACIÓN DE BIOCOMBUSTIBLES	
18:00 - 18:30	**Presentación:** La evolución de sistema regulatorio de biocombustibles en Bolivia Germán Jiménez Terán **Director Ejecutivo - Agencia Nacional de Hidrocarburos**
18:30 - 19:00	**Conclusiones y Clausura del Evento** **Franklin Molina** **Ministro de Hidrocarburos y Energía**

Annex III WUR presentation

Materia prima para biocombustibles:

aspectos de sostenibilidad económica, social y medio ambiental

Ir. Ria Hulsman – agrónoma y gerente America Latina & Caribe

Dr. ir Wolter Elbersen – agrónomo y experto biorefinería

Dr. Ir. Huib Hengsdijk – agrónomo y modelador

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El desafío → Materia prima

Producción (a corto y largo plazo) de:

- 450.000 TM aceite y grasa para HVO
- 170.000 TM aceite y grasa para FAME

- Inclusion social
- Costos competitive
- Sostenibilidad ambiental

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2

2

Consulta con actores en el sector

- YPFB
- CIAT
- ANAPO
- Fundacion Tierra
- James Johnson
- Agroseller
- FAN
- Fundación Tierra
- Fidosa
- BDP

- IBIF
- Roberto Underlatstatter
- CANIOB
- UAGRM
- UMSA
- UPEA
- *Ministerios*
- *INIAF*
- *Proinpa*

- *Miguel Zambrano (ex-palmero)*
- *CATO*
- *Cobija – Riberalta*
- *Miguel Dabdoub*

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3

Impresiones de la semana

- Soja: bajo rendimiento - exportacion – biodiesel
- Ethousiasmo por las palmas: rendimiento?
- Cambio climático: Bolivia extremadamente vulnerable (CAF),
- Preocupación: tenencia y fiscalizacion de tierras > deforestación
- Hay mucha información buena: dispersa, poco publicada

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4

Opciones mecionadas para materia prima

❖ Residuos: grasa animal, UCO (aceites usados) y otros

- Soja
- Girasol
- Maní

- Totai
- Mocororó/ricinus
- Pongamia
- Cusi
- Palma Real
- Palma Africana
- Piñon/Jatropha
- Moringa
- Majo
- Chonta
- Palla
- Colza
- Tara

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5

Criterios para la selección de materia prima

1) Identificar y definir criterios adecuados:

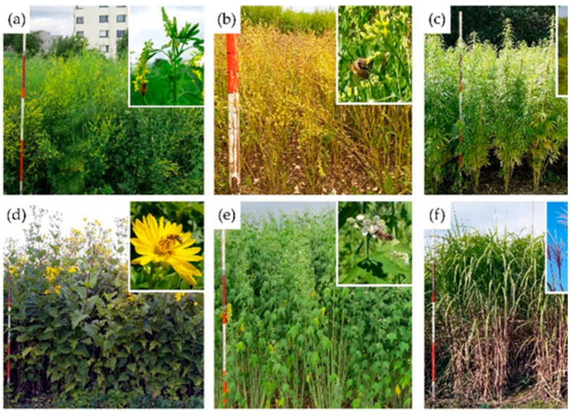
Económicos

Sociales

Ambientales

2) Evaluar los cultivos en función de los criterios

3) Selección de cultivos prometedoras y potenciales



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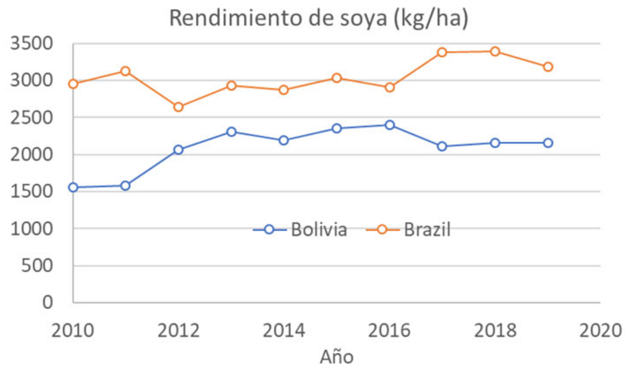
6

Criterios de sostenibilidad ecónomica

- Producción por ha?
- Costos de producción?
- Disponibilidad de mano de obra calificada?
- Disponibilidad de variedades de alto rendimiento?



FAOSTAT, Nov. 2021

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7

7

Rendimiento: ratio equivalente de tierra (LER en ingl)

(intensificar e diversificar produccion > ahorro de tierra)

1 hectarea
trigo – maíz
intercalado

≈ 1.3 hectarea
trigo – maíz
separado

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Fang Gou, 2016

8

Criterios de sostenibilidad social (ejemplos)

- Requerimiento de mano de obra?
- Requerimiento de technología/mecanización?
- Cultivo adecuado para pequenos y medianos productores?
- Cultivo/producto facil de adoptar?
- Seguridad alimentaria?

