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

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Chapter 4
The Second Agro-Food Order (1930s-1980s)
The Emergence of a State-led Crop Development Policy

It was the American long-term strategy for agriculture, developed during the New Deal that was eventually adopted by the entire Western world. First in Western Europe soon after the Second World War, and later in developing countries, when they had freed themselves from their colonial ties. The strategy involved a state-led transformation of the national rural production sector, which would greatly facilitate the industrialization of agriculture.

This chapter examines the crop development policy that was at the heart of the state-led production strategy for agriculture. How did plant breeding, intellectual property protection for plants, and plant conservation develop during the Second Agro-Food Order? What were the main political controversies that determined their evolution? And how did the crop development policy promote the industrialization of agriculture?

The chapter broadly consists of two parts. Sections 4.2 to 4.4 focus on the crop development policies that were designed, debated and implemented in Western Europe and the USA during the post-war period. The final section (4.5) is devoted to developing countries and the mechanisms that transferred the predominantly American crop development policies to developing countries. We start off, however, with a more general description of the Second Agro-Food Order and the main geo-political tendencies that formed the background of crop development.

4.1 State-led industrialization of agriculture

By the end of the Second World War, little was left of the First Agro-Food Order. The pre-war international trade patterns were completely disrupted by the Second World War and national liberation movements in European colonies in the 1940s and 1950s. In addition, the agricultural crisis of the 1930s had generated a political majority for substituting the defensive, short-term governmental policies on agri-
culture by a long-term offensive strategy. The American agricultural strategy served as the model.

At the end of the war, the USA emerged as the new economic and military hegemonic power and successfully fostered a world trade pattern free from pre-war protected intra-colonial trade flows. The American position as agro-food producer was strong. The country spearheaded the process of state-supported agro-industrialization, and American private agro-industry was able to expand internationally. Both tendencies, which involved changing trade patterns and agro-industrial internationalization, would largely determine the post-war international division of labour in agriculture (Friedmann and McMichael 1989).

The First Agro-Food Order had been characterized by an international division of labour, in which a colonial trade flow of tropical products and an international flow of temperate products co-existed. The decolonization process of the 1950s and 1960s interfered with both trade flows. Colonial trade in tropical products to Europe and the USA was disrupted, but would proceed as an extension of the international trade pattern between independent states. Simultaneously, the de-colonized states became part of the international trade in temperate food products, notably as importers of wheat from the USA. America enjoyed great prestige among the newly independent states, which were receptive to the opportunities of trade and aid the country offered. The U.S. farm sector, for its part, desperately needed new outlets for its agricultural surpluses, when the traditional exports to Europe diminished due to a recovery of European production. The Third World share of world wheat imports grew from 19 per cent in the late 1950s to 66 per cent in the late 1960s (Friedmann, 1992:372).

Meanwhile, an internationally operating agro-industry emerged, initially in the USA, and later also in Western Europe. This industry developed transnational chains of agro-food production. The agricultural sectors of various countries were integrated as a producer of industrial inputs in these transnational production chains. Instead of finished agricultural products, this transnationalization implied the exportation of, for example, maize or soyabean as intermediate products, which are degraded and re-assembled elsewhere into meat or processed food items. Worldwide, farms and farming regions began to specialize in order to become more competitive on the world market.

The Second World War also proved to be a watershed in agricultural regulation. During the First Agro-Food Order, governments in some European countries and the USA slowly started to improve the competitiveness of their national agricultural sector. As explained in the previous chapter, only in Germany and the USA were long-term strategies developed to reorganize and industrialize agriculture. The American New Deal was unique in the sense that for the first time a government became deeply involved in the organization of its national agricultural sector without violating the main principles of the market economy. After the war, it was this American strategy that stood as a model for Western Europe and, to a lesser extent, also for developing countries. This is the reason that, in our opinion, the Second Agro-Food Order can be characterized by the dominance of a state-led agricultur-
al production strategy. This production strategy fostered the process of agro-industrialization guided by national political agendas in the Western world, and sustained the new international division of labour in agriculture.

The central role assumed by the U.S. government in reorganizing and industrializing agriculture was part and parcel of an overall economic, interventionist strategy inspired by John Maynard Keynes. Keynesian policy turned the U.S. government into the largest economic actor after 1945. During the post-war period, Keynesian interventionism, including the New Deal agricultural strategy, was 'exported' to Western Europe. With the Nazi regime defeated, and the continent divided into two antagonistic power blocs during the Cold War, Western Europe was amenable to the new American economic principles. Also welcomed was the Marshall Plan. This plan encompassed a massive American economic support programme for Europe that was intended to prevent both a protectionist revival and communist influence in Western Europe. The Marshall aid laid the foundations for an integrated Atlantic economy based on the generalization of the principles developed during the New Deal (Van der Pijl 1984:147-149).

The American agricultural production strategy and its specific crop development policy were introduced into Europe as an element of the Marshall Plan. The new production strategy gained prominence in the 1950s when the agricultural markets of six West European countries were integrated under a Common Agricultural Policy (CAP). The European controversy on the design of the CAP can be considered as a disagreement on the question of how to implement the new agricultural production strategy. The Commission of the European Economic Community (EEC) strongly favoured a European version of the agricultural New Deal. The Conference of Stresa in 1958 (at which the CAP was founded) as well as the Mansholt Reports of 1961 and 1968, reveal the Commission's objectives: higher agricultural productivity, more governmental control over agricultural output, lower internal agricultural prices, and the removal of 'non-viable' farms (cf. Tracy, 1982:227-258; Neville-Rolfe, 1984:185-245).

The state-led agricultural production strategy succeeded in raising agricultural productivity, both in the USA and Europe, due to the specific crop development policy. This policy consisted of three main elements: (a) massive public investments in agricultural research (Alston et al., 1998:55); (b) the creation of hybrid varieties and the adoption of plant breeders' rights legislation; (c) the active adjustment of conservation to plant breeding objectives. Particularly the latter two elements are explained in detail in sections 4.2 to 4.4.

The new crop development policy paid off well. The yields of maize, wheat and other crops more or less doubled in the USA between 1940 and 1970 (Figure 4.1). The improved genetic constitution of crops can be an important factor in yield increase. It has been claimed that 70-80 per cent of the total maize yield gains between 1930 and 1980 can be ascribed to better varieties (cf. Duvick, 1977:187; Duvick, 1984a:15). Better varieties increased wheat yields by 17 per cent between 1958 and 1980 (Schmidt, 1984:89).2
The state-led industrialization of agriculture in the USA and Western Europe involved a drastic reorganization of the farm sector and aroused fierce opposition. Due to the political power of the farming lobby, governments on both sides of the Atlantic were confronted with social costs incurred by industrialization. Both the U.S. government and the EEC Commission were forced to keep internal prices for the main crops well above the world market level. The price policy delayed the removal of smaller ‘non-viable’ farms. Although farm employment diminished rapidly, with superfluous farm labour being absorbed by the expanding industrial and service sectors, the rural exodus did not reach the extent envisaged. The combination of drastic productivity increases and relatively high national prices, resulted in the accumulation of food surpluses which facilitated the export position of the American and European agro-industry.

At the same time the American crop development policy was adopted in Europe, it was also introduced into a number of developing countries through the finance and expertise offered by the U.S. government and American philanthropic foundations. The ‘export’ of the American crop development policy would initiate a “Green Revolution” in many developing countries. It was intended to prevent a red revolution by increasing food security, but also offered the U.S. government the opportunity to establish a centrally organized global conservation system.

