The exploitation of plant genetic information: Political strategies in crop development
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Chapter 1

Crop Development and Agriculture

Controversies on plant genetic information first came into the public spotlight in the early 1980s. Not that they were a new phenomenon; ever since human beings were first able to design crop plants, there have been divergent views on the methods and objectives of crop development. For example, the production of hybrid maize varieties was disputed in the USA in the 1920s because the yields were poor and because they eliminated the opportunities of farmers to produce their own seeds. Some decades earlier, American and French fruit breeders had encountered strong opposition when they started to claim patent protection for their new varieties. And the necessity to conserve plants from around the world as a "resource" for plant breeding was acknowledged as early as the 1930s. Worldwide collection was controversial, however, and would even result in the elimination of one of the greatest geneticists of the century, Soviet citizen Vavilov. Controversies on crop development in the 1980s differed from preceding ones in that they were no longer the exclusive domain of scientific experts. A broad public became interested in plant patenting, genetically engineered food, the degradation of biological diversity, and plant conservation. Moreover, because all these issues were placed into a North-South context, crop development disputes gained a new, international dimension.

This chapter serves as a display of our search for analytical tools to explain contemporary conflicts on the conservation and exploitation of 'plant genetic resources' (PGR). Our analytical framework is built on three arguments. The first is that crop development is strongly related to agriculture. New plant varieties are created with a specific objective. They have to fit into the type of agricultural production that is envisaged. For example, a highly industrialized agricultural sector requires other varieties than the traditional farming sector. The second argument is that every country follows its own strategy to improve its national agricultural performance. The availability of natural resources, the degree of agro-industrialization, as well as the overall economic and political situation may differ widely
across countries, and even within countries. This variation induces an international division of labour in agriculture and forces every country to adjust its goals for agricultural development to its specific position in this division of labour. The final argument is that the international variation in agricultural production also has a historical dimension. Agro-food production capacity has evolved over time, but its pace has varied among different countries. Individual countries have historically had different positions in the international division of labour in agriculture. The policies in support of agricultural development have changed accordingly.

These arguments indicate the scope of our analysis, which is strongly determined by dimensions of time and space. Crop development has always been at the service of agriculture. Since the requirements of agro-food production has differed both internationally and historically, the conditions for crop development have differed as well. It is in these dissimilarities that the root of the conflicts on the exploitation of PGR can be found, and this is the thread not only of this chapter, but also of the entire book.

In section 1.1, the history and main controversial aspects of the present controversy on the conservation and exploitation of PGR is summarized. In section 1.2, we discuss the disadvantages of the scarce literature that has analysed the PGR conflict from a theoretical point of view. Then, in 1.3 and 1.4, our analytical framework is constructed and explained.

1.1 The plant genetic resources (PGR) conflict

Public concern about crop development was first raised by a group of American, Canadian and European activists and researchers that gathered in Canada in 1977, under the aegis of the International Coalition for Development Action (ICDA), to discuss the world’s food supply. Seed was a major issue, arising from the concern that “the genetic base of the world’s food supply was quickly disappearing and that restrictive legislation was making it possible for agribusiness to gain control of this vital segment of the total food system” (Harmston, 1979). Seeds of the Earth was the title of the book that resulted from this gathering (Mooney, 1979). It was widely publicized and aroused a considerable reaction in developing countries and within the seed industry.

The concern for the effects of the prevailing crop development policies outlined in Seeds of the Earth was elaborated on by participants of the ICDA gathering and other authors in the 1980s (cf. Berlan, 1983; Mooney, 1983; Buttel, 1984; Buttel et al., 1985; Doyle, 1985; Hobbelink, 1987; Junne, 1987; Fowler et al., 1988; Kloppenburg, 1988a,b; Juma, 1989; Kloppenburg and Kleinman, 1989; Ruivenkamp, 1989). We summarize the arguments below because of their historical relevance. The publications reflected a new tendency in which civil pressure groups, in OECD as well as in developing countries, question the benefits of the accelerating industrialization of agriculture in general and of crop development in particular. The main arguments put forward were the following.
(a) The prevailing crop development policies are destroying the genetic base of plant breeding

It was pointed out that most crop varieties used in agriculture in the ‘North’ or OECD member countries, do not originate from the temperate zone, but are derived from plants that were introduced from the ‘South’, or developing countries. This implies that plant breeders in the North must return to the genetically more diverse South for genetic resources. ‘Fresh genes’ are necessary to improve crop yields, to increase pest or insect resistance, or to adjust varieties to adverse ecological circumstances. However, due to the rationalization of agriculture, the genetic diversity is gradually being wiped out. Especially the spread of new and uniform, high-yielding varieties during the Green Revolution accelerated the replacement of landraces (the traditional farmers’ varieties) and wild relatives of crop plants. In other words, it was contended that the industrialization of agriculture greatly facilitated a process of ‘genetic erosion’ in the South, which would lead to the destruction of the basic resources for future agricultural production.

(b) Crop development is based on a South-to-North ‘gene drain’

In most publications it was held that, for centuries, colonial powers and later Northern industrialized countries had freely collected seeds and plants of landraces and wild relatives in the South. The seeds and plants collected were transferred to the North where they were stored in botanical gardens or, more recently, in so-called ‘genebanks’; beyond the control of the countries of origin. As landraces and wild relatives were considered to be a public resource - a ‘common heritage of mankind’ - property and payment questions were never raised. The authors argued, however, that landraces and wild relatives represent considerable economic value. Constituting the basis for most agricultural crops, genes derived from the seeds and plants collected in the South would have added billions of dollars to the economies of industrialized countries. Moreover, advances in genetic engineering have expanded the amount of plants with potential value for plant breeding and also pharmaceutical production. The countries of origin, it was pointed out, have never been remunerated for this ‘gene-drain’.

