Summary

Biological diversity is no longer the exclusive area of biologists and environmentalists. Since new biotechnological techniques became available in the 1970s, industrial enterprises have also involved themselves in the conservation of nature. Especially chemical and pharmaceutical enterprises with capabilities in biotechnology are presently interested in the world's plants, insects, micro-organisms, and human blood cells, because they contain a new type of industrial resource that can be explored: genetic information. The control and engineering of genetic information offers the industry new opportunities in the manufacture of medicines and plant varieties.

The industrial interest in biodiversity raised the awareness that ordinary plants, insects, and other organisms may represent economic value. In the 1980s, this awareness formed the starting point for an intense and ongoing controversy over who is to benefit from the exploitation of genetic information. The controversy has a strong international dimension, with OECD member countries and developing countries taking opposing positions. Biological diversity is especially found in relatively undisturbed areas in developing countries, while the know-how for the industrial exploitation of the genetic information in biological organisms is primarily available in advanced OECD countries.

The controversy over the exploitation of genetic information intensified during the preparation of two international treaties: the Convention on Biological Diversity (CBD) and the agreement on Trade-Related Intellectual Property Rights (TRIPS). The CBD was signed during the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992, and is designed to encourage the conservation of the earth's biological resources. The convention offers member states a juridical framework to develop regulation on the access and commercial exploitation of their national biological diversity. The TRIPS agreement resulted from the Uruguay Round of trade negotiations under the aegis of the General Agreement on Tariffs and Trade (GATT), which were
concluded in 1994. The agreement obliges signatory states, *inter alia*, to protect most plant-related innovations by patents or other intellectual property rights. Worldwide protection of such innovations is a high priority for the biotechnology industry, which aims to restrict all unauthorized exploitation of genetic information it has modified.

Because the controversy was most apparent during the preparations of the CBD and TRIPS agreement, most social science analyses on the issue have focused on these international decision-making processes. As a result, the academic contributions generally have the disadvantage that they generalize the unequal benefits that accrue to the ‘North’ and the ‘South’, and reduce the controversy to a series of negotiations between governments of Northern and Southern nations about legal articles and financial resources.

The intention of the present book is to examine the socio-economic causes underlying the international controversy over the exploitation of genetic information. It is argued that the root of the international controversy cannot just be found in an unfair distribution of the benefits derived from plant genetic information, but must be sought in a more fundamental social process: the industrialization of agriculture. Agro-industrialization can be considered as the basic dynamics in agriculture, and comprises the gradual transformation of farming into an industrial production process. Step by step, discrete farming activities are being replaced by industrially manufactured goods; tractors are substituted for horses, fertilizer for manure, scientifically-bred varieties for landraces, and commercial seed for on-farm saved seed. In some cases, industrially produced foodstuffs entirely substitute farm produce.

Since the pace of agro-industrialization differs per country and region, the competitiveness of national agricultural sectors varies greatly and induces an international division of labour in the agro-food production chain. In the various stages of this chain, countries may play a role either as producer, exporter, or importer. The higher is the degree of agro-industrialization, the better the opportunities for countries to improve their position in the international division of labour, and to become producer or exporter in the higher value-added stages.

In the book it is argued that the competitiveness of the national agricultural sector is closely related to its capacity to develop or import new plant varieties. To this end, in most countries crop development policies are designed: policies to promote plant breeding, to collect and conserve landraces and wild relatives, and to protect the plant breeding industry. The direction of these policies may vary, however, and depends on the political choices made as regards the way in which the national agricultural sector is to be industrialized. Three different strategies for the organization of agro-food production are distinguished:

(i) market-led industrialization of agriculture  
(ii) state-controlled industrialization of agriculture; and  
(iii) non-industrialized, farmer-oriented agriculture.
The central argument in the book is that a particular agricultural production strategy requires particular plant varieties. Hence, differences of opinion over the appropriate production strategy provoke controversy over the required crop development policy. The conflicts over plant breeding technologies, the collection and conservation of plant genetic resources, and the protection and promotion of private plant breeding can therefore be considered as 'sparks' caused by the frictions between agro-food production strategies.