The American crop development policy proved to be rather successful in several developing countries. The expansion of agricultural production enabled many countries to improve national food security and take part in the international division of labour in agriculture. Apart from importing non-traditional food, developing countries started to export agricultural products, basically as participant of the transnational chains of production. In respect of global plant conservation, the Green Revolution has also been successful, as we point out in greater detail in section 4.5. The success of the crop development policy in developing countries had a reverse side, however, because of its considerable social and environmental consequences. Chapter six is entirely devoted to the opposition that Green Revolution
agriculture provoked in two Latin American countries.

In sum, the Second Agro-Food Order had two characteristics. On the one hand it consisted of a specific international division of labour in agriculture dominated by a transnational agro-industry. On the other hand, the division of labour was accompanied by a specific agricultural production strategy that was developed on both sides of the Atlantic Ocean. The strategy was directed towards an industrialization of agriculture under guidance of the national government. It entailed a specific crop development policy aiming at an increase in productivity of bulk crops, an increase of private investment in plant breeding, and the avoidance of large social costs.

4.2. Diffusion of the inbred-hybrid breeding method

As explained in the previous chapter, the U.S. government firmly encouraged the inbred-hybrid method as the main breeding policy in maize. Because of the extensive research investments, hybrid varieties eventually began to out-yield the open-pollinated varieties and thus became commercially attractive to American farmers. In 1930, a few years after the first maize hybrids had been introduced, 0.1 per cent of the American maize acreage was planted to hybrid varieties. By 1945, this figure had risen to 53 per cent, and by 1960 to 94 per cent (Kloppenburg, 1988a:120). Hybrid maize was crucial to the development of the private seed industry in the USA. Hybrids effectively eliminated the double use value of plant varieties (the use both as a crop and as propagating material), and gave private breeding firms the opportunity to obtain higher returns on their investment. Prior to the arrival of hybrid maize in the 1930s, there were around forty seed companies operating in the USA. Around 1980, this figure had risen to around 340 companies, most of them dealing with hybrid maize seed (Doyle, 1985:35).

The inbred-hybrid method was also applied to sorghum, a popular new feed grain after the war. Hybrid sorghum boomed in the late 1950s. By 1960, 70 per cent of all sorghum acreage in the USA was planted to hybrids. Hybrids were later also developed in other field crops, such as sunflower and sorghum, but also in pigs, cattle, and chickens. The first hybrid chickens were marketed by Pioneer Hi-Bred in 1942 (Doyle, 1985:43-44).

Research for the development of hybrid wheat has also been under way since the 1940s. Several seed companies, such as Cargill, Northrup King, DeKalb and Pioneer Hi-Bred invested millions of dollars on hybrid wheat research in the early 1960s. The results were poor, however. The genetic and physical make-up of the wheat plant makes it less suitable for hybridization. Moreover, the barriers for wheat hybrids to enter the market were raised considerably in the second half of the 1960s, when new, open-pollinating wheat varieties were released that were high-yielding. This development, and the prospect of legal plant protection (see section 4.3.4) induced a major reduction in hybrid wheat research programmes at the end of the 1960s (Knudson and Ruttan, 1988).
In Europe, the phenomenon of hybridization had been known since the early 1930s and American hybrid maize seed was imported regularly (Van der Have BV, 1979:62). The interest in hybridization was modest, however, since the main carrier of that technology, maize, was of little importance in Europe. Ever since Columbus carried maize kernels from Cuba to Spain, maize has been grown in the Mediterranean region, but only on a small scale. Climatic circumstances prevented maize production in Northern Europe. The traditional grain and forage crops in this region are oats, rye, barley and wheat. Only when early maturing lines that were adjusted to the climate in Northern Europe became available, interest in maize hybrids increased.

The U.S. seed industry was eager to export hybrid maize seed to war-torn Europe. The UN Relief and Rehabilitation Administration (UNRRA) and later the FAO facilitated the introduction of American hybrid maize varieties (FAO, 1959a:3). Willing to adopt the new technology, European seedsmen crossed the Atlantic and visited American maize companies and institutes in the late 1940s (Van der Have BV, 1979:62). Inbred lines were offered by the U.S. research stations within the framework of the Marshall Plan (CEBECO, 1963:95). In 1953, six per cent of the European maize acreage was planted to hybrids (Kjaer, 1955:86). By 1959 the use of hybrids had risen generally, up to 98 and 99 per cent respectively in Belgium and the Netherlands (FAO, 1959a:3).

Most successful in northern Europe was silage maize (or ‘green corn’) which is harvested before the plant reaches maturity. The whole plant is harvested, dried, ensiled and used as fodder. Silage maize proved to be excellent as feed, as its high protein content allows for an efficient transformation into meat. European governments stimulated national maize production with the objective of reducing the import of American fodder maize. The European market of silage maize began to expand in the late 1960s, at the expense of the markets of traditional local feed crops (Van der Have BV, 1979:63).

Nevertheless, since maize was only a minor crop in Europe, the effect of maize hybrids on the private seed firms in Europe was less significant than in the USA. Even though the inbred-hybrid method was also applied to European field crops, particularly sugar beet, governments in Europe supported the private seed industry in a different way. In Europe, the double-use value of plant varieties was restricted by legislation rather than by technology.

4.3 International recognition of plant breeders’ rights

Hybridization was a technique that offered breeders protection against unauthorized propagation of plant varieties. Hybrid varieties, however, could only be produced in a limited number of field and vegetable crops. For the majority of field crops and ornamental plants breeders sought legal solutions to the double-use value of plants. Particularly in Europe, the development of Plant Breeders’ Rights (PBR) was a core element of the crop development policy during the Second Agro-Food Order.
PBR protection evolved in Europe and was in fact the outcome of a conflict of interests between private plant breeding firms, industrial patent departments, and agricultural governmental authorities. The plant breeders aimed at patent coverage for their creations, while industrial patent lawyers and governmental patent offices showed little interest in the issue and were concerned that patent protection of plants would weaken the entire patent system. The agricultural governmental authorities, for their part, intended to facilitate private investment in plant breeding, but disliked the idea of legal monopolies in that sector.

The European controversy on the question of how the unauthorized propagation of plant varieties could best be controlled started in the 1920s and would only be resolved in 1961, with the adoption of the Convention for the Protection of New Varieties of Plants (UPOV). This section examines the route to UPOV: the first plant breeders' protection systems in European countries, the political conflicts between industry and plant breeders, the adoption of UPOV and, finally, the introduction of PBR in the USA.

4.3.1 European initiatives in protecting plant varieties

The way private breeders used to protect their plant varieties against unauthorized propagation was essentially similar throughout Europe. Since the 1920s, their protection relied on two regulatory mechanisms: the plant variety catalogue, and seed certification. National plant variety catalogues were established in several countries with the aim of reducing the 'varietal jumble'. Although the requirements and function of the catalogue varied among countries, registration of both the name of the new variety and its breeder was common. Seed certification was introduced to control the quality of the seed sold on the market, but it was also used by the authorities to check whether the varietal name printed on the label matched the contents of the seed bag. Since no other breeder could register a variety under an existing name, and since only seeds of registered varieties were allowed on the market, the combination of measures offered the breeders some protection. It was, however, the varietal name rather than the variety itself that was protected.