(c) Multinational enterprises take control of the seed industry

Of major concern in the publications were the effects of the privatization of crop development. Since the 1970s, agro-chemical, pharmaceutical, and food processing corporations had become interested in the seed sector and were taking over the family-based seed firms. It was argued that the increasing involvement of private capital in crop development would lead to a situation in which a few multinational enterprises would gain control of the world’s food production. The new seed companies would privately hold unique seed collections, breed varieties which fit their chemical, mechanical and processing interests (but which are not necessarily beneficial to farmers and consumers), produce plants that are genetically uniform (thus affecting genetic diversity) and cannot be reproduced, and protect their new varieties with intellectual property rights.
(d) Intellectual property rights hinder transfer of crop development technology to developing countries

Finally, these publications pointed out that plant breeding and the propagation and marketing of new plant varieties, was being hindered in developing countries, because of intellectual property rights granted to plant breeders on their new creations. Thus, even though the new varieties contained genetic information freely obtained from developing countries, unauthorized exploitation of these varieties has become increasingly difficult. This situation was considered as unfair and disadvantageous for agricultural production in developing countries.

In the early 1980s, the ‘Group of 77’ developing countries began to raise questions about the exploitation of genetic information. The issue fitted the struggle of developing countries for a New International Economic Order (NIEO). The NIEO was an attempt by developing countries to distribute global wealth better, and was adopted as United Nations (UN) policy in 1974. The developing countries used their national sovereignty and their numeric majority in UN forums to challenge political and economic activities - of transnational enterprises in particular - that was sustaining the unequal distribution. Both the ‘gene-drain’ and the legal restrictions in the North-to-South transfer of new plant varieties were new illustrations of general trends which developing countries had addressed since the early 1960s. It was especially the ‘gene-drain’ issue that transformed the FAO deliberations in the period 1981-1983 into fierce North-South confrontations on PGR. The term resources emphasizes the economic and political value attributed to genes. These conflicts intensified because most of the world’s seedbanks, the storage facilities for the collected seeds, plants and plant tissue, were under control of OECD countries. This implied that developing country governments could not exert control over the genetic information contained in the stored plant material. The issue became all the more important when it was revealed that governments of OECD countries had occasionally embargoed the release of seeds stored in their territory to hostile governments (cf. RAFI, 1988).

The international conflict over the exploitation of PGR (in short: the PGR conflict) began to take shape during the controversy over two FAO resolutions which were at stake in the period 1981-1989, concerning the International Undertaking on Plant Genetic Resources, and the establishment of an FAO Commission on Plant Genetic Resources (CPGR). The resolutions had been proposed by a core group of developing countries, which were supported by Northern non-governmental organizations (NGOs) affiliated to ICDA. Both resolutions were adopted in the FAO in 1983, despite opposition from most OECD countries.

The International Undertaking was a non-binding agreement that provided standards and rules for the conservation and exchange of seeds, plants and plant tissue between countries. The Undertaking also formalized the de facto status of PGR as a ‘common heritage of mankind’. At first glance this formalization seems in line with OECD country preferences, but it was not. The developing countries had used their majority to adopt a very broad definition of PGR. As a result, the Undertaking
considered not only wild plants and landraces, but also commercial plant varieties - legally protected or not - as a 'common heritage' and thus publicly available for breeders and farmers worldwide.

A first step in resolving the controversy was taken in the FAO in 1989. In that year most developing and OECD countries achieved agreement on three principles. First, it was accepted that plants protected under the system of plant variety rights were not freely available. Thus, developing countries were prepared to accept and recognize intellectual property rights on plant varieties. Second, it was agreed that 'free access' to landraces and wild relatives did not mean 'access free of charge'. This implied that public and private plant breeders would consider payment for the plants and seeds they collected in developing country territory. Third, a new type of rights, referred to as 'Farmers' Rights', was adopted. These rights were not defined but only justified by referring to the farmers' efforts for thousands of years in domesticating plants.

The Farmers' Rights concept had originally been proposed in 1985 by a number of farmer-oriented NGOs led by the Rural Advancement Foundation International (RAFI), a Canadian NGO, and ICDA. With its concept, RAFI was able to link its concern for further genetic erosion with the contentious issue of 'gene drain'. Farmers' Rights can probably best be understood as collective intellectual property rights which entitle farmers to receive financial support from an International PGR Fund governed by the FAO. However, the contributions to the Fund were voluntary for participating countries, so that neither the International Fund nor the Farmers' Rights concept have materialized.

In later years, the course of the PGR conflict was greatly influenced by two other international agreements: (a) the Convention on Biological Diversity (CBD), adopted during the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992, and (b) the agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), which was part of the new General Agreement on Tariffs and Trade (GATT), concluded in Marrakesh in 1994.

The CBD was the outcome of an international negotiation process that originated in public environmental concern in OECD countries. Rather than being focused on plants useful for agriculture, as is the FAO's Undertaking, the CBD is directed at the preservation of all plants and other organisms sustaining the global eco-system. The most contentious issues in the PGR debates in the FAO also emerged during the CBD preparations: the North-South divide on the distribution of benefits from biological organisms, the property rights on these organisms, and the access to technology required to exploit biological organisms. However, the solution to the controversies in the CBD differed considerably from what had been agreed in the FAO Undertaking. The CBD on the one hand, recognized that many countries had already implemented intellectual property protection of technology involving biological material. On the other hand, the Convention eliminated the 'common heritage of mankind' status of wild plants and landraces. Instead, it was accepted that 'countries of origin' had sovereign rights over all biological material.
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(plants, animals, micro-organisms) originating in their national territory. The CBD thus gave plants the status of national property, providing a legal basis for ‘benefit sharing’ arrangements. The CBD also recognized the rights of indigenous and local communities to share benefits.

The second agreement, that on TRIPS, was the result of an initiative of the world’s main industrial interest organizations better to protect new technology, medicines and audio-visual works against imitation. Legal protection of innovations related to biological material was initially not so relevant, but emerged as a negotiation topic around 1990, four years after the start of the Uruguay Round (Van Wijk, 1990). By that year, the first inventions in biotechnology had been protected under patent law and had found their way onto the market. The large chemical and pharmaceutical companies that had become involved in genetic engineering and crop development began to realize that worldwide legal protection of their biotechnological innovations would soon become essential in order to defend their leading edge. A group of developing countries opposed the plans to strengthen the international patent system. They advocated the exclusion from patentability of (among other things) plant or animal varieties and other products or processes if this was required on grounds of public interest (GATT, 1990). Despite this opposition, the TRIPS agreement was signed by 125 countries in 1994 as part of the new GATT. The agreement implies that legal protection of crop plants is recognized in most parts of the world.

