PART II

NEEDS AND TECHNOLOGICAL CAPABILITIES

9 GAPS AND BARRIERS

Augusto Barbosa Cortez [et al.]. "Gaps and Barriers", p.131-180. In: Luís Augusto Barbosa Cortez (Editor). **Roadmap for sustainable aviation biofuels for Brazil — A Flightpath to Aviation Biofuels in Brazil**, São Paulo: Editora Edgard Blücher, 2014.
http://dx.doi.org/10.5151/BlucherOA-Roadmap-009

9 GAPS AND BARRIERS

9.1 Feedstock

9.9.1 Biomass cultivation

A multicriteria analysis conducted on the 2nd Workshop ("Feedstock") looked at feedstocks according to three broad categories: (i) strategic potential, (ii) technical risks and (iii) commercial risks. That analysis showed that all categories of feedstock alternatives have strategic potential to be compliant with the roadmap goals, but technical and commercial risks need mitigation and are somewhat specific to each feedstock being considered; therefore only the categories (ii) and (iii) are detailed in **Table 27**.

Table 27 Pros and cons of feedstock alternatives.

FEEDSTOCK GROUP	TECHNICAL ASPECTS		COMMERCIAL/FINANCIAL ASPECTS	
	PROS	CONS	PROS	CONS
Sucrose/ starch	• High energy yields • Production systems know-how • Integration (sugarcane and sorghum) • Accumulated scientific knowledge in agriculture and refining technologies	• Need to improve technology adoption (cassava) • Low level of mechanization (more relevant in cassava) • Expansion in new areas increase • Competition with other uses (all feedstock)	• High availability • Well organized supply chains (especially sugarcane) • Potential to promote strong social outcomes (cassava) • Commercial co-products (bagasse, fiber cake and trash)	• High opportunity cost of the sugarcane (sugar and ethanol markets) and bagasse (energy generation) • Land/food security concerns (cassava) • Long term economic activity: requires stable policies to promote investments • Logistics (short shelf life)
Oil-bearing	• High energy yields (palm, algae) • Potential to be a second crop and/ or cultivation in marginal areas (camelina, jatropha, peanut)	• Lower energy yields (except palm) • Competition with food (except camelina, jatropha and algae)	• Well organized supply chains (soybeans) • High availability (soybean and potentially native palm trees)	• Related to food chain (soybeans, palm and sunflower) • A large number of the feedstock alternatives in this group is not produced in scale in Brazil

Table 27 Pros and cons of feedstock alternatives (continued).

FEEDSTOCK GROUP	TECHNICAL ASPECTS		COMMERCIAL/FINANCIAL ASPECTS	
	PROS	CONS	PROS	CONS
Oil-bearing	• Sufficient know-how (soybean) • Good storability	• No available seeds or agricultural technologies (camelina, jatropha, native palm trees and algae) • Logistic (low yielding oil crops)	• Commercial co-products (soybean, palm, sunflower) • Logistic (grains can be stored and easily transported)	• Land/food security concerns • No policies to stimulate production in place (camelina and jatropha) • Logistic (palm): production in Amazon and short shelf life
Cellulosic	• High yields (wood, cane, grasses) • Located in the industrial site (bagasse, forestry residues) • Multiple uses (electricity, fuel, etc.) • Co-products • Suitable for hilly soils • Low use of agrochemicals (fertilizer) per unit biomass produced (wood) • Good storability (wood) • Long (& flexible) harvesting season (wood)	• Efficient refining technologies not developed • Relevant opportunity cost: bagasse, forest products • High demand for N - sustainability (grasses)	• Out of the food chain • Low opportunity costs (co-products) • High availability	• Collection costs (agricultural residues) • High costs to store (grasses)
Wastes	• High energy balance (no energy used for production) • Large supply (cities are main destination of agricultural products)	• Refining technologies are maturing (flue gas, MSW, sewage) • Variable composition (difficulty for refining) • Logistic (used cooking oil)	• Low cost feedstock • Large volumes available now • Out of the food chain • No indirect land use change • Low opportunity costs	• High collection, separation and preparation costs (MSW, used cooking oil, sewage) • Need to build a supply chain

Table 27 Pros and cons of feedstock alternatives (continued).

FEEDSTOCK GROUP	TECHNICAL ASPECTS		COMMERCIAL/FINANCIAL ASPECTS	
	PROS	CONS	PROS	CONS
Wastes	• Positive environmental impact		• Industrial waste is point sourced	• Bureaucratic legislation to obtain environmental permits (MSW) • High cost & other uses (tallow)
General	• Land and water availability, favorable climate • Agriculture know-how	• Competition for land • Irregular (hilly) landscape (annual and row crops)	• Improve rural development • Cost competitive	• Limitation for small farmers (scale or production) • Affected directly and indirectly by food price (and agrochemicals, land)

9.1.1.1 Group 1: Sucrose/Starch

Examples of crops/raw materials with sucrose/starch: Sugarcane, Sorghum, Cassava.

Gaps

Brazil has good infra-structure for R&D on the main feedstocks of the sucrose/starch group because these are already produced in relatively large scale. In the case of sugarcane, more than 8 million hectares are grown with this crop, half of it to produce biofuel. Several research centers in Brazil do research on the various aspects of this feedstock production chain; therefore, implementing new or adaptive research for aviation should not be a problem. In a certain way, the research that is needed to expand present sugarcane first generation biofuel can also apply for the aviation biofuel requirements. Improve feedstock production and lower their costs are important tasks, although sugarcane is already a competitive source of plant material. Among the important issues are the agronomic research focused on incremental gains: plant breeding to create varieties that are adapted to different soil and climate conditions, that have improved drought tolerance (expansion of sugarcane toward central part of Brazil), that are resistant to traditional and new diseases (disease resistance is often broken with time; new diseases and pests are always a risk as it is the case of the orange rust, recently introduced in Brazil), that have upright architecture to make possible mechanical harvest, and that can sprout easily under trash mulch (green cane harvest), amongst other traits. Research on improved agronomic management is needed also to increase yields and longevity of the crop, increase nutrient use efficiency, prevent or decrease soil compaction, and control weed and pest using less agrochemicals. In this sense, precision agriculture is an area of great interest. Research on machines and equipment should focus on increasing harvesting efficiency, producing a feedstock that is less prone to deterioration in a short time, and decrease the damage to the plant stools so that ratoon yields may not decline rapidly.

Sustainability is a key aspect for feedstock production. Research should focus on increasing nutrient use efficiency, particularly of nitrogen (N), on strategies for nutrient cycling, on assessment of carbon dioxide emissions under field conditions and on the carbon (C) balance of the crop, in special on practices that maintain or increase soil C stock. Of particular interest is the assessment of factors that may influence the decision of how much plant material should be left on the soil after harvest in order to maintain soil quality in the long term, vis-à-vis the need of collecting residues for biofuel production.

Current low production and yields of sugarcane in Brazil indicate the need of new varieties and actions to expand production are additional gaps (**Table 28**).

Most of these research lines also apply to other agricultural feedstock, although certain peculiarities must be taken into account. For instance, sorghum, especially sweet sorghum, has a much smaller research base in Brazil; the germplasm is much more restricted and agronomic practices much less developed. Of particular interest is the research to expand the harvesting season, through the development of new varieties. In the agronomic front, sorghum, as a grass, may not be a good rotation crop for sugarcane, especially if repeated rotation cycles are considered. Therefore, options of other crops to include in the rotation are important, having in mind that one of the attractive points of sorghum is that it is processed along with sugarcane and, ideally, it should be grown near the mill.

Research on cassava is not as developed in Brazil as that for sugarcane, but, still, considerable knowledge exists. Research should focus on obtaining new varieties, adapted to different soil conditions and with a wide range of harvesting time – already an advantage of this crop. Besides the research lines highlighted for sugarcane, cassava research should focus on the relatively low amounts of plant residues left after roots are harvested, a limitation both to replenish soil C and as source of energy for feedstock processing and biofuel production.

Additional gaps, related to the lack of tradition of using cassava starch to produce biofuels and the difficulties of mechanized harvest were also pointed out in the experts panel (**Table 28**).

9.1.1.2 Group 2: Oil bearing feedstock

Examples of oil bearing crops/raw materials: soybean, palm, jatropha, camelina, sunflower, peanut, other palm trees, photosynthetic algae.

Gaps

Soybean is also a crop with a large acreage and research base in Brazil, which explains why it is the main feedstock for biodiesel. It is grown practically in all latitudes thanks to intense work of plant breeding done by many institutions in this country. Therefore, the infra-structure is in place, ready to deliver further improvements for this crop. Soybean has a relatively small oil content compared to several other oil crops: breeding to improve oil content is of interest, although the fact that this crop is a good source of protein is an advantage for its multiple uses, a positive aspect for farmers that produce the feedstock (**Table 28**). The short harvesting season is not a problem because of the storability of this grain.

Food security may be an issue in international forums with soybeans and other oil crops such as peanuts and sunflower. However, due to large land availability in Brazil, food security was not placed in high priority in the present document, as discussed earlier. In addition, the processing of oil crops for biofuel leaves high protein meals that can be used as animal or human food.

Research infrastructure of sunflower, peanuts, and castor bean in Brazil is much smaller than that of sugarcane or soybean. Breeding and agronomic research can also improve yield and the potential of these crops to serve as biofuel feedstock; however, these crops have competing uses as food or as source of highly priced oils and may not fit the required low-price characteristic of the ideal biofuel feedstock. However, the marked for biofuel production may be an interesting alternative for farmers to deal with overproduction or to sell grains not suitable for food; therefore such crops may be occasionally used for biofuel production because the transformation technology for oil crops probably will allow different seeds to be processed.

Camelina, in a sense, will have the same limitation of sunflower and peanuts, with the disadvantage of having a much lower germplasm and research base. It may be an option for some markets if the agronomic research challenges are overcome. Other gaps and barriers are listed in **Table 28**.

Jatropha has potential to supply oil for biofuel and has an advantage of not competing in the food market. However, research is needed mostly in plant breeding, selection of uniform plant material, and adaptation to different soil and climate conditions. The research base in Brazil is relatively poor so far, and jatropha may require a greater research effort and long maturation time. However, efforts by newcomers into the Brazilian scene, such as SGB, and by Embrapa, IAC, and other research institutions in Brazil may speed up progress, as discussed in section II.1.1. Harvest mechanization is a topic of interest for jatropha because the plant architecture is much different from that of other oil seeds. Seed production spread through a long period is a problem for mechanical harvesting; therefore, besides machine development, the jatropha plant should also be altered through genetic improvement or management practices such as pruning, use of plant growth regulators etc. (**Table 28**).

Palm is the most productive oil crop. Expanding its production area is a barrier because of the high water requirement of present varieties (today it is suitable only for very wet and hot climates). The research base is limited in Brazil. Research on sustainability issues such as soil C degradation, nutrient cycling, CO_2 and other GHGs emission in the cropping production system, and others are important to turn palm into a viable feedstock for biofuel in Brazil, especially considering that the best areas for production are in wet forests (**Table 28**).

Other native palm trees, as discussed in the workshops, seem to have potential, but the research base is poor. The pathway to developed technology for large scale plantations of such palm trees is known – the same breeding and agronomic research used to create and adapt other crops, as done with several other plants in Brazil and elsewhere - but results are of long term and uncertain. The biofuel industry probably cannot count on this type of feedstock within the next 20 or more years.

Photosynthetic algae is always mentioned as the oil feedstock with the largest yield potential but most of such high production has been obtained under controlled conditions. Much research is still needed to turn algae into a commercial option, especially due their high nutrient, light and temperature requirement. Harvesting is also a problem to be solved. Sustainable algae production in large scale is a project for the long run.

9.1.1.3 Group 3: Lignocellulosic feedstock

Examples of crops/raw materials with lignocellulosic feedstocks: forest wood residues & wood, sugarcane bagasse and harvest residues,iIndustrial forest residues (pulp, sawdust, bark), agricultural residues (straw, grasses), dedicated plants such as forages.

Gaps

If and when converting technology problems for lignocellulosic materials are solved[11], the options of forest-derived feedstocks in Brazil are excellent. Brazil is one of the largest and most efficient producers of planted forests; therefore, a very good research base is available, especially for eucalyptus. Climatic conditions are favorable in most of the country. An additional advantage of planted forest feedstock is that it can be produced in areas with irregular topography, which limits annual or row crops production. The feedstock can be stored for long periods and the harvesting season is long and flexible. Nutrient cycling usually is not a limiting factor for sustainability since most of the harvested parts have low nutrient content. The agronomic research should focus on further adaptation of plant materials for marginal lands (low fertility, relative dry areas), agronomic management for high yield, and practices that minimize soil compaction and degradation due to the operation with large harvesting machines (**Table 28**).

Planted forests are already widely used in Brazil to produce energy for the iron industry. However, it is likely the price competition will limit the use of forest logs for biofuel production, but the large demand for wood, paper and other forest products may increase the supply of forest by-products which can be processed for energy: pulp, sawdust, bark, and other wood residues.

Most of the research on sugarcane residue (bagasse and harvest residues) production was listed under sucrose feedstock. However, specific research applies for sugarcane lignocellulosic feedstock: this is the case plant breeding for the so-called energy cane, in which lignocellulosic material is favored instead of sugars. Sugarcane breeding programs have long been improving sugar concentration in stems and sugar yield. Now plant breeding research may have to go back to other sugarcane germplasm in order to obtain plants with high cellulose content. However, the source of such genes is known so that it may be feasible to have an energy cane in a relatively short period of time.

Nutrient cycling, criteria for decision of how much residue to leave on the field, water use and other topics related to sustainability also need research efforts.