In countries where plant breeding was dominated by the public sector, such as Sweden, Great Britain, Ireland and Switzerland, additional opportunities restricting unauthorized propagation of plant varieties did not become an element of governmental crop development policy until the 1960s. Only in those countries where plant breeding was mainly in private hands, such as France, Germany and the Netherlands, the state offered supplementary protection in the 1930s, even though it was contested within the agricultural community. Breeders' organizations endeavoured to expand the control of the propagation of their varieties, while organizations of farmers and of seed producers opposed any limitation of their seed saving and producing opportunities.

This ongoing tug of war resulted in the French seedsmen protecting their varietal name or logo under trademark law (Strauch, 1972:33). German breeders were
enabled to patent their plant varieties in the mid-1930s until the Nazi regime interrupted the plant patenting route and offered breeding firms de facto protection of their varieties by the authoritarian control of the seed market. In 1953 the West-German government adopted the Law on the Protection of Varieties and Seeds of Cultivated Plants, which offered breeders the exclusive right to produce and market the seed of their varieties (Weibull, 1955:120).

A similar, although weaker, plant variety protection system had been introduced in the Netherlands in 1937. The system, jointly created by breeders' and farmers' organizations, offered breeders exclusive rights on the marketing of seed of their varieties, except for main food crops. For these, exclusive marketing rights were only allowed on the first generations, known as elite or original seed. Although the Dutch system offered breeders less control on the propagation of their varieties than the German legislations, from 1934 and 1953, anyone who propagated the variety for commercial purposes was charged with a levy for every hectare of seed that was certified. The revenues were allocated to a Breeders' Fund from which breeders were remunerated. The more seed of their varieties was certified, the bigger the share of individual breeders in the Fund (Addens, 1952:174).

The interest in legal protection for plant varieties did not remain confined to national territory. The small national production base and market had induced the seed industry since its inception to sell its material throughout Europe. Plant breeders realized, therefore, that legal protection of breeders' creations required international recognition in order to be effective.

One of the first times that the issue of international plant variety protection was raised was probably during the 5th International Congress for Hereditary Science, in 1927 in Berlin. At the same Congress where Vavilov presented his theory on the World Centres of Origin of Cultivated Crops, a commission was established to prepare a proposal on plant variety protection (Van Harreveld, 1934:28). In the subsequent decade, the European agricultural establishment showed its sympathy for property rights for breeders and for an international agreement in this realm, at various occasions. The issue was discussed during the 1931 congress of the Association Internationale des Sélectionneurs de Plantes, the congresses of the Rome-based International Agricultural Institute in 1936 and 1940, and the International Agricultural Congresses of 1931, 1934, and 1937 (Verhulst, 1947:36-41). During the 1937 congress, a resolution was adopted in which the International Agricultural Institute was requested to organize an expert meeting which would prepare an international convention on the protection of breeders' creations (Addens, 1952:184). None of the resolutions and proposals adopted during the agricultural meetings in the 1930s gave any practical results, however.
4.3.2 Industry rejects patent aspirations of European plant breeders

The establishment of a special lobby organization, the International Association of Plant Breeders for the Protection of Plant Varieties (ASSINSEL), illustrates the strong interest of the European breeding firms in an intra-European plant variety protection system. ASSINSEL was founded in 1938 in Amsterdam by seedsmen from France, the Netherlands, Denmark and Belgium. The organization was soon joined by private seed industry representatives from other European countries. Apart from a disruption during the Second World War, ASSINSEL worked continuously on the establishment of a European system for the protection of intellectual property rights for breeders. After the war, the need for protection of plant varieties was intensified by new internationalization strategies of the European seed industry. Many seed firms of North-West European countries started to propagate seed of their varieties in Southern European (and also African) countries, because of the sunny and dry weather conditions during flowering time and the availability of cheap labour (Thielebein, 1955). It was not yet clear for ASSINSEL members, however, which type of protection was most appropriate. During the annual conferences until the mid-1950s, two options were discussed: trademarks and patents.

Trademark law had generally been the system to which many private breeders resorted for the protection of the name of their new varieties. The French seedsmen in particular relied on a combination of trademark law and compulsory registration in the national variety list. The intention of ASSINSEL’s president Ernest Tourneur was to use the French system as the international standard, but this turned out to be impossible. The obligation to register new varieties in the national catalogue only existed in a few countries, while there was still no consensus on the synonyms of plant variety names in the different European languages (ASSINSEL, 1947:5,9). Tourneur eventually dropped the trademark option in 1950 in favour of patents (ASSINSEL, 1950:4).

Patents could offer a more secure protection and were - at least with respect to industrial inventions - already internationally recognized through the Paris Convention. Discussions at ASSINSEL’s annual congresses show, however, that the breeders realized the limited value of patent law for plant breeding. Only plants whose progeny were identical to the parents would have been eligible for protection. Because characteristics of cross-pollinating plants change after each reproduction cycle, it was not possible to provide an exact description of these plants - a limitation that precluded patent protection. Hence, alternative means of protection had to be sought (ASSINSEL, 1949a). But at that time, a specific breeders’ rights system was not yet considered as an option. The German PBR legislation was only enacted some years later, while the association was presumably not impressed by the Dutch system.

By opting for patents, ASSINSEL entered into a controversial area. On the one hand, ornamental plants, mainly roses and carnations, had been considered to be patentable in Germany since the 1930s, in France since 1949, in Italy since 1951, and in Belgium since 1958. In Italy and France the establishment of a Plant Patent
Act was even considered, like the one enacted in the USA in 1930 (Heitz, 1991:29-30). On the other hand, the Agricultural Ministries in Europe generally rejected plant patents. In Switzerland, the Netherlands, Denmark and Great Britain, patents for plants were deliberately not issued. The main opposition to the patent aspirations of the plant breeders during the Second Agro-Food Order in Europe, however, came not from Ministries of Agriculture, but from the industry.

The private crop development industry in Europe generally consisted of small, rural, family-owned firms. Until the 1970s, involvement of large industrial capital in this sector did not occur, because the technical control of the hereditary mechanism of plants was still limited. This factor dimmed the prospects on returns, but also prevented the possibility of ‘invented’ plants meeting the requirements for patent protection. The mechanical and chemical industries, which were the main users of the patent system, had therefore little interest in the efforts of plant breeders.

The first time that industry’s patent lawyers showed their reluctance to accept plant patenting was during the 1932 congress of their professional organization, the International Association for the Protection of Industrial Property (AIPPI). AIPPI had been established at the end of the 19th century to promote patent protection and incorporated patent lawyers of all major industrial enterprises and national patent offices. The 1932 AIPPI congress disapproved of a proposal for plant patenting submitted by a German lawyer, because it was thought that the patenting of plants would endanger the entire patent system (AIPPI, 1933:170).

The AIPPI position on plant patents remained rather static throughout the 1940s and 1950s. Although differences of opinion existed among the national groups, the industrial association generally did not intend to exclude inventions in the realm of plant breeding from patent protection. AIPPI was concerned that a weakening of the patent requirements, which would have been necessary in relation to plants, would negatively affect the patent system as a whole. It argued that the basic criteria for patent protection - that there is an invention and that this invention can be reproduced by others - could not be met in the case of plant varieties. For this reason the overwhelming majority of AIPPI members voted against the protection of plants by patents in 1954 (AIPPI, 1954:63; ASSINSEL, 1954:5). The industry’s lawyers were of the opinion that plant breeders deserved protection for their creations, but through a legal system different from the patent system. It proposed to protect plant varieties by a system specifically designed for that purpose. At an earlier stage AIPPI had encouraged ASSINSEL to take the initiative in this respect (ASSINSEL, 1947:5).

