AGRICULTURAL BIOTECHNOLOGIES AND THE CONCENTRATION TREND IN AGROBUSINESS

Albert Sasson*

Les biotecnologies agrícoles i la tendència a la concentració en el negoci agrícola
Els efectes econòmics de les biotecnologies d'utilització agrícola inclouen tan el fenòmen de la concentració en la indústria de les llavors com la tendència al monopoli o l'oligopoli en les empreses que s'ocupen de portar al mercat els resultats de les ciències de la vida. De tot això ens en parla Albert Sasson de la UNESCO (Paris).

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Agricultural Biotechnologies and the Concentration Trend in Agribusiness
The economic effects of agricultural use of technologies include not only the phenomena of the concentration of the seed industry, but also the tendency towards the monopoly or oligopoly of the corporations whose business is to market the results of life sciences. Albert Sasson, from UNESCO, Paris, tells us all about it.

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Biotechnology contribution and the 'agriceutical' system

Advanced biotechnologies, based to a large extent on genetics, have been successfully applied to create crops with traits such as resistance to insect pests, viruses and herbicides. Indeed, the first wave of agricultural biotechnologies is already in the field. It provides farmers with agronomic traits that make it easier for them to grow their crops and more profitably. The second wave of agricultural biotechnologies goes beyond agronomic traits to qualitative (or output) traits. The latter will change the nature of the crop itself, and food production and supplies will be most affected. Through the third wave of agricultural biotechnologies, plants may provide renewable sources of a broad range of products, especially pharmaceuticals (this form of production has been named 'pharming'). The possibility of improving the health-giving properties of plant products has given rise to interest in 'nutraceutics', i.e. foodstuffs with pharmaceutical properties. The second and third waves are being driven by developments in genomics, which tie agriculture, food and health together for the first time. The 'agriceutical' system encompasses the usual participants of the food-supply chain, but also extends well beyond. The supply side now starts with participants that are generating and supplying fundamental underlying biochemical and genetic information. According to H. Verfaille, the food supply system will increasingly change in order to best capture the value of the new traits introduced into crops. New channels and systems will have to emerge to enable these tailor-made products to move efficiently and separately, from farm to manufacturer and consumer. The frontier between food and drugs will increasingly be blurred (H. Verfaille, Monsanto Co., USA, in *Parallel Conferences Summaries, International Life Sciences Forum, BioVision*, Lyon, France, 26-29 March 1999).

As genomics begins to dissect the genetic from the environmental causes of disease, and as understanding of both increases, there will be more opportunities for the delivery of individualized and holistic services through retail outlets that address diet, drugs and other aspects of treatments. Health-care and food products and services are becoming integrated at every level in this agriceutical chain, from the most fundamental research and development to the consumer. Decision-making in the new agriceutical system will rely on the interaction of the traditional divisions of agribusiness, health and nutrition, and pharmaceuticals —all responding to consumers' and society's needs. Genomics is the common research focus for all three agriceutical divisions. In 2028, the combination of health, science and agribusiness would be almost double the size of the agribusiness alone at over $15 trillion. In the agriceutical sector, processing and distribution would represent 84% of the total value added to the system (Goldberg, 1999).

Agricultural biotechnologies and developing countries

Agricultural research plays a very important role in the improvement of sustainable agricultural production in developing countries. It needs to be integrated into the wider context of poverty alleviation. For this, the expertise of actors in the broader field of development work is needed, including actors involved in institutional reforms such as land distribution, price and tax reforms and human rights. Agricultural biotechnologies, from the simplest and low-cost techniques to the most sophisticated ones, can contribute to increasing and improving agricultural and food production in developing countries. They are in fact doing so without being a panacea and substituting conventional agricultural practices and research (Sasson, 1993, 1997, 1998).

However, given the growing dominance of the private sector in the advancement of agricultural biotechnologies in the industrialized countries, critics have legitimate concerns that small-scale farmers in developing countries should not be exploited for the purely commercial gains of private industries. It seems nevertheless counter-productive to criticize public-private sector collaboration simply because of the profit objectives of the private sector. Private companies want not only to give their shareholders a return on their investments, but also to maintain a credible public image. Civil society should therefore continue to influence and exert pressure on the public accountability of private companies (Manicad, 1999).

