

Editorial

Welcome to the fifth EPOBIO Newsletter. In this Newsletter we focus on the second EPOBIO Workshop (Athens, Greece, 15-17 May 2007). The event is entitled **Products from plants – from crops and forests to zero-waste biorefineries**.

Background to the Second EPOBIO Workshop

As the development of the bioeconomy and zero-waste biorefineries accelerates, we have brought together scientists, academics, industrialists, policy makers and those involved with emerging economies and the developing world. Over the last year we have taken forward research into the priority areas identified during 2004/2005 by the US/EC Taskforce in Biotechnology Research - 'plant-based bioproducts: creating value from renewable resources'. Our holistic approach means that the three Flagship themes of plant cell walls for biorefining, plant oils and biopolymers have been working closely with environmental scientists, agronomists, experts in legislation and regulations, economists, policy-makers and the public to ensure the products we develop are beneficial to our society and for our planet. Putting science in its wider social context is a key outcome of the EPOBIO process. Our aim is to underpin the significance of biorenewables in the emerging knowledge-based bio-economy of this new century.

The Workshop Programme

In Greece the programme, amongst other things, reports the findings of our research since our first Workshop in Wageningen in 2006. In this Newsletter we give an overview of these findings. The full programme for the Workshop is available on the website and, as they become available, contributions to the workshop will be added to: <http://www.epobio.net/workshop0705.htm>

Last minute registration

Please note that the closing date for registration was 4 May 2007. If you still want to attend it is imperative that you contact the Workshop organiser at once at: workshop@epobio.net

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EPOBIO leaflet number 2

An updated EPOBIO leaflet has just been printed and is illustrated on the website. We are happy to supply printed copies in bulk to organisations holding workshops, conferences or meetings, or to those who like to have a supply of such material for visitors in their reception area. Requests should be made by email to: web@epobio.net

Dissemination through BioMatNet

Other results of activities, both in the EU and in the US, relevant to the production of renewable bioproducts and biofuels continue to be disseminated through BioMatNet. Details of recently added ITEMS can be found in ITEM Update number 4: <http://www.biomatnet.org/news/news0705.html>

BioMatNet CD-ROM 7

All the information produced by BioMatNet and EPOBIO, from the late 1990s to the present date, has now been placed on CD-ROM. This CD-ROM is available **Free of Charge** to organisations and individuals working in the area of renewable bioproducts. Order a copy online at: <http://www.epobio.net/register.htm>

Contact Us

We trust you find this a useful indication of the continuing activities within the project and welcome comments or other inputs.

If you have questions about the work or activities of EPOBIO please contact us at: info@epobio.net

Comments about the website should be sent to: web@epobio.net

If you are not already registered with EPOBIO or BioMatNet and would like to receive periodic emails summarising activities, events and additions to the website then please register with EPOBIO at:

<http://www.epobio.net/register.htm>

The EPOBIO Management Team

Second Set of Reports from EPOBIO

A second set of Reports has now been published by EPOBIO. These are available in printed form from info@epobio.net or can be downloaded as PDFs from the publications section of the EPOBIO website at: <http://www.epobio.net/publications.htm>

Crop platforms for cell wall biorefining

The desk researcher for the Plant Cell Walls Flagship is Ralf Möller. Flagship leaders are Markus Pauly and Sarah Hake.

The EPOBIO report **Crop Platforms for Cell Wall Biorefining: Lignocellulosic Feedstocks** considers crop platforms providing lignocellulose biomass for biorefining and complements the report **Cell Wall Saccharification** prepared by EPOBIO in 2006.

Four sources of biomass of relevance to Member States of the EU were considered as case studies. These are poplar and willow, *Miscanthus* and wheat straw. These four potential industrial crop platforms for lignocellulose biorefining have been chosen as representative of woody species, grass and a co-product from arable crop cultivation.

The report provides an overview of the current situation of each of these crop platforms and identifies research priorities that will need to be addressed to achieve an optimised platform for large-scale cultivation/use in 10/15 - 20 years. The report also makes recommendations on how best to address the needs identified in the report.