The industry’s negative position on the patenting of plants was maintained until the 1970s, as is reflected in the outcome of several international patent law agreements. During the 1958 conference on the revision of the Paris Convention in Lisbon, the experts (mainly patent office directors), refused to discuss the issue of plant patenting (Heitz, 1991:34). Neither was the question resolved with the convention on the unification of patent laws of European countries, adopted in 1963 in Strasbourg. The Strasbourg Convention left the decision on granting of patents for
plants to the member states. Ten years later, in 1973, when the European Patent Convention (EPC) came into force, the patenting of plant varieties was explicitly rejected. The European policy not to offer patent coverage for plant varieties was facilitated by the emergence of a new legal intellectual property system, specifically designed for the protection of plant varieties, commonly known as UPOV.

4.3.3 The foundation of UPOV

While the industry was pushing plant protection away from the area of patenting, the agricultural departments of European governments attempted to establish a new protection system under their control. The agricultural authorities seized the opportunity in 1956, when the French government organized an international conference on the issue of plant variety protection. The French conference was in fact a joint initiative of ASSINSEL and the French Department of Agriculture, which had been closely collaborating since the late 1940s. Most participants of the conference also originated from the agricultural sector.

Four years of negotiation resulted in the International Union for the Protection of New Varieties of Plants (UPOV), signed in 1961. The UPOV Convention provides minimum standards which member states have to meet in their national legislation. The important implication of UPOV was that in Europe the creations of plant breeders were not protected by patents, as ASSINSEL desired, but by a legal system exclusively designed (i.e. sui generis) for the protection of the property rights of plant breeders, commonly referred to as plant breeders’ rights (PBR). The plant patent advocates were not left with empty hands, however. UPOV member states were still offered the opportunity to protect a plant variety by a patent, but double protection of plant varieties was prohibited. Member states could provide either patent or PBR protection for one and the same botanical genus or species.

The foundation of UPOV made it much easier for European plant breeders to obtain legal protection, because the requirements are less demanding for PBR protection than for patent protection. Patent law requires an invention, while under PBR law any new plant variety is in principle eligible for protection. Patent law also requires that the invention is reproducible by a skilled person, while the criterion for PBR protection is that the varietal characteristics are defined and described. An invention must be non-obvious and novel worldwide. Since most varieties are obvious adaptations of existing varieties, PBR requires only that the important varietal characteristics are clearly distinguishable from other varieties that are commonly known. Finally, PBR law requires that the variety is sufficiently genetically uniform, while the variety’s essential characteristics must remain stable, i.e. must remain true to its description, after repeated reproduction.

However, these lower protection requirements came at a price, in that the scope of PBR protection is narrower than that of a patent. Whereas patents protect the inventor against all unauthorized commercial use of the invention, a PBR certificate entitles the breeder only to prevent unauthorized commercial propagation of plant varieties.
The narrow scope of PBR protection had two significant consequences. In the first place, PBR did not prohibit a third person from using the protected variety to breed a new one, selling this new variety and protecting this new variety under PBR law. From a legal point of view, new varieties remained independent from their source varieties. The resulting opportunity for breeders to freely use protected varieties for breeding has become known as the 'breeders' exemption'. Secondly, the scope of PBR did not extend to the propagation of protected varieties for replanting purposes by farmers. This 'on-farm seed saving' was considered not to be a commercial activity, thus falling beyond the scope of PBR. Later, on-farm seed saving would be referred to as the 'farmers' privilege' (or the 'crop exemption').

Both the terms 'farmers' privilege' and 'breeders' exemption' suggest that they are derogations from the breeders' right. The absence of these terms in the original UPOV Convention, however, indicates that the European Departments of Agriculture, which prepared the convention, did not want to extend the scope of the breeders' right to on-farm seed saving and the use of a variety for further breeding. The fundamental objective of UPOV was only to limit one of the triple-use values of plant varieties. PBR-protected varieties could be used for growing a crop, for creating new plant varieties, for on-farm propagation, but not for unauthorized commercial propagation.

The UPOV convention was signed by several European countries in 1962, but only entered into force six years later, in 1968, when three countries ratified the convention: the United Kingdom, West Germany and the Netherlands. It would take several more years before the system was operational in other European countries, a delay partly due to an ongoing patent versus PBR controversy at national level. France, for example, ratified the convention only in 1970, almost ten years after signing it. Sweden acceded to UPOV in 1971, Belgium in 1976, Italy and Switzerland in 1977.

4.3.4 Adoption of breeders' rights in the USA

Whereas the USA was not involved in the UPOV process, it did not lag behind and adopted the Plant Variety Protection Act (PVPA) in 1970. The fact that plant variety protection was available in the USA earlier than in most European countries is quite remarkable. At the time UPOV was established, the American seed sector still opposed legal protection for sexually-reproducing plants (Laclavière, 1972:54). Seed companies dealing with hybrid varieties had little to gain from PBR. Moreover, American breeders were reluctant to accept the European PBR system because it was rooted in governmental seed trade regulation, involving compulsory registration in the national variety list and seed certification. They were concerned that the UPOV system would give the government the authority to decide which variety was allowed onto the market and which not (Fowler, 1994:104). Nevertheless, in 1963 the American Seed Trade Association (ASTA) established a committee to assess plant variety protection (PVP).
Advocates of PVP were relative newcomers in the area of plant breeding: the seedsmen involved in the breeding of forage crops, who desperately required income to finance their research programmes (White, 1964:70-71). Moreover, the expectations of hybridization had not materialized. In several crops, hybrid varieties were developed, but not in major commercial crops such as wheat and soya-bean (Bugos and Kevles, 1991:14)

The question of legal protection for plants became topical in 1966 when a revision of the entire patent law, including the PPA, was in preparation. The President's Commission on Patent Reform published its report, and recommended that the 1930 Plant Patent Act be repealed. The Commission considered the patent system not to be the proper vehicle for the protection of plants and seeds, regardless of whether they were sexually or a-sexually reproducing. Nevertheless, the Commission did acknowledge the valuable contribution of plant breeders and urged further study to determine the most appropriate means of legal protection for plant varieties (Doyle, 1985:56-57).

When in 1968 the Senate Judiciary Committee embarked on a series of hearings on the Patent Reform report, ASTA seized the opportunity not only to oppose the patent reform recommendation, but also to push for an extension of the coverage of the PPA to sexually reproducing plants. Despite the support of powerful organizations, such as the National Cotton Council and the National Canners Association, ASTA's amendment failed. The USDA was "particularly firm in opposing plant patents" and argued that a-sexually propagating varieties would not remain true to their description after repeated reproduction (Doyle, 1985:58). The American Farm Bureau Federation also advised negatively on the issue, arguing that the interests of breeders of sexually-reproducing plants were sufficiently served by seed certification programmes (Bugos and Kevles, 1991:16).

When the option of general plant patenting under the aegis of the Patent Office had failed, ASTA was prepared to accept a breeders' rights system for sexually reproducing plants administered by the USDA, in addition to the PPA. The legislative course in Congress changed accordingly, from the Judiciary Committee to the Agriculture Committee. A PVP bill was drafted by representatives of the public and private seed sector and the USDA, and did not meet significant opposition on the part of farmers, consumers and Congress. The bill passed Congress in 1969 and was signed into law in 1970 (Doyle, 1985:60-66).