There is also room in some parts of the developed world for market-driven transfer of biotechnologies. It is equally clear that some parts of the developing world have decided already that genetically-modified crops are the way forward for them. For instance, Empresas La Moderna (ELM, Mexico City) is a seed and fresh produce company, a world leader in the vegetable seed market. To widen its access to biotechnologies, in 1996, ELM acquired the U.S. company, dna Plant Technology Corp., which owned more than 40 biotechnology patents. ELM also collaborates with Monsanto Co. in the development of herbicide-resistant vegetables. Polar (Caracas, Venezuela), one of the biggest industrial conglomerates in Latin America, started building its biotechnological capability in 1986. The company has formed an industry-academic network of laboratories with South American universities and is working with transgenic rice and maize. According to the Venezuelan Government Commission of Biotechnology, the technology core within Polar is the country best platform for biotechnology development. ELM and Polar demonstrate how the private sector can add value to public institutions in developing countries (Salamini, 1999).

Transferring biotechnology-based agricultural innovations in all directions is possible: North to South, South to South, private to public, from academy to factory and field, and co-ordinated bottom-up or top-down. The main problem is no longer

one of finding the right mechanism but providing economic incentives or public support for both developing the technology and then pursuing its local adoption in the field (Salamini, 1999).

Seed industry: restructuring and concentration

The seed industry matured due to the introduction of hybrids, particularly hybrid maize in North America, hybrid sugar-beet in Europe and hybrid vegetables in South-East Asia. According to Suri Sehgal of Plant Genetic Systems (PGS) N.V., Gent, Belgium, of the $15 billion market for commercial seeds in the mid-1990s, hybrid seeds accounted for approximately 40% of sales and most of the profit (Sehgal, 1996).

In the 1970s, the high profits from hybrid seed sales attracted the attention of several agrochemical companies which aimed to exploit possible synergies of the seed business with their own commercial interests. The acquisition of Northrup King (USA) by Sandoz AG (Switzerland), of Funk Seeds (USA) by Ciba-Geigy AG (Switzerland), of Nickerson (USA) by Shell (United Kingdom/Netherlands), and of Asgrow Seeds (USA) by The Upjohn Co. (USA) took place during that period (Sehgal, 1996).

In the 1980s, agrochemical companies engaged in biotechnology research began to acquire seed companies, believing that seed would be the primary delivery system for biotechnologies. Delivering and capturing value from new input and output traits required control over the distribution channel. This brought companies such as E.I. Du Pont de Nemours Co., Inc., Elf Aquitaine-Sanofi (France), Imperial Chemical Industries Ltd (ICI, United Kingdom), Monsanto Co. (USA), Rohm and Haas (USA) and Unilever N.V. (Netherlands) into the seed business. Their commercial strategy was to capture profits along the agribusiness chain from the laboratory to the farm (Sehgal, 1996).

The strategy did not work for all new entrants. Firstly, the time required to convert biotechnologies into products took much longer than originally envisioned. Secondly, there was a conflict between the entrepreneurial management style of the comparatively smaller seed companies, and that of most big chemical corporations. Thirdly, the learning phase has been longer and more complex than expected and has led to poor financial performance. Finally, unlike chemicals, seeds cannot be marketed globally, but only in agroclimatic regions similar to where they are developed. As a result companies such as Shell, Rohm and Haas, Sanofi, The Upjohn Co., began to divert themselves of their seed and biotechnology businesses by the early 1990s (Sehgal, 1996).

Because most transgenic plant products contain or have been developed with several biotechnologies, it is easy for a company owing the intellectual property

