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Editorial comment

Phytobusiness requires social chemistry☆

Our economy is often referred to as a knowledge-based economy. Knowledge has always been central to economic development, but only over the last few years has its relative importance been recognized, just as its importance is growing. The economies of OECD member countries are more dependent on production, distribution and use of knowledge than ever before. R&D expenditure has continuously grown since 1985, despite a period of levelling off in the first half of the 1990s. The high-tech share of OECD manufacturing — including information-, communication-, and biotechnology — has more than doubled between 1985 and 1997 to reach 20–25% (OECD, 1999).

The healthy prospects of biotechnology have attracted considerable venture capital, and the market capitalization of many biotech companies rival the astronomical price/earnings ratios of the Internet dot.-coms. Genentech was valued 200 times earnings in March this year, Immunex 700 times, and Millennium Pharmaceuticals 17,175 (!) times (*Financial Times* 20/3/2000). Whereas the information- and communication-technology is the main driver for the present new wave of economic growth, the New Economy is likely to be further propelled by the emerging life science industry.

The increased economic importance of biotechnology has aroused much public attention for plant-related technology. Plant science and the industrial exploitation of plants used to be the exclusive area of scientists who were breeding new varieties for agriculture or used plants for pharmaceutical purposes. But now that plants have become big business, everything has changed. The continuously improving opportunities to control the functioning of plants or to screen their bio-chemical compounds have generated a variety of stakeholders that cannot be ignored: shareholders, consumers, environmentalists, farmers, churches, Third World organisations, and social scientists. All these interested parties want to have a say in the development, application and marketing of the new plant-derived products. Let's take a look at some of the controversial issues.

1. Consumer acceptance of GM food

A major problem for the life-science industry has been the negative, even hostile, consumer reaction to GM food released on the market. The consumer dislike for GM food, particularly in Europe, is the main reason why the projected premium markets for GM crops have failed to materialize. This situation is a headache for the biotechnology industry that has massively invested in plant biotechnology. The industry has responded by blaming its secondary stakeholders for creating an anti-biotechnology climate. Consumers would behave irrationally, and "ecoterrorists" — as the organized opponents to GM food have been labelled — would attempt to slow down technological development. The industry's own responsibility as regards the present negative image of GM food has hardly been addressed. This is remarkable, because it is obvious that the corporate strategy and communications departments have hopelessly miscalculated the public attitude towards GM food. These departments have not detected and addressed the public confusion and misconceptions about what genetic engineering is. Basic biological knowledge among consumers has probably been highly overestimated, while concerns about health and environmental impacts have not been convincingly refuted. Most important perhaps has been the industry's failure to offer consumers GM food products that have clear advantages. Retail prices of GM food are not lower than prices of other food, and a transgenic sunflower plant with increased oleic fatty acid content is not the kind of scientific achievement that arouses much excitement among consumers. The industry still faces the challenge to show consumers that the increased industrial control over a plant's biological activity results in better, more diversified, personalized, and cheaper food.

2. Controlling knowledge

Since knowledge has become so fundamental to our economy, it is not surprising that the question has arisen as to who controls it. The increased use that is made of the patent system indicates that a large part of knowledge and technology is being privatized. Patents

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are especially popular in the USA, where their number jumped unprecedentedly over the past decade. Between 1985 and 1995, the number of annual patent applications in all technology sectors doubled to over 120,000. The number of patents actually issued has risen less drastically, but reached an all-time high in 1996 (Kortum and Lerner, 1997). A company is awarded a patent on the assumption that it will stimulate private R&D investment. The temporary monopoly on the commercial exploitation of the technology provides the rightholder a mechanism to secure a return on investment, while the compulsory disclosure of the invention enables other innovators to expand the existing knowledge. In theory, this is a win–win situation for business and society. In reality, however, the strategic use that is made of patents nowadays may derogate from the role that patents play in innovation. Patents are filed in order to protect the invention that gives a start-up company access to venture capital, or to build up a patent portfolio so that protected technology can be swapped with other companies, or to prevent innovative activity by competitors in an entire, new technology area. For small companies, the cost of filing, maintaining and, especially, defending a patent is often too high a barrier. The average patent litigation costs are between US $25,000 and US $2 million, but US $1million is normal as well.

The strategic patents on plant DNA or plants as such have proven to be quite controversial. Whereas individual biotech companies may benefit from such patents, innovation in the biotechnology sector as a whole, or society in general, may not. Patents raise the barriers for innovation when individual companies use patents for land grabbing, i.e. acquiring property rights over new technological areas that can only be accessed by others under conditions imposed by the rightholder. The controversial character of many biotechnology patents is fuelled by issuance policy of the US Patent and Trademark Office. The office has granted patents on plant-related inventions without carrying out adequate research on prior art, patents on plant-related inventions containing extremely broad claims, and patents on DNA sequences that have raised questions about inventiveness. It is doubtful that such patents serve as an incentive for further innovation. In this respect, it is worthwhile to take a look into an interesting development in the software sector. Some of the main software programmes, such as Linux, Apache and Perl, are so-called "Open Source" software. They are not protected by intellectual property rights and are freely available for users and innovators. The free software has given rise to several commercial companies that make profit by offering tailor-made versions of the programmes. Why not consider an Open Source initiative in biotechnology?

