Fuelling debate

Jacqueline Grima-Pettenati, CNRS Research Director at the Laboratoire de Recherche en Sciences Végétales, is coordinating the TreeForJoules project. Here, she shares the consortium's collective thoughts on the project as well as on the future of second generation biofuels

COLLECTING XYLEM FROM 25-YEAR-OLD EUCALYPTUS TREES

TREEFORJOULES

Your research focuses on the production of second generation biofuels; can you explain what these are?

Second generation biofuels are derived from the whole plant transformation instead of only from grains, as first generation biofuels are. The feedstock is lignocellulosic biomass corresponding to lignified secondary cell walls, and it is mainly found in the wood of trees and in the vegetative parts of crop plants (stems of cereals, bagasse from sugarcane and other non-food remnants of food crops). The fact they are second generation means they are already more sustainable since they are not competing with food production for land use.

The overall goal of the TreeForJoules project is to improve the genetic material of eucalyptus and poplar species to make their use as second generation biofuels more efficient and sustainable. How do you propose to achieve this and what are you hoping will be the outcome?

Understanding the genetic control and architecture of productivity and wood quality traits is a first step to breeding new varieties (cultivars). One major objective of the TreeForJoules project is to identify key regulatory genes controlling wood properties through a combination of functional genomics and genetics approaches for both eucalyptus and poplar. This knowledge will help the discovery of favourable alleles associated with these traits and their use as molecular markers in the breeding process. The project also aims at developing high-throughput spectroscopic tools for wood characterisation (NIRS) as well as analytical pyrolysis combined with gas chromatography (Py-GC), which can be used to accelerate the screening of the best performing varieties in the breeding process.

What key qualities are ideal for growth as an energy crop in species such as poplar and eucalyptus? Do any of their characteristics present a challenge to the creation of second generation biofuels?

Poplar and eucalyptus have been chosen as potential energy crops first because of their rapid growth characteristics, which allow for high productivity of biomass per area unit, and also because of their faculty of coppicing, which gives them the capacity to produce harvestable material several times on the same root stock. Another key advantage is that they are able to grow on marginal lands not dedicated to food production and need very low energy input.

The chemical composition of wood is also a key factor influencing the efficiency of conversion into biofuels. In bioethanol production, for instance, lignins that are cell wall phenolic polymers play a negative role by impairing the accessibility of cellulose to the hydrolytic enzymes. Optimisation of cell wall composition is thus an important trait to improve when wood has to be efficiently converted into biofuels.

The sustainability of these biofuel-driven cell wall optimisations will have to be monitored in Short Rotation Coppices (SRC's), since this cultivation system might be favourable to disease development.

Biogas and biofuels are both forms of renewable energy. Could you clarify the differences between the two?

Biogas and biofuels are generic terms with either narrow or wide definitions according to different schools of thought; they both use energy from carbon fixation by plants. Biofuels are non-fossil liquid fuels produced either enzymatically, mechanically (bio-diesel) or thermochemically (bio-oil) from biomass; biogas is produced through either anaerobic fermentation (methane) or aerobic thermal gasification (hydrogen, carbon monoxide), resulting in a fuel that can be burnt directly or in an engine. Regarding biofuels derived from trees, fast pyrolysis – which is a medium temperature process – enables the liquefaction of biomass and after a high pressure treatment with hydrogen – allows us to produce a diesel-like transportation fuel.

Do influencing factors such as weather pose much risk to the increase in demand for plants as energy sources?

Weather matters for woody plants' productivity and also impacts wood quality. This is why it is important to choose the right varieties, especially those that are well-adapted to local climatic conditions such as drought periods and temperature constraints. This is one of our objectives. We are also evaluating the consequences of environmental cues on biomass production and wood quality.

Will the production of bioenergy eventually make us independent from gas imports in the future?

To reach that point, the relative integrated cost would have to become truly competitive. The total figure includes direct fuel cost to private and industrial energy users, together with indirect costs corresponding to public incentives, taxes and cost or reward from positive and negative environmental impacts. To reduce the direct costs, it is important to sustainably grow highly productive plants whose biomass quality is well adapted to the downstream processing.

Ultimately, we believe that bioenergy could occupy a significant part of a multi-sourced energy network in the future that could alleviate our dependence on gas imports.