For other crop residues (corn, cotton, rice, wheat) the most relevant research topic for their use as feedstock for biofuel production regards collection and transport, nutrient cycling, soil C balance, and soil fertility maintenance.

Tropical grasses used as forage, especially, Guinea grass (Panicum maximum) and Elephant grass (*Pennisetum purpureum*), have huge potential to produce cellulosic material. However, high yields usually require large nutrient inputs, which raise questions about sustainability and nutrient cycling. These are topics of interest for research with such

11 A commercial plant to produce second generation ethanol was planned to operate in a commercial scale in Brazil in 2013 (GRAALBIO, 2012), now 2014 (See also section II.5.2).

grasses. Plant breeding is an alternative to increase nutrient use efficiency and generate varieties more suitable for biofuel production. In addition, harvesting practices and equipment, and storability deserves attention (**Table 28**).

9.1.1.4 Group 4: Residues or Wastes

Urban wastes, industrial flue gases, tallow and used cooking oil are options for biofuel production, not only to recycle products that would otherwise require costly disposal, but also because they avoid the food vs. fuel issue. In the European Union, for a feedstock classified as a residue or a waste, it will be easier for the fuel producer to fulfill the sustainability criteria of the Renewable Energy Directive (RED). Further, there is a double counting mechanism depending on the use of a residue or a waste. As well, in some member states there is a direct link to eligibility for state aid for instance in the form of tax benefits. This makes feed stocks classified as residues or wastes attractive from the fuel producer's perspective.

Gaps

"Wastes" or "residues" are non-desirable products, with no or low-commercial value. The processes or production chains from which the waste materials (solid, liquid or gas) are produced are not discussed here.

The potential for biofuel production from municipal solid waste and agricultural wastes is enormous because most of the agricultural products, be it food, paper, wood, ornamental plants, clothes etc, end up in the urban areas where they are consumed and generate wastes. An Important part of the logistic costs for transportation from the site of production to the cities is covered by the consumer of the original product. An estimated 50% of food produced globally is lost somewhere in the long production chain from the farm to the retail places (Smil, 2000). Theoretically, a sizeable part of the food produced can be recycled and used to generate energy.

Differently from the agriculture feedstocks, the objective is not to produce wastes but rather to make use of them, since they represent an environmental problem that needs to be mitigated such as with carbon dioxide emissions. On the contrary, probably the main R&D objective concerning wastes should be how to avoid their production, since their non-existence represents an important value in itself. The R&D related to wastes should be oriented to:

1. Reduce the generated wastes;
2. Reduce the final disposal costs;
3. Optimize and reduce collection costs;
4. Produce a "more friendly" waste with respect to environment and;
5. Use its remaining potential value, so to exhaust the use of its chemical and energy potential. What is a "waste" in a process can be considered an input in another;
6. Cogeneration (for example, use of a fuel to generate mechanical work and electricity and process heat widely used in all sugar/ethanol mills in Brazil).

Several biofuels programs like the Brazilian sugarcane ethanol, the American corn ethanol, and the European biodiesel try to make a complete use of the raw material to generate no residues or wastes; however even these industries have substantial wastes (gases and energy) with potential to be used.

Even though there are very promising processes to convert the above mentioned residues to jet fuel – such as LanzaTech's process for fermentation of CO rich flue gases, Terrabon's MixAlco® Process for the organic wet fraction of MSW (municipal solid waste), or HEFA (hydrogenation of esters and fatty acids) process to convert used cooking oil or animal fats – the main difficulty is to have the residue available under controlled quality and low cost conditions.

For the case of CO-rich flue gases, the main petroleum refineries in Brazil already have CO boilers that use the flue gases, for instance from catalyst regeneration process, to produce steam that is used in the refineries. Many of the large integrated steel mills also are using their main flows of flue gases to generate power. Probably there are some steel mini-mills that have CO-rich flue gases not yet recovered, but they have to be identified and the available amount quantified.

One possible very efficient process to exploit the energy contained in municipal solid waste (MSW) is to begin with a separation of the dry and wet portions and proceed with separate routes. The dry portion, after recovery of recyclables, can be burned in a boil to produce steam and generate electricity or be gasified to produce liquid fuels through a GTL (gas to liquid) process. The wet organic fraction can be fermented to produce bio-gas (mainly methane and carbon dioxide) that can be used as energy, feedstock for chemical process or even be transformed in liquid hydrocarbons through a GTL (gas to liquid) process. Another possibility is to interrupt the fermentation process inhibiting methanogenesis, therefore avoiding the gas phase to reduce costs, and producing carboxylic salts using the MixAlco® Process, to be discussed in more detail in the next chapter. Important to recall that MSW in Brazil has a large wet organic fraction, rich in food residues that are not permitted to go into sewage, what makes this last process quite appropriate for the Brazilian conditions.

The amount of MSW per capita runs about 1kg/day, which if summed up in the metropolitan areas where the main airports are located, could supply near around 20% of the jet fuel consumed. The main gap here is that nowadays almost the totality of MSW is dumped in landfills without any separation. Although a specific law to deal with solid residues and to pinpoint responsibilities has been recently approved in Brazil, the waste management in this country is in general poor and even worse when referring to MSW. Although some recycling is usual, mainly for paper and cardboard, aluminum cans and glass, and approximately 20% of the produced methane in large landfills is captured to generate electricity, until now, the amount of MSW burned to produce power is negligible, because of a comparatively low dumping cost. Therefore, the main gap to make use of MSW, and also the main opportunity, rests on the improvement of solid waste management as a whole, to be pushed mainly by municipalities.

The utilization of used cooking oil to produce biofuel is determined by the necessary management to make viable a reverse logistics process. Even though some private companies are doing it to produce biodiesel, the total amount nowadays collected in the Brazil for this purpose, if directed to jet biofuel, would respond for less than 0.5% of jet fuel consumption. Certainly that amount could be increased several times, but again, the whole process of education for better residue management, pushed by public policies, is the main gap.

The use of animal fat to produce biofuel is well developed in Brazil due to the biodiesel production program. Presently, the total amount of tallow and other animal fats processed to biodiesel in the whole country, if directed to jet biofuel production, would suffice to 5% of jet fuel consumption. The main gap for this alternative is the final price that, for the biodiesel production condition, runs about adding US$ 0.40 per liter.

The possibilities of using the remaining energy in sewage for producing liquid biofuels is small, because of the very high dilution and Brazilian rules that determines the exclusion of food leftovers in the sewage, in such a way that this alternative was dropped out during the discussions of previous workshops.

The gaps and barriers presented are those identified by the authors of this report based on the ideas discussed in the four previous sections. They are presented both individually per feedstock and grouped when the feedstocks share similar situation (**Table 28**).

Table 28 Main gaps and barriers associated with feedstocks for aviation biofuel.

FEEDSTOCK	GAPS AND BARRIERS
Soybean	- Low oil content, low energy yields and reduced perspective for researches focused on increasing oil content, given that the protein market is still more relevant for soybean producers and crushers. - Although oil and meal do not compete, because they are products of the soy crush, the crop is strongly connected to the food markets. - Food security concerns[12].
Palm	- Although its productive potential is known in Brazil, planted area is still too small. The main gap is to create conditions for the expansion of the planted area. - The increase of the planted area can potentially create agronomic problems and problems with diseases (such as bud rot). A second gap is that it can be expected that production cost will probably be higher in the first years of implementation of plantations. - Deforestation may be an issue because palm requires much water and is best grown in rain forest regions. Food security and deforestation will probably not be a barrier for palm oil as long as plantations are developed in low yield pasture lands. - Food security concerns[13].
Camelina	- The main gap is that the performance of the crop is still not known in Brazil and energy yield, although potentially higher than soybean, is lower than palm. On the other hand, camelina requires N fertilization, which soybeans do not. - Barriers can be overcome if camelina turns out to be an efficient second crop, which still needs to be proved for Brazilian conditions.
Jatropha	- The main gap is that the crop is not commercially available for production because several agronomic problems still need to be solved through research. Mechanical harvest is important to guarantee economical return. - The toxification problem of the jatropha cake is also a gap.

12 See discussion about food security in 6.1.1.2.
13 See discussion about food security in 6.1.1.2.

Table 28 Main gaps and barriers associated with feedstocks for aviation biofuel (continued).

FEEDSTOCK	GAPS AND BARRIERS
Sugarcane	- Sugarcane is facing a short term gap due to supply shortage and lower yields. Sugarcane is not performing yield increases as it used to in the past, which requires larger investments to promote the expansion of the production. Increasing yields is the main gap, also because production costs have increased in the last years. - A barrier for the use of sugarcane in the jet biofuel market is the high opportunity cost of the cane (sugar and ethanol markets) and the bagasse, given that it is largely used for electricity generation. Although being a residue of the cane crushing, the bagasse is not a tip free residue. - Sugarcane expansion is taking place towards regions with longer water deficit periods, low fertility and non-traditional areas, increasing risks and costs. - Food security concerns[14].
Sweet sorghum	- The main gap is to create conditions for the integration of the crop in the sugarcane production chain. The economic rationale of sweet sorghum arises from its integration to sugarcane. - Once integrated to sugarcane, the main gaps are related to plant breeding oriented to increasing yields and to extending the harvesting period. - To develop an industrial process to allow the use of the starch contained in the grain is a gap in the industrialization, specially having in mind that the sorghum is to be processed in sugar mills.
Cassava	- The main gap for cassava is that Brazil has no tradition in producing energy from starch. - Although being a rustic plant and cropped in different regions, examples in Brazil show that the achievement of high yields requires good crop management. - Mechanization is a barrier for allowing the use of cassava as a feedstock for biofuels. - Food security concerns[15].
Eucalyptus	- Similar to sugarcane, expansion is occurring in degraded areas and in areas susceptible to high degrees of water and thermal stresses. Given that it is very difficult to balance in a same genotype biotic resistance, tolerance to drought or frost, good productivity and good quality of wood, it is necessary to produce interspecific hybrids (cross-bi, tri-cross and so on). - Creating the facilities and the infrastructure necessary to allow the use of residues for producing biofuels is also a gap.
Grasses	- The use of grasses to produce energy is something new in Brazil. Grasses have been used for animal feed; management practices such as the use of fertilizers, are not widely adopted. - Cut, collect and dry large amounts of biomass is a barrier. Costs are not known and solutions and machinery are not in the market. - Selection of more productive and efficient genotypes is also a gap.

14 See discussion about food security in 6.1.1.2.
15 See discussion about food security in 6.1.1.2.

Table 28 Main gaps and barriers associated with feedstocks for aviation biofuel (continued).	
FEEDSTOCK	GAPS AND BARRIERS
Industrial and Municipal Solid Waste	- Tallow is already widely used to produce biodiesel in Brazil (15% of the non-fossil oil) but the other residues require big efforts to solve collection and or separation problems. - Logistical issues are the key barriers. Feedstock volume required for large scale production facility takes time to develop, because it requires transition from compost or anaerobic digestion to biofuel plant. Biogenic MSW collection costs must be competitive with current costs. - Environmental legislation can potentially be a constraint because the use of solid waste should require different permits.

The gaps and barriers can be aggregated into groups according to feedstock characteristics (**Table 29**).

Table 29 Gaps and barriers for feedstocks with different categories.	
GROUPS	EXAMPLES
(i) Feedstock in early stages of research that still need time to be introduced in the market. In these cases, the gap is the lack of technological packages available for farmers:	camelina and jatropha
(ii) Feedstock with high opportunity cost:	sugarcane, palm and eucalyptus
(iii) Feedstocks for which the production costs are high due mainly to logistics costs:	grasses and municipal solid waste
(iv) Feedstock for which food security is an issues because of the importance of the feedstock for the food market:	soybean and cassava
(v) Feedstock viable only if integrated to production systems:	sweet sorghum and camelina

9.1.2 Feedstock logistics

Transportation infrastructure is considered a major bottleneck for transporting commodities in Brazil. The country large territory, high population concentration along the coast and lack of capital are probably the main reasons. Major agricultural crops such as soybean, sugarcane and products from planted forest have difficulties to reach final markets. Off course this lack of infrastructure greatly affects product costs and may represent an obstacle to the interiorization of feedstock production for biofuels production in Brazil.

Other risks are associated with harvesting during the rainy season (December to March) resulting the need to encounter another solution (store the feedstock or the final product). Finally, introduction of ICT technology can greatly contribute to improve feedstocks logistics (Information and Communication Technologies as GPS, GIS, softwares to optimize the fleet, etc.)

9.1.3 Gaps and impacts from sustainability requirements

The 4th workshop was divided in sections according to the three pillars of sustainability (economic, social and environment), as well as a section focused on the sustainability standards. The sections on the sustainability pillars had three speakers, being one from academia, one from the productive sector and another one from an NGO.

On the second day the stakeholders were divided into four groups, according to the feedstock groups – Sucrose, Oil, Waste and Lignocellulosics. Each group discussed and filled out a spreadsheet in order to identify, for each sustainability requirement, the compliance gaps and the impact of the sustainability requirement on the following dimensions: Technical (related to the production process), Financial (related to the monetary resources required) and Commercial (related to market issues). The assessment of the impact of the sustainability requirements on the three dimensions was necessary because they were also part of the discussions of the workshops on feedstocks and refining technologies. The three dimensions, therefore, although apparently not related to sustainability, create channels of communication among the three workshops.

The stakeholders were asked to give their opinion regarding compliance gap and the requirement impact on the afore mentioned dimension.

