BioTOPics BERLIN-BRANDENBURG

Green Biotechnology

In the Region of Berlin-Brandenburg

Dear BioTOPics readers,

in the European research landscape, the Berlin-Brandenburg region does not only play a leading role in red biotechnology, but offers high potential in the area of plant biotechnology as well.

Aside from internationally recognised research facilities such as the Max Planck Institute for Molecular Genetics in Golm, the Institute for Agricultural Technology in Bornim, the Centre for Agricultural Landscape and Land Use Research (ZALF), the University of Potsdam und the institutes of the biological federal agency, strong networks – such as the business office of the GABI (Genome Analysis in the Plant Biological System) – and a number of successful companies from Berlin and Brandenburg are active in plant biotechnology.

In previous years, green gene technology did not have it easy in Germany. While the battle about the legal framework went on in Europe, many countries outside Europe gained important farming experience, and some began to make extensive use of genetically modified plants. In Europe, the use and consumption of products from plant gene technology has long been controversial. The first licensing for the strictly regulated farming of genetically modified plants in Germany and recent voting measures by the EU commissaries in Brussels give hope that in the future genetically modified plants and foods will be handled from a unified standpoint.

In the current issue of BioTOPics, we deal in depth with plant gene technology and here especially with functional genome research as well as metabolomic analyses and the optimisation of useful plants. This field of research on genetically modified organisms, in particular, is accompanied by numerous safety tests and the monitoring of results. Plant biotechnology also plays an important role in the Bio Profile Nutrigenomics which is supported by the BMBF with 18 million € until 2007. The goal of the research field is the prevention and treatment of nutrition-related illnesses. Further contributions in the current issue describe the preparation of plant-based secondary metabolites for application in pharmaceuticals and plant protection as well as in the manufacture of valuable substances from biomass.

In this issue of BioTOPics, we would like to inform you about the scientific developments in plant biotechnology in Berlin-Brandenburg and their political and economic importance within Europe.

Enjoy your reading!

Dr. Kai Bindseil
Director BioTOP Berlin-Brandenburg

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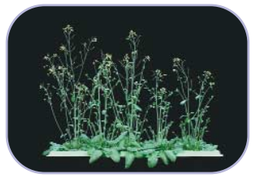
Green Biotechnology in Germany



A summer day in June 1982 in Cologne. In a greenhouse in Cologne-Vogelsang, a group of journalists was listening closely to the explanations of a wiry, middle-aged man with red hair. Obviously enthusiastic and gesticulating wildly, he pointed again and again at a group of tobacco plants. Sentences such as „That is our miracle plant" and „This will revolutionize agriculture" could be heard.

The red-haired man was Prof. Jeff Schell, at that time one of the directors at the Max Planck Institute for breeding research in Cologne. And these tobacco plants with their entirely innocuous appearance were the first genetically modified altered plants produced anywhere in the world. Let us state it more clearly: At that time, Germany held the leading position in fundamental research in plant biotechnology. Cologne's Max Planck Institute was the world's Mecca for molecular plant biology.

And what about today?

I think that plant biotechnology is a textbook case for how innovations resulting from largely excellent and internationally pre-eminent fundamental research are handled in Germany. Anti-technology attitudes, inertia, strangulation of research and development through innumerable absolutely superfluous regulatory bodies which generally give rise to cost overruns and produce mountains of paper but no discoveries whatsoever have done much to hinder the consistent development of this technology for years in the sense of the long-term development of an industry engendered by this new technology. Consciously encouraging irrational fears not only with regard to green biotechnology, but towards all gene-technological approaches, not only led to several bomb attacks on various institutes in the years 1984 – 1988, but also to death threats against scientists in an exposed position (Prof. Schell among them).

How should the situation for green biotechnology in Germany be evaluated today? Fundamental research continues to have an excellent reputation and is extremely well positioned internationally. In the field of plant genome research, a significant foundation has been laid by the creation of GABI (Genome Analysis in the Plant Biological System), permitting a research approach in this direction, although it is still marginal by comparison to the USA. However, it has made it feasible to bring the experimental approaches which have been made possible by functional genome research closer especially to young scientists.

Where realisation into marketable products is concerned, it can be determined that of the six remaining large agbiotech companies, two are headquartered in Germany. Germany is also well positioned among the independent breeding companies.

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So is everything ok then?