1.2 ‘International Regimes’ become comfortable objects of analysis

Since the FAO ceased to be the dominant forum for negotiating the exploitation of plant genetic information, the PGR conflict has no longer been tied exclusively to the production sector that depends on plant genetic information: agriculture. Instead, the PGR conflict spilled over into negotiations on the CBD and TRIPS agreement. As part of the CBD, the questions about the access to, and conservation of landraces and wild plants are now related to the broader issue of biodiversity preservation for the sake of ‘sustainable development’. Under the TRIPS agreement, the exploitation of new plant varieties is also generalized and considered as the exploitation of a protectable ‘innovation’. This common denominator gives plant varieties equality with, for example, computer chips, movies and compact disks.

The fragmentation of the PGR conflict over three international treaties has induced a growing body of literature in which the conflict is separated from its political-economic context (cf. Hamilton, 1993; Rose, 1993; Sánchez and Juma, 1994; Leskien and Flitner, 1997; Mugabe et al., 1997). Rather than taking into account the conflicting interests in agriculture, these publications tend to reduce the PGR conflict to a series of tough negotiations at international forums between Northern and Southern states on legal provisions that regulate a ‘sharing of benefits’ derived from genetic information.
At a more theoretical level, the strict focus on regulatory disputes seems to gain in popularity as well. The ‘Regime theory’ focuses on the international regimes under which states interact in order to solve an international problem. Although the definition of international regimes was first formulated more than 20 years ago by Ruggie (1975:570), the question of what regimes precisely are has remained a matter of dispute. Most generally accepted is the definition of Stephen Krasner, who characterizes regimes as “principles, norms, rules, and decision-making procedures around which actor expectations converge in a given issue area.” Krasner refers to ‘principles’ as coherent sets of theoretical statements about “how the world works”. ‘Norms’ specify standards for behaviour, while rules and decision-making procedures refer to specific prescriptions for behaviour in clearly defined areas (Krasner, 1982:186).

Regime theorists often present principles, norms, rules and decision-making procedures as ‘intervening variables’ between the political and economic power of states and their actual political behaviour (cf. Keohane and Nye, 1977; Krasner, 1982; Rittberger, 1988). States involved in a regime tend to negotiate with each other, or at least listen to each other’s positions. As a result, narrow national interest calculations are moderated so that the number and intensity of international conflicts can be reduced. ‘Strong states’ participate in a regime with ‘weak states’ and accept compromises to maintain power at a minimal cost. Cooperation with weaker states often involves less political risk (and is cheaper) than confrontation and full (military) control. Weaker states, on the other hand, may also benefit from a regime, as it allows them to avoid confrontation with other, more powerful states. These mutual benefits create the basis of ‘collective action’ in international relations.

Regime analysis has been the major social science approach to study negotiations on the ‘global commons’ within the United Nations (cf. Krasner, 1985; Young, 1989; Wolf, 1991). The global commons (such as the high seas, space, and the polar regions) are among the issues which strong states prefer to manage through collective action, rather than unilateral control. This strategy should prevent a ‘tragedy of the commons’ and ensure that exploitation benefits all people. When the Food and Agriculture Organization of the United Nations (FAO) in 1983 officially declared plant genetic resources to be part of the ‘common heritage of mankind’, the regime analysis was the most obvious theoretical approach to examine the conflicts on the management of this new global common.

We discuss three recent regime contributions on biodiversity and intellectual property rights negotiations in relation to PGR. The first is from Arts (1998), who places the CBD within what he calls the “nature conservation regime”, but does not tie this regime to a specific organization or treaty. Nor does he interpret regimes as the sum of explicit principles, norms, etc., formalized in treaties and organizations. In his conception, regimes are marked out less visibly. They consist of both formal and informal rules which “frame (common) actions of state and non-state actors” in a specific issue-area. The second contribution, from Spector et al. (1994), analyses the UNCED which is presented as a step towards an “umbrella regime for sustainable development” which may spawn sub-regimes in particular environmental
issues, including biodiversity.

The publications of Witmeyer (1994a and 1994b), the third regime contribution, focus on PGR for agriculture in particular. The author's concept of a regime is much narrower than that of Arts and Spector et al. Witmeyer identifies three regimes on the basis of three international agreements: the “PGR regime” based on the FAO Undertaking; the “biodiversity regime” based on the CBD; and the “intellectual property rights (IPR) regime” founded by the agreements on TRIPS and UPOV (the International Union for the Protection of new Varieties of Plants). According to the author, the conflicts within the PGR regime are a “collective action problem” which result from the limited financial and political commitment on the part of industrialized countries. The weak legal and financial basis of the Undertaking has handicapped the implementation of its main principle: the ‘common heritage of mankind’ in respect of PGR. The younger biodiversity regime promotes a more market-driven regime for the conservation of biodiversity, including PGR of agricultural crops. Being a legally binding contractual agreement, the rules of the CBD have legal precedence over the FAO Undertaking. Witmeyer argues that biodiversity conservation based on economic incentives, as promoted in the CBD, may harm the free availability of PGR, which he considers as particularly relevant to public plant breeding in developing countries. Moreover, he doubts whether the CBD will result in large revenues for source countries because of the renewable and ‘non-rival’ quality of the wild relatives and landraces of most food crops.

Despite the wide differences in defining a regime, the three publications have a number of characteristics in common. Notably, they all approach international conflicts from a managerial perspective. The basic question underlying the books is how common principles, norms, and procedures in the area of nature conservation and nature exploitation can be established so that collective action is enabled. Questions as to who is to gain from the regime and who is to lose are hardly considered.

This limited scope of analysis becomes clear in the way the ‘issue-areas’ are approached. None of the books provides a framework in which the utility of genetic information is examined in such a way that the relevance of its exploitation for distinct producers and consumers is explained. Such an account would necessitate an examination of the political strategies involved in the regime formation. Instead, the authors tend to follow the negotiation agendas prepared by the respective secretariats, and even use the distinct articles of the international agreements at issue as the thread of their analysis. By reducing the PGR conflict to a dispute over legal articles that are being negotiated in at least three different international forums (FAO, UNCED, GATT/WTO), the regime approach inevitably results in a fragmented, administrative and legalistic perception of the conflict at stake.

