SUNLIBB

Sustainable Liquid Biofuels from Biomass Biorefining

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Sustainable Liquid Biofuels from Biomass Biorefining (SUNLIBB)

Policy Brief #2 - September 2013

The SUNLIBB project is funded under the Seventh Framework Programme (FP7) within the Energy theme: Second Generation Biofuels – EU Brazil Coordinated Call. SUNLIBB (GA 251132) started on 1st October 2010 for 4 years and collaborates with a parallel project in Brazil, CeProBIO.

Background

First generation biofuels – which are mainly produced from food crops such as grains, sugarcane and vegetable oils – have been increasingly questioned over concerns such as food security, land-use impacts and climate change. Developing second generation biofuels has emerged as a more attractive option, as it is intended that these will be manufactured from inedible sources, such as woody crops, energy grasses, or even agricultural and forestry residues.

Residues from sugarcane and biomass from maize, as well as 'whole-crop' miscanthus are all potential raw material (called feedstock) for second generation bioethanol production. Because these three plants are all closely related, processing the biomass from these crops raises common technical challenges, offering the opportunity for breakthroughs in one species to be rapidly exploited in the others. Despite the potential sustainability benefits of second generation bioethanol, the current inefficiency of conversion makes it economically uncompetitive. Taking up this challenge, the SUNLIBB consortium's multidisciplinary team of scientists – in cooperation with CeProBIO, our sister project in Brazil – combines European and Brazilian research strengths so as to open the way for environmentally, socially and economically sustainable second generation bioethanol production.

Objectives

- Improve feedstock quality in order to reduce the high economic costs associated with converting biomass to second generation bioethanol.
- Apart from ethanol, develop other value streams for which potential markets already exist in order to enhance the profitability of second generation biofuels.
- Enhance the economic sustainability of second generation biomass by bringing together in model (or pilot) biorefineries our improved feedstock, enhanced conversion processes and added value product extractions.
- Develop life cycle assessment (LCA) models suited to biorefineries so as to ensure that our products are sustainable at all stages of the process.
- Review all pertinent guidelines, policy and regulatory frameworks for sustainable biofuels in both the EU and Brazil in order to take into account any influential developments that could affect the future potential to harness benefits from this work.

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Mid-term progress report

In order to create biofuels, feedstock is first broken down into sugars (saccharification). The sugars are then fermented (converted) to produce bioethanol. Unlike easily-processed first generation biofuels, the complex substances found in the woody or inedible tissues of plants are much harder to break down and are more complicated to convert to fuels and/or chemicals with currently available methods. This greatly impedes their commercialization. SUNLIBB uses modern crop breeding approaches and cutting-edge plant cell wall research to identify genes that allow modification of the cell wall composition of the plants in ways that reduce the cost associated with the conversion process. SUNLIBB has focused on two approaches to identify genes of interest.

The first approach relies on reverse genetics, whereby we predict which genes are likely to impact on the saccharification potential of our three selected plants and then use targeted approaches to disrupt their function in order to assess the consequent impacts. This work has been proceeding efficiently and material from the first 'gene knock out' maize plants is now being analysed. Work on characterization of cell wall polysaccharides and lignin in sugarcane and miscanthus is also advancing smoothly. So far, few similar studies have been performed, meaning that the novel and exciting data that have been generated as part of our work make an important contribution to scientific knowledge.

The second approach, namely forward genetics, is to identify all the regions in the chromosome (i.e. Quantitative Trait Loci, QTLs) that influence the saccharification potential of our selected plants. To be able to identify QTLs, detailed genetic maps are required, which are in turn compiled by large collections of genetic markers (DNA sequences with a known physical location on a chromosome). These resources are available for maize, with SUNLIBB having already identified QTLs for this species. However, for sugarcane and miscanthus, our consortium is analysing mapping populations segregating for cell wall composition and identifying QTLs associated with different cell wall traits. The complex genetics of these two species make this a rather arduous process. However, our CeProBIO colleagues have recently managed to develop an extremely elegant mathematical solution for identifying sugarcane genetic markers. This represents a highly notable achievement, with CeProBIO and SUNLIBB partners working together to drive this process forward and potentially integrate the work on sugarcane with that on miscanthus.

Miscanthus sinensis (Wageningen University)

Another objective of our work is to generate additional products (beyond biofuels) from biomass processing that will further increase the total energy output and

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profitability of second generation biofuels. For instance, we potentially see butanol and Hydrogen (H_2) fuel coming off as well. Relevant processes are currently being developed at laboratory scale before being tested in pilot biorefineries. This work is coming together now with outputs to be delivered as the programme matures. Life cycle assessment (LCA) models suited to biorefineries have also been developed to assess primary energy inputs and total greenhouse gas emissions, coupled with qualitative investigations into impacts on local environments, biodiversity and food production or prices. Finally, all pertinent guidelines, policy and regulatory frameworks for sustainable biofuels in both the EU and Brazil have been reviewed to provide recommendations that could help inform the more effective implementation of the EU's biofuels policy targets. We are currently conducting research on cooperation between the EU and Brazil in the area of biofuels in order to assess its impact and future development potential.

Outcomes from the project

Apart from maintaining the programme of work on course to achieve our research aims, progress so far has been marked by the successful cooperation between European and Brazilian groups and a clear sense of trust and community that has evolved through the sustained integration of our efforts. Working closely with the Brazilian group has also enabled the development of embryonic links in the area of bioenergy with neighbouring countries such as Argentina and Chile. For instance, an International Workshop on Bioenergy and Industrial Biotechnology will be held in Buenos Aires on 9-11 December 2013 to establish a South American/European working group on biomass for biorefineries.

Project public website address

For public information on the SUNLIBB project, please refer to our website: **www.sunlibb.eu**

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Miscanthus sinensis (Wageningen University – Assoc Prof Luisa Trindade)