No, definitely not, as the most recent discussion about the new guidelines on the growing of GVO in Germany shows! As previously, actions are taken and decisions made on the basis of political convictions and not scientific facts. However, the lifting of the EU moratorium regarding the farming of genetically modified plants could mean a glimmer of hope, so that plant biotechnology will now have a chance to show whether the hopes of the red-haired man from Cologne in 1982 will become reality in Germany and the EU as a whole.

Max Planck Institute of Molecular Plant Physiology

- The MPI-MP is part of the new Max Planck Campus in Golm, Germany (near Potsdam) and studies the dynamics of plant metabolism in the context of the plant system as a whole.
- Prof Lothar Willmitzer directs Department 1, Molecular Physiology, which started operating in 1995. To gain insight into plant systems, it focuses on metabolism in its broadest sense, primarily using reverse genetics to alter plants and functional genomic approaches to analyse the pleiotropic effects of these alterations. The development of new methods and tools for biochemical analysis and data mining is emphasised.

The German Plant Genome Research Program

Why do we need Plant Genomics Research?

Plants are the basis of our lives and well-being. Plants produce directly or indirectly all food and feed and provide medically-active substances and renewable raw materials. Plants are also key to maintaining and regenerating complex ecosystems and the biosphere. Plant genomic research aims at a comprehensive understanding of plant function at the molecular level. Plant genomics is an integrative research area driven by the development of new analytical techniques and the rapid expansion of computing power. These developments enable researchers to accumulate and analyse comprehensive information and to elucidate complex life processes. Plant genomics provides the means to uncover the genetic basis of plant characteristics with significance to human life and health. Plant genome research integrated with human genome analysis, nutritional science, and medicine, constitutes a novel discipline of research in support of human welfare. This exiting new multidisciplinary approach called nutrigenomics focuses on the highly complex interplay between human genetic predisposition and nutrition, in regard to both food nutritional quality disease prevention.

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The recent sequencing of higher plant genomes such as those of Arabidopsis thaliana and rice has provided the basis for the development of novel tools for molecular and biochemical studies. Despite this, knowledge about the roles of the tens of thousands of plant genes is still extremely fragmentary. It is expected that many genes of the genes responsible for plant growth, development, and environmental homeostasis, will turn out to be important for human health, specifically in regard to nutritional quality, food safety, and protection against human diseases. In addition to the genes that control the accumulation of bulk nutrients, genes will be uncovered that determine the content of valuable compounds such as potential pharmaceuticals, health-promoting probiotics, flavour and fragrance compounds, protectants, biocides, fine chemicals, etc. Even more important will be genes that determine characteristics supporting the production of crops in an environmentally friendly and sustainable manner. Every year, billions of Euros are spent on crop protection measures. Yet, many of the chemicals used may impact negatively on our health or the environment. The rapid progress of plant genomics, notably in Europe, will provide new knowledge in these areas and will open up ways for targeted crop improvement, both through the use of natural genetic diversity and genetic engineering.

The task is immense, but let's go for it! We need the functional analysis of plant genomes!

How is Plant Genomic Research organized in Germany?

GABI - is the acronym of Genome Analysis of the Plant Biological System. The GABI program commenced at the end of 1999. It is an associative research program supported by the German federal ministry for education and research (BMBF) as well as by a consortium of some 30 commercial companies linked into the Industrial Network of Plant Genome Research (WPG). WPG members are companies active in the fields of plant breeding and plant protection as well as plant biotechnology the food and feed processing industry. Their structures range from global companies, small and medium-sized enterprises, as well as start-up companies founded by members of academia.

The objectives for GABI are:

- Strengthening plant genome research in Germany
- Creating a national network and establishment of centres of excellence
- Supporting European and international cooperation
- Gaining information on the structures and functions of commercially significant and other important plant genomes
- Efficiently securing knowledge and transferring technologies between the scientific community and companies
- Comprehensively protecting intellectual property
- Rapidly transferring research results into crop improvement, breeding practice, and accelerated development of new products with added value.

