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POSITION PAPER

Sustainable Future for Bioenergy and Renewable Products

Venice, 21 September 2007 – With the 2007 report from the Intergovernmental Panel on Climate Change (IPCC) stating the need to reduce the anthropogenic emission of greenhouse gases from fossil fuels and the directive of the European Community calling for biofuels to meet 5.75 percent of European transport needs by 2010, and 10 percent by 2020, an urgent need for action in plant sciences arises to obtain an economically viable and sustainable production of biofuels, renewable chemicals and materials. While other countries already attribute significant research money to this field (e.g. more than $800 million in recent projects on biofuels in the USA), Europe still lacks concerted action. In response, EPSO, the European Plant Science Organisation, has established a set of recommendations for how Europe can meet this challenge and provide a basis for integrated approaches towards a future bio-economy. EPSO represents more then 140 academic institutions from 25 European countries with over 20 000 people in plant research.

European plant science is willing to take a responsible role in the implementation of a sustainable future bio-economy by developing the knowledge and skills required for obtaining increased quantities of biomass suitable for conversion to biofuels and to renewable resources, at economically competitive prices, and within an environmentally and economically sustainable agricultural system that is an essential part of a future bio-economy.

Societal and economic relevance. Today's economies are based on **carbon resources of fossil origin**, which provide societies with their major energy sources and raw materials for chemical production. However, several major challenges for mankind arise from this approach:

- the use of these fossil-based resources as fuels, but also as non-degradable substances and composites, causes severe regional and global environmental problems, including CO_2 emissions for which there is increasingly compelling scientific evidence that they are a major contributory factor in global warming and climate change;
- the availability of fossil resources does not match the expected increase in consumption of energy and raw materials in the future;
- the distribution of fossil carbon sources around the globe makes them an even less reliable source in the future.

These aspects make clear that the present high dependence on fossil fuels is not sustainable. Together with the economic fact that energy and raw material prices have drastically increased over the last decade, these factors necessitate the development and establishment of alternative concepts and products.

Bio-based strategies hold great promise for sustainable solutions and are presently being developed worldwide to contribute significantly to the future mix of energy sources. Plants provide the major source of organic substances on our planet. They include relatively under-utilised forms such as cellulose, hemicellulose, starch, lipids and lignin that have major potential for use as raw materials for energy and industrial feedstocks. Significant impact is expected from bioenergy with respect to mitigation of climate change, development of rural areas and employment options as well as the provision of alternative energy forms. This is especially true for fuels used in transportation.
However, in order to make bioenergy a sustainable alternative, a holistic approach is needed, which:

- improves biomass supply with respect to amount and quality;
- improves conversion of biomass into other energy forms;
- reduces or eliminates toxic waste products ;
- develops zero-waste biorefinery concepts for efficient conversion of plant raw materials into diverse products;

- manages bioenergy production systems in a sustainable manner;
- has minimal impacts on the environment.

Effective and multilateral networking between the different, hitherto separated, research communities will be crucial to make bioenergy and bio-economy a sustainable success. This approach will form the basis for the network required for a knowledge-based bio-economy (KBBE) and will also provide new opportunities to farmers, the forestry sector and other stakeholders.

Plant science issues: creating the knowledge base for biomass production and supply. As plants will provide the major resource in a KBBE, plant science will play a major role in developing the capacity and novel opportunities for a bio-economy in line with the environmental and economic settings in Europe. European plant science is very well positioned to contribute with its strong expertise to obtain increased quantities of biomass at adequate qualities for the various optional routes of conversion, at economically competitive prices and with acceptable impacts on the environment.

There are numerous fields of action in which knowledge from plant sciences on agriculture and forestry crops needs to be used to deliver to the overarching aim of a sustainable bioenergy economy:

- **Higher biomass production is urgently needed**. This includes activities that increase biomass potential through direct improvement of growth and biomass production. This can be realised by increased growth rates, prolonged vegetation periods, or improved architecture of crops. It can also be achieved by reducing the loss of biomass due to pathogens and pests, by improved stress tolerance to allow using marginal lands and to lower competition with food production. Since the amount of biomass has to be enlarged significantly, all possible options have to be addressed in parallel.

- **Improved processability of biomass, with respect to the specific conversion options for bioenergy and biomaterials, needs to be achieved.** This requires strong interdisciplinary interactions with microbial, chemical, engineering and process sciences to develop new industrial processing methods. In plant science, activities include modifying cell wall structure and composition to increase the ease with which it can be decomposed into units that are either themselves useful as biofuel, or are good starting points for the production of chemicals. Enhancement other aspects of the organic and inorganic composition of biomass with respect to the conversion processes (e.g. removing compounds inhibiting decomposition or fermentation, reducing alkali for improved combustion behaviour, etc.) and residue handling should also be achieved. Improving composition of harvestable plant biomass will also be beneficial, for example to provide lignin more suitable for making lignin-based composites.