The development of a crop platform of the woody species poplar and willow will benefit from the broad science base of poplar and the fact that its genome sequence is known. Together with willow, short rotation coppicing of poplar offers many opportunities for the agricultural sector. A significant issue facing all perennial crops, however, is the timescales required to

recover investment costs, as well as costs associated with recovery of the land if replaced by arable crop production. The market will determine uptake relative to other biomass crops and land use competition with food crops.

In terms of R&D needs, classical breeding programmes to increase biomass yield and disease resistance should be further enhanced by the use of molecular tools and greater understanding of gene function gained from studies on poplar. Rust susceptibility of willow and poplar and the associated risk to plantations needs to be addressed both by research and plantation management. Information on the synthesis and organisation of cell walls in poplar and willow with targeted studies to define properties of direct relevance to ease of hydrolysis would be highly beneficial as these crops are developed in the longer term.



Miscanthus stand

The perennial grass, *Miscanthus*, has substantial strengths in terms of yield potential and ability to grow successfully under low inputs of fertiliser and pesticides. *Miscanthus* is already recognised to present a considerable opportunity for bioenergy production, given parameters such as biomass yield and low inputs. However, its use for bioenergy is currently severely limited because the grass is not developed as yet as a crop for widespread cultivation.



Harvesting Miscanthus

The report finds that research needs are those associated with any plant species that is undeveloped as an agricultural crop. There are urgent needs to improve our understanding of the genetics of *Miscanthus*, to establish a robust breeding programme and to develop molecular tools for fast-track breeding. Research is also required to establish a robust genetic transformation system for *Miscanthus*. In this context, parameters for successful tissue culture systems need to be optimised for regeneration purposes. In terms of bioconversion, much more work needs to be undertaken on understanding *Miscanthus* cell walls and the properties that determine ease of susceptibility to saccharification. Whilst clearly less developed than poplar and willow, *Miscanthus* undoubtedly offers opportunities in the 15-20 year timeframe to become a widespread biomass crop and it will be essential to undertake underpinning R&D in the near term to enable a successful outcome in the long term.

Agricultural co-products as a feedstock for biorefining have the advantages of adding value to the main use of the crop. Thus the use of co-products from food crops – such as wheat straw, and in the US, maize stover – holds considerable commercial advantages. Since there is an excellent knowledge base globally available on wheat genetics, genomics and breeding, the platform is in place to develop alternative varieties with a view to optimising its use as an energy crop in entirety, and/or its use as a provider of wheat straw co-product for energy biorefineries. However, it may well be problematic to improve the functionality of the co-product for biorefining whilst maintaining the high quality bred into the crop as a food feedstock over many generations. It will be a strategic decision, in terms of development of new feedstocks for energy and chemicals biorefining whether to disadvantage use and yield of crops for food production.

The economic assessment of perennial species demonstrates the significance of the single farm payment so far as viability is concerned. The report recommends that the European Commission reviews access to the single farm payment where perennial crops are grown for non-energy uses. This is important given the economic advantage that perennial crops grown for the energy market have through access to the single farm payment and other support.



Harvesting Willow

Industrial crop platforms for the production of chemicals and biopolymers

The desk researcher for the Biopolymers Flagship is Jan van Beilen. Flagship leaders are Yves Poirier and Bill Orts.

The second report of the biopolymer flagship for the EPOBIO project - **Industrial Crop Platforms for the Production of Chemicals and Biopolymers** - analyses the suitability of three crops for the production of platform chemicals and biopolymers.