That the three publications are preoccupied with the question as to how a regime develops, rather than who is to benefit from it, is exemplified in the approach of non-state actors involved in regime formation. In the negotiation processes on the International Undertaking and particularly the CBD, a large number of NGOs have been officially involved, which has made them unavoidable
research objects. The attention devoted to these NGOs, however, is induced by only one characteristic they have in common, namely that they are non-state actors participating in international regimes. This managerial focus results in a rather technical analysis of the NGOs’ role in international regime formation. Witmeyer pays attention to some NGOs as ‘critics’ of the PGR regime, but it is not at all clear to what extent and in what direction they have influenced the FAO Undertaking. Spector et al. devote an entire chapter to the role of NGOs during the UNCED and conclude that many NGOs are disappointed about their impact on the official UNCED process. The editors, however, state with tacit satisfaction that the NGOs have been useful in assisting national delegations as well as in opinion-building in the various countries, while they also may be helpful in implementing the agreements (Spector et al., 1994:234,238). Arts, for his part, meticulously measures the influence of international NGOs on the final drafting process of the CBD. Article by article, he judges the impact of NGOs in terms of their ability to win national negotiators for their point of view.

Left out of these three publications is the political dimension. NGOs represent business interests or social movements. They have political and cultural principles and economic interests that may greatly diverge. Even though in one of the contributions it is acknowledged that regime formation does not take place in isolation but is influenced by international political and economic forces (Arts, 1998:71), the NGOs are not related to them. Neither is the authors’ conception of government helpful in providing an insight into the political structure of the conflicts. All three authors consider governments as if they were monolithic units that take unequivocal positions in international relations. Obviously, governments are forced to present one more or less consistent position when it comes to the adoption of an agreement. Difficulties certainly arise when states adhere to different international treaties with conflicting obligations. Even though this formal position is a political reality, it would be an error to take it as the only point of reference in political analysis. The formal position reflects the dominant economic and political strategy within a government. Alternative positions, however, exist and continuously play a role during regime formation, implementation, enforcement and amendment.

Particularly in respect of the PGR conflict, many governments have been internally divided. Nevertheless, neither Witmeyer, nor Arts take into account that the government is a many-headed organism, which may take different or even contradictory positions at different international forums. For example, the Ministries of Agriculture in OECD countries have been representing their countries in UPOV, where they advanced plant variety protection as a legal protection system for plants. The Ministries of Industry and of Trade of the same countries, however, considered patent protection for plants during the Uruguay Round of GATT negotiations. At the same time, the Ministries of Environment and of Development Cooperation, for their part, tended to play down the importance of IPR for plants, or even criticized such protection during the UNCED process. Another example is that Ministries of Environment tend to stress the global importance of preserving
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plant species as carriers of large ecosystems. The Ministries of Agriculture, however, often prefer to use the limited conservation funds for ‘agro-biodiversity’ (i.e. genetic resources of crop plants), while the Finance Ministries and those of Industry and Trade have never been enthusiastic about additional public funds for plant conservation. Such a diversity of attitudes within the government is only recognized in the book of Spector et al., but has subsequently been considered a management problem, hindering regime formation.

Overall, the three regime analyses do offer detailed and interesting overviews of the international decision-making processes on crop development policy. As political analysis, however, they are of limited value, as they tend to reduce the PGR conflict to a series of negotiations between (Northern and Southern) governments about legal articles and financial resources. From such analysis it is hardly possible to reconstruct the political and economic interests involved and the extent to which these interests are reflected in the regimes that are negotiated. Moreover, the analyses cannot provide any insight into the increasingly transnational character of the conflict. The North-South alliances between governmental departments, business organizations and non-profit NGOs on the basis of common views as to how PGR should be exploited cannot be discovered and explained through regime analysis. In our opinion, however, contradicting views between such transnational alliances are at the heart of the PGR conflict.

1.3 Analytical framework of the book

Considering the limited value of the Regime theory in explaining the international PGR conflict, we propose an alternative analytical framework which relates the PGR controversy to changes in agro-food production. The international conflicts emerged when crop development entered a period of major transformation. Since the mid-1970s, massive capital investment in genetic engineering has accelerated a process in which crop development is genuinely being industrialized. This process changed the value attached to plant genetic information, reshuffled the power constellation of actors involved in crop development, and rearranged governmental intervention.

The transformation of crop development is not an isolated event, however. It is part of an overall process of industrialization of agriculture, which began in the 19th century or earlier and has not yet come to an end. The socio-economic transformation that has been related to this process particularly provoked resistance among those parts of society that could not benefit from the changes. We consider the opposition to the replacement of landraces by new, uniform varieties, the ‘gene-drain’, the resistance to plant patenting and to the increasing importance of transnational seed companies, to be a reaction against the overall industrialization, not only of crop development, but of agriculture in general.

In the following section, the PGR conflict is placed within the context of changing conditions for agricultural production. We first examine the industrial-
ization of agriculture as such, and then the opportunities to support, steer, or resist this industrialization process, or support non-industrial improvement of agriculture. In the final section, we focus on the historical and international differences in agro-industrialization.

1.3.1 Industrialization of agriculture

In political economy, the agricultural sector traditionally has been considered an anomaly in capitalism. In the 19th century, all production sectors attracted capital investment, which induced a replacement of the traditional craft work by mechanized production processes and wage labour. Agriculture remained the exception, however. Agrarian capitalism did develop in Europe and the USA, but ended up in a "miscarriage" around the 1870s, basically because the capitalist farm enterprise could not compete with the family farm (Koning, 1994). This raises the question why capital investors failed to organize a superior production system that undermined the competitive advantage of household production.

According to Goodman et al. (1987) the basic constraint for private capital investment in agriculture has been the inability to eliminate the risks and discontinuities intrinsic to a natural or biological production process. In their 'theory of agro-industrial development' they hold that, unlike the sectors of handicraft activity, agriculture could not be directly transformed into a branch of industrial production. There was no industrial alternative to the biological conversion of amino acids and solar energy into food. Agriculture relies on outdoor space, on climatic conditions and biological reproduction cycles, which are difficult to control.