The Sustainability requirements analyzed were:

(i) Laws and International Conventions

Compliance with relevant national laws and international conventions;

(ii) Land Rights

Having official documents to prove title to land or right to use land

(iii) Employment, Wages and Labor Conditions

Compliance with laws and regulations related to wages, working hours, breaks, overtime and formal contracts. Rights to organize, complaints and communication mechanisms (labor unions, etc.);

(iv) Human Health and Safety

Comply with regulations and standards of conditions of occupational safety and health for workers (Example: NR-31);

(v) Carbon dioxide emissions

Emissions reduction potential and calculations. Different requirements for each standard;

(vi) Biodiversity and Ecosystems

No negative impacts on biodiversity and ecosystems

(vii) Soil

Soil conservation, maintaining soil health and reversing soil degradation (example: erosion)

(viii) Water

Maintaining or enhancing the quantity and quality of rivers and groundwater and respecting formal and customary water rights

(ix) Air

Mitigation of air pollution and limitations/restrictions on open air burning as part of the production cycle

(x) Waste

Reduction, treatment and disposal of waste to avoid environmental contamination

(xi) Crop Management and Agrochemical Use

To use best practices of storage, handling and disposal of fertilizer and agrochemicals; application rates; Use of integrates pest management system and other non-chemical systems

(xii) Direct Land Use Changes

Restrictions related to the conversion of areas considered to have high conservation value, which can include degraded pasture areas (the requirements vary among the standards and the European Union has not yet defined maps of high conservation areas)

(xiii) Social and Environmental Impact Assessment

Preparation or existence of official document specifying how social and environmental impacts of operations are identifies, monitored and mitigated

(xiv) Rural and Social Development

Provision of social benefits to employees and social surroundings and implementation of actions to promote social development and improvement of socioeconomic status of local stakeholders. Plus assessing and mitigating negative impacts on communities and groups (women, youth, children and indigenous communities)

(xv) Contractors and Suppliers

Existence of requirements for contractors and suppliers to comply with human rights and labor standards

(xvi) Engagement and Communications with Stakeholders

Existence of requirements in the context of implementing processes or structures (governance) to guarantee multiple and relevant stakeholder participation throughout stakeholder consultation phases and certification process.

(xvii) Economic Viability and Production and Processing Efficiency

Using all resources efficiently, using less inputs to generate more outputs. Promoting long term economic viability of business

(xviii) Food Security

Assessing the impacts that biofuel production/processing may have on the production, availability, and prices of food. Producers and processors may be using food or land for biofuels that could be used to grow food for local communities.

The first discussion of the group section aimed to assess how difficult it is to be compliant (or keep being compliant) with each sustainability requirement. The participants had to choose which alternative they considered most appropriate for each requirement: (i) Easily compliant; (ii) Compliant with only few difficulties; (iii) Compliant with great difficulties; (iv) Very hard to be compliant; (v)neutral or irrelevant or not applicable.

As for the impact of the sustainability requirement on each dimension, we aimed to identify:

(i) Technical impacts

If the sustainability requirement will have positive or negative impacts on the level of technical risks the economic agents operate today.

i.e.: technical complexity, need for new or external technologies and/or qualified personnel, new processes impacting production capacity.

(ii) Financial Impacts

If the sustainability requirement will have positive or negative impacts on the Business Plan the economic agents have today.

i.e.: investment (capital expenses and operational expenses), profit margins, payback period.

(iii) Commercial Impacts

If the sustainability requirement will have positive or negative impacts on the level of commercial risks the economic agents operate today

i.e.: meeting customer demands, modification of channels, and access to raw materials or other essential supply components.

The results are presented according the group of feedstock. The option for focusing the analysis of the sustainability gaps and impacts on the feedstock itself, rather than on the industrial process, is justified because the main sustainability gaps and impacts reported by the stakeholders were related to feedstock production. Furthermore, with the exception of carbon dioxide emissions, which is related to the entire production process, all parameters used by the sustainability standards are directly related to feedstock production. The results are presented, for each feedstock group, according to the compliance gaps and impacts on the three dimensions.

9.1.3.1 Sucrose

9.1.3.1.1 Sustainability gaps

Considering the 16 requirements[16] analyzed by the stakeholders in the sucrose group's discussion, it can be observed in **Figure 58** that the great majority of the requirements were considered to be in the category "Compliant with only few difficulties", and two of them were considered to be "Easily compliant". Furthermore, three of the requirements were considered to be compliant with great difficulties and one of them very hard to be compliant.

16 There was not enough available time to discuss all of the 18 requirements.

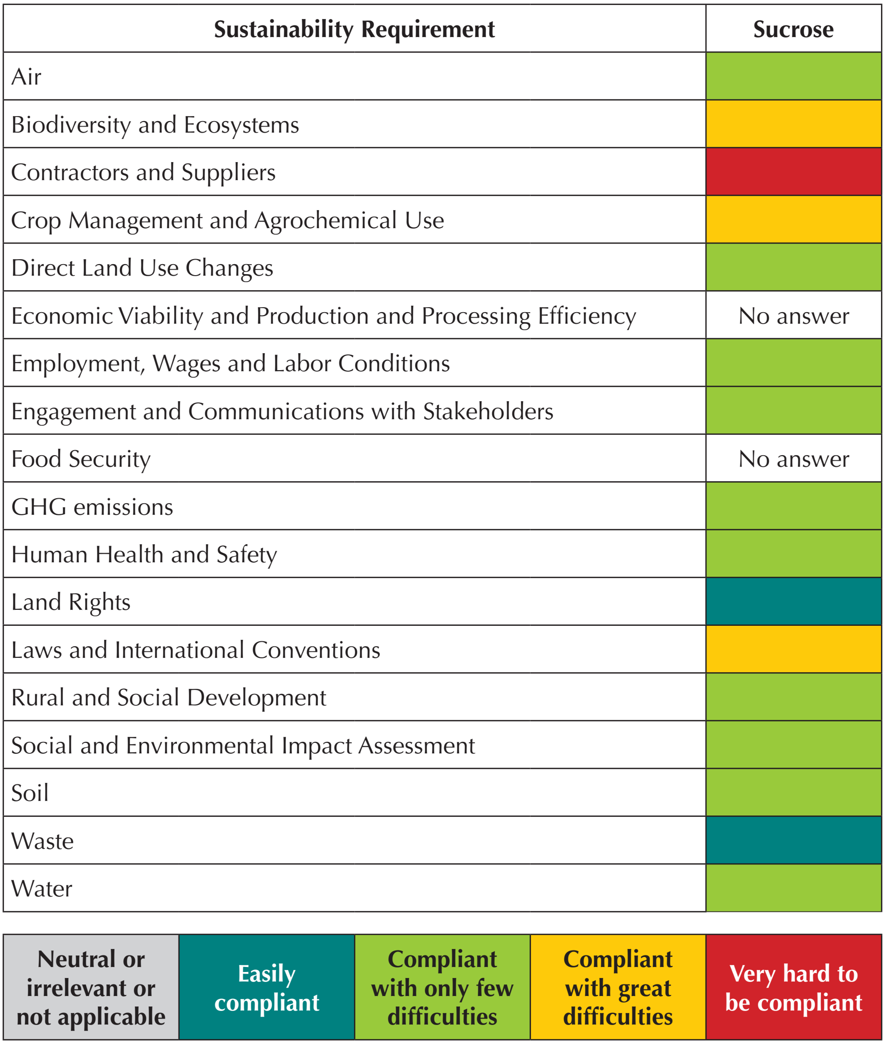

Figure 58 Sucrose: Evaluation of the degree of difficulty to meet requirement.

The most difficult requirement to be met was considered the need for contractors and suppliers to comply with the labor and environmental norms. There is a consensus among the stakeholders that major compliance difficulty is related to sugarcane independent suppliers, which should also be compliant with the requirement[17].

Besides the difficulty with the contractors and suppliers, the main compliance difficulties were related to: (i) *national laws and regulations*; (ii) *biodiversity and ecosystem*; (iii) *crop management and agrochemical use*.

17 Ethanol plants in Brazil are usually vertically integrated through sugarcane production. The sector comprises 70 thousand independent sugarcane producers, accounting for 25% of national sugarcane production; 75% of sugarcane comes from self supply of vertically integrated mills (mills have sugarcane fields plus processing plants).

As regards *international laws and international conventions* it was considered that they are not a problem for the producers to meet. Laws governing pesticides are not a problem also. However, *national laws and regulations* were considered a concern both for the stakeholders and for some panelists. The large number of social and environmental laws and regulations in Brazil, some conflicting, makes their application difficult.

They evidenced that there are different interpretations of the law (there is a lack of knowledge on how to apply some laws and regulations) that contribute to non compliance of some of them. As standards require compliance with national legislation, some difficulties arise in meeting this requirement.

It is not impossible to comply with the legislation (there are already many companies certified), but it requires considerable investments. The Brazilian Forest Code was cited as an example: there are many items that need a lot of investment, as well as items that mills have difficulty to accomplish.

Specifically on the compliance with the national *social legislation and norms*, it was emphasized that some labor laws are not adapted to the rural context. With regard to the use of *Personal Protective Equipment* by rural workers (as required in the legislation), it was mentioned that they are not adapted to rural workers, which can cause compliance difficulties.

Another consideration was that, although labor conditions have improved in the recent years (State of São Paulo presents the best social indicators, the new producing states also have good indicators), this is still an issue in some regions, especially considering small independent sugarcane suppliers.

As for the *biodiversity and ecosystem* requirement, it was considered that it can be accomplished with great difficulties, mainly due the need for investments. There are no technical difficulties in meeting the requirement to preserve biodiversity, but there is lack of investment in conservation areas. The technology exists, and producers should use the information they have on ecosystems to improve biodiversity.

Another requirement that is considered difficult to comply with is related to *crop management and agrochemical use*. For instance the case of vinasse (by-product of ethanol production), which was seen by the stakeholders group as a fertilizer. The conformity with the certification schemes regarding the use of vinasse depends on the established amount allowed by the certification standard. In Brazil, there is a specific legislation for fertilizer, but if one of the certification schemes sets a different limit, it creates a divergence and increases compliance difficulty.

Compliance with *crop management and agrochemical use* depends upon the maximum level established by the certification schemes. Besides, the compliance difficulty varies among regions and soil situation (physical and chemical conditions of different soils may require more or less fertilizer), and the type of fertilizer needed.

The requirements that were classified in the category "Compliant with only few difficulties" are: (i) *Employment*, *Wages and Labor Conditions*; (ii) *Human Health and Safety*; (iii) *Soil*; (iv) *GHG emissions*; (v) *Air*; (vi) *Direct Land Use Changes*; (vii) *Social and Environmental Impact Assessment*; (viii): *Engagement and Communications with Stakeholders*.

Considering "*Employment, Wages and Labor Conditions*" and "*Human Health and Safety*" requirements: it was considered that when the sugarcane production is under the control of the mills, there is no difficulty in meeting the requirements. Also, when activities agricultural are mechanized (planting and harvesting sugarcane), is not difficult to enforce the law (given that the main difficulties are linked to employees of manual cutting).

It was recognized that since 2005, labor conditions have improved a lot in the sugarcane sector. There may still be isolated cases of problems, but generally producers meet the standards. As mentioned before, difficulties arise from the large number of laws and rules and due to the lack of a clear interpretation. However, it was emphasized that compliance with these requirements can be more difficult for the independent sugarcane producers, mainly the small ones.

As regards the potential of *GHG emissions reductions*, there was a consensus among the stakeholders regarding the classification of this requirement as "compliant with few difficulties". There are many studies (national and international) showing that the production of ethanol from sugar cane in Brazil reduces GHG emissions (including American studies).

However, there are some measurement issues. The measurement of GHG varies according to the certification scheme: RSB is more difficult than Bonsucro. There are still methodological uncertainties regarding how to measure GHG emissions, especially regarding whether the Indirect Land Use Change – ILUC – should be considered or not.

Exemplifying the difficulty of measurement and data needed to prove GHG reductions: if an area of pasture is used to plant sugarcane, it is necessary to have information from previous years of the pasture area: whether it was degraded pasture or not in 2008 (the cutoffyear for Bonsucro, RSB, EU, RED and ISCC) or in 2009 (for the RSB Global Standard). Often, there is no data for the previous years; the images of the Satellite maps for those years are frequently of poor quality. This way, in some cases there are no available data to assess GHG reductions.

Although Indirect Land Use Changes (ILUC) was considered a difficult issue to be overcome, efforts should be dispended to find an adequate methodology or a harmonization of the existing ones as this is an especially important matter in South American ecosystems.

Concerning the related matter of "*Land Use Change*" requirement (also considered in the category of those requirements "compliant with few difficulties") accounts for the direct change of land use caused by bioenergy crops: major difficulties stems from the interpretation of what is *degraded area*, and from the data availability to prove that the expansion of sugarcane occurred over the degraded area.

As in the previous case (CO_2 *emissions reduction* requirement) it is necessary to have a database to prove that sugarcane was really planted over a degraded area. If it can be proven, there is no problem to comply with the requirement, because this area is not considered "high conservation value" area. The important variable is whether significant biodiversity existed at the time of the sugarcane planting.

The calculation of LUC is different according to the classification of the previous area (degraded natural pasture or degraded artificial grass). In Brazil there are a lot of artificial pastures, so the classification of the grass as "natural pasture" or "artificial grass" is not simple.

Besides, to carry out the calculations it is important to go back to the time when the standards were implemented. Some companies find it difficult to retrieve the information on what used to be in the area before the year 2008 (or 2009). The satellite technology (and its interpretation) is an important issue.

In the border regions, it can be more difficult to comply with this requirement due to the lack of data. For the states of São Paulo and Minas Gerais, which have more data, it is easier to prove (there is a consolidated usage history).