Summary

Throughout the Second Agro-Food Order, American and European plant breeding firms tried to restrict the dual-use value of plants by means of technology and legislation. Hybrid varieties were developed in maize and in some other crops. But hybridization did not offer a solution to unauthorized propagation of plant varieties of major commercial crops, such as wheat, soya-bean, flowers and fruit. Attempts to patent new varieties were thwarted by the industry. Until the 1970s, the major
industrial sectors had little interest in plant breeding, which was basically a rural-based business in the hands of family-owned firms. The industrial position left plant breeders no other choice than to accept the plant breeders’ rights system.

4.4 American versus European conservation strategies

The large-scale conservation of landraces as breeding material is the third element of the state-led crop development strategy during the Second Agro-Food Order. Like the diffusion of hybrid varieties and the emergence of breeders’ right protection, considerable differences existed in the strategy for landrace conservation between the USA and Western Europe.

On both sides of the Atlantic, the conviction grew that landraces constituted an important resource of genetic information for plant breeding and agriculture. As we show in section 4.4.1, it was only in the USA that the state took a leading role in adjusting conservation strategies to plant breeding policies. The growing involvement of the US state in conservation in the 1950s led to a far more centralized conservation strategy than in Europe. This allowed the U.S. government to adjust conservation to long-term, national plant breeding policies.

In Europe, the conservation of landraces would largely remain in the hands of breeders themselves. This tradition, in combination with diverging national considerations, prevented the emergence of a common, centralized European conservation strategy (section 4.4.2). Long-term national conservation strategies emerged only the 1980s and 1990s, while a common European conservation strategy is still under construction. This explains why in Europe an adjustment of conservation strategies to long-term plant breeding policies never emerged as it did in the USA.

4.4.1 Central seedbank system for American ‘new crops research’

Since the USA is poor in native genetic resources, the uninterrupted supply of exotic plant material has always formed a key element of national crop development. From its establishment in 1862, the USDA systematically imported landraces and wild relatives of the most important crop plants (cf. Wilkes, 1983; Yeatman et al., 1984; Cox et al., 1988). In the first two decades of the 20th century, a national network of Federal Plant Introduction Stations was established (see section 2.2.3). In order to ensure ready access to germplasm in the future, the U.S. government further extended this national network after the Second World War. The juridical basis for this extension was provided by the 1946 Research and Marketing Act, which included an amendment to the Bankhead-Jones Act of 1935. The 1946 act resulted in the construction of four Regional Introduction Stations and a National Potato Introduction Station. All were built between 1947 and 1953. Some years later, in 1957, the national ‘mega’ seedbank emerged: the National Seed Storage Laboratory (NSSL) in Colorado (Brown, 1984:32). The NSSL is still generally
known as the world’s largest *ex situ* cold storage facility.

The extension of the seedbank network was inspired by a broader and long-term view on the importance of landrace conservation for agriculture. Apart from serving as a genetic backup to augment the overall performance of crops (in terms of yield, resistance, etc.), the landrace collections were intended to adapt plant characteristics to the specific requirements of the agro-industry. The 1946 act repeatedly speaks of the conservation of plants for “agricultural or industrial use”. Reference is made to the food processing industry, as well as to the “chemical or manufacturing” industry (Wilkes, 1983:148). The screening of landraces for traits with a variety of (potential) agro-industrial uses expanded the scope of conservation and collection.

The extensive American seedbank network also played a valuable role in solving a contradiction in the agricultural production strategy. The advances in crop development had greatly contributed to the rise in agricultural productivity. The strong lobby of farmers and agro-industry, however, prevented overall production from being adjusted to national demand. Through the Marshall plan, American excess production could be exported to Europe in the aftermath of the Second World War, but after the Korean War had ended, American food surpluses accumulated rapidly (Cochrane and Ryan, 1976:14-15).

It is against this background that, in 1959, the American Association for the Advancement of Science organized a symposium on Germ Plasm Resources. Two USDA researchers, Quentin Jones and Ivan Wolff, presented a paper titled: Using Germ Plasm for New Products, in which they proposed a “new crops research” policy for public agricultural science (Jones and Wolff, 1961:267). The policy had two objectives. The first was the introduction of new crops to “eliminate expected future increments of surplus of wheat”. Particularly soyabean, at that time a relatively new crop, was recommended as a candidate. The other objective was to find industrial rather than food markets for agricultural crops.

“It ... appears evident that we should concentrate on those industrial needs for which plant products have an inherent competitive advantage over materials of non-agricultural origin. This means that our efforts should be centered on those plant constituents, such as seed oils, proteins, gums and fibrous cellulose which ... can be adapted to special uses.” (Jones and Wolff, 1961:267).

The growing possibilities of using “germplasm” for new agro-industrial needs required a new conservation strategy. In the 1960s, the existing national seedbank network was expanded again with twelve new seedbanks. The extended network, in turn, became part of the National Plant Germplasm System (NPGS). Besides seedbanks, the NPGS encompassed a network of research units and agencies, which jointly introduced, evaluated and distributed seed and plant material (Hougas, 1984:17-20). Quentin Jones, one of the architects of the new crops research strategy, was appointed as the NPGS director.

The NPGS expresses an important characteristic of American crop development
policy during the Second Agro-Food Order: i.e. a strong synergy between plant breeding and conservation. In the post-war period both branches became locked within one bureaucratic system under direction of the Agricultural Research Service and the USDA. The NPGS facilitated an adjustment of conservation strategies in accordance to the changing demands of plant breeders. To this end, an advisory National Plant Germplasm Committee was established, which consisted of representatives of the private sector (the Council of Commercial Plant Breeders) as well as the public sector (the Cooperative State Research Service) (Hougas, 1984:21).

4.4.2 Fragmented European seed collections

During the Second Agro-Food Order, European conservation policies contrasted quite sharply with those of the USA. While American crop development policy was directed by the USDA, European conservation efforts were fragmented because of the absence of an overall European policy. After the war, Western European countries followed their own, national conservation policy, while many collections remained in the hands of private breeding firms serving ad hoc needs.

Until the 1940s, conservation in Europe had merely been an activity of botanists who collected for the benefit of public botanical gardens. The collections were used for academic taxonomic study, but their most important function was as a ‘transfer point’ for botanical exchanges within the colonial empires. The interest in central seed collections of temperate crops has never been as extensive as in the USA. In part, this can be explained by the prevailing interest in tropical, colonial agriculture. Other reasons, however, lie in the long-standing history of plant introduction in Europe, which goes back several millennia, and the fact that the world’s main Centre of Origin of grain crops, the Mediterranean basin, was at hand. In this sense the very active and central conservation policy of settler states, notably the USA, can be considered as an attempt to catch up with agricultural history.

The importance of collecting landraces for breeding was well known among European plant breeders since Vavilov had presented his findings. A European central conservation policy, however, would prove difficult to materialize. National considerations, and the existence of a relatively strong private breeding sector, for a long time prevented something like a ‘common conservation policy’ form developing in Europe. Various initiatives in this direction failed.