It is shown that frictions between rival agro-food production strategies - and hence conflicts over crop development - have existed throughout history. However, the stakes have varied considerably. In order to analyse this historical variation, three historical Agro-Food Orders are distinguished. These orders refer to specific periods in agricultural production, characterized by (a) a particular international division of labour in agriculture, and (b) a regulatory framework that facilitates this temporary division of labour. When the regulation no longer fits the division of labour, the order enters a period of crisis, in which the foundations are laid for a new Agro-Food Order. By distinguishing different Agro-Food Orders it is possible to show that the political frictions between supporters of the respective production strategies have changed according to the different periods in the process of agricultural industrialization.

In the second chapter of the book the First Agro-Food Order (1870s-1930s) is characterized by two different trade patterns: the traditional intra-colonial trade, based on the complementarity of products resulting from different climates, within and among the European colonial empires, and the emerging international trade in temperate agricultural products among core capitalist countries. The agricultural crisis of the 1870s revealed the vulnerability to cheap agricultural imports and low prices, and pressed governments in all capitalist core countries to undertake initiatives in support of national agricultural competitiveness in temperate crops. By initiating a seed market regulation and elementary agricultural research, the U.S. and European governments laid the foundation for a rationalization of crop development that was to the advantage of both farmers and private seed firms. The reduction of fraud in the seed sector raised the quality of seed, and facilitated opportunities for further capital investment in crop development.

Governmental involvement in crop development was a major prerequisite for the rediscovery in 1900 of Mendel's insights into the heredity mechanism of living organisms. The new genetic principles offered the prospect of more effective control in the design of new plant varieties, and an expansion in the production of temperate crops. The USA was the first country where genetics was applied to crop development. The intention was to curb surplus production of wheat through crop diversification. The U.S. Department of Agriculture (USDA) also initiated an extensive plant collection and conservation system, which was urgently required, as native species of temperate crops were absent in North America.

Governments in Europe were less keen to fund genetic research for crop development in temperate crops. Throughout the First Agro-Food Order, they continued to focus on their colonial territories, and on tropical agricultural production. The rela-
tively slow application of Mendelian genetics in Europe was also expressed in the plant collection and conservation strategies. The European governments apparently continued to facilitate the so-called botanical exchange. They slowly turned away from the inter-colonial exchange of individual plant species to plant selection based on characteristics of plants.

With the expansion of capital investment in crop development, a new interest group emerged that required governmental support in the legal protection of its creations. The interest in patent protection for plant varieties was most pronounced in the horticultural sector, where competition was intense and the cloning of varieties relatively easy. Due to the lack of technical control in the biological reproduction process and the inability to distinguish adequately among varieties, legal protection of plants became available at the very end of the First Agro-Food Order, but only for fruit and flowers, and only in the USA and Germany.

Chapter three examines how the international food crisis of the 1930s induced governments in the USA and Europe to step up their support of agriculture and to become more involved in crop development. The ‘champions’ of state intervention in crop development were Germany and the USA. These countries were unique, in the sense that they gradually developed a long-term and state-led strategy for a structural transformation of agricultural production. The strategies entailed specific policies on plant breeding, plant collection and conservation, and the protection of private plant breeding firms. In Germany the incentive came from the National Socialists’ quest for food autarky, which tied together political, scientific and military strategies. The strong involvement of the U.S. government in crop development was embedded in the overall economic recovery programme of the Democratic Administration in the 1930s: the New Deal.

The spread of Mendelian genetics in the first decade of the 20th century provoked breakthroughs both in breeding and conservation. Rather than phenotypical features, genetic features became increasingly important as criteria for researching and evaluating plant characteristics. The new genetic criteria greatly expanded the scope of plant material with potential economic value. Not only cultivated varieties, but also landraces, and to some extent wild relatives were increasingly seen as ‘resources’ for breeding. This development opened the door for a new type of scientific activity, of which the Russian geneticist Vavilov was the exponent: the world-wide collection of plants as germplasm resources in their centres of origin. The strategic value of germplasm of temperate crop plants was realized by the main economic and military powers of the time: the Soviet Union, Germany and the USA. During the interbellum they became the key players in the worldwide collection and conservation of seeds and plants.