rights on one such technology to block development of a product. As a result, in order to maximize value recovery, minimize the threat of litigation and secure access to technology, several strategic 'partnerships' were formed in 1995 and 1996. Monsanto Co. acquisitions of Calgene, Inc., DeKalb Genetics and Agracetus, Inc., were, to a large extent, driven by technology and intellectual property-right issues. The acquisition of Plant Genetic Systems (PGS) N.V., Belgium, by AgrEvo AG (Germany) in August 1996 for approximately $750 million was perhaps the noteworthy strategic partnership. Both Monsanto Co. and AgrEvo AG have invested heavily to gain access to technologies that were subject to intellectual property rights held by PGS N.V. and others. Similarly, in 1996, Empresas La Moderna (ELM, Mexico City) fresh produce subsidiary Bionova combination with DNA Plant Technology Corp. (Oakland, California) was driven by the acquisition of DNA Plant Technology Corp. portfolio of delayed fruit-ripening patents. Dow Elanco (Indianapolis) 46% participation in Mycogen Corporation, bought out from Lubrizol Corporation shares, was driven by the desire to secure access to the transfer to crops of *Bacillus thuringiensis* (*Bt*) genes encoding insecticidal proteins, and to other patents. On the other hand, Zeneca plc (United Kingdom) and Vanderhave (Netherlands) merger was triggered more by geographical convenience and other considerations than by intellectual property rights considerations (Sehgal, 1996).

New competitive strategies are therefore emerging in the seed industry and business . These strategies focus on four areas: pricing based on separating the value of technology from the value of the seed; market segmentation; product development using conventional breeding, genetic engineering and technologies to reduce cycle time; and sales and distribution. For instance, in the hybrid maize seed market, the very existence of many local and regional U.S. companies depends on the success of Holden's Foundation Seeds, Inc., a major supplier of foundation seed, in integrating new technologies in its proprietary germplasm. Through foundation seed (or parent seed) Holden's Foundation Seeds, Inc., is the supplier of genetic material to most of the local and regional U.S. maize and seed companies. Unless Holden's Foundation Seeds, Inc., could gain access to biotechnologies, those companies might be excluded from the current shift in the competitive landscape (Sehgal, 1996). The acquisition by Monsanto Co. of Holden's Foundation Seeds, Inc., was precisely intended to ensure seed companies, regardless of their size, have access to sustainable technologies for maize crops through the best available seeds.

Formation of the life-sciences companies: a trend toward monopoly or oligopoly

The latter half of the 1990s has seen the formation of life-sciences companies. The markets of businesses such as Novartis AG., E.I. DuPont de Nemours & Co., Inc.,

Monsanto Co., Astra-Zeneca plc, AgrEvo AG, Dow AgroSciences , Aventis (merger of Hoechst AG and Rhône-Poulenc SA) and American Home Products Corp., encompass many aspects of health and wellness provision from foods to pharmaceuticals, diagnostics and vaccines. The purpose of these companies is not only to conquer the agricultural market (seeds and agrochemicals) which has a value of some $35 billion (1998) including seeds and plant-protection products, but also to change food processing through genetically modifying agricultural raw materials so as to meet the special requisites of the food industry. Another objective is to extend their activities to the production of pharmaceuticals the world annual sales of which amount to about $300 billion (1999), either directly, or through the production of 'nutraceutics'(Kempf, 1999).

The globalization of biotechnological research is manifested by the realignment of bio-industries. Nowadays, a high number of technologies are involved in the development of a single product and many products are dependent on technologies and their corresponding patents owned by several companies. Already with a single-trait transgenic plant, the IPR issues are extremely complex. For instance, a transgenic insect-tolerant plant may involve plant breeder's rights (PBR), patents, as well as several patents relating to transformation technology, the selectable marker employed, the gene coding for the insecticidal protein, the promoter, and various regulatory elements and modifications needed to express genes adequately in plant cells. Any IPR holder of even one element could block the commercialization of an insect-tolerant variety based on this package of technologies. Because of the difficulties of sorting through various IPRs, the cost of doing seed business is increasing, as is the likelihood of litigation. 'Freedom to operate', which can be defined as legal access to all the technologies required to launch a product, becomes even more complicated as companies seek to bundle traits to gain competitive advantage, e.g. insect resistance, herbicide tolerance and new quality traits (Sehgal, 1996).

The complexity of these technologies and the associated intellectual property-right issues account for the trend toward oligopoly with respect to patent ownership as well as for the mergers and acquisitions leading to the big life-sciences corporations. The size of the latter, their great research capacity and patent portfolio enable them to deal with the complexity of intellectual property rights and bring their products onto the market.