An early proposal for the establishment of an “inter-European system for plant exploration, collection and introduction” was submitted in 1958 but never materialized. None of the countries that were initially interested (Denmark, France, Germany and Norway) eventually wanted to host more collections than they already had. The seedbank curators involved in the negotiations refused to have their collections swamped with material that was beyond the needs of the national breeding programmes. The FAO also had to turn down the request to host the collection, because European donor countries were not prepared to pay additional funding to this UN organization (FAO, 1958a:3; Whyte, 1959). Another initiative
to set up a European conservation system came from the European Association for Research on Plant Breeding (EUCARPIA) in 1966. This too was bound to fail. In 1962, EUCARPIA began to lobby (also within the FAO) for a permanent bureau for exploration and introduction, and the establishment of “various germplasm stations in various parts of the world” (Hawkes and Lamberts, 1977:1). One year later, EUCARPIA proposed to establish a cooperative germplasm conservation project between Germany, the Netherlands, and the UK. The proposal failed because the UK government was not interested, while support from the Organization for Economic Cooperation and Development (OECD) was refused for financial reasons. Eventually, the German and Dutch governments agreed to establish a joint storage facility for seed potatoes and planting material in Braunschweig (Hawkes and Lamberts, 1977:1).

Instead of creating a centralized conservation network, national governments in Europe left conservation to those who directly used seed: the breeders. In fact, the maintenance of ‘working collections’ of germplasm by plant breeders of private firms and of public institutes served as an alternative, decentralized conservation strategy. Working collections met the short-term and direct germplasm requirements of national private and public breeders, and were generally located close to the breeder. The variability of conservation practices among Western European countries is illustrated in the following brief discussion of the post-war national conservation initiatives of France, Great Britain, the Netherlands, and West Germany.

In France, the public working collections were spread over three agricultural research institutions: the National Institute for Agricultural Research (INRA), the Centre for International Collaboration in Agriculture (CIRAD), and the French Institute of Scientific Research for Development and Cooperation (ORSTOM). The plant breeders in these institutions kept the responsibility their ‘own’ working collections, which were passed on to succeeding generations of plant breeders (Busch, 1995:134). This system apparently functioned well. A hidden strength of the French conservation system was the landraces on which many small farmers still relied until the 1960s. By maintaining personal contact with the farmers in the region, French breeders had ready access to these landraces. It would take INRA until the 1990s to design a centralized conservation policy (personal communication Ph. Auriau, INRA, 1997).

As discussed in chapter two, the colonial Kew Botanical Gardens remained for a long time Great Britain’s most important collection of seed. Kew Gardens, however, was not designed to serve breeding research for temperate crops in the home country, but served as a transfer point in the colonial botanical exchange system. Collections of temperate crops were established in the 1950s, such as the Commonwealth Potato Collection at Dundee and the Barley Collection at Cambridge, but they mainly served academic and taxonomic objectives, rather those of plant breeders (personal communication J. Hawkes, University of Manchester, 1997). Other, more ‘informal’ collections were held under the responsibility of the Ministry of Agriculture and the Agricultural and Forestry Research Council. The remainder of the British collections consists of a plethora of small
public and private working collections. Until the late 1980s a national conservation policy was absent (Hardon, 1988:9).

The picture of scattered conservation initiatives also applies to the Netherlands where the government deliberately confined its role in plant breeding to support private firms. Some of the Dutch working collections, especially those containing potato breeding material, were quite large and international in scope. The lack of a centralized conservation policy caused some collections to be simply thrown away when they were no longer useful for the private breeding programmes. The abandonment of the entire collection of Dutch spelt landraces in 1951 (Zeven, is 1996:339) may serve as an example. Other collections, among them considerable parts of the field collections of the Wageningen University, were lost in 1940, as they happened to lie in the middle of the Dutch-German front line. The Dutch Centre for Genetic Resources (CGN) set up a centralized seed bank policy in 1984 (Van Soest and Van Hintum, 1995:7-10).

The exception to the fragmented conservation infrastructure in Western Europe were the West German collections. Before the Second World War, considerable plant collections had been established by the Kaiser Wilhelm Institute (KWI) in view of Germany’s strategy towards food autarky, but the war had taken its toll on them. Some collections were destroyed, some fell into British hands, and some were (re)captured by the Soviets (later forming the basis of the East German seed bank in Gatersleben). Only a part of the original KWI collection could be maintained in West Germany. The remaining collection was of little interest for German plant breeders because the character of the German agriculture changed rapidly after the war. Due to the division of the German empire, West Germany lost its traditional grain and sugar beet production area to East Germany, while livestock production gained importance (Andrews et al., 1979:12-13).

Flitner (1995) remarks that post-war German conservation activities were strongly linked to those of the USA. The leader of the U.S. Point-Four Programme, Waldee, personally took an interest in the conservation work of the KWI. The Point-Four programme financed a large, joint USDA/KWI expedition in 1952-53 for the collection of wheat samples in Iran (Flitner, 1995:125-139). Another KWI expedition to the Andes in 1959 was financed by the Rockefeller Foundation, the German Scientific Society (Deutsche Forschungsgemeinschaft) and several large German pharmaceutical and chemical companies (IG Farben, Leverkusen, and La Roche) (Flitner, 1995:140-148).

If a centralized European conservation policy existed during the Second Agro-Food Order, it was behind the Iron Curtain. After 1964, East European countries integrated into the Council for Mutual Economic Aid (COMECON) established a large seed exchange system coordinated by the VIR in Leningrad. Although the USSR could not resume its key role in international conservation, due to the outbreak of the Cold War, West European and American geneticists and conservation specialists continued to visit East European and Soviet countries in the 1950s and 1960s, albeit less frequently (Loskutov, forthcoming). Integrated East-West conservation strategies were intensified again only after 1989.
Summary

The traditional American dependence on the import of landraces of temperate crops culminated in a strong state-led conservation policy after the Second World War. The approach of the USDA gradually evolved into the National Plant Germplasm System, which maintains the most advanced conservation facilities in the world. This system allowed the USDA to adjust conservation to new plant breeding objectives. The European situation was entirely different. The larger involvement of the private sector in crop development, as well as the ready availability of temperate landraces in the field, resulted in a far more fragmented conservation 'strategy'. Until the 1980s when governments individually set up national conservation strategies, the bulk of the European collections was still maintained in individual working collections of private and public plant breeders. As will be shown in the next section, the centralized U.S. conservation system was relatively easy to replicate in developing countries.

4.5 American crop development policy transferred to developing countries

In the second chapter of this book we examine why and how, during the First Agro-Food Order, governments in Europe and the USA began to design and implement crop development policies. To maintain national agricultural competitiveness, governmental authorities started to regulate the seed market, control the quality of the seed, and fund agricultural research institutes. During the Second Agro-Food Order the involvement of the government in crop development increased considerably. Public agricultural research expenditure was increased in the USA, and most West European countries followed the American example. A PVP system was also established on both sides of the Atlantic, but only in the USA did the government play a central role in plant conservation.

Shortly after the Second World War, it was predominantly the American crop development policy that was transferred to the newly independent former colonies and other developing countries, by means of American agricultural research aid programmes and by FAO seed dissemination activities. The introduction of the state-led crop development policy substantially changed the organization of agricultural production in developing countries. Governments regulated the seed market, actively promoted the substitution of landraces by new, scientifically bred plant varieties, and encouraged the introduction of agro-chemicals. These changes greatly facilitated the process of agro-industrialization. Agricultural regions of many developing countries increased their productivity and were able to export. In fact, they became incorporated into transnational production chains chiefly for the production of meat, fruit and flowers.