As for "*Soil*" requirement, the stakeholders' opinions varied a lot. One of them thought that the vinasse disposal should be considered in this requirement (because someone believes that it contaminates the soil), while the others thought that it should be considered in the "agrochemicals or nutrient" requirement (this was the final decision of the group).

As for compliance with the "*soil*" requirement, it was found that soil management in Brazil with mechanization activities is not a problem. The group thinks that the compliance with this requirement varies among producer states.

Concerning compliance with the "*water*" requirement, it was considered that it can be accomplished with only few difficulties. The majority of sugarcane is not irrigated. Most use of water in sugarcane production is to extinguish the fire when it happens in the fields. It was observed that it is important to avoid the water contamination with vinasse (in this sense the limits of vinasse disposal in the soil established in the legislation must be taken into consideration).

One of the stakeholders suggested that the analysis should consider the entire production process and not only the agricultural area, since the industrial process could cause environmental impacts. Future research should take into consideration the entire value chain, which will require a database.

As for the "*Land Rights*" and "*Waste*" requirements, both were considered easily to comply with.

The majority of the stakeholders presented in the sucrose group agreed that the ethanol production brings positive impacts to rural development (which spreads to neighboring cities), mainly related to job creation, income generation, schooling and training improvements.

9.1.3.1.2 Technical Impacts

For all dimensions (Technical, Financial, Commercial), the stakeholders' opinions are that the impacts vary when considering the short run or the long run. When applicable, they can be negative in the short run and positive in the long run, as discussed below.

Considering the *Technical Impacts*, the sustainability requirement can cause *positive*, *negative or neutral impacts* on the level of technical risks the economic agents operate with today (to be compliant with the requirement can imply changes in technical complexity, need for new or external technologies and/or qualified personnel, new processes impacting production capacity, and so on).

As for the stakeholders' opinions on the impact of the sustainability requirement on the *Technical Dimension*, they considered that eight requirements will cause negative impacts; seven are neutral, and one will have a highly negative impact on the technical risk, as observed in **Figure 59**.

Sustainability Requirement	Sucrose
Air	Negative
Biodiversity and Ecosystems	Negative
Contractors and Suppliers	Highly negative
Crop Management and Agrochemical Use	Negative
Direct Land Use Changes	Negative
Economic Viability and Production and Processing Efficiency	No answer
Employment, Wages and Labor Conditions	Neutral or irrelevant or not applicable
Engagement and Communications with Stakeholders	Neutral or irrelevant or not applicable
Food Security	No answer
GHG emissions	Negative
Human Health and Safety	Neutral or irrelevant or not applicable
Land Rights	Neutral or irrelevant or not applicable
Laws and International Conventions	Neutral or irrelevant or not applicable
Rural and Social Development	Neutral or irrelevant or not applicable
Social and Environmental Impact Assessment	Negative
Soil	Negative
Waste	Neutral or irrelevant or not applicable
Water	Negative

Neutral or irrelevant or not applicable	Highly positive	Positive	Negative	Highly negative

Figure 59 Sucrose: Impact of Sustainability Requirement on Technical Risks.

The reason they considered that most of the requirements cause negative impacts in the short run is the necessary investments to adopt new technologies. For sugarcane suppliers the impact is considered even more negative, due small production scale, lack of credit, etc.

Compliance with the social and environmental legislation does not necessarily require a new technology to be adopted or developed (for instance mechanical agricultural activities), rather it requires the adoption of an existing technology, usually more capital intensive than the one used.

Concerning the impacts of the requirements *Employment, Wages and Labor Conditions and Human Health and Safety*, the negative impacts in the short run are related to the improvements in housing, training, and safety equipment. The national norm "NR-31" is very specific and requires many changes. However, in the long term, the use of more advanced technologies can contribute to better working conditions, increase in labor productivity, and so on, resulting in positive impacts.

As regards the impacts of the *CO_2 emissions* requirement, the negative side for the producer is to find alternatives for the use of fertilizers. The positive aspect is that this improves the CO_2 calculation, where the producers need to improve accounting. The biggest impact in the technical risk was considered the methodology for calculations of land use change.

As regards the impact of *Biodiversity and Ecosystems*, it was considered that there is no technical risk, because the technology is available, it is just a matter of implementing the technology to improve biodiversity.

In conclusion, the impacts were considered negative (or neutral) in the short term, and positive in the long term.

9.1.3.1.3 Financial Impacts

Considering the impacts of the sustainability requirements on the Financial Impacts, they were considered mostly negative in the short term (**Figure 60**). In the long term, some could be considered positive due to higher rates of return.

Sustainability Requirement	Sucrose
Air	
Biodiversity and Ecosystems	
Contractors and Suppliers	
Crop Management and Agrochemical Use	
Direct Land Use Changes	
Economic Viability and Production and Processing Efficiency	No answer
Employment, Wages and Labor Conditions	
Engagement and Communications with Stakeholders	
Food Security	No answer
GHG emissions	
Human Health and Safety	
Land Rights	
Laws and International Conventions	
Rural and Social Development	
Social and Environmental Impact Assessment	
Soil	
Waste	
Water	

Neutral or irrelevant or not applicable	Highly positive	Positive	Negative	Highly negative

Figure 60 Sucrose: Impact of Sustainability Requirement on Financial Risks.

As mentioned before, the impact of meeting the requirements related to employment and labor conditions is negative in the short term, because of investments in training, housing, safety equipment, etc. However, it can be positive in the long term, because it can increase productivity.

Concerning CO_2 *emissions* requirement, it was considered that there is a financial risk in the short run due the adoption of the new technology. For instance, to reduce CO_2 emissions, the use of mechanical harvesting can cause problems such as soil compaction and yield reduction. But on the other hand, it can be positive in the long run, because trash preservation in the soil can lead to increased productivity. Once the new system is in place, the workers are trained, new varieties of sugarcane introduced, etc., the productivity can increase.

In general, negative financial impacts in the short term and positive in the long term.

9.1.3.1.4 Commercial Impacts

The commercial impacts were all considered positive (**Figure 61**).

Sustainability Requirement	Sucrose
Air	
Biodiversity and Ecosystems	
Contractors and Suppliers	
Crop Management and Agrochemical Use	
Direct Land Use Changes	
Economic Viability and Production and Processing Efficiency	No answer
Employment, Wages and Labor Conditions	
Engagement and Communications with Stakeholders	
Food Security	No answer
GHG emissions	
Human Health and Safety	
Land Rights	
Laws and International Conventions	
Rural and Social Development	
Social and Environmental Impact Assessment	
Soil	
Waste	
Water	

Neutral or irrelevant or not applicable	Highly positive	Positive	Negative	Highly negative

Figure 61 Sucrose: Impact of Sustainability Requirement on commercial Risks.

The explanation for considering the impacts in the *Commercial Aspect* as positive is that if the practices adopted are not in accordance with the law, it is too difficult to market or export the product. The higher the compliance with the requirements is, less the commercial risk.

Customers want effective compliance; they concern themselves with the regulations and sustainability criteria. Companies not want their image linked to sugar production through bad working conditions, environmental degradation etc.

9.1.3.1.5 Sucrose: Summary

Compliance	- Social: great number of laws and regulations; different interpretations and lack of knowledge on how to apply laws; small and/or independent producers have more difficulty to comply; labor laws not adapted to the rural context; issue in some regions, especially with independent suppliers; difficulties with documentation on land rights, especially in some regions.
	- Rural development: job creation, income generation, improve schooling and capacitation
	Environmental: The compliance of some requirements caries among regions and soils situation (Example: the limit of nitrogen content established by standards: compliance depends of the situation of the soil)
	Main difficulties related to:
	- (i) biodiversity and ecosystem; (ii) crop management
	- Land Use Change: compliance different among regions: SP e MG ok; Others: may have lack of data to prove that the area was a degraded area
	- Vinasse: some states have legislation, others don't. Depending on the standard, criteria can be easy or difficult to comply
	- Economic: standards are focused on production efficiency of feedstocks; lack of data on costs of jet biofuels since there is no scale production in Brazil. Experimental production has taken place, but the costs are unknown. Price policies must be defined and should consider the positive externalities of biofuels.
Technical Impacts	The impacts varies if we are talking about the short run or long run. Are negative in the short run, and positive in the long run.
	- For sugarcane suppliers even more negative (production scale, etc.)
Financial Impacts	Financial: all negatives in the short run. Can increase productivity and be positive in the long run.
	- Investment: training and qualifying people (mechanical harvesting); equipment; production scale
Commercial Impacts	All positives

9.1.3.2 Oils

9.1.3.2.1 Sustainability gaps

Considering the requirements analyzed by the stakeholders in the oil group's discussion, it can be observed in **Figure 62** that three requirements were considered in the category "easily compliant"; and seven of them were considered "Compliant with only few difficulties". Furthermore, the stakeholders that were in these groups classified eight of the requirements to be "compliant with great difficulties".

Sustainability Requirement	Oils
Air	Easily compliant
Biodiversity and Ecosystems	Compliant with great difficulties
Contractors and Suppliers	Compliant with great difficulties
Crop Management and Agrochemical Use	Compliant with only few difficulties
Direct Land Use Changes	Compliant with only few difficulties
Economic Viability and Production and Processing Efficiency	Compliant with only few difficulties
Employment, Wages and Labor Conditions	Compliant with great difficulties
Engagement and Communications with Stakeholders	Compliant with only few difficulties
Food Security	Easily compliant
GHG emissions	Compliant with great difficulties
Human Health and Safety	Compliant with great difficulties
Land Rights	Compliant with only few difficulties
Laws and International Conventions	Compliant with great difficulties
Rural and Social Development	Compliant with great difficulties
Social and Environmental Impact Assessment	Compliant with only few difficulties
Soil	Compliant with only few difficulties
Waste	Easily compliant
Water	Compliant with great difficulties

Neutral or irrelevant or not applicable	Easily compliant	Compliant with only few difficulties	Compliant with great difficulties	Very hard to be compliant

Figure 62 Oils: Evaluation of the degree of difficulty to meet requirement.

The following explanations justify the option chosen for each category. In the easily compliant categories are the following requirements: *air; food security and waste*. Concerning the waste, it was considered that the oil feedstock produces little or no harmful waste. Co-products (cakes) have several uses (animal feed, fertilizer). Regarding food security, agricultural feedstocks for bioenergy in Brazil nowadays do not compete with food production (CGEE, 2012; GOLDEMBERG, 2008; GOLDEMBERG et al., 2008; NASSAR et al., 2011; NEVES et al., 2011).

The requirements *Land rights; Soil; Crop Management and Agrochemical Use; Direct Land Use Changes; Social and Environmental Impact Assessment; Engagement and Communications with Stakeholders; Economic Viability and Production and Processing Efficiency* were in the "Compliant with only few difficulties" category.

Land use change was considered easy or neutral to be complied with on older farming areas, but may be difficult in expansion areas (agricultural frontiers) and also for palm oil producers.

Concerning *Social and Environmental Impact Assessment*, it was emphasized that compliance depends on production scale: very hard to comply for smallholders; and compliant with few difficulties for larger farmers.

The category "*Compliant with great difficulties*" took into account *Employment, Wages and Labor Conditions; Human Health and Safety;* CO_2 *emissions; Biodiversity and Ecosystems; Water; Rural and Social Development; Contractors and Suppliers*. Reasons to justify the option include the difficulties to calculate CO_2 emissions, which depends on the crop, being more favorable for palm oil than for soybean. On the other hand, ILUC may be greater for palm, although there are still no widely accepted methodologies to address this issue. Concerning labor conditions (human rights and labor), compliance may be difficult because it is dependent on third parties (suppliers).

The difficulties identified for the oil group, especially regarding GHG emissions calculations and biodiversity, are concerning and need to be addressed. The development of standard protocols and methodologies are important to be considered.

9.1.3.2.2 Technical Impacts

The majority of the impacts of sustainability requirements on technical risks were perceived as positive. Specifically on the impact of *Law and International Conventions*, the technical impact was considered positive because it leads to the use of more skilled workers (**Figure 63**).

Sustainability Requirement	Oils
Air	Neutral or irrelevant or not applicable
Biodiversity and Ecosystems	Positive
Contractors and Suppliers	Positive
Crop Management and Agrochemical Use	Positive
Direct Land Use Changes	Neutral or irrelevant or not applicable
Economic Viability and Production and Processing Efficiency	Positive
Employment, Wages and Labor Conditions	Positive
Engagement and Communications with Stakeholders	Neutral or irrelevant or not applicable
Food Security	Neutral or irrelevant or not applicable
GHG emissions	Positive
Human Health and Safety	Positive
Land Rights	Neutral or irrelevant or not applicable
Laws and International Conventions	Neutral or irrelevant or not applicable
Rural and Social Development	Negative
Social and Environmental Impact Assessment	Positive
Soil	Positive
Waste	Neutral or irrelevant or not applicable
Water	Positive

Neutral or irrelevant or not applicable	Highly positive	Positive	Negative	Highly negative

Figure 63 Oils: Impact of Sustainability Requirement on Technical Risks.

Concerning the impact of the *Water and Soil* requirement, the positive impact on technical risk can be explained due to the adoption of best practices (avoiding water contamination with pesticides, controlling erosion). However, it was emphasized that this would cause cost increases for the business in the short run. This group did not take into consideration impacts in the short run or in the long term as the other did.

9.1.3.2.3 Financial Impacts

Only three requirements were perceived as causing positive financial impacts (Waste, Crop Management and Agrochemical Use and Economic Viability and Production and Processing Efficiency). Besides those ones considered neutral or irrelevant, all other requirements were considered as causing negative financial impacts, due the need of investments to accomplish them (**Figure 64**). This group did not take into consideration impacts in the short term or in the long term as the other did.