By 2004, genetically-engineered maize containing *Bacillus thuringiensis* (*Bt*) genes encoding insecticidal proteins, would have 75% of market share in the U.S. western Corn Belt, and it is not therefore surprising that this crop species is at the heart of the bio-industry research efforts on *Bt*-engineered plants (particularly of those of major maize breeders such as Monsanto Co. and Pioneer Hi-Bred International, Inc.). By March 1995, there were no less than 440 either granted or pending patents related to *Bt*. The public sector with some 12% of these patents was

virtually excluded. The top ten *Bt* companies, including Ciba-Geigy AG, Zeneca plc, Monsanto Co. and Sandoz AG controlled 44% of all patents and applications for patents. A single company, Mycogen Corporation, accounted for 16% of all of them, while a number of other biotechnology companies, such as Plant Genetic Systems (PGS) N.V. and Ecogen, Inc., were also actively present (*Seedling*, The Quarterly Newsletter of Genetic Resources Action International-GRAIN, vol. 12, no. 4, December 1995, pp. 2-10).

While they fought each other on the patent front, the same companies formed alliances to get hold of missing pieces of technology, or to transfer the technology to the market. It was striking that most of the alliances were developed within the group that was already strong in *Bt* technology thus ensuring that no unwanted newcomers entered this field. For instance, Mycogen Corporation had cross licensing agreements with Ciba-Geigy AG and Pioneer Hi-Bred International, Inc., to work on *Bt*-engineered maize. Pioneer Hi-Bred International, Inc., has sold its 2 million shares of Mycogen Corporation to Dow AgroSciences at $20.06 per share, and Dow AgroSciences ownership in Mycogen Corporation increased to 69%. On the other hand, Pioneer Hi-Bred International, Inc., is expanding its gene discovery collaboration with CuraGen Corporation, by doubling its funding at CuraGen to at least $5 million annually. Monsanto Co. licensed *Bt* technology from Novo Nordisk A/S (for their *Bt* potatoes), while it allowed Sandoz AG to commercialize Monsanto Co. *Bt* maize.

Examples of mergers and acquisitions

In the current prevailing situation, one company (or very few), through successive purchases, succeeds in owning the technologies for improving crop varieties, but also the corresponding transgenic seeds, herbicides and pesticides, as well as the seed-processing and distribution networks. This situation of monopoly or oligopoly, may lead bio-industrial and seed companies to also control the levels of production and commodity prices.

At the end of 1996, Monsanto Co. sold its plants and activities devoted to chemistry (nylon and acrylic fibres) which were valued at $3 billion, so as to focus on life sciences and genetic engineering applied to plants. In 1996, after nearly fifteen years of research and development, Monsanto Co. commercialized the first significant biotechnology-derived commodity crops. In 1997, the company introduced three new products to customers in the cotton and maize markets. Growers on the three continents planted more than 19 million acres of Monsanto Co. transgenic crop species in 1997 - about six times the 1996 acreage.

At the beginning of July 1998, Monsanto Co. announced that it acquired international operations of the leading seed corporation, Cargill, Inc., outside the USA and Canada, as well as some operations in the United Kingdom, for $1.4 billion. In May 1998, Monsanto Co. acquired the seed company DeKalb Genetics and Delta

and Pine Land (D&PL) Company (specialized in cotton breeding) for $4.4 billion. In addition to increasing full ownership of its stake in Calgene, Inc., Monsanto Co. has established genomics-research agreements with Millenium Pharmaceuticals and International Business Machines Corporation (IBM) to strengthen its research-and-development activities concerning new agricultural and pharmaceutical products. The St. Louis-based company has also put $17.2 million into privately-held GeneTrace to investigate the genomes of plants and animals, and will obtain options to exclusive licences to all aspects of GeneTrace technologies for plant and animal breeding world-wide, funded research and development, equipment purchases and supply agreements, as well as an equity investment. Monsanto Co. has exercised its option to license GeneTrace genotyping ability and intends to apply it to many crops.