Instead of removing the technical obstacles directly, the industrial transformation of agriculture has taken place through two long-term processes: "appropriation" and "substitution". Appropriation refers to a process in which the controllable elements of farming are being transformed into industrial activities and re-introduced into agriculture as inputs. Facilitated by scientific advances, ever more elements of the biological production process could be controlled and replaced by industrial activities and industrial labour. Major examples are the replacement of horses by tractors and of manure by synthetic fertilizer. Thus, industrial capital has been gradually 'appropriating', or industrializing agriculture. Thus, while appropriation tends to control the volatile and unpredictable processes of agriculture, it remains dependent on a rural-based production process. Substitution, however, tends to eliminate the material base of agriculture. Substitution refers to the process directed at industrial food production and tends to undermine the relationship between food and fibre production on the one hand, and the countryside on the other. Agricultural products are increasingly reduced to interchangeable industrial semi-products (e.g. starch, or carbohydrates) and may eventually be substituted by synthetic products (e.g. artificial sweeteners) (Goodman et al., 1987).

The concept of appropriation is very suitable for explaining the historic transformation of crop development. This process began in the early 20th century in
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Europe and the USA, and involves the gradual replacement of landraces by scientifically bred commercial plant varieties. Farmers increasingly buy fresh, commercial seeds instead of using their traditional varieties and on-farm saved seeds. The industrial appropriation of crop development is severely hampered by nature, however, as plants do reproduce themselves. This natural mechanism enables farmers to re-use seeds in principle indefinitely and significantly lowers the demand for commercial seeds. Thus, in order to make crop development attractive for private investment, nature had to be controlled.

Kloppenburg (1988a) has extensively described the subjection of crop development to market economy principles, a process he dubbed the "commodification of seed". Kloppenburg's starting point is the dual character of seed. When seed transforms into a plant, the original seed is in fact replaced by manifold new seeds, which may be used as product (as grain), or may be employed as a means of production (as seed) for planting the next crop. The duality of seed, which enables its use for growing a crop and for producing seed, has been fundamental to the expansion of agriculture. Farmers always saved a part of their crop as seed, for replanting purposes or for exchange with other farmers. They used to purchase seed of a new variety only once, because they could reproduce the seed by themselves in the following years. This practice, however, hindered agricultural entrepreneurs who tried to make a living out of crop development. On-farm saved seed is cheaper than commercial seed and, overall, exerts a downward pressure on seed prices. Thus, the elimination of the dual use of seed was a condition for maximizing the expansion of the commercial seed business. This could only be achieved with active support of the state. In his book, Kloppenburg maps out the crop development policies of the U.S. government in the 1920s and 1930s, which laid the fundament for the process of seed commodification. Public breeders developed so-called 'hybrid' varieties that were deliberately designed to obstruct the biological reproduction process. For biological reasons, only the first generation of such a hybrid performs well. The yields of the second and further generations of hybrids will decline and are generally less attractive to farmers. Thus, the dual character of seed is effectively eliminated by hybrids. They produce grain or fruit rather than useful seed. Farmers will shift from landraces to commercial hybrid varieties, if the hybrids significantly out-perform the traditional varieties. This knowledge was the incentive particularly for the U.S. seed industry to invest in hybrids as soon as the technology became available in the 1930s. Since, for technical reasons, hybrids could not be produced in some important crops, such as wheat and soyabean, the dual-use value of seed was also tackled by legal means: intellectual property rights. Through the grant of a patent or a plant breeders' right certificate, breeders are entitled to prevent or restrict unwanted propagation of varieties they have developed.

Whilst it is convincing to present the dual character of seed as a major obstacle to capital investment in crop development, the argument, in our view, is incomplete. The biological make-up of plants not only enables farmers to 'copy' and multiply the genetic information contained in the plant by saving seed, it also facilitates competing breeders to make use of that information. By crossing his own variety
with that of a competitor, a plant breeder can freely acquire genetic information encoding for commercially valuable plant characteristics. In fact, the free exchange and crossing of plant varieties that have valuable traits has been of fundamental importance to agriculture. Farmers and breeders have built on each other’s work so that yields have increased and quality has improved. However, the free access to the genetic information of a plant and the free exploitation of that information has also been an obstacle to capital investment. Controlling the transfer of valuable plant characteristics into the varieties of competing breeders was almost impossible. For this reason, we maintain that it is not the dual character of seeds, but the triple character of plant varieties that constitutes the major obstacle to capital investment in crop development. By nature, plants can be used for growing a crop, for propagation, and for creating a new plant variety. The ‘appropriation’ of crop development therefore requires the elimination of the latter two opportunities.

Ever since plant breeding commenced, the free use of varieties for breeding purposes has been a sensitive issue, but it became a real problem only in the 1970s. The free access to genetic information by breeders began to be questioned particularly when genetic engineering and promising commercial prospects in agriculture raised the interest of large industrial capital in crop development.

1.3.2 Rival agricultural production strategies

Although the theory of agro-industrial development is helpful in analysing the dynamic forces in crop development, it also raises questions. A major question involves the role of the state in agro-industrialization. Why have governments been facilitating processes of appropriation and substitution?

In their respective contributions, Goodman et al. (1987) and Kloppenburg (1988a) assume that strong governmental support has been a prerequisite for the industrialization of agriculture in general and the commodification of seed in particular. The authors, however, tend to simplify the concept of the state as such, as well as the political processes that determine state intervention.

Goodman et al. (1987) consider the state as an institution with a specific, and apparently pre-determined “task” to serve the interest of capitalist development. It is argued that, in ancient civilizations, the state was involved in food procurement and storage. During a “second major phase of state intervention” the state designed policies to reform feudal land structure, while in a third phase, emerging with the advent of industrial appropriation, state intervention has been in support of industrialization of agriculture. This is a rather teleological conception of the state. Even though the state indeed has played a pivotal role in the industrialization of agriculture, one should take into account the fact that state intervention is determined by political struggle, the outcome of which is, in principle, contingent.