Sustainability Requirement	Oils
Air	Neutral or irrelevant or not applicable
Biodiversity and Ecosystems	Negative
Contractors and Suppliers	Negative
Crop Management and Agrochemical Use	Positive
Direct Land Use Changes	Negative
Economic Viability and Production and Processing Efficiency	Positive
Employment, Wages and Labor Conditions	Negative
Engagement and Communications with Stakeholders	Negative
Food Security	Neutral or irrelevant or not applicable
GHG emissions	Negative
Human Health and Safety	Negative
Land Rights	Negative
Laws and International Conventions	Negative
Rural and Social Development	Negative
Social and Environmental Impact Assessment	Negative
Soil	Negative
Waste	Positive
Water	Negative

Neutral or irrelevant or not applicable	Highly positive	Positive	Negative	Highly negative

Figure 64 Oils: Impact of Sustainability Requirement on Financial Risks.

9.1.3.2.4 Commercial Impacts

Compliance with all of the requirements was considered to have positive commercial impacts (**Figure 65**). The main reasons cited were: compliance with legislation will increase costs, but will have a positive impact with customers and it is favorable for trade; if land rights are not proven there would be problems with access to credit (negative financial impact), as well as to market the product.

Sustainability Requirement	Oils
Air	
Biodiversity and Ecosystems	
Contractors and Suppliers	
Crop Management and Agrochemical Use	
Direct Land Use Changes	
Economic Viability and Production and Processing Efficiency	
Employment, Wages and Labor Conditions	
Engagement and Communications with Stakeholders	
Food Security	
GHG emissions	
Human Health and Safety	
Land Rights	
Laws and International Conventions	
Rural and Social Development	
Social and Environmental Impact Assessment	
Soil	
Waste	
Water	

Neutral or irrelevant or not applicable	**Highly positive**	**Positive**	**Negative**	**Highly negative**

Figure 65 Oils: Impact of Sustainability Requirement on Commercial Risks.

9.1.3.2.5 Oils: Summary

Compliance	- Social: Human rights and labor issues: difficult to depend on third parties; Comply with the laws will increase costs but will have a positive impact with customers; If land rights are not proven there would be problems with access to credit (financial) as well as to market the product; Small producers may have more difficulty to comply; Brazilian feedstocks for bioenergy are not competing with food. There is a positive impact for clients, therefore improves commercial impacts. Food versus fuel may be a problem in the future.

Compliance	- Environmental: Comply with the laws will increase costs but will have a positive impact with customers; Small producers may have more difficulty to comply; Difficulties with calculating CO_2. Depends also on crop. More favorable for palm oil than for soybean. On the other hand ILUC may be greater for palm; Better farming practices may have a positive technical impact but there are several unknowns on this topic; LUC: Easy or neutral on old farming areas but may be difficult on the frontiers; may be difficult for palm oil; Great difficulties for expansion of feedstock production.
	- Economic: standards are focused on production efficiency of feedstcoks; lack of data on costs of jet biofuels since there is no scale production in Brazil. Experimental production has taken place, but the costs are unknown. Price policies must be defined and should consider the positive externalities of biofuels.
Technical Impacts	The impacts vary. They can be negative in the short term, and positive in the long term. All negatives in the short term. - Social impact: positive because of more qualified personnel; comply with law is favorable for trade. - Impacts will be different for each region: more difficult in the lands of frontier.
Financial Impacts	Financial: the financial impact is negative. However, the additional cost could affect the commercial impacts. If the image of the feedstock/product was positively affected by compliance with the requirement, a favorable commercial impact shall also be considered.
Commercial Impacts	The group had some difficulty to decide when the net commercial impact was negative or positive.

9.1.3.3 Lignocellulosics

9.1.3.3.1 Sustainability gaps

The lignocellulosic group comprises mainly sugarcane bagasse and forestry wood residues, although agricultural residues and grasses were also mentioned occasionally in the discussions. Given that the lignocellulosic feedstocks selected are mostly from residues, the general evaluation is that the lignocellulosic group is able to comply with the majority of the sustainability requirements. Out of the 19 requirements, only one was considered possible to comply with great difficulties. The others were ranked as easily compliant and as compliant with only few difficulties.

The requirements considered as easily compliant are those in which the impacts are associated to the main product, such as sugarcane – in the case of sugarcane bagasse – and commercial forests – in the case of wood residues. The impacts associated with requirements such as *crop management and agrochemical use, economic viability and production and processing efficiency, engagement and communications with stakeholders, food security, CO_2 emissions, rural and social development* and *waste* are mostly attributable to the main products, which allow their residues to be easily compliant (**Figure 66**).

In the case of the requirements of *air, biodiversity and ecosystems, contractors and suppliers, direct land use changes, employment, wages and labor conditions, human health and safety, land rights, social and environmental impact assessment, soil and* *water*, the assessment was that, although the impacts are also attributable to the main product, the residues could not be dissociated from these impacts.

Sustainability Requirement	Cellulosic
Air	Compliant with only few difficulties
Biodiversity and Ecosystems	Compliant with only few difficulties
Contractors and Suppliers	Compliant with only few difficulties
Crop Management and Agrochemical Use	Easily compliant
Direct Land Use Changes	Compliant with only few difficulties
Economic Viability and Production and Processing Efficiency	Easily compliant
Employment, Wages and Labor Conditions	Compliant with only few difficulties
Engagement and Communications with Stakeholders	Easily compliant
Food Security	Easily compliant
GHG emissions	Easily compliant
Human Health and Safety	Compliant with only few difficulties
Land Rights	Compliant with only few difficulties
Laws and International Conventions	Compliant with great difficulties
Rural and Social Development	Easily compliant
Social and Environmental Impact Assessment	Compliant with only few difficulties
Soil	Compliant with only few difficulties
Waste	Easily compliant
Water	Compliant with only few difficulties

Neutral or irrelevant or not applicable	Easily compliant	Compliant with only few difficulties	Compliant with great difficulties	Very hard to be compliant

Figure 66 Cellulosic: Evaluation of the degree of difficulty to meet the requirements.

The following explanations justify the option chosen for each requirement:

1. *Air*: associated to the slash and burning practices of sugarcane still used in the harvesting.
2. *Biodiversity and Ecosystems*: some regions in Brazil would have more difficulties to comply with the preservation of biodiversity and ecosystems, especially if the level of technology in production is too low or in frontier regions.
3. *Contractors and Suppliers*: integrated value chains (sugarcane and commercial forests) were considered as easily compliant, but non-integrated chains may face greater difficulties.
4. *Crop Management and Agrochemical Use*: GMO varieties were not considered and the only concern is vinasse application.

5. *Direct Land Use Changes*: it can be an issue in Cerrado's expansion frontier both for sugarcane and commercial forests.
6. *Economic Viability and Production and Processing Efficiency*: being residues, the economic viability of production is not an issue for cane bagasse and wood residues.
7. *Employment, Wages and Labor Conditions*: risks are never zero in labor conditions, although both sugarcane and commercial forests sectors have high standards.
8. *Engagement and Communications with Stakeholders*: this is a current practice in sugarcane and commercial forests sectors.
9. *Food Security*: it can be an issue in marginal areas but it is not relevant in general.
10. CO_2 emissions: even allocating some emissions in the production of the main product to the residues, CO_2 emissions reductions are high.
11. *Human Health and Safety*: varies according to the region where the feedstock is produced.
12. *Land Rights*: varies according to the region where the feedstock is produced.
13. *Laws and International Conventions*: although not discussed in detail, the general assessment is that there are international conventions that might not be easy to comply with.
14. *Rural and Social Development*: as a general evaluation, sugarcane and commercial forests production promote rural and social development.
15. *Social and Environmental Impact Assessment*: compliance with social and environmental regulations is an issue, especially in the case of independent sugarcane suppliers.
16. *Soil*: soil conservation needs to be improved in the production of sugarcane.
17. *Waste*: easily compliant because wastes from sugarcane and commercial forest production would have value and thus would not be disposed of.
18. *Water*: assuming production without irrigation, which is the majority of the cases for sugarcane and commercial forests, water usage is not an issue. However, water yield is a topic to be monitored in situations with certain types of land use changes. The issue of surface water contamination is also important and included in the principles and criteria of sustainability standards. However, it was not discussed specifically by the group. The Brazilian law addresses this to some extent.

9.1.3.3.2 Technical Impacts

Given that the feedstocks for cellulosic biofuels are residues, all impacts of sustainability requirements on technical risks were perceived as positive and highly positive. The assessment is that compliance with the sustainability requirements helps to reduce technical risks or to reinforce lignocellulosic biofuel as a strong alternative for renewable fuels in comparison with other sources of renewables (**Figure 67**).

Sustainability Requirement	Lignocellulosics
Air	
Biodiversity and Ecosystems	
Contractors and Suppliers	
Crop Management and Agrochemical Use	
Direct Land Use Changes	
Economic Viability and Production and Processing Efficiency	
Employment, Wages and Labor Conditions	
Engagement and Communications with Stakeholders	
Food Security	
GHG emissions	
Human Health and Safety	
Land Rights	
Laws and International Conventions	
Rural and Social Development	
Social and Environmental Impact Assessment	
Soil	
Waste	
Water	

Neutral or irrelevant or not applicable	Highly positive	Positive	Negative	Highly negative

Figure 67 Lignocellulosics: Impact of Sustainability Requirement on Technical Risks.

9.1.3.3.3 Financial Impacts

The criteria used to analyze the financial impacts was to divide the impacts from sustainability requirements in two groups: one with the capacity to aggregate value to the final product and a second one that only generate additional costs without necessarily aggregating more value to the final product.

Based on these criteria, the requirements considered as only adding costs were employment, wages and labor conditions, laws and international conventions, and social and environmental impact assessment (**Figure 68**).

Sustainability Requirement	Cellulosic
Air	Positive
Biodiversity and Ecosystems	Positive
Contractors and Suppliers	Positive
Crop Management and Agrochemical Use	Positive
Direct Land Use Changes	Positive
Economic Viability and Production and Processing Efficiency	Highly positive
Employment, Wages and Labor Conditions	Negative
Engagement and Communications with Stakeholders	Positive
Food Security	Positive
GHG emissions	Highly positive
Human Health and Safety	Positive
Land Rights	Positive
Laws and International Conventions	Negative
Rural and Social Development	Positive
Social and Environmental Impact Assessment	Negative
Soil	Positive
Waste	Highly positive
Water	Positive

Neutral or irrelevant or not applicable	Highly positive	Positive	Negative	Highly negative

Figure 68 Cellulosic: Impact of Sustainability Requirement on Financial Risks.

9.1.3.3.4 Commercial Impacts

Following similar criteria used in technical and financial risks, the impact of the sustainability requirement on commercial aspects was considered positive if it is able to aggregate value from a marketing perspective. Based on this criterion, all sustainability requirements were considered positive and highly positive (**Figure 69**).

Sustainability Requirement	Cellulosic
Air	Positive
Biodiversity and Ecosystems	Highly positive
Contractors and Suppliers	Highly positive
Crop Management and Agrochemical Use	Positive
Direct Land Use Changes	Positive
Economic Viability and Production and Processing Efficiency	Highly positive
Employment, Wages and Labor Conditions	Positive
Engagement and Communications with Stakeholders	Highly positive
Food Security	Positive
GHG emissions	Highly positive
Human Health and Safety	Positive
Land Rights	Positive
Laws and International Conventions	Positive
Rural and Social Development	Positive
Social and Environmental Impact Assessment	Positive
Soil	Positive
Waste	Highly positive
Water	Positive

Neutral or irrelevant or not applicable	**Highly positive**	**Positive**	**Negative**	**Highly negative**

Figure 69 Cellulosic: Impact of Sustainability Requirement on Commercial Risks.

9.1.3.3.5 Lignocellulosic: Summary

Compliance	- Social: compliance with some of the laws; Land rights: there are regions in which this must be a larger issue; depending on the region; Contractors and Suppliers: sustainability compliance would be much like positive in integrated value chains such as sugarcane and planted forests and systems that are able to generate by-products than systems dedicated to one product; integrated systems have different results than non integrated; issue of equivalence and overlapping of regulations and requirements, although we have two layers (national and international).
	- Environmental: compliance with some of the laws; CO_2 emissions calculation is a complex issue, depends on the feedstock, the process, local conditions, etc; Biodiversity: some regions and feedstocks where the compliance might be more difficult; assuming that water usage is not an issue compliance is easy; Water yield can be an issue depending the land use change; Biological control and chemical control (it is working); - LUC: Can be an issue for future expansion in the Cerrados. Comparing to other feedstocks it is creating value and positive impacts; issue of equivalence and overlapping of regulations and requirements, although we have two layers (national and international).

Compliance	- Economic: standards are focused on production efficiency of feedstocks; lack of data on costs of jet biofuels since there is no scale production in Brazil. Experimental production has taken place, but the costs are unknown. Price policies must be defined and should consider the positive externalities of biofuels.
Technical Impacts	- The group adopted a long term perspective, therefore positive and highly positive scales predominate in the responses
Financial Impacts	- The group adopted a long term perspective, therefore positive and highly positive scales predominate in the responses
Commercial Impacts	- Positive.

9.1.3.4 Wastes

9.1.3.4.1 Sustainability gaps

Differently from the other feedstocks in which the sustainability requirements were assessed from the production perspective, mainly agriculture and forest for instance, the perspective used in wastes was more related to the process of collecting, cleaning and preparing the different types of wastes (flue gas, used cooking oil, municipal solid waste and animal fat), as well as the refining process.