3. Traditional healthcare and agriculture

Scientists recently received worldwide media coverage when they announced that the human genome has almost completely been mapped. The "Book of Life" is said to offer fundamental new approaches in drugs design and cures for serious human diseases. In a similar vein, genome maps of plant species are expected to be helpful in creating better crop varieties that boost agricultural productivity. However, the attention and financial resources for genome research contrast sharply with the interest in the low-tech improvement of traditional medicines or traditional plant varieties in developing countries. These are usually considered as primitive elements in backward medicinal and agricultural systems that already should have been replaced. Nevertheless, around 80 per cent of the world's population depends on herbal medicines for their primary healthcare, while the peasantry still relies on traditional varieties, on-farm saved seed, and organic fertilizer. It is doubtful that these people are going to benefit from the achievements in genetics. When the cost of, let's say, ordinary hybrid maize seed, including the necessary agro-chemicals, is too high a burden for subsistence farmers, what then is the chance that seed of highly advanced GM varieties will be adopted in traditional agriculture? And when we are not able to distribute HIV medicines at affordable prices among Africans, how then can we explain them the relevance of genome-based drugs? It would be a big mistake when the fascination for the new technological achievements distracts attention from down to earth medicinal and agricultural practices. Scientific support in this area is probably far more effective in improving the quality of life for many in the developing world. And now we are not talking about genetic engineering. This is about research necessary to develop quality controlled, standardized and safe plant-based medicines, and about demand-driven research that helps farmers to improve plant varieties and soil fertilization by a better use of locally available resources. The credibility of biotechnology would probably rise when scientists and business managers would also show respect for traditional practices and make time and funds available for their improvement.

4. Bio-piracy

Although a wide range of tropical plants is being used in traditional healthcare, the biochemical potential of these plants has largely been overlooked in Western pharmacy. Due to the new molecular screening techniques, this attitude has changed. In their search for DNA and for biological models for new chemical compounds, Western life science companies have become highly interested in the wealth of plant biodiversity in devel-

oping countries. For this reason, they are teaming up with nature conservationists in an effort to slow down the rapid disappearance of the natural reservoirs of plant species, particularly the tropical forests. The potential economic value of plants in their territory also raised awareness in developing countries that there was a new source of income that should be tapped.

The high stakes involved in the protection and exploitation of biological wealth (and the knowledge of local healers) caused a widely published North–South controversy. The political problems were partly solved with the conclusion of the Convention on Biological Diversity that put an end to the 'commons' status of plant material. All biological material within a country's borders is now defined as national patrimony, and this enables developing countries to negotiate a price for exporting plant material. Nevertheless, biopiracy remains an issue that is to be reckoned with.

In the first place, developing countries may improve their services as suppliers of diverse genetic information and may become well-equipped biodiversity treasurers, but they remain in a vulnerable position as providers of raw material. The industrial exploitation of this material is managed by foreign enterprises with sufficient financial and technological capacity. The bio-prospecting programmes that have been initiated show no long-term prospect of developing country organizations appropriating more value-added stages in the industrial exploitation of their national biodiversity. Moreover, the global market for 'raw' genetic information is highly specific and demand-driven. Exporting developing countries therefore largely depend on marketing conditions set by pharmaceutical companies.

Secondly, the access of pharmaceutical companies to tropical areas in developing countries might be complicated by internal political conflicts. Particularly indigenous peoples dispute central government control over the plant diversity within their territory. In Colombia and Chile, it was found that questions on access to plant resources provoked controversy as they interfered with broader political controversies, involving territorial and ethnic rights, and socio-economic conditions of indigenous peoples. This could seriously obstruct national biodiversity access regulation and hamper pharmaceutical companies in their search for biological compounds (Pistorius and van Wijk, 1999). The challenge for the industry is to set up bio-prospecting programmes under conditions that are acceptable for both the national biodiversity authorities as well as for indigenous communities. As these communities are often not involved in industrial agriculture or high level health care, the bio-prospecting contracts should take into account the pressing needs of the local population.

Plant-based science has entered an interesting era. Not only because the breathtaking scientific advances, but also because the challenge to find innovative ways to communicate research policies with society. Scientist and business managers must learn to cope with many different perceptions of biotechnology. They have to develop skills in what may be called "social chemistry": the careful analysis of the various stakeholders, their interests, arguments and networks, and the options for an adequate corporate response.

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