Kloppenburg (1988a) demonstrates more ambivalence in his conception of the state. On the one hand, he implicitly recognizes that the role of the state in the industrialization of agriculture is not predetermined. He shows that public agricul-
Cultural research policies and the intellectual property rights systems in the USA were changed in favour of the seed industry, only in response to an effective lobby of private seed companies. On the other hand, Kloppenburg follows the North-South dichotomy and tends to generalize the role of the state within this divide. The historical role of the U.S. government as facilitator of the industrialization of seed production is projected onto all core capitalist countries. He overlooks the fact that the private seed industry in Europe has never had the political impact of its American counterpart. As regards developing countries, Kloppenburg only presents one voice from the 'South', the voice of opposition to seed commodification. By doing so, he assumes complete consensus within states, between states, and between states and non-state actors in developing countries. The wide diversity of interests and strategies regarding crop development across the 'South' is neglected.

Both Goodman et al. and Kloppenburg seem to ignore the fact that governments have more options for their involvement in agriculture - options that also have considerable relevance for the way a government intervenes in crop development. In our opinion, the state may (a) advance a market-led industrialization of agriculture, (b) actively steer the industrialization process, or (c) support non-industrial forms of agricultural development.²

(a) The state may advance a market-led industrialization of agriculture by facilitating the removal of technical and political obstacles to the 'appropriation' of agricultural elements. The intended rise in productivity lowers production costs and farm prices, makes exports more competitive, allows for lower wages, and is beneficial for the processing industry.

(b) The state may actively steer the industrialization process on the basis of a national political agenda. Socially undesirable developments in agro-industry are slowed down in order to reduce the social costs, while other desirable developments are stimulated. For example, governments may protect those national farm sectors that are not internationally competitive, or they may restrict the application of genetic engineering for ethical reasons. On the other hand, governments may encourage organic farming as an alternative route for agro-industrialization.

(c) The state may support non-industrial forms of agriculture. This option is particularly relevant in developing countries where the peasantry cannot be incorporated in the agro-industrialization process, because they lack the necessary land, capital, infrastructure and markets. Facilitating non-industrial development of agricultural production on the basis of locally available knowledge and natural resources is a policy to combat rural poverty and food shortage.

The three options of state intervention presented here constitute the basis for three alternative and conflicting strategies for the organization of agriculture. In this publication we distinguish a 'market-led' agro-industrialization strategy, a 'state-led' agro-industrialization strategy, and a third strategy directed to non-industrial, farmer-oriented agricultural production. We will refer to them as rival agricultural
production strategies. These three strategies must be considered as ideal types. They are constructions of agricultural production strategies of public and private organizations, in the most pure form. The strategies encompass all socio-economic, technology and legal policies that are intended to speed up, steer or slow down agro-industrialization, or support non-industrial agriculture. Which of the strategies will prevail over the other in a particular country depends on national and international political processes.

The typology of rival agricultural production strategies will be used as an analytical concept to help us better understand the differences of opinion about how agriculture should develop and, consequently, what crop development policy should be followed. We maintain that in the most advanced capitalist countries the political dispute in the past century has primarily been located between the market-led and the state-led production strategy. The third strategy, directed to the support for non-industrial agriculture, has become relevant with the introduction of the Green revolution, when in developing countries a large part of the rural population was marginalized. Particularly the peasantry, including the indigenous communities, could not be incorporated in the process of agro-industrialization, while no alternative employment opportunities in other economic sectors were available.

We propose to locate the roots of the PGR conflict in the existence of rival production strategies. The value attached to the conservation of landraces and wild plants, the desirability of a free exchange of PGR, the perception of hybrids technology and of intellectual property protection, and the attitude towards transnational seed companies, is, in our view, determined by the preference for either of the three strategies. Thus, the PGR conflict involves not just crop development policy, but the strategy for organizing agricultural production in general.

1.3.3 Historical Agro-Food Orders

The rival agricultural production strategies concept is intended to explain political differences in the organization of agriculture within individual countries and among different countries. It is necessary however, to examine the reasons for these differences. Why do we find a political majority in favour of the ‘market-led’ agricultural production strategy in country X, while in country Y the ‘state-led’ strategy is dominant? In order to find an answer to this question, we must consider that the degree of agro-industrialization varies considerably among countries. It is this variation that induces an international division of labour in agriculture. The position of a country in the international division of labour, as well as the historical changes in that position, greatly influence the national political processes involving agricultural production strategies, including the associated crop development policies.

In their classic paper, Friedmann and McMichael (1989) have worked out the national and historical differences in agro-industrial production and consumption. They organize their argument around the concept of food regime, a concept that "links international relations of food production and consumption to forms of
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accumulation broadly distinguishing periods of capitalist transformation since 1870" (Friedmann and McMichael, 1989:95). The food regime concept is theoretically connected to the 'Regulation school'. This school of thought in political economy has developed a theory on "social regulation", an institutional framework with corresponding regulating norms, basically involving the wage relation, which organize capital accumulation during a specific period of time: the "accumulation regime" (cf. Aglietta, 1979 and 1982; Bonefield, 1988; De Vroey, 1984). Historical changes in social regulation would have prevented the capitalist system from collapse during periods of crisis. The Regulation school distinguishes two accumulation regimes. The first is placed in the period 1873-1914. The second accumulation regime had its heyday between 1945 and the 1970s and is usually referred to as "Fordism".

In order to analyse historical trends in international agricultural production and trade, Friedmann and McMichael distinguish two food regimes that correspond to the two accumulation regimes from the Regulation school. The 'first food regime' was based on the wheat and meat exports from the settler states (mainly the USA) to European metropolises. These exports facilitated the urban industrialization in Europe and provided the capital that enabled the import into the settler states of manufactured goods, essentially for railways. The 'second food regime' was based on the integration of the former colonies in the international division of labour as newly independent states. They began to import wheat, particularly from the USA, at the expense of domestic food production, while their traditional markets for tropical exports, such as sugar and vegetable oils, declined due to import substitution policies in OECD countries. At the same time, the emerging transnational agro-industry, which centred on meat and new processed food production chains, began to restructure and integrate agriculture worldwide (Friedmann and McMichael, 1989).