The majority of the sustainability requirements were considered as easily compliant or compliant with few difficulties. The easily compliant requirements are those unrelated to the supply of waste. Waste supply is not associated to the use of land and does not use land as an input, which facilitates compliance with requirements associated to land use changes, land rights, biodiversity, food security and soil conservation.

Regarding the other requirements for which wastes can comply with only few difficulties, the explanations vary depending on the case. Air and water are inputs for the waste supply chain and depending on the type of the waste to be processed, those inputs can be intensively used. According to stakeholder discussions, the MSW and flue gas processes use more water than the used cooking oil and animal fat processes, due to water use in fermentation process compared to catalysis.

Waste processes can also generate products that need must be treated in order treatment and, therefore, some difficulties may appear to comply with sustainability requirements.

The requirements that were classified as compliant with only a few difficulties are not related to inputs, but to conditions not necessarily linked to the supply of the feedstock. On the economic viability requirement, some processes still need to be more efficient. Waste collection from landfills faces the problem of competition with large and informal labor (without formal labor contracts) communities that work in collecting and sorting trash in Brazil. Although there is space for improvement, big cities would probably be better positioned than small cities, since economies of scale apply across technologies and, therefore, aggregating a larger waste resource in one place is key. To develop a mechanism to communicate with the stakeholders of these communities can be a challenge.

In the case of MSW, protection of human health and safety needs strong improvements, although for other types of waste it is easy to comply with the requirements. Social development may be improved if existing workers are involved in sorting wastes for use in fuel production, however the level of informality in some cases may be a limiting factor.

Regarding the social and environmental impact assessment requirement, the perception is that compliance can be easier for waste than for other feedstocks, although transaction costs to carry out an impact assessment are high in Brazil.

Compliance with CO_2 emissions requirements depends on the type of waste. Some processes are extremely energy intensive, which can undermine CO_2 emissions reductions (although this depends on the system boundaries and on how the CO_2 emission are calculated and allocated). For flue gases primarily containing CO and CO_2, hydrogen may be needed, and, therefore renewable hydrogen sources such as biomass syngas may be used to be compliant with CO_2 emission requirements. In the MSW process, the biodegradable portion, can be compliant with great difficulties. Tallow and used cooking oil can comply more easily than the others, but also depend on specific situations.

Waste supply chains, in general, have several middlemen and intermediary agents, making traceability very hard to be implemented. Therefore, it was considered as very hard to be compliant (**Figure 70**), eventhough for industrial residues this may be easier.

Sustainability Requirement	Waste
Air	Compliant with only few difficulties
Biodiversity and Ecosystems	Easily compliant
Contractors and Suppliers[1]	Very hard to be compliant
Crop Management and Agrochemical Use	Neutral or irrelevant or not applicable
Direct Land Use Changes	Easily compliant
Economic Viability and Production and Processing Efficiency	Compliant with only few difficulties
Employment, Wages and Labor Conditions	Compliant with only few difficulties
Engagement and Communications with Stakeholders	Compliant with only few difficulties
Food Security	Easily compliant
GHG emissions	Varies
Human Health and Safety	Compliant with only few difficulties
Land Rights	Neutral or irrelevant or not applicable
Laws and International Conventions	Easily compliant
Rural and Social Development	Compliant with only few difficulties
Social and Environmental Impact Assessment	Compliant with only few difficulties
Soil	Easily compliant
Waste	Compliant with only few difficulties
Water	Compliant with only few difficulties

Note: [1] For industrial residues it can be considered as "Compliant with only few difficulties"

Neutral or irrelevant or not applicable	Easily compliant	Compliant with only few difficulties	Compliant with great difficulties	Very hard to be compliant

Figure 70 Waste: Evaluation of the degree of difficulty to meet the requirements.

9.1.3.4.2 Technical Impacts

In terms of the impacts on technical aspects, the majority of the requirements were considered as neutral, or irrelevant or not applicable. The requirements considered neutral are almost the same as those considered neutral in the previous section, plus the ones considered easily compliant because they are not related to waste supply. In this instance, the multiple neutral ratings reflect the minimal impact these feedstocks have on sustainability criteria.

In the case of requirements ranked with positive impacts, the main criterion was that the use of the waste for processing jet biofuels will improve the capacity of the industry to comply with the requirement and, therefore, reduce technical risks (**Figure 71**).

In several other requirements, the risks are different among the waste types (MSW, tallow, flue gas and used cooking oil) and depend on the process. In general, those sustainability requirements are expected to have highly positive or positive impacts.

The perception is that reducing CO_2 emissions increases technical complexity, although it would also push for innovation. There is a perception that, at the margin, it may be difficult to further CO_2 emissions reductions.

Sustainability Requirement	Waste
Air	Varies
Biodiversity and Ecosystems	
Contractors and Suppliers[1]	
Crop Management and Agrochemical Use	
Direct Land Use Changes	
Economic Viability and Production and Processing Efficiency	
Employment, Wages and Labor Conditions	
Engagement and Communications with Stakeholders	Varies
Food Security	
GHG emissions	
Human Health and Safety	Varies
Land Rights	
Laws and International Conventions	
Rural and Social Development	
Social and Environmental Impact Assessment	
Soil	
Waste	Varies
Water	Varies

Note: [1] LanzaTech considers as "Highly positive" for industrial residues

Neutral or irrelevant or not applicable	Highly positive	Positive	Negative	Highly negative

Figure 71 Waste: Impact of Sustainability Requirement on Technical Risks.

9.1.3.4.3 Financial Impacts

The requirements considered as neutral or irrelevant or not applicable are very similar to the previous section and, therefore, the reasons are the same: the requirement is not related to the supply of the waste.

Engagement with stakeholders, CO_2 emissions, human health and safety, law and international conventions and social and environmental impact assessment were considered as having positive impacts on financial risks of operating facilities. On the other hand, requirements perceived as directly associated to production costs, such as employment, wages and labor conditions, rural and social development and waste treatment, were considered as increasing financial risks.

In the case of water and air, additional treatments may increase investment costs but a more efficient process can economize on the use of the resource. For this reason, the impacts can be both positive and negative (**Figure 72**).

Sustainability Requirement	Waste
Air	Varies
Biodiversity and Ecosystems	
Contractors and Suppliers[1]	
Crop Management and Agrochemical Use	
Direct Land Use Changes	
Economic Viability and Production and Processing Efficiency	Varies
Employment, Wages and Labor Conditions	
Engagement and Communications with Stakeholders	
Food Security	
GHG emissions	
Human Health and Safety	
Land Rights	
Laws and International Conventions	
Rural and Social Development	
Social and Environmental Impact Assessment	
Soil	
Waste	
Water	Varies

Note: [1] For industrial residues it can be considered as "Positive"

Neutral or irrelevant or not applicable	Highly positive	Positive	Negative	Highly negative

Figure 72 Waste: Impact of Sustainability Requirement on Financial Risks.

9.1.3.4.4 Commercial Impacts

The assessment of commercial risks was different from the technical and financial risks. The majority of the requirements were considered highly positive or positive (**Figure 73**). The main perception is that complying with sustainability requirements creates value in the market for fuels from wastes, acting as an incentive for waste value chains to adopt sustainability standards as a commercial strategy. The conclusion is that fuels from wastes are sustainable from a marketing perspective.

Sustainability Requirement	Waste
Air	
Biodiversity and Ecosystems	
Contractors and Suppliers[1]	
Crop Management and Agrochemical Use	
Direct Land Use Changes	
Economic Viability and Production and Processing Efficiency	
Employment, Wages and Labor Conditions	
Engagement and Communications with Stakeholders	
Food Security	
GHG emissions	
Human Health and Safety	
Land Rights	
Laws and International Conventions	
Rural and Social Development	
Social and Environmental Impact Assessment	
Soil	
Waste	
Water	

Neutral or irrelevant or not applicable	Highly positive	Positive	Negative	Highly negative

Figure 73 Waste: Impact of Sustainability Requirement on Commercial Risks.

9.1.3.4.5 Wastes: Summary

Compliance	- Social: Eye for conflicting laws. Careful not to inhibit process of developing solutions; formality or informality of waste collection and landfills. Room for improvement. May not be as easy to compliant. In the case of big cities, it will probably be easy, but in smaller cities it might be harder; Improve the safety of employees. Making conditions of workers better; Social Development: Infrastructure development, jobs. Consider financial difficulties that are involved. Different financial options that do not result in the same amount of social development.

Compliance	- Environmental: Eye for conflicting laws. Careful not to inhibit process of developing solutions; CO_2 emissions: some processes are extremely energy intensive. Compliance varies among process (easy to comply with difficult to comply) ; Increases technical complexity and push innovation. Maybe not very much of a margin to increases CO_2 reductions. Biodiversity: Easily compliant because there are no problems related. - Water: Processes with a lot of use of water (cooking oil); Animal fat: comply with great difficulties;
	- Economic: standards are focused on production efficie°ncy of feedstocks; lack of data on costs of jet biofuels since there is no scale production in Brazil. Experimental production has taken place, but the costs are unknown. - Price policies must be defined and should consider the positive externalities of biofuels.
Technical Impacts	Medium and long range. In the short run, start-up phase, may be negative. Positive: transform something bad into something good. Differences among waste feedstocks.
Financial Impacts	- Important to consider financial difficulties that are involved. - Laws will push technology development. This will have a positive impact on business plan. Understanding of what laws apply. - In the beginning it may be neg°ative. No personnel to employ because they must be trained - Business plan, you may get results later on. Getting money at lower interest rate (would also be positive).
Commercial Impacts	Positive: perception that using waste is a good thing. Not part of fuel and food debate

9.1.3.5 Overall view

Figure 74 provides an overall view of the whole of feedstocks groups regarding the classification of the requirement gaps. It can be observed that, for all groups, the following requirements were considered easily compliant or compliant with only few difficulties: Air; Direct Land Use Changes; Social and Environmental Impact Assessment; Waste; Engagement and Communications with Stakeholders; Soil; Waste.

Economic and Food Security requirements were considered also in these categories, however one of the groups did not evaluate these requirements.

The other requirements, as observed, vary according to the feedstock group.

9.1.3.5.1 Final Remarks

It is important to highlight, as emphasized by some of the presenters in 4th and 7th workshop, that sustainability should not be treated as static theme, since it is constantly changing and improving: "*Sustainability comes from continuous improvement in best practices through innovation*". From our point of view, both the criteria and the methods to assess compliance with them established by the main certification schemes evolve over time, as well as the indicators themselves.

In the specific case of agricultural feedstocks in Brazil, it is noteworthy that the sustainability agenda has become effective from the year 2000, when important improvements started to occur in the environmental and social sustainability indicators for some crops,

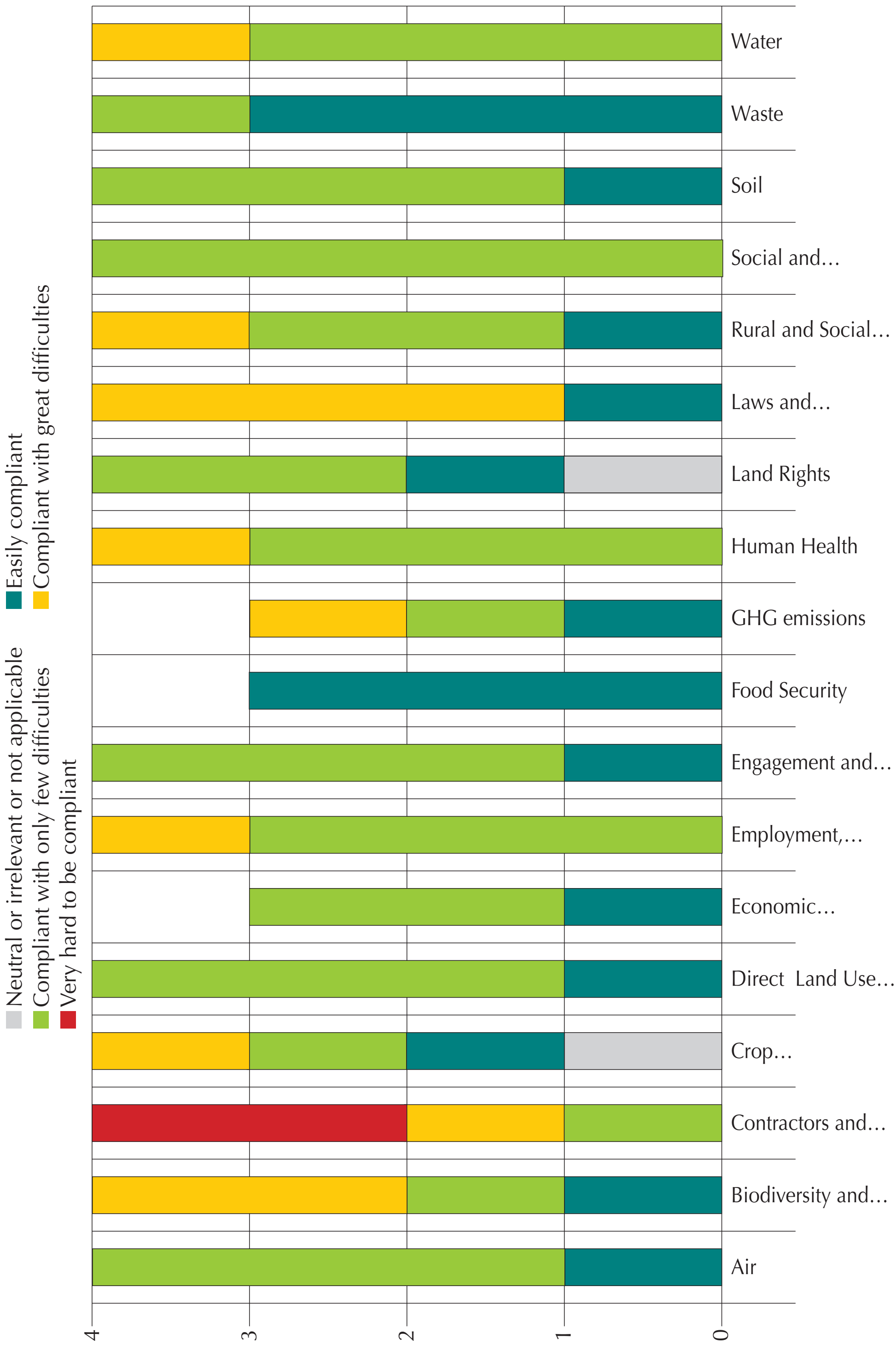

Figure 74 Overall evaluation of the degree of difficulty to meet requirement.

particularly soybean, cotton and sugarcane. In 7th Workshop, it was emphasized that positive advances in the sugarcane indicators ended up positively influencing some traditional agricultural crops that did not originally see themes related to sustainability as concerns.

