Environmental viability of bioethanol derived from the poplar clone Imola

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Why 2G biofuel? Transport – 30% of energy consumption and 25% of GHG emissions in the EU.

2G biofuel - abundant resources & government mandates.

Why environmental modelling? Bottleneck in biofuel development – controversy regarding biofuel overall environmental sustainability in the EU and globally.

Why Imola? Italian poplar elite clone - a potential biofuel feedstock with high biomass yield, excellent rooting ability and resistance to rust, leaf disease and wooly aphid.

Biogeochemistry model Denitrification-Decomposition (DNDC) was modified for simulation of perennial bioenergy crops. Imola, a hybrid poplar clone, obtained by controlled crossing of Populus deltoides Bartr. with Populus nigra L. and grown under short or very short rotation coppice (SRC or VSRC) management in a plantation located at Casale Monferrato was modelled (Latitude 45°13’N, Longitude 8°51’E, Mediterranean climate with annual precipitation 600-1100 cm and mean temperature 15-3°C, sandy loam soil).

Experimental Results

• The elemental analysis results were used to develop C/N partitioning models for DNDC and LCA modelling.

DNDC simulation vs. observation

• The biomass yield and C pool derived from DNDC simulations were consistent with the experimental observations.

DNDC simulated daily C/N fluxes

• The NEE (net ecosystem exchange of carbon) simulation shows the carbon sequestered in poplar biomass and soil.

• N₂O emission peaks and N leaching are strongly related to N fertilizer inputs and rainfall events which triggered the anaerobic zones developed in the soil.

• NH₃ emission peaks (by volatilization) roughly match the daily maximum temperature trends.

Supply chains modelled

• Hypothetical bio-refinery - 2,000 oven-dry tonne of Poplar biomass per day.

• Two pre-treatment technologies - dilute-acid (DA) & liquid hot water (LHW).

• Enzymatic saccharification with Celic Tce 1; co-fermentation of C5 and C6 sugars by Zymomonas mobilis.

• Combined heat and power (CHP) & wastewater treatment (WWT).

At farm gate

• Bioethanol derived from Imola delivers lower environmental impacts than petrol in GWP100, ODP and POCP.

At refinery gate

• Bioethanol from poplar: a commercially viable alternative to fossil fuel in the EU.

Bioethanol vs. petrol

• Biogenic carbon sequestered into poplar biomass and C absorption in soil brings GHG’s ‘savings’

• Higher chemical inputs and induced emissions in DA process than LHW.

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