In the fourth chapter it is shown how the American, state-led agricultural production strategy, developed during the new Deal, was adopted in most of the OECD countries after 1945. The spread of this production strategy was one of the features of the Second Agro-Food Order (1930s-1970s). In this period, the governments in OECD countries became the central organizers of agriculture and crop development. The governmental initiatives concentrated on two areas: the funding
of basic breeding research and the reduction of unauthorized propagation of new plant varieties.

Public investment in basic research, such as genetics, rose substantially, because such research was beyond the financial reach of the generally small, family-owned breeding firms. Undoubtedly, government support for breeding research has greatly contributed to the tremendous yield increases of the main crops achieved in the post-war period. A similar picture can be offered for conservation as far as the USA is concerned. The U.S. National Plant Germplasm System, (NPGS) established in the 1960s, was a large-scale and centrally organized conservation network closely connected to the plant breeding objectives. The NPGS, however, could never have been organized by private breeding firms. A similar European conservation policy did not develop. Part of the reason lies in the European breeders' traditional preference for the maintenance of their own 'working collections'. Antagonisms within the European agricultural establishment played a role as well.

The other way to promote private investment in crop development was the public assistance offered to private breeders in reducing the unauthorized propagation of their varieties. The hybrid varieties, which were developed with strong support from the USDA, effectively diminished this problem for plant breeders of certain crops, such as maize, sorghum and sunflower. For crops in which hybrid varieties were not developed, unauthorized propagation could be reduced by legal means. To this end, the system of plant variety protection (PVP) was created by European governments in the 1960s. PVP offered far less protection than the patent coverage that the private plant breeding firms had envisaged. However, governments and international, industrial organizations opposed patents for plants respectively because of concern for monopolies in plant breeding and because plant patents could weaken the industrial patent system.

During the Second Agro-Food Order, the newly de-colonized countries became part of the international trade in temperate food products, which was increasingly dominated by transnational agro-industry. The developing countries boosted national production during the Green Revolution, but also became major importers of cereals from the USA and Europe. Moreover, the coherence of its national conservation system allowed the USDA to 'export' the American system to developing countries in the 1950s and 1960s. Unlike the FAO, which had similar plans for a 'global conservation system', the USDA received support from powerful donors: the World Bank, and the Rockefeller and Ford Foundations. These allies enabled the U.S. conservation system eventually to overrule the initiatives of the FAO.

In the Third Agro-Food Order (1980s-), national crop development seems to become delinked from national agricultural production, while the state is losing its position as key organizer of agriculture and crop development. In chapter five it is shown that in all countries the growth of public investment in agricultural R&D has declined since the 1980s, that the private industry has obtained a greater say in the allocation of public agricultural R&D funds, while private investment in agricultural research has risen rapidly. A major reason for large industrial capital to become interested in crop development was the advances in genetic engineering,
New techniques made it possible to pass on characteristics to the progeny under controlled, industrial circumstances, through the isolation, recombination, and transfer of genetic information. These techniques are considered to be time saving and more accurate than conventional breeding, and they also offer the opportunity to make crosses between different species. Genetic engineering enables chemical and pharmaceutical companies to transform themselves into 'life science' corporations and to employ the same biotechnological knowledge for the manufacture of biochemical products, medicines, and plant varieties.

The life science corporations have thoroughly restructured the organization of crop development by initiating the formation of industrial ‘crop development conglomerates’. These conglomerates are clusters of companies with a diverse industrial background, and mainly comprise plant breeding, biotechnology and genomics firms that have close ties with or are part of the life science corporations. Six of the largest large crop development conglomerates are identified, named after the corporations that determine the overall corporate strategy: Monsanto (USA), DuPont/Pioneer (USA), ELM/Pulsar (Mexico), Novartis (Switzerland), Rhone Poulenc/Limagrain (France) and Zeneca/Cosun (UK and the Netherlands). Given their unrivalled financial and technological capacity, these industrial conglomerates seem to replace the national state as central actor and dynamic force of crop development.