During the first funding period of GABI (GABI1:1999 - 2003), more than 70 individual projects with a total financial volume of about 40 million € were supported. In the year 2002, eight new projects have been selected to extend the program more into the analysis and use of natural genetic diversity. They cover another 7 million € of funding. Research within GABI is being conducted on nine different plant species. Major emphasis is given to the model species barley (Hordeum vulgare) and Arabidopsis thaliana for mono- and dicotyledonous plants, respectively. The results obtained through the work on these two model organisms will support the analysis of the crop plants rapeseed, sugar beet, potato, rye, wheat and maize. The ninth organism examined is poplar. Furthermore, four plant and two bioinformatics resource centres are supported within GABI. One third of the total financial resources in GABI are spent on the resource centres. The GABI activities are assigned to two research areas. Research area one covers fundamental research activities, while research area two is focused on applied aspects. A patent and license agency (PLA for GABI) associated with GABI has the function of securing the protection of intellectual property and stimulating the commercialisation of research results. Members of the WPG have great interest in exploiting these results.

Building upon the national activities, international co-operation is also supported, most notably with the French plant genome research initiative, Génoplante. Joint projects on Arabidopsis research started in 2002. The model species Arabidopsis became a model for a European co-operation. Supported by the positive political background of this international cooperation and driven by the scientific communities in Europe another bilateral call was lunched on more applied joint research activities between France and Germany. Furthermore the first trilateral (France – Spain – Germany) projects will start in spring 2004. Together with the new call for proposals in 2003 GABI 2 and the international research activities will run from 2004 to 2007. Therefore international co-operation will become a major element in the second phase of GABI and become a basis for the creation of the European Research Area.

GABI - 'Genome Analysis in the Plant Biological System'

- GABI is an associative research program and a living example for a well function public – private partnership that started at the end of 1999.
- From 1999 till 2003 more than 70 projects with a total financial volume of approx. 50 million e in total were supported. The research activities are assigned to two research areas: Area 1 focuses on basic science-oriented research while area 2 bundles activities with applied character.
- Within the GABI program nine plant genomes are examined. Arabidopsis thaliana and barley (Hordeum vulgare) serve as model organisms for mono- and dicotyledonous plants; their results will support the analysis on the crop plants rape seed, sugar beet, potato, wheat, rye, maize and poplar.
- In the beginning of 2004, a new project period will start (2004-2007). A so called 'bridging concept' will combine genomic research on model organisms and crop plants within the projects.
- Joint projects with the French partner initiative Génoplante as well as multilateral projects between France, Spain and Germany will continue international cooperation in Europe.

Therefore Plant Genomics Research is competitive and cooperative.

Plant genomic research activities now conducted at national levels need to be interlinked at the European echelon. The joint Génoplante – GABI projects serve as a prototype for further co-operations between national plant genomic programs in Europe. As a visible sign celebrating the onset of the interaction among GABI, Génoplante, and GARNet (the UK plant genome initiative), GABI was organizing the first Plant Genomic European Meeting (Plant-GEMs) 2002 in Berlin. Plant-GEMs provides a series of annual meetings (www.plant-gems.org). The second Plant-GEMs was jointly organized in September 2003 in York (UK) and the next meeting is already announced for Lyon (France) September 2004. Furthermore, GABI expressed our interest in building a European Research Area Network for Plant Genomics (ERA Net PG) within EU framework program 6. The ERA Net PG will start January 2004 and combines the activities if 11 European countries from the beginning. Nine additional countries manly recruiting new member countries of the EC are nominated as candidate countries and can join the ERA Net as soon as an plant genomic program combines ongoing activities within these nations. Plant genomics research therefore serves also as a model for future political activities and stays as a driving force to build up the European Research Area.

Plant Genomics Research is not only a need of the 21st century, Plant Genomics Research is an example for joint national and international research activities.

Research for Benefits and Risks of GMOs

Since 1996, the BBA's Institute for Integrated Plant Protection in Kleinmachnow has launched field and laboratory experiments with transgenic oilseed rape, maize and potatoes to elucidate the importance of GMOs which could meet the objectives of integrated plant protection. That means, on the one hand GMOs with plant protection related traits like herbicide or insect resistance must reduce environmental risks of pesticide use, and on the other GMOs with quality traits like potatoes, genetically modified in their carbohydrate metabolism, may not cause a higher intensity of pesticide use compared with existing practices or conventional cultivars. Furthermore, the BBA's research is also focused on ecological side effects of GMOs on weed biodiversity and non-target organisms in the field. Out-crossing of transgenic oilseed rape on conventional cultivars and wild relatives, and the behaviour of transgenic volunteer rape are also among the key issues to be addressed. The experiments are based on long-term field trials in Dahnsdorf/Fläming with glufosinate-ammonium resistant oilseed rape and maize, and with fructan accumulating potatoes, developed at the MPI in Golm, and on farm-scale evaluations with insect resistant maize (Bacillus thuringiensis maize) in Brandenburg's location Oderbruch where Bt maize cultivars have been grown annually on approximately 250 hectares since 2000.