The advantage of Friedmann and McMichael's approach is that it adds historical and spatial specificity to the basic tendency of agro-industrialization. Nonetheless, the food regime concept also raises questions. The authors neither define the concept of 'regime' thoroughly nor do they explain its origin. This is particularly confusing because the food regime concept has also appeared in the context of Regime theory analysis, a different theoretical approach that was discussed above in section 1.2. This conception of food regime, defined as a set of principles, norms, and decision-making procedures which regulate and control the "global food system", was used in publications that explored the nature and severity of world food problems and the effects of the active international diplomacy of food affairs around 1980 (Hopkins and Puchala, 1978; Puchala and Hopkins, 1982). Friedmann and McMichael (1989), however, explicitly refer to the Regulation theory, but they do not explain how their conception of food regime fits into that theory.

The focus on the production level supports the assumption that the food regime is considered as a 'sub-species' of the accumulation regime used in the Regulation school. However, Aglietta and other regulation theorists deal especially with 'social regulation', while Friedmann and McMichael in their paper pay little attention to the
regulatory system that has conducted the historical patterns of (inter)national relations in agriculture. Where they do mention regulatory elements (e.g. post-war food aid and agricultural support measures), their argument suffers from economic determinism. The role of the state (and of regulation) seems to be pre-determined by economic requirements, and they fail to take into account the political conflicts about the direction and aims of regulation in agriculture, as well as the unique national socio-cultural and techno-economic settings in which these conflicts take place.

Rather than food regime we propose a new, but related analytical concept: the historical Agro-Food Order*. The historical Agro-Food Order refers to a specific period in agricultural production that can be distinguished on the basis of (a) a particular international division of labour in agriculture, and (b) a regulatory framework that facilitates this temporary division of labour. The term “order” may sound at odds with a world which is typically chaotic and where social and (international) political relations are almost inherently volatile. We do use the term nevertheless, to indicate a period of relative stability of major tendencies in international agro-industrial trade and related social regulation.

The international division of labour in agriculture refers to the global production and distribution of farm products or industrially produced food. Countries have different positions in this international division of labour because of their dissimilar capacity to produce, export and import agricultural products. This capacity is related to the degree in which their agricultural sector has been industrialized. In individual countries a regulatory framework is designed in a political process by governmental departments, private industry, farmers’ organizations and other non-governmental, non-profit organizations. Each of these actors may advocate one of the rival agricultural production strategies, discussed above. Depending on the economic and political strength of the actors involved, one of the agricultural production strategies will become dominant.

We distinguish three historical Agro-Food Orders, basically following the food regime periodization of Friedmann and McMichael (1989). The First Agro-Food Order is situated in the period between the 1870s and the 1930s, the Second between the 1930s and the 1980s, while the Third Agro-Food Order began in the 1980s and will presumably have its heyday in the 21st century. Each of these Agro-Food Orders is thus characterized by a historical international division of labour in agriculture with corresponding dominant agricultural production strategy. The latter commenced as a purely national strategy in the First Agro-Food Order, but has become increasingly international in the Third, due to international political integration and globalization of the economy.

We use the Agro-Food Order concept in finding an explanation for the PGR conflict. In each of the historical Agro-Food Orders, a dominant agricultural production strategy, including an associated crop development policy, can be distinguished. The relationships between the Order, the strategy and the policy have been visualized in Figure 1.1. For the sake of clarity, the figure exhibits only the internationally dominant agricultural production strategy and crop development policy in a given period, ignoring the variation among different countries and within individual
<table>
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<tr>
<th>Agro-Food Order</th>
<th>International division of labour in agriculture</th>
<th>Dominant agricultural production strategy</th>
<th>Aim and features of dominant crop development policy</th>
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| FIRST 1870s - 1930s | Settler states, notably USA, export grain to feed urban labour in European metropolises  
- Internal colonial trade of tropical crops loses significance vis-à-vis emerging international market for temperate agriculture. | Initial state intervention to support national temperate agricultural sector in industrial core countries | Improving competitiveness of national temperate agricultural sector  
- Focus of crop development shifts away from exchange of tropical plants among colonial territories to introduction of foreign landraces in temperate areas.  
- Emergence of national, public agricultural research system.  
- Early state control of seed market.  
- Development of hybrid technology in public maize breeding (USA).  
- Private industry attempts to patent ornamental and fruit varieties. |
| SECOND 1930s - 1980s | North America and Europe become food exporters. Developing countries emerge on world market as importers of temperate cereals  
- Emergence of a transnational agro-industry centred on wheat, meat and processed foods. | State-led industrialization of agriculture  
- Deep state involvement in agriculture facilitates emergence of transnational agro-industrial capital.  
- State-led agro-industrialization exported to and adopted by developing countries in ‘Green Revolution’. | Rise of productivity in staple crops  
- Plant genetic resources are considered as ‘global commons’.  
- National seed collections linked to worldwide seed bank network to augment food production.  
- Private industry controls unauthorized propagation of plant varieties through technology (hybrids) and law (plant variety protection).  
- Worldwide replacement of landraces and wild plants by genetically uniform plant varieties. |
| THIRD 1980s - .... | OECD countries strengthen position as major food exporters; Developing countries obtain niches in world market  
- International food production chains dominated by agro-industrial conglomerates. | Market-led industrialization of agriculture  
- International treaties substitute the national state as main regulating agent.  
- Liberalization of agricultural trade. | Rapid adaptation of plant qualities to diverse and changing world markets  
- DNA sequencing becomes new conservation strategy for industrial conglomerates  
- Private industry controls unauthorized propagation of plant varieties and the use of genetic information for the creation of new plants through technology (hybrids and ‘terminator’ gene) and law (plant variety protection and patents). |
countries. This variation, however, is discussed in more detail in later chapters.