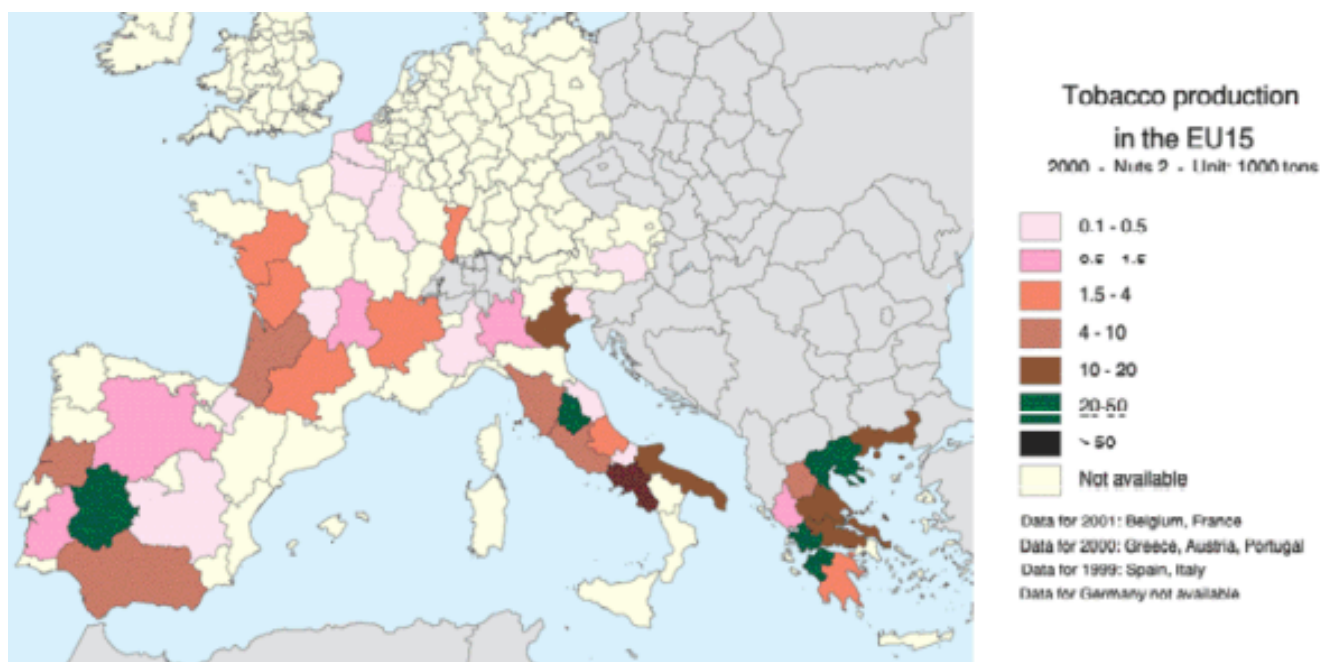
Most applications in this theme are in an early stage of development necessitating a longer lead-time to market (10/15 to 20 years). We have considered three quite different crops: sugar beet, tobacco, and *Miscanthus*. The strengths and weaknesses of developing each of these three crops as future industrial crop platforms turned out to be quite different. Central issues are the future acceptance of GM-crops, especially in the case of sugar beet, fitting the new crops in the supply chains,

and integrate the crops in existing or future processing technology.

Due to high biomass yield, and as a profitable crop for farmers, sugar beet has great potential as an industrial energy crop that could be further modified to produce platform chemicals. The extensive area on which this crop is already cultivated in Europe and the opening of markets through CAP reform are positive issues that support new developments. As a food crop feeding in to sugar refining, a substantial change in perception would be needed before alternative uses involving GM could

be taken up. This process may already occur with sugar beet increasingly in use as a biomass crop for bioenergy. Currently used beet has been optimised for sugar refining. Industrial utility of the crop would be greatly enhanced if new breeding targets aimed at industrial applications were undertaken. Beyond bioenergy, there are opportunities for using beet to produce novel chemicals and biopolymers.

Tobacco is a conventional crop that is already grown in Europe and offers interesting potential as an industrial crop.



Tobacco Production in the EU 15

Tobacco has many strengths for high yield production of designer compounds by GM and the possibility for development into a relatively high yielding biomass crop if breeding targets are changed. Due to the cost of developing and registering GM-crops large biotechnology companies will have to take the lead. As a non-food crop with limited risks of outcrossing it stands a good chance of being accepted by the general public in European countries.

Miscanthus has great potential as a bioenergy crop for the mid- to long-term future, especially once the grass has been optimised for large-scale commercial cultivation. Based on experience with the closely related sugar cane, *Miscanthus* also offers potential for co-production of added value products in parallel to

biomass for biofuels as soon as the necessary genetic tools are available.

In all cases, it is necessary to initiate pilot projects to establish proof of concept, and allow testing under industrial conditions. These will also help to communicate the concept to the general audience, investigate effects on the supply chains, and make field measurements of sustainability indicators.

