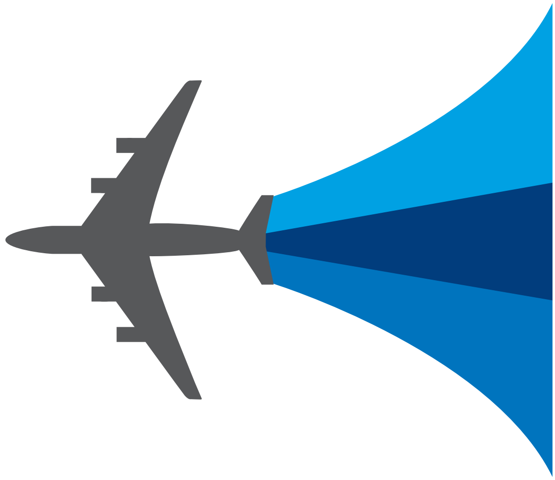

PART III

TECHNOLOGY DEVELOPMENT STRATEGY

13 R&D PROGRAMS AND COMMERCIALIZATION GAPS

Augusto Barbosa Cortez [et al.]. "R&D Programs and Commercialization Gaps", p.217-218. 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-013

13 R&D PROGRAMS AND COMMERCIALIZATION GAPS

In broader terms R&D programs need to be created having defined its objectives considering the biofuels for aviation goals and the large number of pathways to be considered. Therefore the R&D program for biofuels for aviation can have the following objectives to overcome existing gaps:

1. make the pathway technically feasible, when there is a need to demonstrate technical-commercial feasibility;
2. reduce CO_2 emissions (LCA), when the biofuel net CO_2 emissions is still too high to justify its use;
3. reduce biofuels production costs, when the biofuel final production price (cost + profit margin) is still above the jet fuel market price;
4. improve the environment and socio-economic indicators, when its benefits are still not significant.

Commercially, it is important to recognize that successful biofuels have built their economic viability on co-products. This was the case of Brazilian sugarcane ethanol with sugar, the American corn ethanol with corn cake used as feed, and of soybean biodiesel in different countries, where soybean cake was commercialized as feed. Of course the co-product market size and characteristics will also determine how the biofuel-co-product economic equation will be built. However, it is recognized that when aviation biofuel is been considered, an important strategy to obtain a lower cost biofuel certainly is by obtaining value added-products.

Besides the above drivers for R&D definition, it is also essential to define an R&D strategy (approach) to be followed. This will determine the efforts, translated as the amount of financial and human resources to be invested, and future accomplishments and benefits.

1. **Research approach type 1** should guarantee incremental gains in productivity or efficiency objecting to reduce cost and mitigate CO_2 emissions. This type of research approach will guarantee a medium-long term learning curve, similar to what was experimented by the Brazilian sugarcane ethanol Program. Examples of this type of research are: the development of new plant varieties and the introduction of better management practices such as to improve cane logistics.
2. **Research approach type 2** aims at generating breakthroughs changing the existing paradigm and at causing great effect in the overall production efficiency with significant reduction on costs, CO_2 emissions and also land use. Examples: i) the improvement of plant photosynthesis (even for C4 plants the photosynthetic efficiency is very low, about ~3%) can cause great impact on biofuels, affecting cost, CO_2 emissions, and mainly land use; ii) to develop genetically modified plants to produce biomass in arid lands (abundant worldwide and presently offering very low agricultural yields) can both have a significant impact on reducing hunger by increasing food production in poor areas of the globe and also allowing biofuels production in marginal lands; iii) to develop processes such

as hydrolysis or FT can allow the use of lignocellulosic materials which are much more abundant and easy to produce then sugar, starch, or oil.

3. **Research approach type 3** focus not on improving the system performance such as discussed in the previous cases, but rather, on the great surroundings of the biofuels production systems where most activities take place for the production of food and fiber today. It is recognized that presently 3.5 billion ha worldwide are devoted to pasture land (all types, including grasslands, planted pasture, etc.) and another 1.5 billion ha are presently used in agriculture. Just to exemplify, of all kerosene presently used for aviation (~250 billion liters) was to be replaced by biofuels using overall yields from 5,000 to 7,000 liters/ha/year (for palm oil in Malaysia and sugarcane ethanol in Brazil), the required amount of land would range from 35 to 50 million ha (LEAL et al., 2013). Therefore, between 1 and 1.5% of land currently used in pasture land or 2.5 to 3% of land used for agriculture.