

REPORT ON THE MEETING TO REVIEW PROGRESS OF THE US-EC COOPERATION IN BIOBASED PRODUCT RESEARCH

EXECUTIVE SUMMARY

The **US-EC Biobased Products Steering Committee** sponsored a meeting with European and U.S. specialists from industry, academia, and government on March 1-2, 2005, at the Head Quarters of the Agricultural Research Service, U.S. Department of Agriculture. The purpose of the meeting was to: (1) evaluate the Steering Committee's Strategy Paper of a new vision for US-EU collaboration in agricultural and industrial biotechnology; (2) evaluate the two identified flagship research projects and identify new ones if relevant; and to (3) determine the next steps towards implementation. The discussions held during this meeting resulted in unanimous support to seek approval from the US-EC Biotechnology Taskforce for the strategic vision. This includes the two proposed flagships, with slight modification and refinement, along with an additional (third) flagship proposed by meeting participants. Further, while acknowledging the hard work of the participants during these two days, this meeting was only the next step in a much longer journey. While the research communities and industries on both sides of the Atlantic have made great strides in the past years to develop needed technologies for biobased commerce, there are still major technical constraints that must be overcome to make such products more effective and efficient.

The Strategic Vision Paper

The Paper describes the main technical and societal constraints that face the biobased product industry at this time, and defines the role of the Steering Committee in developing flagships and other cooperative activities needed to address these challenges. The meeting participants concurred that the vision was targeted and well described, but should more fully consider economic issues. The consensus was that economists should be incorporated into both the Steering Committee and the flagships.

The flagships were deemed extremely effective mechanisms for implementation of the Strategic Vision. The participants also concurred that the criteria to select flagships were not only relevant, but necessary, to address the major technical constraints identified as flagship projects. The criteria are as follows:

- (1) consumer/user benefit;
- (2) scientific challenge;
- (3) economic benefits/risk;
- (4) private sector involvement.

1. Plant Cell Wall Flagship

The cell wall breakout session included a range of experts from the U.S. and European research sectors, grower representatives, and industry, with expertise ranging from those involved in bio-refining to geneticists. An initial general discussion addressed the choice of the plant cell wall flagship, its wider political and environmental issues, components needed for a possible future scientific program, and the technical barriers of the challenge. The discussion then focused on how to address the cell walls: (1) as a source of subunits and how to release them into a usable form as cheaply as possible; (2) potential novel functionalities in cell walls; or (3) consider cell walls as sinks for novel products that can be stored until processing. The breakout group agreed that this flagship had to include process/chemical engineers, economists and material scientists in addition to geneticists, microbiologists, cell biologists, and biochemists. The results of the

flagship would be improved processes and coproducts, new products to replace petroleum-based products, new value from agricultural residues, maximized value creation per acre of land, and maximized resource utilization per acre of land, all of which would benefit consumers, society and the environment. As a scientific challenge, the group considered the cell wall project an “enabling technology”, *i.e.*, it would create something that is not now possible. The consensus was that the breakthrough should be massive, not a step change. Easily digested cell walls are the target, but much more must be known about cell wall structure and how it can be modified. The economic benefit/risk analysis of this project is linked to the finite supply and fluctuating cost of fossil reserves. Depending on the technology that is developed, the cost may include the need for infrastructure changes, however, industry representatives agreed that the research was needed and was beyond the means of any one company. In addition, the group agreed that anything that improves conversion to monomers would increase economic gain.

Following the report for the Cell Walls Flagship breakout session, the following points were made in the general session: (1) The road map for the flagship should include time lines and milestones. (2) The flagship should have teams to address specific research issues (e.g., team for lignin; teams for different crops). These points will be incorporated in the flagship description.

Plant Cell Wall Flagship Team: Dr. Dianna Bowles, University of York; Dr. Sarah C. Hake, Center Director, Plant Gene Expression Center, Agricultural Research Service-USDA, Albany, CA.