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9

Palma de aceite

Ingresos para muchos pequeños productores en Indonesia y Malasia

1 obrero/a: 5 – 10 ha.

5 ha x 4 TM aceite = 20 TM aceite/año.

20 TM aceite x 300 USD = 6000 USD

> Bolivia tiene clima para palma de aceite?

> Totaí puede tener un mismo rendimiento?

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10

Criterios de sostenibilidad ambiental (ejemplos)

- Capacidad de captura de carbono?
- Effecto sobre medio ambiente: GEI y biodiversidad
- Riesgos de ampliar frontera agrícola > deforestación?
- Normativa existentes y capacidad de fiscalizar y controlar (en campo)?

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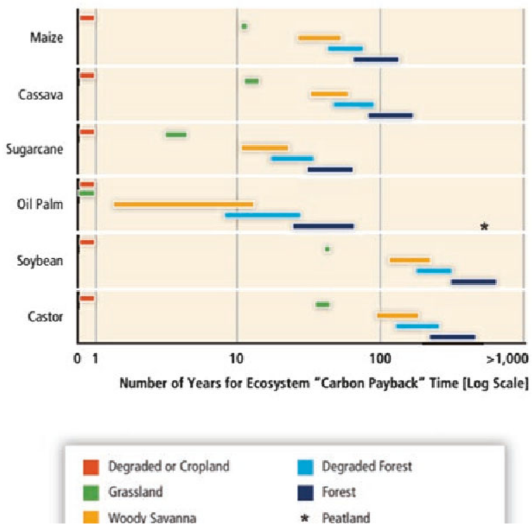
11

Tiempo de recuperación de carbono



Chum el al., 2011: Bioenergy

- ..es alto si cultivada sobre bosque talado (>100 años)
- ....es bajo si cultivada sobre tierra degradada/barbecho (1 año)
- ...palma de aceite recupera carbono mas rapido
- Bolivia: 1,1 (INE 2013) - 5 mln ha en barbecho;

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12

Evaluar la materia prima:

Residuos: grasa animal, UCO y otros residuos:

Opcion segura y clara por la ventaja ambiental:

- uso de algo ya producido e usado > economia circular

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13

Probar y evaluar la materia prima selecionada

Arranque a pequeña escala con UCO, grasa animal, otros disponibles

.. con un FAME 50.000 TM

Ensayos en campo de cultivos preseleccionados

- integracion de cultivos
- enriquecimiento del bosque

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14

Consideraciones adicionales

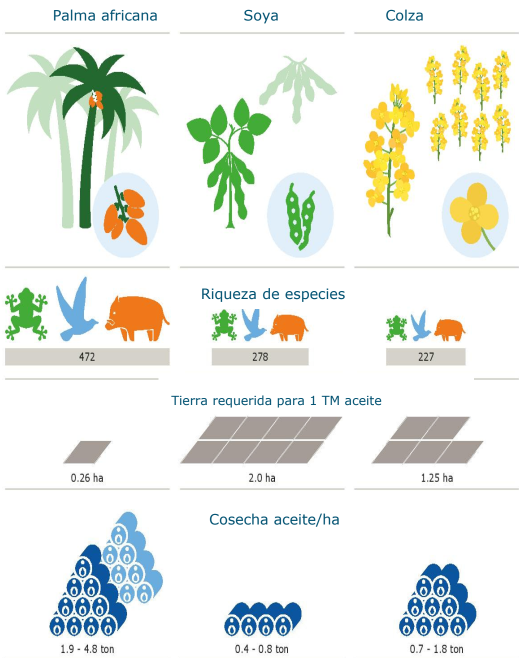
- Efecto de cultivos de biocombustibles sobre medio ambiente:

  > GEI balance and biodiversity

- Insensificación:

  producción/ha, recolección/ha y recuperar barbecho.

- Logistica y cadena



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Sugerencias finales:

- Desarrollar (nuevos) cultivos y recuperacion de residuos require tiempo para desarrollar systemas de produccion sostenibles

  > arrancar inteligente y en etapas q permite ajustar planes

  > institucionalidad que acompana, soporta y coordina

  > decisiones basados en evidencia

- Bolivia tiene un potencial grande para producir materia prima para biodiesel inclusivo y sin deforestacion

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16

16




Gracias!

ria.hulsman@wur.nl
+31-612797448

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17

17

Corresponding address:

H. Hengsdijk
P.O. Box 16
6700 AA Wageningen
The Netherlands
T +31 (0)317 48 07 00