In conclusion, the production of industrial feedstocks in plants is a challenging but worthwhile opportunity that requires strong input from funding organisations, with a special emphasis on public acceptance, integration and specific science areas.

Oil crop platforms for industrial uses

The desk researcher for the Plant Oils Flagship is Anders Carlsson. Flagship leaders are Sten Stymne and John Dyer.

Replacing petroleum as the predominant industrial oil feedstock with renewable and sustainable plant oils requires new and efficient oil crop platforms to be developed. The latest report from the EPOBIO plant oil flagship, entitled **Oil Crop Platforms for Industrial Uses**, addresses the establishment of industrial crop platforms for oil.

The EPOBIO report asserts in its introduction that both common as well as unusual plant oils are capable of satisfying demand from existing markets served by petrochemicals, and their use can also lead to the development of new market applications due to unique chemical functionalities present in unusual fatty acids. However, the successful development of oleochemical-based products for global markets is critically dependent on the effectiveness and cost competitiveness of the strategies chosen for the production of the industrial oils.

The importance of robust crop platforms for the production of feedstock oils was highlighted at the first EPOBIO Workshop held in Wageningen in May 2006. A number of plant species were identified as potential candidates. After additional discussions within EPOBIO, three crops, crambe, rapeseed and oats, were chosen to be evaluated in detail in for their use as non-food oil crop platforms. This evaluation, with its conclusions and recommendations, are presented in the EPOBIO plant oil flagship report.

Several criteria were regarded important in the selection process of the crop alternatives:

- Yield and agronomy are important parameters to avoid high production costs.
- Ease of processability of the crop is essential to avoid the need of developing new processing technologies and infrastructure.
- Cost competitiveness is highly influenced by the utility and value of by-products.
- Identity preservation and out-crossing from the non-food crop are critical issues to ensure that industrial products do not enter the food chain.
- Fast track plant breeding such as 'Tilling' should be available to genetically improve the chosen plant species.
- It is recommended that various genetic tools are available, including transformation protocols, to further facilitate improvement of the agronomic traits through genetic engineering.

The EPOBIO report **Oil Crop Platforms for Industrial Uses** concludes that production of special plant oils designed to be used as feedstock for a broad range of industrial applications, are highly recommended to be accomplished in specific non-food crop platforms. The designed plant oil qualities contain unusual fatty acids and should not mix with the food chain. The report identifies *Crambe abyssinica* (crambe) as a crop platform ideal for this purpose and recommends that substantial resources should be directed into improving the seed yield as well as cold tolerance in crambe.

The report also concludes that a large part of the chemical industries in principle needs basic carbon chains as their feedstock. These can be provided by, for example, oleochemicals derived from high oleic acid oils produced by crop platforms such as rapeseed and oats. To meet industrial demand for high volume - low price material, the oleic acid content of plant oils needs to be at 90% or higher. This type of oil quality comprises only a minor issue if mixed up in the food chain since oleic acid is already a major component of vegetable oils.

The report recommends that rapeseed cultivars with high oleic fatty acid (90% and above) should be developed. This will require the use of genetic engineering. It is also necessary that substantial breeding activities be directed towards increased disease and pest resistance and decreased demand for fertiliser in order to optimise this crop platform.

Besides rapeseed, oat is identified as having clear potential to be transformed into a high yielding oil crop platform with high oleic acid oil quality as well. Modifying key metabolic switches and redirecting much of the carbon accumulating as starch into oil instead would develop this future oil crop. Conventional breeding and techniques such as "Tilling" as well as genetic engineering might be required to accomplish high oil oats producing high oleic oils.

The EPOBIO plant oil flagship report presents a detailed literature survey on the crops genetics, breeding and status on the availability of different molecular techniques.

It also looks at the crops agronomy and environmental impact, as well as presents a SWOT (Strength, Weakness, Opportunity and Threats)

analysis with a conclusion on what research and development are needed for each individual crop.

Results are also presented on the revenue from the cultivation of each of rapeseed, oats and crambe in the five countries Germany, Italy, Poland, Sweden and UK.

Public attitudes towards the industrial use of plants

The desk researcher for this EPOBIO support theme is Maria Paschou. The support theme leader is Dr George Sakellaris.