Proving Grounds in Dahnsdorf

Many investigations are being carried out in close cooperation or even in joint projects with partners in Brandenburg like ZALF Müncheberg, MPG's Institute for Molecular Plant Physiology Golm and regional offices for plant protection. After seven years of research, results have shown that a post-emergence spraying of glufosinate-ammonium in herbicide resistant maize and rape gave higher weed densities after last spraying, and reduced ecotoxicological risks. But herbicide resistant volunteer rape in maize needed an extra herbicide which did not meet the aims of integrated plant protection. The out-crossing of transgenic HR rape to conventional rape could not be entirely prevented. Therefore, co-existence between farms with and without GMOs will be only possible in the future with practicable thresholds for adventitious presence. Abstention from transgenic rape growing in certain regions also seems to be an acceptable solution. Fructan potato lines have not shown changes in their susceptibility against important diseases and pests like late blight, black wart, nematodes or insects. But, they are surprisingly characterized by a smaller type of growth and, therefore, this GMO can not reach canopy closure in late season which can reduce its competitiveness against weeds and requires potentially a more intensive use of herbicides. Growing of Bt maize was extremely effective against the serious lepidopterous pest European corn borer (ECB). But for preventing a high selection pressure on resistant genes, strategies to reduce the risk of developing Bt resistant populations are absolutely necessary. Therefore the BBA in Kleinmachnow collaborates with farmers and local authorities in Brandenburg for developing and introducing an insect resistant management (IRM) in order to keep populations of ECB as long susceptible as possible.

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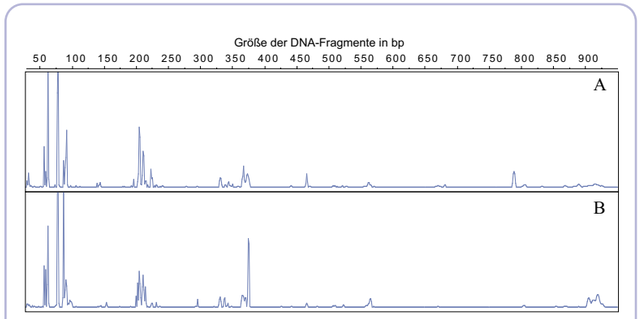
Federal Biological Research Centre for Agriculture and Forestry (BBA)

- Superior federal authority and research centre, founded in Berlin in 1898 with headquarters in Brunswick (Braunschweig) and Berlin, and further research institutes and branch offices: Kleinmachnow, Dossenheim, Darmstadt, Munster/Westphalia and Bernkastel-Kues.
- BBA research tasks are defined by the Plant Protection Act, the Gene Technology Act, and the Federal Epidemics Act and aim to develop methods and systems serving to protect plants and plant products and avert dangers which may arise to the health of man and animal or to the environment from crop protection measures or from genetically modified plants.
- These research activities are a basis for decision-making in the fields of food, agriculture, forestry, and consumer politics.

Biosafety Research

and Monitoring of Genetically Modified Crops

In the state of Brandenburg, several institutes are involved in research projects evaluating the potential ecological risk of genetically modified crops. The studies on risk assessment include both the impacts of transgenic plants on the agro-ecosystem under field conditions and the evaluation of parameters for monitoring transgenic plants after introduction into the market (according to EU Directive 2001/18/EG). Our investigations are focussed on potential effects of herbicide-tolerant oilseed rape and maize as well as potatoes modified in carbohydrate metabolism on the plant-associated microflora. A key role in the decomposition of organic matter and in nutrient cycling of the soil ecosystem is attributed to micro-organisms. Moreover, micro-organisms are an appropriate indicator for environmental impacts of transgenic plants due to their close association in rhizosphere and phyllosphere. These habitats, especially soil and rhizosphere, are characterized by a multitude of phylogenetically different bacteria and fungi. Molecular fingerprint techniques can be used to study the composition of microbial communities. Changes in such fingerprint profiles indicate an impact on the microflora. Based on long-term investigations, specific effects beyond the variability of conventional varieties could not be detected.