The crop development conglomerates have their home base in OECD countries but intend to supply the global market. Increasing demand for commercial seed in developing countries, in combination with decreasing public investment in agricultural R&D, induces the commercial agriculture in these countries to purchase varieties produced by the crop development conglomerates. This development indicates that a new division of labour is emerging in crop development itself, with the industrial conglomerates as the world’s main suppliers of plant varieties.

The central position of crop development conglomerates in crop development is reflected in their support for global conservation efforts. Advances in genetic engineering, and the computerized screening of living organisms for commercially interesting DNA sequences, have broadened the conservation strategies of the conglomerates substantially. The seedbanks, built during earlier Agro-Food Orders, now represent only a limited share of the total gene pool the conglomerates are interested in. Industrially useful genetic information is now being sought in any biological organism found in tropical forests, wetlands, in and around the peasantry’s fields, but also in the bodies of members of indigenous peoples.

The accelerating investment in genetic engineering, and the increased competition in the crop development sector have rendered inadequate the existing systems for the protection of intellectual property of breeders. Both PVP and hybridization aim to reduce the unauthorized use of a plant variety for propagation; they do not, however, prevent the use of the genetic information incorporated in these varieties for the generation of new varieties. For this reason, the genetic engineering companies of the conglomerates seek to protect plant genetic information under the patent system. Patents protect the genetic engineer from all unauthorized exploitation of the genetic infor-
mation, and all varieties - including the progeny - that contain this information.

Both in Europe and the USA, the opportunities to patent plant-related inventions have been greatly increased since the 1980s. The developing countries are following suit, partly as a result of the TRIPS agreement, and partly because of the import of advanced plant varieties from OECD countries to keep national agriculture competitive. The 'import' of international IPR regulation has become a precondition to keep national agriculture competitive. The consequences of IPR protection for export producers, domestic plant breeding firms and various categories of farmers are explored.

In the final chapter of the book the present international controversy over the exploitation of plant genetic information is analysed against the background of the developments in crop development during the Third Agro-Food Order. Rival agricultural production strategies and corresponding crop development policies in Chile and Colombia are used as case studies in an examination of how developing countries respond to the emerging international division of labour in crop development.

Around one hundred persons in both of the selected countries were interviewed in 1994 and/or 1996. The interviewees represented 75 different organizations or departments, including Ministries of Industry, Agriculture and the Environment, domestic and transnational seed firms, public research institutes, producers' organizations, and NGOs representing farming and indigenous communities. The interviews indicated that both countries are strongly divided on the issue of crop development. Plant breeding organizations and agricultural export producers prefer a relatively open access to the national biological resources for foreign researchers, and advocate plant-related IPR protection. Opposition to such open access and to IPR protection is voiced particularly by nature and farm-oriented NGOs and indigenous peoples' organizations. These organizations act as a last resort for all those farming and indigenous communities that cannot participate in the process of agro-industrialization. The communities seem to have little to gain from the emerging international division of labour in crop development, because they lack the land, appropriate soil, capital, markets, and infrastructure. Despite national rural development programmes, these resource-poor farms cannot be converted into commercially 'viable' family farms and are increasingly marginalized from the market economy and left to their own, non-industrial production and survival strategy.

For peasant and indigenous groups in Chile and Colombia the implementation of new IPR and conservation regulation is an expression of the dominant agricultural production strategy. They strongly oppose plant-related IPR, as they consider that it encourages industrialized, export-oriented agricultural production, from which they have little to expect. They follow the implementation process of the CBD keenly, as it provides for opportunities to oppose the global conservation strategies that are considered to serve industrial conglomerates most. We therefore conclude that conflicts over the exploitation of plant genetic information cannot be resolved by means of compensatory mechanisms. However, the conflicts may be mitigated if agricultural researchers in both the public and private sectors begin to pay serious attention to the strategy directed at non-industrialized, farmer-oriented improvements in agricultural production, and conservation and IPR regulation is adjusted.