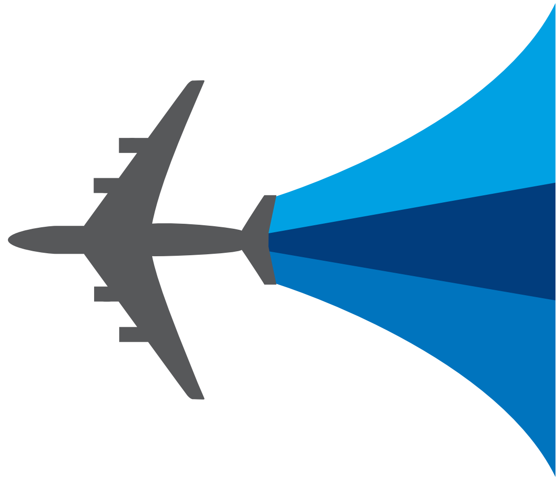

PART II

NEEDS AND TECHNOLOGICAL CAPABILITIES

5 CRITICAL SYSTEM REQUIREMENTS

Augusto Barbosa Cortez [et al.]. "Critical system requirements", p.99-102. 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-005

5 CRITICAL SYSTEM REQUIREMENTS

5.1 Feedstock

The expert panels pointed out areas that are critical for the production of the potential feedstocks used to make aviation biofuels, taking into account the three pillars that guided this study: the need to have a cost-competitive biofuel, that it be made sustainably, and that its production also brings benefits to the rural communities involved.

Eight main critical system requirements were identified and are listed in **Table 15**.

Table 15 Critical system requirements for feedstocks for jet biofuel production.

REDUCE (OR MAINTAIN) PRODUCTION COSTS	
1) Increase feedstock yield	This is a critical issue for all considered feedstocks, with the exception of the non-agricultural ones, such as industrial wastes and municipal solid waste; for the latter increased production is not goal although improvements in separation process can increase the yield of usable material. Even the most established feedstocks, such as sugarcane, face the challenge of increasing productivity, especially in order to reduce production costs. Through genetic breeding and improvement, and crop management programs, some feedstocks may double productivity by 2020.
2) Reduce feedstock costs	Reducing feedstocks costs is critical to reduce production costs and allow the jet biofuel to be cost-competitive relative to the regular fuel. For biofuels that are already produced in large scale, feedstock costs represent 60% or more of the cost of biofuels; this, probably, will be the same with aviation biofuels. Several of the feedstocks considered do not have established production systems or are in experimental phases and, therefore, have high costs. The potential reduction of costs is variable for each feedstock, however, the means to achieve such reduction were common among feedstocks: genetic improvement and breeding and crop management programs. Improve logistics harvest/collection and transportation is also relevant to reduce costs. Reducing production costs is equally important in the case of the non-agricultural feedstocks, although the means to achieve the reduction are related to logistics and collection, especially in the case of residues and wastes.
ENVIRONMENTAL SUSTAINABLE BIOFUELS	
3) Reduce GHG emissions/ Potential of CO_2 net reduction per hectare	This is a fundamental requirement since it is the main driver for the development and implementation of biofuels for aviation. The potential of reducing emissions in the feedstock production stage is essential in this sense.
4) Energy balance	The ratio between energy input and output is vital in terms of the efficiency of the feedstocks/technologies, and must also be considered along with the potential to reduce GHG emissions.

Table 15 Critical system requirements for feedstocks for jet biofuel production (continued).