Fingerprint profiles of bacterial communities of the rhizosphere obtained from the potato variety Désirée planted on two different sites. The single peaks represent the relative proportion of the various bacterial groups. Differences in fingerprint profiles indicate the impacts of the field sites on the bacterial community.

In order to establish ecological monitoring of transgenic crops, baseline studies were performed to characterise the ecosystem in arable fields planted with potatoes. Besides the soil and plant-associated microflora, epigeal arthropods and the spread characteristics of conventionally grown potatoes were analysed. Our results demonstrated a distinct impact of the study site on both the microflora and the arthropods, whereas the community of the flower-visiting insects and the spread behaviour of potato plants were more influenced by the variety planted. Based on these results, a monitoring of transgenic potatoes should strictly consider the dependence of the selected parameters on site properties.

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Leibniz-Centre for Agricultural Landscape and Land Use Research

- Integrative landscape research with seven institutes and 80 scientists that focuses on sustainable development of predominantly agrarian landscapes
- Identification of substantial functions, characteristics and processes within agrarian landscapes, analytical work as well as deduction of goal-driven utilisation concepts including their scientific attendance and testing
- Biosafety research with respect to genetically modified crops (in close cooperation with other institutes)
- Institution of the "Leibniz-Association" (WGL; a file of high standard research facilities financed through both federal and state funds)
- Financed by the Federal Ministry of Consumer Protection, Food and Agriculture (BMVEL) and the Ministry of Agriculture, Environmental Protection and Regional Planning of the Federal State of Brandenburg (MLUR) 50% each
- Research Station for Agriculture with three sites

Potato field in Brandenburg. Potato production is characterised by different cropping intensity on nutrient-poor sandy soils.

Biorefined

A Plea for Bio-Based Industrial Products and Biorefineries

Cargill-Dow-Bioraffinerie, Nebraska, USA

The use of renewable raw materials will gain importance over the next few years and decades for many reasons, and seriously alter economies to a previously unknown extent. We are referring to the transition from raw fossil materials to biological raw materials. Only economies which oppose the fossil-fuel based economy in good time and promote the development of technologies for the utilisation of biological raw materials will win out.

Sustainability without a substance-transforming industry?

Sustainable economic growth requires secure, sustainable raw material resources for industrial production and long-term investments. It also takes financial confidence in the economy, ecological security, and secure and long-term living and earning options for the population. The raw material base of fossil-fuel materials such as crude oil, natural gas and coal is neither secure nor sustainable and sometimes is no longer economically sensible even today.

While the energy economy can be based on various alternative sources such as wind, sunlight, geothermal energy, water, biomass and - where acceptable to society – on nuclear fission and nuclear fusion, substance-transforming industries such as the chemical industry and industrial biotechnology must largely look to biomass as their alter-native.

Biomass is a constantly self-renewing chemical, cosmetic and pharmaceuticals factory. It is present in Germany to a sufficiently large degree for this purpose. However, the conversion of this material and also agrarian raw materials into valuable products like chemicals, biopolymers, materials and consumer goods requires fundamentally new base technologies which go far beyond the processing of renewable raw materials into pressed sheets and garden tools. Depending on the raw material and the target substance, such complex technologies are referred to as biorefineries or green biorefineries.

Why not learn from the old chemistry?

The success of the chemical industry depends on the principle of the construction kit – also referred to as the "family tree of chemistry": Simple base substances can be used to produce, in controlled chemical reactions, more complex intermediate products which, in their turn, can become an endless variety of resulting and end products due to the multitude of combinations being created. In this process, chemistry has learned to transform crude oil into easily handled and precisely defined, chemically pure substances in refineries – this was the key to success. The triumph of synthetics would have been as impossible without an exact knowledge of the functioning principles as the creation of the many thousands of other chemical products which make our life safe and comfortable today.

With a view to maintaining our standard of living as well as that of succeeding generations, it will be an important task to transfer the functions of crude oil refineries into biorefineries processing biomass. Analogously, the biorefineries will then utilise raw materials which are available in large amounts and can be regrown, as well as leftovers and waste products from agrarian and food production. Biotechnological substance transformation can and must play an important role beside chemical substance transformation.

Research Institute for Bioactive Polymer Systems (biopos) e.V.