This section first examines the role of the FAO as a distributor of finished varieties and conservator of landraces. Then, we focus on the reasons for and the effect of the agricultural development aid by the U.S. government and some American...
philanthropic organizations. Under the Point-Four programme, the USA set up an extensive breeding programme on wheat and maize in Latin America, complemented by a plant conservation system. The complementarity was subsequently repeated in other international agricultural research centres (IARCs) in the 1960s and after. Finally, the involvement of the FAO and the USA in the industrialization of agriculture in the Third World initiated parallel efforts to set up a global plant conservation system. In the last section, we illustrate how this situation led to a conflict over the control of the global system.

4.5.1 The FAO's seed dissemination and exchange programme

The yield increases achieved by the American plant-breeding sector were substantial and widely known after the Second World War. They gave rise to an optimistic and assured FAO initiative, in the late 1950s, to re-organize the seed distribution system in developing countries in order to eradicate hunger. The FAO's seed programmes culminated in the World Seed Year, organized in 1961, a year that was dedicated to "the promotion of first class seed of superior crop and tree varieties" (FAO, 1960a:2). First class seed was considered to be higher yielding, disease and draught resistant, and adapted to mechanical harvesting (FAO, 1958b:4). The World Seed Year fell within the Freedom From Hunger Campaign and seems to have been fairly successful. The 1960 World Seed Campaign News, a journal that monitored the preparations and achievements of the World Seed Year, proudly reviews the many new seed certification bureaus in developing countries, established by new National Seed Campaign Committees with FAO support (FAO, 1960b:7). In the 1960s, the National Seed Campaign Committees were the primary actors in setting up a controlled distribution system of imported varieties in the Third World.

In order to stimulate the shipment of new varieties to developing countries, the FAO, in collaboration with the United Nations Educational Scientific and Cultural Organization (UNESCO), established a Gift Coupon Project. The Project supplied National Seed Campaign Committees with new varieties and agricultural equipment from industrialized countries. The Project reflected a rather supply-driven approach: Donor-organizations and charity groups bought coupons from UNESCO and offered these to the National Seed Campaign Committees.

The imported new varieties were deliberately considered to replace traditional seed stocks. The FAO's World Seed Campaign News (FAO, 1958b:5) mentions no less than 27 measures to bring "first class" seed to developing countries. The measures, for example, demanded "facilities for representatives of foreign breeders and seed firms [for] the introduction of high quality seed of approved varieties from abroad." Simultaneously, the Committees were to avoid the use of "inferior seed of unsuitable varieties" by local farmers (FAO, 1958b:5). The FAO's stance on the abandonment of local varieties is clearly stated in a text presented in 1958 by the FAO International Rice Commission:
“Although in most countries ... rapid progress has been made in rice breeding, an excessively large number of rice varieties ... is still in cultivation in many countries. To increase the average yield of rice it is important that the lower yielding types be eliminated. ... Only a limited number of improved varieties should be included in a seed programme.” (FAO, 1959a:9).

“First class seed” specifically included hybrid varieties. The 1962 newsletter of the FAO Freedom From Hunger Campaign reflects the FAO’s expectations as regards hybrid varieties: “Enormous progress has been achieved in this field in the last four or five decades in the agriculturally advanced countries. A convincing example in recent times is the immense success of hybrid maize in the USA.” (FAO, 1962:2). Hybridization was considered “today’s most important type of breeding” (FAO, 1958b:6).

The FAO’s role was limited to the dissemination of new plant varieties. The organization did not embark on large ‘in house’ crop development programmes. It had a mandate to deliver short-term food security, and the organization’s budget - not more than US$ 80 million at the end of the 1960s (Talbot, 1990:29) - did not allow for such expensive initiatives. Also, the FAO’s Crop Production and Improvement Branch merely functioned as a seed exchange service. Limited budgets and political strife between member countries also frustrated and prevented the establishment of Plant Exploration Centres for research on locally available landraces in Turkey, Argentina and Pakistan (Pistorius, 1997:17-18).

Although the FAO’s direct role in crop development was limited, it did pave the way for the export of a state-led seed distribution system of finished varieties. The activities of the Crop Production and Improvement Branch in distributing unimproved material would in due time become even more important. As the Branch distributed and registered source and destination of tens of thousands of landraces and parental lines, it was gradually able to obtain a fairly accurate picture of the world’s stock of landraces. This information was published in the FAO Plant Introduction Newsletter (FAO, 1957-1970) and the World Catalogues of Genetic Stocks (FAO, 1950a,b; 1959b). The newsletter and the World Catalogue gradually became key information sources for breeders worldwide.

It was with this global scope in mind that an FAO expert team was commissioned to design a new policy for the conservation of landraces and wild relatives. In the early 1970s, the team, under the name of the Panel of Experts on Plant Exploitation and Introduction, came up with a proposal to set up a world-encompassing seed storage system. In line with Vavilov’s broad scientific interest, each seedbank would maintain a broad ‘generalist’ conservation strategy, also covering many minor food crops of local importance (FAO, 1969; FAO, 1973). This high ambition soon aroused opposition from the other major player involved in exporting industrialized agriculture, the USA.
4.5.2 Sowing and collecting seed in Latin America

In a meeting with the Rockefeller Foundation about agriculture in Mexico in 1941, U.S. vice president Henry Wallace, the man who had been so instrumental in initiating the restructuring of American agriculture, noticed that: "In the field of agriculture ... there has been no long-term policy and there has been a lack of continuity in the programmes which have been adopted." (Wallace quoted in Lewontin, 1983:78). The policy Wallace had in mind went far beyond that of the FAO's seed campaign. Wallace envisaged a plan-wise industrialization of agriculture along the lines of the New Deal. The instruments of the associated crop development policy, later referred to as the Green Revolution, would be delivered by the U.S. government and private philanthropic organizations, notably the Rockefeller and Ford Foundations.

Green Revolution research strategies were carried by the ideal of the progressive entrepreneurial middle class-type farmer, superior to the peasant (Lewontin, 1983:27), and by the belief in the efficacy of modern, labor-saving technology and the development of new high-yielding varieties. Most work was directed to the design of specific varieties that would facilitate the rationalization of farming. Breeding to reduce stem height of maize, rice and wheat was a key activity as shorter plants allowed for a better uptake of chemical fertilizer and more efficient mechanical harvesting. The other major task for plant breeders was the adaptation of new varieties to regional circumstances (day length, precipitation, and soil condition). Both types of work required a constant access to (local) landraces, which explains why seed conservation played a central role during the Green Revolution.

In 1943, the Mexican Department of Agriculture, with strong support of Wallace, embarked on a maize-breeding project that fell within the larger Mexican Agricultural Program (MAP) (Lewontin, 1983:77). While the Rockefeller Foundation had long-term experience with foreign agricultural aid, the MAP was its first long-term involvement in agricultural research. The MAP became "the method for effectively transferring technology from the developed to the less developed world ... through a complete partnership between the farmer, the state, modern industry, and modern science" (Perkins, 1997:92,117). The MAP would eventually evolve into the first IARC, the International Maize and Wheat Improvement Center (CIMMYT) in 1966 (Fitzgerald, 1994:73).

The significant contribution of the MAP/CIMMYT programmes to the increase in maize and wheat production in Mexico created concerns among the American agricultural establishment and conservative forces within the U.S. State Department (Oasa, 1981:106-112). Why did the U.S. government and the Rockefeller Foundation encourage the free international diffusion of advanced plant breeding technology, in which the country had a leading position? The answer must be sought in a mixture of American geopolitical concerns and (corporate) agricultural interests in genetic information.