With this, positive advances are expected from national producers through time.

Although there are important differences among the four groups of feedstocks, some general common considerations can be made regarding biofuels production and also related to the gaps to comply with the sustainability requirements.

Concerning the social area, the main positive impacts are the high potential of job creation and income generation, and the positive impacts on regional development. As for the sustainability requirement's gaps, several factors were emphasized that make compliance more difficult, such as the great number of labor laws and rules in Brazil, sometimes more strict than sustainability standards; different interpretations and the lack of knowledge on how to apply laws; and labor laws not adapted to the rural context. It was also noted that there is a need for qualification and training of workers.

As for the Environmental Aspects, the positive impact related to compliance with requirements is the reduction in CO_2 emissions compared to fossil fuels, especially in the sucrose and cellulosic groups, although there are still some difficulties with CO_2 calculation and data.

Macedo et al., (2008) analyzed the GHG emissions and mitigation for ethanol from sugarcane in Brazil for the 2002-2008 period and the expected changes in the expansion from 2008-2020. Regarding the land use changes (LUC) effects, ethanol expansion started in 2002 led to a very small use of native vegetation lands (less than 1%), and a large use of low productive pasture lands and some crop areas (soy and maize). The relatively small area used for the expansion was due to land availability[18], environmental restrictions, and local economic conditions. Growth scenarios for 2020 (reaching 60M m^3 ethanol) indicate the need for relatively small areas (approximately 5 Mha) as compared to the availability (non-used arable lands or degraded pasture lands). Thus if policy and law enforcement are implemented so as to ensure optimal land use for biofuels, they found that very little impact (if any) from LUC on GHG emissions is expected. Considering the local conditions in Brazil, Macedo et al., (2008) found the area needed for the expansion to be very small when compared with the area liberated with increased cattle raising efficiency (30 Mha) and other non-used arable land. They showed that sugarcane expansion has been independent (and much smaller) than of the growth of other agricultural crops. In all sugarcane expansion areas the eventual competition products (crops and beef production) also expanded.

An important issue is the food versus fuel debate, a global concern that has been widely addressed in the media and discussed by stakeholders in defining sustainability standards. Biofuel production using agricultural feedstocks (especially maize, sugarcane and cereals) is accused of displacing land that could be used to produce food, causing food prices to increase and threatening food security in certain regions. According to Rosillo-Calle (2012): "*biofuel production and food security needs to be complementary*". It is important to assess food security impacts from biofuel production, but without disregarding the positive impacts that the additional income has on agricultural productivity. It is equally important to remember the benefits that these alternative fuels generate if they meet their most important function, which is to reduce GHG emissions from the whole supply chain when compared to fossil fuels.

18 See Brazilian Sugarcane Agroecological Zoning (ZAE Cana) http://www.cnps.embrapa.br/zoneamento_cana_de_acucar/

In Brazil, there is enough available land for the production of food and biomass for biofuels (CGEE, 2012; GOLDEMBERG, 2008; GOLDEMBERG et al., 2008; NASSAR et al., 2011; ADAMI et al., 2012; NASSAR; MOREIRA, 2013). Agricultural expansion has been taking place in degraded pasture areas and productivity of livestock production has increased significantly, from 0.92 heads/hectare in 2000 to 1.15 heads/hectare in 2010 (FIESP; ICONE, 2012).

The great number of environmental laws and rules (sometimes more strict than sustainability standards) and legal uncertainty (changes in the Forest Code, law regulating the conditions for Foreign Investors) are considered difficulties to comply with the legal requirements.

Brazilian legislation establishes that at least 20% of the land of individual farms (50% to 80% in the Amazon region) be set aside under Legal Reservation in order to preserve natural resources, water sources, biodiversity, and shelter for the native fauna and vegetation. In addition, stretches of land along water bodies as well as those with slopes above 45° are Areas of Permanent Preservation and cannot legally be converted to production. Aspects of Brazilian legislation on sustainability issues and considerations about difficulties of law enforcement are discussed in **Box 1** below.

It was considered that it is possible to be compliant with national and international rules and norms, but this requires investments. In general terms, small and independent producers have more difficulty to comply with the requirements.

The need for a clear price policy for fuels was emphasized, in order to make the production economically sustainable and to attract private investments and the use of jet biofuels.

Furthermore, it is fundamental that certification initiatives make an effort to harmonize standards among themselves and also with national standards in order to minimize conflicts and to promote the main objective of certification, which are more sustainable operations. In addition, it is fundamental that these initiatives implement actions to increase knowledge on these sustainability standards and to educate growers and companies on how to apply them.

Box 1: Law Enforcement & Sustainability

Environmentally sustainable production of jet biofuel is a strategic objective of the aviation industry, therefore meeting sustainability standards is of great importance.

Brazilian laws are quite strict to protect natural resources, water and biodiversity. The Brazilian Forest Code is among the most restrictive legislation on land use. Labor laws are equally severe. However, complying with legality principles of sustainability standards is regarded as challenging, in some circumstances. Many laws and rules are complex, prone to different interpretation, and sometimes, as in the Forest Code, demand expensive investments to make up for land clearing done in the past under other legislation. Generally small and independent producers have even more difficulty to comply with the rules because of the high costs involved. In addition, the extensive Brazilian territory makes it more difficult to enforce some laws. Under these conditions the legal framework in place, which could be quite effective to guarantee high sustainability standards, often falls short of its objectives.

It is critical that the Action Plan for implementation of aviation biofuels in Brazil emphasize that companies, institutions, or farmers that receive any incentive or benefit from public policies that involve public funds, abide by the laws related to the sustainability of processes in the whole production chain. Proof of compliance must be tied to receiving any benefits.

Table 30 Feedstock compliance to sustainability laws and regulations.

FEEDSTOCK GROUP	SOCIAL	ENVIRONMENTAL	ECONOMIC
Sucrose/starch	• Great number of laws and regulations; different interpretations and lack of knowledge on how to apply laws; small and/or independent producers have more difficulty to comply; labor laws not adapted to the rural context; Personal Protective Equipment not adapted to rural workers; although labor conditions have improved, this is still an issue in some regions, especially with independent suppliers; difficulties with documentation on land rights, especially in some regions; • Rural development: job creation, income generation, improve schooling and training	• The compliance of some requirements varies among regions and soil situation • Main difficulties related to: - biodiversity and ecosystem; - crop management - Direct Land Use Change: compliance different among regions (e.g. good in São Paulo and Minas Gerais, but other states may have lack of data to prove that the area was a degraded area) • Vinasse: some states have legislation, others don't. Depending on the standard, criteria can be easy or difficult to comply with.	• Standards are focused on production efficiency of feedstock; lack of data on costs of jet biofuels since there is no scale production in Brazil. Experimental production has taken place, but the costs are unknown. Price policies must be defined and should consider the positive externalities of biofuels.
Oil	• Human rights and labor issues: Difficult to depend on third parties; Compliance with the laws will increase costs but will have a positive impact with customers; If land rights are not proven there would be problems with access to credit (financial) as well as to market the product; Small producers may have more difficulty to comply;	• Compliance with the laws will increase costs but will have a positive impact with customers; Small producers may have more difficulty to comply; Difficulties with calculating GHG. Depends also on crop. More favorable for palm oil than for soybean. On the other hand ILUC may be greater for palm; Better farming practices may have a positive technical impact but there are several unknowns on this topic; LUC: Easy or neutral on old farming areas but may be difficult on the frontiers; may be difficult for palm oil; Great difficulties for expansion of feedstock production; Brazilian feedstocks for bioenergy are not competing with food. There is a positive impact for clients, therefore improves commercial impacts. Food versus fuel may be a problem in the future.	• Standards are focused on production efficiency of feedstocks; lack of data on costs of jet biofuels since there is no scale production in Brazil. Experimental production has taken place, but the costs are unknown. Price policies must be defined and should consider the positive externalities of biofuels.

Table 30 Feedstock compliance to sustainability laws and regulations (continued).

FEEDSTOCK GROUP	SOCIAL	ENVIRONMENTAL	ECONOMIC
Lignocellulosic	• Compliance with most of the laws depends on the region; Land rights: there are regions in which this may be a larger issue; • Contractors and Suppliers: sustainability compliance would be easier in integrated value chains such as sugarcane and planted forests and systems that are able to generate by-products than systems dedicated to one product; integrated systems have different results than non- integrated; issue of equivalence and overlapping of regulations and requirements, especially since we have two layers (national and international)	• Compliance with most of the laws and standards is expected to be achievable because the impacts are attributable to the main product; GHG emissions calculation is a complex issue, depends on the feedstock, the process, local conditions, etc; Biodiversity: in some regions and feedstocks the compliance might be more difficult; assuming that water usage is not an issue compliance is easy; Water yield can be an issue depending the land use change; Biological control and chemical control; • LUC: Can be an issue for future expansion in the Cerrados. Compared to other feedstocks cellulosic is creating value and positive impacts; issue of equivalence and overlapping of regulations and requirements, especially since there are two layers (national and international)	• Standards are focused on production efficiency of feedstocks; lack of data on costs of jet biofuels since there is no scale production in Brazil. Experimental production has taken place, but the costs are unknown. Price policies must be defined and should consider the positive externalities of biofuels.
Wastes	• There is potential for conflicting laws. Careful not to inhibit process of developing solutions; informality of labor for waste collection and landfills. Room for improvement. May not be as easy to compliant. In the case of big cities, it will probably be easy, but in smaller cities it might be harder; Improve the safety of employees. Making conditions of workers better; Social Development: Infrastructure development, jobs. Consider financial difficulties that are involved. Different financial options that do not result in the same amount of social development	• There is potential for conflicting laws. Careful not to inhibit process of developing solutions; GHG emissions: some processes are extremely energy intensive. Compliance varies among processes (easy to comply with difficult to comply); Increases technical complexity and pushes innovation. Maybe not very much of a margin to increases GHG reductions. Biodiversity: Easily compliant because there are no problems related to land. • Water: Processes with high water demand (cooking oil); animal fat: comply with great difficulties; Water pollution must be addressed.	• Standards are focused on production efficiency of feedstocks; lack of data on costs of jet biofuels since there is no scale production in Brazil. Experimental production has taken place, but the costs are unknown. Price policies must be defined and should consider the positive externalities of biofuels.

Box 2: Regional Outreaches

In addition to the 9 programmed workshops conducted in the Sustainable Aviation Biofuels for Brazil Roadmap Project, three Regional Outreach workshops were organized by BOEING with the objective to provide regional views on challenges and opportunities that helped broaden the range of perspectives and stakeholders. EPFL (Victoria Junquera and Sébastien Haye) and 4CDM (Cristiane Azevedo) joined local stakeholders including producers, NGOs, academic experts and public agencies in three workshops. The main roadmap had the greatest concentration of stakeholders (and most of its workshops) from the Southeast region so the Regional Outreaches provided input from three regions: Northeast (Recife), Center-West (Cuiaba) and South (Curitiba). The North Region was not included in the Regional Outreaches due to the fact that it is predominantly composed of Amazonian forest therefore it was not considered a likely candidate for sustainable aviation fuel development.

The major findings and recommendations of the Regional Outreaches are listed below:

FEEDSTOCKS – Explore the potential of feedstocks adaptable to each region such as: Northeast – native palm species (Babaçú – Attalea speciosa, Catolé – Syagrus cearenses, Licuri Palm – Syagrus coronata, and Macaúba Palm – Acrocomia intumescens), castor seed, cotton, oiticica – Licania rígida, other oils, and microalgae; Center West – camelina, cotton, non-edible sweet potato, and soy; South – camelina, castor bean – Ricinus communis, cártamo – Carthamus tinctorius, crambe – Hochst abyssinica, forestry, forrage turnip – Raphanus sativus L., jatropha, macaúba, microalgae, peanut, rapeseed, sunflower, tungue – Aleurites fordii, and woody residues. Very little agronomic information is available for most, so agronomic studies must establish producing guidelines and best practices.

FOCUS – In the short term, focus on medium – to large-sized producers since they can produce at the scale needed.

COLLABORATION – Develop a model enabling structured collaboration between universities, national and state research organizations, government agencies and industry that stimulates innovation and dialogue while minimizing bureaucracy, leveraging capabilities across the country and transferring technologies to industry. Provide mechanisms for funding from national and international investors, as well as government. Drive productivity and regional development with mechanisms such as the "rural extension" program to transfer knowledge of best practices between state agronomic institutes, local Embrapas and research entities.