The conflicts that have occurred since the end of the 19th century on plant patenting, plant conservation, and on the direction of plant breeding research, suggest that crop development has been controversial throughout all Agro-Food Orders. Apparently, since the 1870s there have been differences of opinion about the way plant varieties should be improved in order to support national agriculture. The controversy gained an international dimension in the Second Agro-Food Order, when more countries began to participate in the international division of labour, and the social costs of regional and international differences in capacity in agricultural production and trade began to be felt worldwide. In the Third Agro-Food Order the controversy on crop development policies turned into ‘the PGR conflict’ as described in the introduction to this chapter. This conflict is not just national or international, but basically transnational in scope. There has been a considerable reduction in the national state’s room for manoeuvre in designing a crop development policy in support of its national agricultural sector. Much of the regulating power has shifted to both intergovernmental organizations, such as the World Trade Organization, and to transnational corporations involved in crop development. Also, the political conflict over the rival agricultural production strategies has become transnationalized. Both advocates and opponents of a rapid industrialization of agriculture can be found everywhere, in OECD as well as in developing countries. This is the basis for the emerging transnational coalitions in the PGR conflict.

The book is organized in such a way that each chapter focuses on the conflicts over crop development in a specific historical Agro-Food Order. In chapters two, three and four we show that during the First and Second Agro-Food Orders the governments of several capitalist core countries provoked opposition when they facilitated the entrance of industrial capital in crop development. As agricultural production was largely organized on a national scale, conflicts on genetic information remained limited to national interest groups, e.g. between farmers, plant breeders and specialized seed producers. Chapter five illustrates how during the Third Agro-Food Order, the rapid expansion of private capital in agriculture has induced a transnationalization of crop development policy - and hence of the associated political conflicts. Because crop development increasingly depends on a ready access to specific genetic information, the rivalry between advocates of the alternative agricultural production strategies has provoked an intense conflict on the exploitation of genetic information. The final chapter examines the way export producers, domestic plant breeding organizations, commercial farmers and the peasantry in Chile and Colombia are embedded in this transnational conflict.

Conclusions

In a growing body of literature that documents or explains the controversy over the conservation and exploitation of plant genetic resources, the prime focus is on the international negotiations in which Northern and Southern states try to regulate the
benefit sharing derived from genetic information. Also the few theoretical, social science accounts on the subject tend to separate the PGR conflict from its political-economic context and reduce it to a legal argument over international treaties.

We propose to assess the PGR conflict essentially as only one of the ‘sparks’ caused by frictions between what we call “rival agricultural production strategies”. These strategies are based on different conceptions of how agricultural production should be organized. Since every strategy includes a particular vision about the role of new plant varieties in agricultural production, the differences also apply to crop development policies. The root of controversy on the exploitation of plant genetic information must be sought here.

Frictions between the production strategies not only differ per country but also vary throughout history. In order to analyse their historical dimension, we use the concept of the ‘historical Agro-Food Order’. The purpose of distinguishing historical Orders is to illustrate that these frictions between agricultural production strategies are induced by two factors: (a) the degree of capital involvement in agriculture and crop development in a particular period, and (b) the political dominance of some of the actors involved in agriculture in that period. Hence, each Agro-Food Order produces its ‘own’ conflicts over crop development policies because of the diverging interests in the organization of agriculture.

Notes

1 The term ‘genebank’ is confusing. The term has become the common, but incorrect, term for national and CGIAR-storage facilities that specialize in the conservation of populations representative of landraces, advanced cultivars, wild relatives of domesticated plants, and wild (i.e. non-domesticated) species, which are usually maintained in the form of plants, seeds, and tissue cultures. By far most collections consist of seed. As shown in chapter 5, the term ‘genebank’ is more useful to describe recently established collections of cloned DNA sequences, some of which are indeed identified as ‘genes’. In this publication we will therefore speak of a ‘seedbank’ when we refer to a storage facility of seed, plants, and plant tissue.

2 The term ‘plant genetic resources’ was first commonly applied by the FAO Panel of Experts on Plant Genetic Resources during their series of technical meetings on the design of global conservation strategies in the late 1960s and early 1970s. The term referred to landraces, advanced cultivars, wild relatives of domesticated plants, and wild (i.e. non-domesticated) species used by man (Frankel and Soulé, 1981:181) but simultaneously emphasized the scientific importance and agricultural economic value of landraces and wild relatives. By consistently using the term in its reports, the Panel sought support within the FAO for the creation of the global conservation system. The lobby campaign of the Panel for a global plant genetic resources conservation system backfired on the agricultural scientific community when, in the early 1980s, critics adopted the term genetic resources to emphasize the North’s economic benefits derived from the historical import of landraces and wild relatives from the South. In the present book, however, the term ‘plant genetic resources’ will be employed for genetic information in plants to which economic and political value is attached.

3 In fact, the elimination of the ‘common heritage’ status of plants in the FAO preceded the CBD adoption. In anticipation of the conclusion of the CBD in June 1992, the signatory states to the FAO Undertaking in November 1991 agreed to include a third annex to the Undertaking in which the national sovereignty
of nations over their plant genetic resources was recognized (Anonymous, 1991).

In 1968, the American biologist Garreth Hardin published his often cited article “The tragedy of the commons” in which he contended that common natural resources are bound to become subject to over-exploitation if access and use were not managed (Hardin, 1968).

The CBD was facilitated by an unprecedented number of nearly 1500 NGOs, which were officially accredited to the UNCED process. The NGOs encompassed civil, non-profit groups as well as industrial lobby organizations. Many of them were permitted to assist in the preparation of the national report of their governments, submit written statements, and make oral interventions during the official meetings of the preparatory and UNCED sessions (Doherty, 1994).

In biology and plant breeding, all generations arising from a cross between genetically unlike parents are termed “hybrids”. In the seed trade and in this publication, however, the term hybrid refers to the first generation of a cross between inbred lines.

In this publication we only refer to agricultural production in market economies, because the processes of ‘appropriation’ and ‘substitution’ cannot take place in socialist economies. Even though in these economies agriculture has been greatly industrialized and many of its effects are similar to those in market economy countries, the dynamics of this industrialization is different. Since in socialist economies, the compelling need for capital accumulation is absent and the family farm has been replaced by alternative production units, the main actors and strategies for organizing agriculture have been different. The industrialization of agriculture in socialist economies consequently requires an alternative explanation, which is beyond the scope of this publication.

Friedmann and McMichael (1989) also use the term “international food order” in their article, but without any explanation. The “food order” seems to be interchangeable with “food regime”.