The Social Attitudes and Expectations Support Package has succeeded, via means of empirical social research, in mapping a sample of European countries according to their citizens' views on the industrial uses of plants and the forthcoming introduction of bio-based products into the market. The main results are summarised in the report **Public Attitudes towards the Industrial Uses of Plants: The EPOBIO Survey**.

For the European public as a whole, the main outputs of the survey are the following:

- The attitudes of Europeans towards plant-derived engine oils, products made from alternative sources of rubber and biorefineries are positive, with a majority declaring their willingness to replace conventional commodities with plant made ones and being in favour of giving the Flagship areas incentives to support development.
- Regarding the special issues involved in industrial plant exploitation, i.e. genetic engineering, energy production by combustion of plant-made products and the usage of food crops in industry, most Europeans would approve of them providing that they are tightly regulated. For genetic engineering a considerable proportion of one in four indicate disapproval.
- With regard to the decisional level, there is a clear support for decisions to be taken at the European level in all countries except for the UK.

The key findings of the survey from a comparative perspective are:

- There is considerable variation across the European countries with regard to their awareness of the industrial uses of plants and the proposed projects, with Spain, Germany and Sweden recording the highest levels of awareness and Italy, France and Greece recording the lowest.

Finally, the report presents a section on the related policy issues for the bioeconomy and makes a number of strategic recommendations – both scientific as well as policy related, on what is needed in order for the three crop platforms to be realised in a 10/15 - 20 years time period.

- Italians and Greeks rank lowest for their willingness to change their purchasing habits but they rank highest for their position in favour of governmental support. Interestingly, this pattern reverses when it comes to Spaniards and Swedes.
- The socio-demographic breakdown of results suggests: First, males, urban dwellers, highly educated and those aged 35-54 are more knowledgeable about the industrial uses of plants and more likely to support the development of the EPOBIO proposed projects and products. Second, familiarity with general and issue specific technological matters has a positive influence on the acceptability of the proposed projects.

The additional information provided to assist science communicators suggests:

- The most persuasive reasons for the European support of the EPOBIO proposed projects and products relate to their environmental benefits and the reduced dependency on petroleum.
- The most trusted actors by the European public are scientists and environmental organizations, while the less trusted actors are politicians and the industrial sector.
- The newspapers and television are the most effective media for the dissemination of relevant news, whilst scientific journals and the internet are less effective.

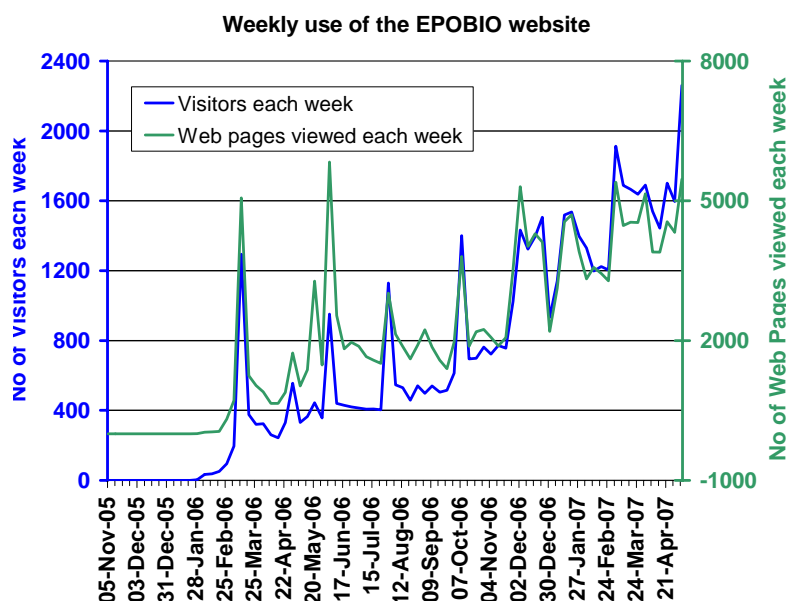
Taking everything into account, the Social Attitudes and Expectations Support Theme recommends a number of actions:

- Develop an integrated communication strategy aiming at intensifying media coverage.
- Raise public interest and stimulate public participation.