SUSTAINABILITY – A common definition frames sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs." It is critical to address economic, social and environmental aspects of sustainability in developing supply chains for aviation biofuels. It makes business sense to avoid creating unnecessary impacts and triggering controversies over land, water, labor conditions, food prices or deforestation, and to demonstrate long-term financial viability in a world that may be dominated by climate change effects on agriculture. International sustainability standards and voluntary certifications, such as the RSB or Bonsucro, allow producers to demonstrate to their whole supply chain that they are using good practices, giving them an advantage in the market, especially for aviation biofuels, where the buyers are interested in proving the sustainability of their fuel supplies

POLICIES – Establish policies that incentivize and consider the whole supply chain and the biofuels industry as a whole, not policies specific to a particular feedstock or process. Apply smart incentive policies over time, at regional and national levels, to eventually make production economically sustainable. Expand investment in infrastructure, especially road and rail, is a fundamental condition for acceleration of sustainable regional biofuels industries as well as overall development of Brazil.

More details about the Regional Outreach Workshops can be found in Annex 1 of this report.

9.2 Refining Technologies

Current technologies allow conversion of feedstocks to drop-in jet biofuel and following a similar method previously used for feedstock assessment, a multicriteria analysis was conducted on 3rd Workshop ("Refining Technologies"). It also showed that all alternatives have strategic potential to be compliant with the roadmap goals, but, again, technical and commercial risks need mitigation and are somewhat specific to each alternative. **Table 31** lists some of the most important technical and commercial aspects identified. Gaps and barriers summarized and briefly described here.

Sugars and vegetable oils can be efficiently transformed into jet biofuel and the technologies are well known and can be implanted immediately, however both are foodstuffs and not available in sufficient amounts to substitute a large percentage of jet fuel. Furthermore, vegetable oil market prices are following petroleum price developments.

Table 31 Pros and cons of refining technology alternatives.

REFINING TECHNOLOGIES	TECHNICAL ASPECTS		COMMERCIAL/FINANCIAL ASPECTS	
	PROS	CONS	PROS	CONS
Alcohol to jet fuels	• Technology available to be implemented	• Significantly more alcohol may be produced in Brazil (1st generation and may be even more by 2nd gen. technol. • No commercial plant set up yet.	• No expensive equipment necessary • Alcohol in Brazil is currently made from sugarcane (1st gen) and it is planned to be produced also by 2nd gen. technol.	
Direct fermentation of Sugars to Hydrocarbons (DSHC)	• First generation commercial plants exist in Brazil. • DSHC is produced in Brazil from sugar(1st generation and 2nd gen. technol).	• Standard sterilization is required.	• No expensive equipment necessary, however the technology development is expensive	• Alcohol in Brazil is currently made from sugarcane (1st gen) and expected to be soon produced by 2nd gen. technol.
Hydroprocessed Esters and Fatty Acids (HEFA)	• Commercially available	• Needs expensive hydrogen, however integration of this plant to an existing refinery/ power plant would lower costs for the hydrogenation step.	• Efficient process	• Product is expensive due to the high price of feedstocks. Algae and microbial lipids are potentially cheaper (long term).

Table 31 Pros and cons of refining technology alternatives (continued).

REFINING TECHNOLOGIES	TECHNICAL ASPECTS		COMMERCIAL/FINANCIAL ASPECTS	
	PROS	CONS	PROS	CONS
Thermal Cracking of fatty materials	• Cheaper option than HEFA	• Forms a complex mixture of different products	• Can be performed in small plants	• Many different products have to be separated
Fisher- Tropsch	• Available in demonstration plants	• Needs expensive equipment	• Any biomass can be gasified	• Expensive equipment necessary, needs large amounts of carbon-rich feedstocks
Solvent Liquefaction	• Forms bio-oil in a single process	• Needs further research	• Any biomass can be liquefied	• Expensive equipment necessary
Fast Pyrolysis	• Good yields of bio-oil and bio-char	• Needs further processing of the products (i.e. hydrotreating or gasification)	• Any biomass can be pyrolized, can be performed in small plants	• Products need further processing
Acid/enzyme Hydrolysis	• Cellulose available in huge amounts	• The enzymes are expensive and slow	• Forest and agriculture residues available in large amounts	• Hydrolysis is a slow process, needs expensive enzymes and high dilution of feedstock
Industrial Residues Recycling	• Treatment/ reduction mandatory	• Needs further development	• Need to be treated/reduced	• Costs of conversion unknown
Municipal Waste	• No costs of feedstock (short term)	• Expensive separation, availability not known	• Available at negative costs	• Expensive processing
Gases	• Low to negative cost of feedstock	• Low concentration and availability	• Interesting source for hydrocarbons, needs to be treated/reduced	• Costs of conversion unknown
Sewage	• Negative cost of feedstock	• Expensive processing	• Interesting source for hydrocarbons, needs to be eliminated	• Needs further development

Lignocellulosics are available in sufficient amounts to substitute petroleum, however, there are logistic problems – their energy density is too low for transportation on long distances – and the capital investment for gasification or solvent liquefaction is high. Fast pyrolysis may be an interesting option to increase energy density. Mild-acid hydrolysis produces a pentose-rich slurry able to be fermented by robust yeasts to produce lipids. The cellulose rich fraction would be enzymatically hydrolyzed to sugars, followed by fermenting to alcohols (i.e. bioethanol), a well developed and commercially executed around the world; these sugars can also be fermented to lipids and hydrocarbons.

Brazil has a long tradition in producing bioethanol and this biofuel is currently used as a building block to generate poly(ethylene) in a commercial chemical plant, in a similar process used for the ATJ technology. Naturally, second generation sugars would improve the sustainability of sugar derived alternative jet fuel, such as ATJ, DSHC and some HEFA pathways (i.e., algae oil derived from sugar).

Lignocellulosic biomass has low energy content. Therefore, it has to be converted into higher energy materials (bio-oil, bio-char) which can be transported to the hydrotreating and gasification plants. On the other hand, solvent liquefaction can be done in a small scale at the production site of the biomass.

Enzymatic hydrolysis of cellulose is certainly an interesting option. However, the process is still slow and needs substantial improvement to provide good quality hydrolizates to supply the large potential demand for fermented biofuels and up to now, only pilot and demonstration plants were built and all of them show sincere economic problems, i.e. the price of ethanol from these plants is higher than from sugar cane (MOSIER et al., 2005). A commercial second generation plant for bioethanol is expected to lauch in 2013 by Granbio in the northeast of Brazil. Besides this, cheaper and more efficient enzymes are needed in order to make enzymatic hydrolysis economically viable. The improvement of the microorganisms to excrete larger amounts of enzymes, synergistically working, would be very advantageous. It is desirable to have enzymes with higher turnover number and more affinity for their substrates, as increased robustness to biofuel process conditions.

Conversion of vegetable oils to hydrocarbons (HEFA) is commercial, however expensive feedstocks are needed, even though their costs can be shared with other co-products, as soy protein, for instance. The integration of this plant to an existing refinery/power plant would lower costs for the hydrogenation step of the process. Similar technology developed in Brazil by Petrobras (HBIO) is able to produce a similar product, which would allow blending with conventional jet fuel. Optimization of this process is under way. The existence of a Brazilian Biodiesel Program, well established in the market since 2005 and based upon the same type of feedstock, simplifies the economic comparison of feedstock pricing, because they are already competing for the same market. Consequently, the prices of feedstock, after the diverse necessary pre-processing can be considered equivalent, once taking into account the social benefit provisions of the Brazilian Biodiesel Program. In 2011, the country has produced circa 2.5 billion liters of biodiesel, quantity enough, in energetic terms, to more than one third of its jet fuel consumption (LA ROVERE et al., 2011).

Vegetable oils are totally consumed by domestic use for bio-diesel production. To use vegetable oils as a source of jet fuels, the production would need to be increased and then, their price would lower. Another feedstock for hydro-processing would be microbial oils which potentially could be cheaper when second generation lignocellulose technology is available.

Microbial oils (algae & yeasts): Concerning sugar fermentation processes (yeast/algae), the limitations are mostly related to the cost of the first generation sugar and to the low conversion of the overall reaction. It is expected that improvement of metabolic engineering knowledge would help to increase the yield and productivities moving to second and third generation fuels.

Wastes should be used for the production of transportation fuels, however, the quantities available seem to be rather small and the conversion technologies are not always well known.

Conversion of **Municipal waste, sewage, flue gases, industrial residues** by biochemical processes, avoiding therefore the high temperature conditions of the thermochemical processes applied for cellulosic materials, is being developed and not much can be said about commercial viabilities. Clearly, the main gap for solid municipal waste is the separation and fractionation. A new industry dealing with solid waste could be developed in Brazil. This study did not find enough information to answer the costs of conversion into jet fuels for industrial residues, gases and sewage. On the other hand, wastes are often available at null costs and transforming wastes into useful products should be encouraged, even though their future price will increase to reflect their value. More research is required to know the costs of separation and processing of the different constituents, mainly for municipal solid wastes. Conversion of tallow and yellow greases is possible using the HEFA process, but the limited availability and opportunity cost of these feedstocks are driving them to biodiesel production under Brazilian conditions. Financial support for the transformation of lignocellulosics and waste to jet fuel should be available.

9.3 Logistics

Discussions about the logistics of production and distribution of jet fuel in Brazil included, quality control requirements and safety procedures associated with jet fuel handling and the impacts of jet biofuel commercialization on the distribution system. The main stakeholders of the conventional jet fuel distribution chain in Brazil, future jet biofuel producers, airlines association, international specifications boards and Brazilian regulatory agencies participated in the discussion process.

The main aspects of the installed jet fuel logistics and of the necessary adjustments for introduction and commercial use of biofuels are:

1. The logistics of conventional jet fuel in Brazil are well organized. Although consumption is very concentrated in large international airports close to oil refineries, a small fraction goes to regional airports that sometimes can only be reached regularly by air or by water ways during part of the year. Furthermore, some regions of the country are supplied almost exclusively by imported jet fuel. All these important aspects will have to be considered in the implementation of a national policy promoting jet biofuel and, therefore, depending on the adopted model for jet biofuel utilization in the country (if mandatory for instance), these aspects could become barriers, or eventually opportunities;
2. By adopting the international concept of “drop-in” jet biofuel, the essential anticipated barriers for the distribution logistics of the fuel, like recertification of aircrafts, changes of airports infrastructure are surpassed. Even if for the initial experimental steps of using aviation biofuels there may be some impacts in the

fuel supply infrastructure at airports due to especially dedicated tank trucks, on the long term the biofuels will be blended somewhere else in the distribution chain and will come to the airports simply as jet fuel ASTM D1655, therefore implying no change in the airports infrastructure. Explaining, after approval of the blend according to ASTM D7566, attested by the batch Certificate of Quality, the biofuel is re-identified as satisfying ASTM D1655 and it becomes fungible with any approved jet fuel and subjected to the same requirements as conventional jet fuel. However, some new infrastructure will be needed in the blending point of the distribution chain for commercialization. According with ANP Resolution Nr 20/2013, recently issued, the commercialization of alternative jet fuels is restricted to importers or jet-A1 producers authorized by ANP, and the commercialization of the blends is restricted to jet-A1 producers or distributors authorized by ANP. Therefore, this new infrastructure should occur as part of these businesses. To reinforce this aspect, one should imagine the overall picture of a future jet biofuel distribution logistics in Brazil, keeping in mind that of the 13 largest airports responsible for 85% of jet fuel consumption in the country, 10 are mainly supplied by nearby oil refineries, 2 are supplied through imports by sea (7%) and only Brasilia International airport (6%) is supplied via tank trucks from a refinery 700 kilometers away. Therefore, on the long run, the best alternative for finishing the synthesized paraffinic kerosene and preparing the blend are refineries or terminals nearby important airports. From this blending-point on, the jet fuel containing a certain percentage of biofuel would be using the same distribution chain of the conventional jet fuel;

3. On the other hand, an airport like Brasilia's which consumes approximately 500 million liters of jet fuel a year distant from refineries and close to agricultural feedstock production sites, could economically benefit twice of the high logistics cost in the country by finishing the jet biofuel blend close to the consumption site. However, it is worth to remember that batch certification is expensive for small volumes and, if necessary for the fuel production process, the cost of hydrogen can be lower close to oil refineries. For this step to be taken, one gap to be surpassed is the reduced installed competence in the country to do the necessary quality tests;
4. Because the initial processing of agricultural feedstock should be made nearby the farms for economical reasons, the logistics of the jet biofuel production deserves detailed studies for each type of feedstock and applied processes to maximize economic benefits. Due to the high contribution of logistics cost on the overall cost of the biofuel, this gap deserves special attention;
5. In the future, when there will be different suppliers of jet biofuel and several airlines buying it from the same airport jet fuel pool, the jet fuel received by one airline in its fuel tanks will be just jet fuel ASTM D1655, with or without some percentage of biofuel in it, following the same exact procedures used for conventional jet fuel. The quality control systems and traceability requirements by aviation will be kept the same, based on the physical chain of fuel supply. Therefore, the amount of biofuel bought by one airline, to ensure it is doing its part on the effort to reduce CO_2 emissions, will be demonstrated by emission certificates specific for the aviation sector. Eventual energy benefits of the biofuels will be included in the agreed price and on the effective participation of the airline in the pool. The establishment of specific commerce rules and the respective assurance system is a gap deserving attention in due time;

6. If different excise taxes are applied to renewable and fossil jet fuels to facilitate the penetration of biofuels some future work will have to be carried out together with Federal and State fiscal authorities.