- **Improved resource use efficiency is the key to higher biomass yield at low environmental impact.** This includes improving processes such as energy collection through enhanced photosynthesis efficiency and nutrient use efficiency. This will reduce the dependence of plant growth on the application of additional inputs such as fertilizers that require high amounts of energy for production and have a deleterious environmental impact. Also topics like nitrogen-fixing bioenergy crops, associations with beneficial soil microorganisms and improving phosphate use efficiency are of prime importance to address decreasing availability and anticipated rising costs of fertilisers. Furthermore, minimising the water consumption per unit of energy gained is critical because fresh water will be a key limiting factor for food and energy production in the future on marginal land and with changing climatic conditions. Utilisation of plant varieties that can remove harmful substances from water and soil (e.g. excess nitrogen in overfertilised land, excess salt in highly irrigated land) can even provide additional beneficial effects.

- **Increased genetic diversity of bioenergy plants is key to achieving new properties in bioenergy crops.** A bioenergy roadmap needs to be established and will include (i) the use of traditional food crops for which all the scientific tools are available, (ii) the development of novel crops via genomics-driven domestication of hitherto not or not significantly used species, (iii) the development of specific energy crop rotation systems and (iv) the use of the different options originating from agriculture, forestry or even an biofactory (e.g. algae) approach. Actions include the development of specific energy crops having improved properties in comparison to the classical crops, probably via an initial round of genomics-supported breeding, followed by introducing novel features through smart breeding or genetic modifications. Throughout the introduction of novel species, their potential to displace native species and their potential impact on biodiversity needs to be considered. It will be crucial to address the alternatives of food and energy utilisation.

Plant research in tune with bioenergy and environmental sciences

Plant scientists in Europe are prepared to take this challenge in close coordination with researchers and engineers in related disciplines in order to develop a new, sustainable and economically viable bioenergy sector within the bio-economy of the future. Integration of plant research programmes must be obtained with:

- White biotechnology: in order to obtain new biocatalysis features to form useful energy sources (e.g. bioethanol, biogas, etc.)
- Conversion technology, chemistry and chemical engineering: significant interaction is required to obtain useful breeding targets on quality and quantity of biomass supplied to the alternative conversion routes.
- Agricultural and forestry management, ecosystem and biogeochemical research: as the production of large scale biomass for bioenergy will be done in new production systems, new plant features must be integrated in them and they must be checked for their biogeochemical impacts.
- Agricultural and forestry management and economics: it will be important to consider the potential to utilise non-food components of existing crop plants (e.g. straw, stover) for bioenergy as an added-gain that does not jeopardise food/feed production, and to consider how new dedicated energy crops are best integrated into agricultural practice and rotations in a manner that aids rather than competes with food and feed production.
- Sustainability assessment: for an ecologically, socially and economically viable bioenergy sector, impact analysis on all the above stated aspects must be integrated and evaluated in macro and microeconomic contexts. It is important to provide society with scientifically validated information about options using transgenic and/or clonal plants and on the conversion of marginal land, grass or agricultural land and forests into efficient production units for various energy feedstocks. A thorough discussion of the balance between food-feed-energy outputs from agriculture must be based on sound scientific evidence.

Taking significant steps forward

This concept for a sustainable bio-economy is in agreement with the strategic research agenda (SRA) of the European Technology Platform 'Plants for the Future' published in June 2007. EPSO member institutions are committed to contribute to the implementation of the SRA, but significant steps are required in a coordinated manner between stakeholders from the public and private sector to transfer this plan into action:

- significant investments into research and implementation similar to those presently done in leading countries outside Europe at national and European levels;
- co-ordination with industry as well as governmental agencies and NGOs;
- co-ordination and development of a common research agenda between all platforms committed to the idea of a sustainable knowledge-based bio-economy along the entire value chain.

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Useful links

Position paper webpage: http://www.epsoweb.org/commun/Position_Paper_Bioenergy.htm
Position paper press release:
http://www.epsoweb.org/commun/Position_Paper_Bioenergy/Bioenergy_Press_Release_EN.pdf
European Technology Platform 'Plants for the Future': http://www.epsoweb.org/Catalog/TP/index.htm
Strategic Research Agenda:
http://www.epsoweb.org/Catalog/TP/Launch_25June07/TP_SRA_Summary.pdf

About EPSO

EPSO, the European Plant Science Organisation, is an independent academic organisation that represents more than 140 leading research institutes and universities from 25 European countries. EPSO's mission is to improve the impact and visibility of plant science in Europe.
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