- Founded early in 1996 at the Teltow-Seehof research facility as a non-profit scientific facility.
- Main research focus: biorefining concepts and systems.
- Subject areas: both complex natural products, such as cellulose and proteins, and biotechnological and chemical-hydrolytic decomposition products, such as hydroxy-carbonic acid (lactic acid), amino-carbonic acids (lysine), oxocarbonic acids (laevulinic acid) und betaines (carnitine). By applying modern methods, these biorefinery products are converted into new bioactive substances and polymer materials.
- The institute and its subsidiary, biorefinery.de GmbH, are leading the way in Europe in the future-oriented research fields of bio-based products and biorefineries.
- Basis of these developments: a network centred in the Berlin-Brandenburg region (including, among others, the Institute of Agricultural Technology Potsdam-Bornim and the University of Potsdam as well as small and mid-sized companies) which operates in Europe and is also in demand overseas.

What can we learn from the USA?

Decisive attempts to introduce the transition to a biomass economy are currently observable in the USA. It is expected that by the year 2030, 25% of the organic base materials (base value 1994) which are currently derived from raw fossil materials and 10% of oils and fuels will have shifted to a biological raw material base and be produced primarily through the use of biorefinery technologies. A biobasis for 25% of the entire chemical stock is a huge task, and the economic potential is gigantic.

In the USA, legislators and executives are already cooperating closely with agriculture, industry and science. Following the government program „Biobased Industrial Products" from the year 2000, more than 40 states have initiated their own products. Goals and support tasks have been set out and are already being realised. Associations of chemistry and biotechnology, such as the American Chemical Society (ACS) and the Biotechnological Industrial Organisation (BIO) work together closely. At the New York Stock Exchange, discussions on trading have commenced. The „Economist" magazine regularly reports on assessments of this development. Increasingly, US companies at the stock exchanges are also valued on the basis of their sustainability performance (Dow Jones Global Sustainability Index). And last but not least, the major US industries (among others Dow Chemical, E.I. du Pont de Nemours, Cargill Dow LLC, Genecor International Inc.) have positioned themselves positively towards the biomass industry with their own „vision" and a corresponding "roadmap".

Chemistry, biotechnology and agriculture. Why not work together?

An industrial beacon for the young „Biobased Industry" is the American company Cargill Dow LLC. For two years, the joint venture of US chemistry giant Dow Chemical and the agro and foods group Cargill has been making biosynthetics from corn. These are suitable for plastic packaging, foils and even t-shirts. Approximately 140, 000 tons of biosynthetics can be produced annually by the facility in Blair, Nebraska and part of a planned complex biorefinery. For this purpose, the cornstarch is biotech-nologically decomposed into glucose, fermentated into lactic acid and then chemically processed into a polymer – polymer lactic acid (PLA, Polylactic Acid), which is thermoplastic and can be spun. There is a market opening for active breathing clothing from PLA particularly in South East Asia. In Germany, bedding from PLA fibres has recently come to the market. (Illustration PLA facility Cargill Dow LLC, Blair, Nebraska USA).

And what about Germany?

Despite many individual programs by the federal government and the European Union to drive forward the use of non-fossil raw materials, it has been shown that the substance utilisation of sustainable raw materials and their gigantic potential have not been given sufficient consideration in Germany. This means that entire branches of industry, like the base materials and production goods industry as well as small and mid-sized processing companies have been helld back in favour of a pure energy and fuel economy. However, it is the sustainable production of material goods, i.e. base materials, wares and consumer goods and the related service provisions that is the engine driving economic development and the foundation of societal and social prosperity.

Activities at all levels are therefore in demand. Here are a few concrete examples:

BioVision 2030: An initiative group „Biobased Industrial Products" from industry, KMU's, as well as research and development facilities (Dow Deutschland GmbH Rheinmünster, Dow Europe GmbH, Horgen, Swiss; biorefinery.de GmbH, Potsdam; Fraunhofer-ICT Pfinztal, biopos e.V., Teltow-Seehof) has formed in Germany and created a strategy paper, „BioVison 2030", which will soon be introduced to a broad public.

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Biorefinica 2004 (International symposium „Biobased Products and Biorefineries") On October 27 and 28, 2004, a symposium on sustainable industrial and industry-related substance use of biogenic raw materials in biorefineries will take place in the Deutsche Bundesstiftung Umwelt (DBU = German Foundation for the Environment), Osnabrück. The symposium, under the auspices of DBU, DECHEMA, the Association of German Chemists (GDCh) as well as biopos e.V. would like to assess German activities in the field of biobased products and biorefineries and conduct a dialogue with scientists, politicians and entrepreneurs about the opportunities and requirements of a sustainable bio-based substance economy in the European region.

