Biorefinery, the bridge between Agriculture and Chemistry

Professor dr Johan Sanders
Wageningen University and Research Centre, Dept. Valorization of Plant Production Chains, P.O. Box 8026, 6700 EG Wageningen, The Netherlands

johan.sanders@wur.nl, Phone +31-317-476332
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Economic factors, such as costs increases of oil, connected to the depletion of mineral resources, and environmental considerations, such as the negative impact of CO₂ emissions, has led to interest in the use of renewable resources as feedstock for transportation fuels, energy (heat and electricity) and chemical products. When used in combination with environmentally sound production and processing techniques, the use of biomass can be seen as a sustainable alternative to conventional feedstock. In the Netherlands a Governmental Committee on Renewable Resources has designed a plan how to substitute 30% of the Dutch fossil raw materials by biomass in the year 2030. Obviously a lot of the biomass will have to come from abroad, but strategies to optimize the use of the biomass that is already used every year might limit the additional area to about the size of the Netherlands. Other European countries having less import of biomass at the moment, but more agricultural area available, might solve their biomass availability in other ways.

Production of chemicals might take advantage of the biomass molecular structure in a much better way than the production of fuels or electricity from biomass can do. The production of chemicals from biomass saves more fossil energy than producing just energy from biomass! This is reflected by sound economic advantages as well in raw material cost as in investment costs.

To develop technologically sustainable routes, the whole chain of biomass production, i.e. from cultivation and harvest, its (pre)treatment and conversion to products should be considered. Biorefinery opens the way towards the production of bulk chemicals and thereby obtaining the highest value from biomass by knowledge intensive technologies that can be patented.

Several examples will be shown with sugar beet, wheat and rapeseed. Some amino acids are very suitable starting materials for highly functionalized petrochemicals. Economical production routes of chemicals from biomass require large scale substitution of bulk chemicals and connection to current approaches and facilities (process integration) of the petrochemical industries to convert crude oil into chemical building blocks.

Protein will be an abundant ‘waste’ product from the boost in production of transportation fuels. Ethanol from sugar beet, wheat and corn and biodiesel from rape and palm will supply an additional amount of protein around 100 million tonnes/year if these biofuels will substitute 10% of the fuel demand.

Genetic modification of plants will increase the potential of biomass to chemicals because of increase of the concentrations of the actually present biochemicals that can serve as precursors for bulk chemicals. Beet offers specific advantages because of its high fresh weight volume. Comparison will be made of various fermentation systems, with the direct production by beet.

Also it will be addressed that small scale (pre)processing of the biomass can give advantages over large scale processing because of less transportation costs but also because of the opportunity to use process-integrations that can not be used on large scale. These integrations will yield high efficiencies of energy utilization but can be improved on social or organisational levels. The biorefinery of biomass will offer new economic opportunities for the Agriculture and the Chemical industry by the production of a world of chemicals, transportation fuels and energy.