After the failure of the merging between Monsanto Co. and American Home Products (AHP) Corp. in October 1998 (Gallois, 1998), the St. Louis-based company decided to review its organization and economic structure. Monsanto Co. which has spent more than $8 billion to strengthen its competence in biotechnologies and pharmacy, had to find out a system of fund-raising through loans and emission of shares. The company also expected to lay off 1,700 employees. In 1998, Monsanto Co. annual turnover amounted to $8.6 billion, including $3.3 billion in the agricultural sector. On 22 April 1999, Monsanto Co. reported a 33% drop in its three-month net profit to $132 million, compared to $196 million in 1998 for the same period. However, the share price did not change and remained at $42.5. Monsanto Co. chief executive, R. Shapiro, considered that the company developments during the first quarter of 1999 were encouraging, in particular the commercialization in the USA of a new drug against arthrosis, Celebrex, which contributes to 11% of the company sales. This product was expected to reach an annual turnover of about $1 billion very quickly. In addition, the chief executive highlighted the successful integration of recently-acquired seed corporations, the sustained demand for newly-developed crops, as well as the good performance of Monsanto Co. basic activities such as the production and sale of herbicides (Lorelle, 1999a). By the end of June 1999, in order to reduce its debt, Monsanto Co. decided to sell its sweetener-production facilities (Canderel and NutraSweet brands) the annual turnover of which amounted to $1 billion.

E.I. DuPont de Nemours & Co., Inc., (Wilmington, Delaware) has been created in 1802 and it took this group almost two centuries to move from the commercialization of gun powder to soybean proteins. It took only two years to its new president, Chad Holliday, to reorganize this U.S. chemical conglomerate around two major sectors for the 21st century: chemistry and life sciences (pharmacy, agriculture, health and nutrition). While its oil company Conoco was to be sold totally by the end of 1999, DuPont currently has a strategic position in life sciences by being

the only agrochemical group whose activities range from the farm to the consumer's plate (Lorelle, 1999c).

During the summer of 1997, DuPont acquired 20% of the seed corporation Pioneer Hi-Bred International, Inc., and thereafter Protein Technologies International (PTI), a world leader in the production of soybean proteins for the food and paper industries. In 1998, it purchased the British company, Cereals Innovation Centre (CIC), specializing in wheat-derived food ingredients, as well as the French company, Hybrinova, a subsidiary of the group Lafarge, involved in hybrid wheat production. On 15 March 1999, when DuPont acquired the remaining 80% of Pioneer Hi-Bred International, Inc., it became the indisputable world's biggest seed corporation. With this acquisition ($7.7 billion), DuPont considers that it has the necessary critical size in the life sciences, with an annual turnover of more than 6 billion. The pharmaceutical sector (DuPont has purchased the subsidiary which it owned jointly with Merck & Co., Inc.) is expected to expand thanks to new acquisitions or partnerships (Lorelle, 1999c). Good returns are expected from the successful commercialization of an anti-AIDS drug called Sustiva.

DuPont redeployment in the agrifood sector targets the consumer's plate. According to DuPont's Director of cereal agrochemistry and biotechnologies, the company aims to produce new high value-added seeds for human consumption, animal feeds and industry in general, while most of DuPont competitors are using plant biotechnologies to replace conventional pesticides by transgenic pest-resistant crops, in an agrochemical market estimated at $30 billion and $35 billion by 2004. DuPont ambition is to 'weigh' $30 to $50 billion by 2004. It is therefore less the race for new transgenic crops which interests DuPont than the discovery of new 'superproteins'. Protein Technologies International (PTI) which holds 75% of the world market of soybean proteins, is the optimal tool for this conquest, from powder milk for infants to meat substitutes and via paper making. PTI tries to assess the real consumer's needs and it is up to the company researchers to find out which genes (from soybeans, lupin or pea) would bring the best proteins to meet a particular nutritional need (Lorelle, 1999c).

The estimated 1999 turnover of 30.9 billion (after selling Conoco and acquiring Pioneer Hi-Bred International, Inc.) is distributed in the following way:

nylon and fibres	$7.9 billion
polyester	$2.8 billion
paints and polymers	$5.8 billion
specialty polymers	$4.1 billion
chemicals and pigments	$3.7 billion
agriculture, nutrition and health	$5.0 billion
pharmaceuticals	$1.6 billion

Products derived from the applications of life sciences represent 21% of total sales (Lorelle, 1999c). These applications are expected to contribute to 30% of the annual profit in 2002, compared to 15%-20% in 1998 (Gallois, 1999). The shoring up of the traditional chemicals businesses and the new emphasis on biotechnologies and life sciences were reflected in the issuance of a new tracking stock linked to the company life-sciences businesses to give investors more choice.