- Enhance the role of EU authorities in decision-making processes.
- Make the viewpoints of scientists clear in public debates.
- Improve the corporate profile of the industrial sector.
- Ensure transparency of the processes involved.
- Further social research to be put in place if technological progress is to meet societal needs.

Full details are a discussion point for the Second EPOBIO Workshop in Greece and are available from this EPOBIO report.

EPOBIO – A growing audience



Statistics on the use of the EPOBIO website collected each week now show a satisfactory trend with a steady rise in the number of users recorded. As illustrated by the following graph, the number of visitors to the site each week is now in excess of 1500 individuals who, on average, visit around 4 pages per visit.

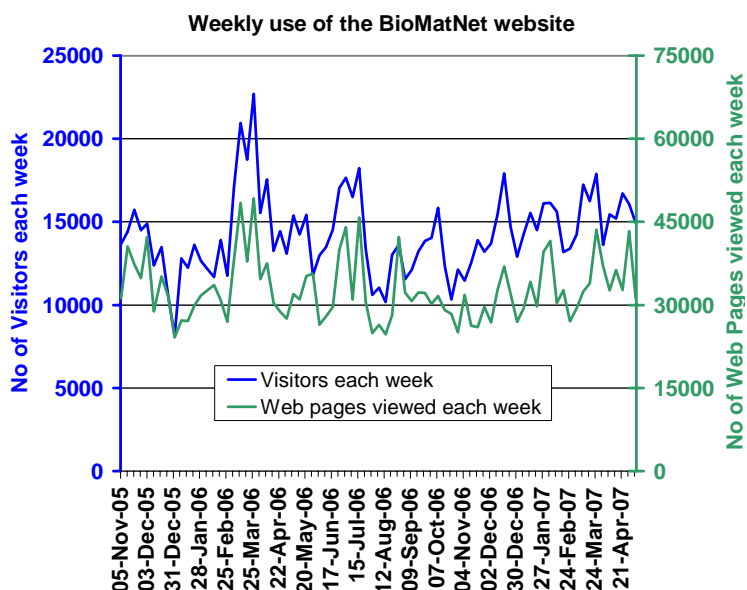
This figure also shows the impact of the periodic emails, indicated by the periodic peaks, sent out to registrants each time information is added to the website. The decrease in magnitude of the peaks indicating that these established users are also periodically visiting the website to check for new information, independent of the mailings.

Dissemination through BioMatNet

Information concerning renewable bioproducts and biofuels continues to be added to the BioMatNet website on a regular basis. The more recent additions are listed in the recent ITEM Update number 4. However, the rate of addition of such information has slowed over the last period since most of the new FP6 and IEE project descriptions have been added and reported in previous editions of ITEM Update.

The re-organisation of the website has continued, with most of the commercial organisations now transferred to the database of websites with the contact list updated. This means that many of the individual contact names have been removed from older projects funded under programmes such as ECLAIR, JOULE, AIR and Thermie. The project descriptions and 'further information' has been retained, since in some cases revision of the official EU sites means that this is the only widely available source of information on the earlier Framework Programmes.

As shown in the graph, the use of the BioMatNet site remains fairly constant attracting around 15,000 users each week.



BIS Information system

For almost a decade BioMatNet has collaborated with the US-based Biobased Information System™ system that has provided a focused information system highlighting US developments on a daily basis through a link (Global News) on the BioMatNet website. In 2006, the BIS received additional investment of capital and expertise allowing for a more robust system, more information, and a host of new services and expanded content that are being introduced throughout 2007. For those of you interested in what is happening in the USA this is the most comprehensive source for business-related information on biofuels, new crops, biobased products, and industrial biotechnology in the United States, providing an unparalleled resources for the entire Biobased economy.

BioMatNet CD-ROM 7

Dissemination of information concerning EC-funded RTD activities under the various Framework Programmes through BioMatNet and its predecessors (NF-AIRID and NF-2000) has been supported by the issue of a series of CD-ROMs. This tradition has now been continued by the issue of number 7 in the series.

To order a copy of the BioMatNet Non-Food CD-ROM 7 complete the online registration form at: <http://www.epobio.net/register.htm>