ENVIRONMENTAL SUSTAINABLE BIOFUELS	
5) Land use	Land use change (LUC) is a factor accounted in CO_2 emission and thus contributes to climate change. Therefore, the expansion of currently produced feedstocks and the production of new feedstocks should take this into consideration. Depending on type of soil and its current vegetal coverage, implementation of new agricultural activities may have a favorable or unfavorable LUC footprint.
6) Agrochemical use	The environmental impacts (on air, water, etc) of agrochemical use in agricultural feedstock production are an issue to be considered regarding the sustainability of jet biofuels. It is of particular importance the use of nitrogen fertilizers because of the high energy consumption for their synthesis and the significant emission of GHGs associated with their use in the field. Crops that require low or no nitrogen (N) fertilization inputs (soybeans) or have high biomass/N ratio (sugarcane, eucalyptus) have an advantage here. Feedstock production systems that make ease the recycling of nutrients, byproducts, and residues on the field are also preferred. It is also desirable to decrease or have responsible the use of chemical products for the control of plant pest, diseases, and weeds. On the other hand, crop intensification is also an option, through the use of modern technologies and, sometimes increased use of agrochemicals in order to increase plant production. Crop intensification may have a positive overall impact in the sense that it allows the use of less land and, therefore, frees land to other purposes, including food production and areas of natural preservation. Waste feedstocks do not have these issues.
7) Pollution	Pollution is an issue related to environmental and social sustainability of biofuels and, therefore, should also be taken into consideration when analyzing potential feedstocks. In this sense, pollution includes the amount of waste material generated in the production of the feedstock as well as soil erosion and the soil, water, and air contamination due to agriculture practices and processing of feedstocks.
IMPROVE REGIONAL DEVELOPMENT	
8) Job creation and quality	The generation of jobs and the improvement of the quality of jobs (through formalization, training, etc) are also fundamental when considering potential feedstocks.

Efforts in R&D are important to increase yields and reduce costs but yields can improve substantially by just applying current knowledge as the data of **Table 16** indicate. The Strategic Committee of Soybean Brazil (CESB) promotes a contest with farmers in order to stimulate performance. The average soybean yields of the best farmers in the last two contests are more than double those of Brazilian average and some farmers have obtained yields above 6 t/ha. Such output may improve the competitiveness of soybean as feedstock for jet biofuel production, but costs and environmental impacts of these high yielding systems must be evaluated.

Table 16 Potential for increasing soybean yields in Brazil in rainfed areas.

SOYBEAN PRODUCTION CONDITIONS	SOYBEAN YIELDS IN YEAR (kg/ha)				
	2008/09	2009/10	2010/11	2011/12	2012/13
Brazilian average yields	2,628	2,928	3,114	2,646	2,934
Average of 10 best farmers1	4,668	5,286	5,724	5,730	6,228
Best farmer1	4,968	6,504	6,036	6,522	6,630
Difference best farmers/Brazilian average (%)	78	81	84	117	112
Number of participating farmers	140	800	1,185	1,314	1,198

Notes:
1- Best farmers yields obtained in a farmer competition organized by CESB (Strategic Commitee of Soybean Brazil). According to CESB's rules the field must have between 5 and 10 ha and be managed in a similar manner to that of the rest of the fields enroled in the contest. Source: htttp://www.desafiosoja.com.br/IVForum.aspx (accessed on 2013-8-20)

5.2 Refining Technologies

The critical high level parameters in terms of the goals of the project are listed in **Table 17**.

Table 17 Critical system requirements for refining technologies for jet biofuel production.

REDUCE (OR MAINTAIN) PRODUCTION COSTS	
1. Increase the yields of each step of pre-treatment of biomass, conversion (chemical or biological) and final synthesis of jet biofuel	This is critical for every technology considered, since the cost of the feedstocks is responsible for a large part of the final cost of the fuel and they cannot be largely wasted as by-products. For the termochemical conversion of lignocellulosics the price of feedstocks is lower, however, the investment costs for reactors is rather high.
	Reduced overall cost would be achieved by converting biomass into refinery ready material that uses today's infrastructure and distribution channels
ENVIRONMENTALLY SUSTAINABLE BIOFUELS	
2. Reduce GHG emissions and CO_2 footprint of the jet biofuel	These are requirements for implementation of biofuels for aviation. The potential for simple and energy economic/profitable technology is fundamental in this sense.
3. Energy balance	The ratio between energy input and output of the technology is fundamental and should also be considered along with the potential to reduce GHG emissions.
IMPROVE REGIONAL DEVELOPMENT	
4. Industrial employment	The generation of jobs and the improvement of the quality of jobs (through formalization, training, etc.) are also fundamental when considering the different technologies.