On 3 March 1999, the *New York Times* reported the initiation of negotiations between Monsanto Co. and DuPont. While mentioning that these were preliminary negotiations which may not succeed, the U.S. newspaper indicated that the transaction was estimated at $28 billion (25.4 billion euros). It seemed that Monsanto Co. wished to be purchased by a group three times bigger, while keeping its identity and entrepreneurial culture. The merger would represent a new ensemble with an annual turnover of $39.5 billion ($30.9 billion from DuPont and $8.6 billion from Monsanto Co.). The merging of DuPont, first U.S. chemical group and world's fourth-biggest, with Monsanto Co., 25th pharmaceutical group in the world, aimed to strengthen their presence in agrochemistry and crop protection; they would become number one in these areas, ahead of the Swiss corporation Novartis AG and Aventis (merger of the French group Rhône-Poulenc SA and German company Hoechst AG) [Gallois, 1999].

DuPont would represent a perfect partner having important means. In addition, DuPont has signed an agreement with the John Innes Institute, Norwich, United Kingdom, a renown centre in plant biotechnologies, and the Sainsbury Laboratory for collaborative work on genetically-modified wheat. Astra-Zeneca plc also invested some $100 million in joint research conducted at the John Innes Institute, while Monsanto Co. expects to create a new research institute ($150 million) in collaboration with Danforth Foundation and Washington University, St. Louis (Tardieu, 1999). Monsanto Co. also signed an agreement with the Agronomic Institute of Campinas, São Paulo State, Brazil, with a view to developing transgenic sugar-cane and coffee plants.

In 1999, Novartis AG was the world leading group in life sciences and biotechnologies with an annual turnover of 31.7 billion Swiss francs in 1998 (50.72 billion euros or approximately $52.8 billion), half of it corresponding to pharmacy. In eight months, Novartis AG has sold six companies and recouped 1.3 billion Swiss francs. In contrast, at the end of January 1999, the Swiss group acquired from the French group Danone Jacquemaire Santé, a firm specialized in clinical nutrition. The new division thus created within Novartis AG, Consumer Health, evaluated at 5.3 billion Swiss francs (8.48 billion euros), was expected to make 70 million Swiss francs (192 million euros) of savings per annum, and to put Novartis AG as one of the three world leading groups on the market of specialized nutrition products and medicines which do not need prescriptions (Lorelle, 1999b).

While withdrawing from the sector of large-consumption foodstuffs, Novartis AG intends to focus on high added-value sectors (health and nutrition), e.g. baby food, nutritive beverages, dietic foodstuffs. These 'nutraceutics' comprise products which are used to prevent or treat diseases. The nutraceutical market which draws the interest of big agrifood groups such as Danone, would double its world market value in 2002 to reach $20 billion (18.69 billion euros). Novartis AG is focusing its research-and-development endeavours on products which are effective in the treatment of cardio-vascular diseases, osteoporosis, digestion and immune system dysfunction. A good image in certain types of medicines as well as a very strong presence in the distribution networks are considered prerequisites for purchasing 'nutraceutics' which the consumer would buy in supermarkets or at retailer shops. In addition, Novartis AG has close relations with the medical profession, which is considered a powerful driving force for increasing the consumption of nutraceutics, because of the physicians' pressing recommendations in favour of a healthy nutrition (Lorelle, 1999b).

The French pharmaceutical and agrochemical group, Rhône-Poulenc SA, and the German corporation Hoechst AG are merging to form Aventis, whose annual turnover will reach more than $20 billion, including some $4.5 billion in 1997 in the agricultural sector (Lorelle, 1999e,f). AgrEvo AG, a subsidiary of Hoechst AG, had an annual turnover of $48 million (1998) in the transgenic-crop business.

Rhone-Poulenc Agro has joined with the French research company Biogemma, set up in 1997 by Limagrain and Pau-Euralis, combining their biotechnology laboratories, to form a plant biotechnology joint venture called RhoBio. The latter will carry out research on agricultural biotechnologies in several areas, including disease resistance. In 1998, in France, the annual turnover of the agrochemical sector (plant-protection products) reached 20.4 billion francs (about $4 billion), including 13.6 billion francs for the local market, a 6.7% increase over 1997. Rhône-Poulenc Agro sold transgenic cotton to the USA for about $20 million.