Bioconversion

of Starch-Containing Agricultural Raw Materials into Lactic Acid

In view of the disuse of agricultural lands in Europe, there is an ever increasing de-mand for alternative use options for agricultural products in the non-foods sector. Renewable raw materials can be utilized directly, e.g. as energy carriers, as packaging materials, as fibres, for the production of colouring agents or as lubricants. However, they can also be converted biotechnologically, giving us access to a multitude of new, biocompatible products and possible uses. The goal here is always to create interesting products, representing a refining process of the substances in renewable raw materials that is more efficient und competitive for chemical synthesis.

Within the framework of an EU project, partners from three countries are currently working on the direct application of grains and green mass in biotechnological sub-stance transformation processes.

At ATB in Potsdam, we are working on the bioconversion of renewable raw materials into lactic acid. Tests on substrate preparation, microbial substance transformation, physical-chemical basic research on substance separation as well as the technological optimization of processes for fermentation, product separation and product cleansing are being carried out.

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Lactic acid has a wide range of potential uses und is utilized in highly diverse fields within industry and agriculture. The previously listed work packages form the basis for operating a pilot facility and are therefore about to be put into practice.

Participating SME:
- IBC - Icelandic Biomass Company, Hafnafjordur (ISL)
- Beltra Forestry Ltd., New Port (IRL)
- tetra Ingenieure GmbH, Neuruppin

Participating RTD:
- RALA Agric. Res. Inst., Reykjavik (ISL)
- University of Heidelberg
- Biorefinery.de, Potsdam
- BIOPOS, Teltow
- Institute for Agricultural Technology Bornim (ATB)

Institute for Agricultural Technology Bornim e.V. (ATB)

- The ATB is member of the Leibniz Association and financed by the Federal Min-istry for Consumer Protection, Nutrition and Agriculture (BMVEL), the Ministry for Agriculture, Environmental Protection and Land Use Regulation (MLUR) of Bran-denburg Province, and by third-party funds.
- It creates a process-technological foundation for sustainable land management and prepares innovative technical solutions for the industry. The combination of natural science and engineering discoveries, particularly in the field of new tech-nologies such as biotechnology and information technology, with economic and social sciences expertise will ensure that the newly developed processes and technical solutions are profitable for manufacturers and users and simultaneously take into account the needs of environmental protection and sustainability.
- The ATB has 168 employees, among them 60 scientists, and cooperates with 160 partners from education, research, industry and agriculture.

Metabolic Network

Analysis for GMO Plant Products Benefiting the Consumer

The products of the second and third generation of genetically modified plants will directly benefit consumers. Such plant derived products improve human nutrition, health and stimulate wellness. Beneficial effects are derived from improved metabolite composition, or elevated concentrations for example of omega-3-fatty acids, which are natural ingredients of plants. To reach this goal plant genes must be identified and linked to optimized fatty acid composition in plants. The food derived from these plants can reduce the development of coronary heart diseases. Health benefits come also from increased vitamin concentrations, optimized amino acid concentrations or reduced or completely eliminated allergens in plants.

metanomics has been pioneering this new field of Metabolic Functional Genomics - the direct linking of genes to their metabolic functions. metanomics creates genetic diversity with innovative approaches on genome scale in plants and subjects these plants to wide-range, high throughput metabolite profiling. The enormous scale of these approaches and of the data sets generated required the development of new technologies in Genomics, Bioanalytics and Bioinformatics, and for stringent process control, data validation and data mining.

The metanomics metabolite profiling platform utilizes >50 GC-MS and LC-MS/MS instruments. Novel bioinformatics tools for data interpretation and correlation mining are employed. The combined bioanalytics and bioinformatics platforms are one of the largest and most powerful worldwide. They allow the analysis of hundreds of specific target analytes, such as vitamins, oils, sugars, amino acids, in parallel to a wide spectrum of other compounds, even unknown structures.

Tens of thousands of genetically altered plant lines were analyzed to date. This led to the identification of hundreds of novel lead genes already. They are utilized by metanomics' customers, such as BASF Plant Science, to develop improved crop plants for better foods.

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