2. Oilseed Crop Flagship

The major theme of this project focuses on the production of novel oils as industrial feedstocks in crop plants. The breakout session was attended by a variety of U.S. and European academia, scientists, industry representatives and science policy leaders. Plants are capable of producing a wide array of fatty acid structures that have potential usage in industry, but attempts to produce these fatty acids on a larger scale has met with limited success due to low accumulation resulting in levels not commercially viable. Optimizing novel oil yields in plants represents a formidable scientific challenge requiring the joint efforts of U.S. and EU scientists. This challenge includes pursuing various types of fatty acid targets, establishing plant platforms – initially non-food crops – for industrial oil production, and establishing the knowledge-base required for rational engineering design. The breakout group further agreed on an ice-breaker project that would provide tangible results in a short time period and help spark public interest and acceptance of engineered oilseed crops: *the production of wax esters in an industrial crop such as crambe*. While acknowledging that specific types of lipids have different marketing potential, the group also concurred that successful production of novel oils in crop plants should establish the knowledge platform required for production of many types of oils in plants. Many U.S. and EU companies have demonstrated an interest in producing novel oils in crop plants, either through their own in-house research programs, or by communicating with the Oilseed Flagship organizers. It will be important for the flagship organizers to continue to work closely with private companies, in an IP transparent manner, for downstream adoption of technology, information, and products generated by this flagship project.

Following the report for the Oil Seed Flagship breakout session, the following points were made: (1) Industry has shifted focus from the production of industrially-useful unusual fatty acids in transgenic crops, due in large part, to the inability to engineer high levels of accumulation of these fatty acids in seeds (2) This flagship needs to tackle the underlying problem caused by unnatural oils – the negative effects on plant cells. Further discussion clarified that the production of novel fatty acids in transgenic plants has been a major goal of a variety of industries, and targets have included both food and nonfood applications. Despite the investment of millions of dollars from individual companies in both the EU and USA, the technical challenges of producing desired fatty acids in plants have been formidable, and many projects have stalled. A principal reason for this failure to overcome the barrier of low yields of unusual fatty acids in oil

crops is that industry-led research has focused on specific targets - *i.e.* introducing fatty acid modifying enzymes and analyzing transgenics in an iterative manner - rather than aiming to understand the biochemical basis of the processes causing the barriers. The time is now right for the public sector to invest in a team-based approach to discover the nature of the barriers that have prevented the successful production of novel fatty acids in plants. Participants agreed that the flagship represents an excellent opportunity to address this issue, and that the EU and US can together provide the expertise and talent that is needed to accomplish these goals.

Oilseed Flagship Team: EU: Professor Sten Stymne (Swedish University of Agricultural Sciences), Professor Ian Graham (CNAP, University of York). US: Dr. John Dyer (USDA-ARS, Southern Regional Research Center), Dr. Edgar Cahoon (USDA-ARS, Danforth Plant Science Center), Dr. Jan Jaworski (Danforth Plant Science Center). Additional EU and US project leaders and company representatives will be provided in an appendix, to be submitted shortly.

3. A New Flagship to Address Biopolymers

Although participants concurred that the two identified flagships addressing constraints presented by the plant cell wall and oilseed crops are very important issues that merit the attention of the Steering Committee and the biobased product research community, a third area of biopolymers was identified to be explored as a flagship project. This Biopolymer Flagship should focus on biological material of sufficient molecular weight that macroscopic bio-materials could be produced (e.g., polyhydroxyalkanoate-PHA, rubber from guayule, protein and starch). Biopolymers offer economic and environmental impact with their potential to replace non-renewable materials derived from petroleum, as well as offer a reliable (domestic) source of rubber, a national security concern on both sides of the Atlantic. The development of cost effective, high-performance materials from biopolymers is a formidable challenge necessitating interdisciplinary, cooperative research. The economic assessment for individual biopolymers varied; co-product development to enhance overall process economics at the bio-refinery was deemed essential. The Breakout Session group felt the candidate biopolymers represented a healthy market range of interested corporations, from micro-companies (guayule) to mega-companies (starch). It was also noted that the need for research regarding specific aspects of each biopolymer lent itself best to the role of government to address higher risk research. If difficult technical challenges can be overcome, platform technologies will result that industry on both sides of the Atlantic could expand upon.

Upon the general session re-convening, participants endorsed further development of a candidate Biopolymer Flagship. Participants agreed that the candidate Biopolymer Flagship could also include improved production of gums for industrial and/or food uses through biotechnology and isoprenes as a potential additional component biopolymers. As the flagship further develops, other biopolymers should be considered as possible components by a flagship writing team.

Biopolymer Flagship Team: Professor Yves Poirier, Universite de Lausanne, Lausanne, Switzerland), Dr. Bernward Garthoff, Board Member, Bayer CropScience AG, Mannheim, Germany (offered to identify a European scientist with biopolymer - starch expertise); Dr. William Orts, Research Leader, USDA Agricultural Research Service, Albany, CA; and Dr. Daniel Solaiman (Research Molecular Biologist, USDA-Agricultural Research Service, Wyndmoor, PA.