On 9 December 1998, Zeneca plc, the third-biggest British pharmaceutical group and the world's twentieth-biggest, and Astra, the Swedish company, the world's fiftieth-biggest, announced their merger, thus becoming Astra-Zeneca plc., the world's fourth-biggest pharmaceutical group in 1998. The new group has a market capitalization of $70 billion and annual sales of around $16 billion, including $11.5 billion in the pharmaceutical sector.

The Swedish company Astra has become well known thanks to the anti-ulcer drug Losec (Prisolec in the USA and Mopral in France), the most-sold medicine throughout the world. Sales of Losec amounted to $3.8 billion for an annual turnover of $5.6 billion in 1997 and a profit before taxation of $1.78 billion.

Zeneca plc was born in 1993 from the scission of the British group ICI Ltd. It employs 16,500 persons and is the third-biggest pharmaceutical company in the

United Kingdom, behind Glaxo Wellcome plc and SmithKline Beacham plc. Two-thirds of Zeneca plc activity are in the pharmaceutical sector, and it is the world's third-biggest agrochemical group. Zeneca plc is specialized in the production of drugs used in anti-cancer treatments and cardio-vascular diseases; in 1997, a new drug against asthma has been launched (Accolade) whose share on the international market is estimated at 9%. Zeneca plc annual turnover, before the merger, amounted to about $9.8 billion, including $3 billion in the agricultural area, but its sales of transgenic seeds were low.

In November 1997, Zeneca plc decided to sell its division of chemical specialities, whose annual turnover was £885 million and which employed 5,000 persons. The company considered that it has not the right size in that sector and that its priority investments were devoted to the life sciences. Zeneca plc nevertheless kept its food subsidiary, Marlow Food, which produces a meat substitute under the Quorn label.

On 12 May 1998, Astra-Zeneca plc sold its speciality-chemical subsidiaries and, according to the *Financial Times*, might sell its agrochemical companies (annual turnover $4.78 billion). As usual, the merger had a social cost: 6,000 jobs are expected to be eliminated out of the 47,500 which were existing at the time of the merger. The companies also assumed that after three years, they would be able to save $1.1 billion per annum on their costs before taxation.

By mid-1999, the big life-sciences companies and particularly the leading pharmaceutical groups showed some hesitation to pursue their investments in seeds and agrochemicals. While agricultural divisions have been providing several advantages, like research synergies with some pharmaceutical projects, the world-wide market for seeds and herbicides proved to be more turbulent than most pharmaceutical executives would have thought. Many pharmaceutical executives projected that sales of seeds and herbicides world-wide would grow by 9% annually; these projections proved to be shortsighted. Plagued by market troubles in Europe and South-East Asia, sales of agricultural products world-wide are projected to drop 3% or so in 1999, according to analysts (Morrow, 1999).

The pharmaceutical companies learnt an important lesson, according to Alex Evans, a pharmaceutical analyst at Deutsche Bank Securities in London: 'when things get messy in the agricultural industry, they really get messy'; the beautiful thing about pharmaceuticals in that they are non-cyclicals'. Consequently, three major companies, American Home Products (AHP) Corp., Novartis AG and Astra-Zeneca plc, would like to jettison their agricultural divisions. Analysts stated that several board members at the three companies have balked at allocating additional research money to agricultural projects when the cash could be used to develop new drugs, which would deliver much higher profit margins (in

1998, the best pharmaceutical groups' profits before taxes were 30% for Glaxo-Wellcome plc and 20% for Novartis AG, Roche Holding AG and Smith Kline Beecham plc). In May-June 1999, there has been speculation in European markets that Astra-Zeneca plc and Novartis AG would spin their agricultural businesses into one which would easily be the world's biggest (Morrow, 1999). Meanwhile, E.I. DuPont de Nemours & Co., Inc., decided, on 1 July 1999, to restructure its activities relating to crop protection and to cut 800 jobs from its crop chemicals business as it contended with tougher competition in that market (*The Wall Street Journal Europe*, vol. XVII, no. 110, 8 July 1999, p. 3). See also Lorelle (1999 d).

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