The geopolitical concerns stemmed from the desire to create political stability on America's southern border. The economic depression of the 1930s and the out-
break of the Second World War had made Latin America receptive to populist and nationalist regimes. After 1943, the Roosevelt Administration responded to this situation with a non-interventionist Good Neighbour policy, which promoted American interests by other than military means. Like the New Deal, the Good Neighbour policy considered agriculture to be more than a residual sector in urban-industrial development. The objective was to foster rural social stability by transforming poor peasants into strong, progressive farmers. The translation of the Good Neighbour policy into technical agricultural assistance came in 1949 under the Point-Four programme of the Truman administration. The close collaboration between the U.S. government and agricultural experts of the Rockefeller Foundation allowed for a quick implementation of the Point-Four principles in Mexico (Lewontin, 1983:28-30,69; Perkins, 1997:108,117).

Mexico was the first candidate to demonstrate the new American foreign policy, and deserves closer attention for two reasons. First, the MAP integrated a long-term agricultural research strategy with conservation policies in a typically American way: centralized, well funded, and in accordance with the latest scientific insights. Second, the MAP’s success (at least, in terms of production) created a format for the creation of many more IARCs in the 1960s and 1970s. It was during the MAP period that the agricultural research and conservation strategy of the Green Revolution first took shape.

The American initiatives were warmly welcomed by the Mexican elite. In the late 1930s and early 1940s, the Mexican agricultural sector was suffering from a crisis and parts of the rural population had become increasingly susceptible to socialist and fascist ideologies. Pressures from the rightist factions to curb the crisis by any means other than land reform induced the Camacho Administration (1941-1946) to find a ‘technical fix’ to increase agricultural production and defuse attacks on the power of the hacienda owners (Cotter, 1994:98). Another factor was the gradual replacement of maize and beans by wheat in the urban diet pattern. The growing preference for wheat created difficulties in the balance of payment, which made the emerging middle class favour domestically grown wheat. The proposals of the Rockefeller Foundation to set up an extensive wheat breeding programme thus fell in fertile ground, especially after the first large wheat crops in Mexico were hit by severe attacks of wheat rust (Perkins, 1997:111-112).

Next to geopolitical motives, the U.S. government had an interest in Mexico’s rich diversity of genetic information. The MAP, and later CIMMYT, formed a perfect institutional base for the collection of genetic information of various crop plants, particularly maize. During the first years, the MAP, the Rockefeller Foundation and the USDA extensively collected landraces which were expected to be replaced by the new Green Revolution varieties. A Committee on the Preservation of Indigenous Strains of Maize was established, operating under the U.S. Agricultural Board of the National Academy of Sciences/National Research Council (NAS/NRC). The Committee cooperated with the Rockefeller Foundation and numerous Latin American governments and institutes (Brown, 1975:468; Dowswell, et al. 1996:58). In 1952, the Committee was joined by William Brown,
research director of Pioneer Hi-Bred (USA), the world’s largest maize breeding firm. According to a later vice-president for research of Pioneer, “Brown believed that for the future welfare of humanity, it was imperative to collect and preserve the fast-disappearing landraces and wild relatives.” Brown managed to get support within his own company to fund a special Latin American Maize Program (LAMP) which placed Pioneer at the centre of maize collection in Latin America (Cunningham, 1992:17-18).

Thus, the export of crop development technology from the USA to Mexico also set in motion a flow of genetic information in the reverse direction. This pattern would be repeated when in 1959 the Rockefeller and Ford Foundations and the USAID established the International Rice Research Institute (IRRI) in the Philippines (cf. Perlas and Vellvé, 1997:1-16). IRRI’s seedbank has grown to become one of the best equipped and managed in the world. The state-led integration of plant breeding research and conservation activities was typical of American crop development policy, and was also subsequently transplanted to CIMMYT and IRRI. The ‘model’ policy consisted of three ingredients: (a) advanced research on a limited number of high-caloric food crops (root crops, beans), (b) a strict division of labour between the participating research institutions, and (c) one overarching bureaucratic system through which information on research results and collections could be distributed. As will be discussed in the next section, the replication of this model formed the basis for a global network of IARCs financed by the OECD countries, the Rockefeller and Ford Foundations, and the World Bank. The free flow of seed that gradually emerged within the global network would eventually raise tensions within the FAO.

At this point we may conclude that the successful replication of the American crop development policy in the Third World gave a strong impetus to the involvement of the USDA and American philanthropic organizations in the Green Revolution. Geopolitical interests muted protests from conservative forces in the American agricultural establishment that feared a diminishment of their export markets in the Third World. A hidden but no less important benefit was the function of the new international research centres (CIMMYT, IRRI) as transfer points in the global exchange of landraces and wild relatives. The control over these centres offered the USA a strong position in the global exchange of seed, plants and plant material. The long-term access to these sources of genetic information was considered paramount for the future of the American agricultural sector.

**4.5.3 FAO and USA battle over global conservation**

During the late 1960s and early 1970s, two parallel global conservation systems were emerging. In Rome, the FAO Panel of Experts was in the midst of designing a global conservation system that would extend the activities of the Crop Production and Improvement Branch in the dissemination of new plant varieties in developing countries (see section 4.5.1). Simultaneously, the Rockefeller and Ford
Foundations and, most of all, the World Bank took an interest in extending the number of IARCs and associated seedbanks. This parallel development raised the question of who was to control global conservation. Both parties had different but strong reasons to take the lead. The FAO's mandate to create food security made conservation of landraces a logical start for more research on food crops. The two Foundations and the World Bank, however, were specifically interested in strengthening the Green Revolution in areas susceptible to communism. By locating IARCs precisely in these areas, political turmoil could be prevented. Also, the 'seed flow' between the IARC collections could be of use for the agro-industry in the USA and other industrialized countries.

The World Bank and the Foundations had little interest in funding agricultural research and a global conservation system through the FAO. Firstly, the USA, and particularly the USDA had a difficult relationship with the FAO (Talbot, 1990:43-45), because the developing countries, due to the one-country-one-vote system, could easily create a majority. The atmosphere became worse when, in the early 1970s, the Group of 77 developing countries started to call for a New International Economic Order (NIEO). Increasingly tense NIEO discussions on access to and benefit sharing of 'global commons' (deep sea, space, Antarctica) in the mid-1970s indicated that the Group of 77 would sooner or later question the hitherto common practice of the free exchange of seed and plant material between the IARCs (Pistorius, 1995a:209-211). Secondly, the World Bank and the foundations understood that the export of the American crop development policy to developing countries would become very complex if the associated conservation strategies did fall into the hands of the FAO. The FAO funded national governments to set up their own national agricultural research centres (NARS). NARS, however, were not automatically supporters of the American crop development policy or the Green Revolution. In a later comment, World Bank vice-president Warren Baum explicitly states that "considerable doubt was expressed within the Bank about whether [OECD] countries would rush to borrow in support of national agricultural research programmes [the NARS]" (Baum, 1986:35).

The World Bank and the foundations thus had considerable interest in keeping the issue of global conservation away from the FAO arena. This was not an easy task since the FAO, as a UN organization was a logical candidate to host a multilateral conservation system. Also, the FAO Crop Production and Improvement Branch had accumulated much experience in the exchange of seed among breeders of member countries. Moreover, the FAO Panel of Experts on Plant Exploitation and Introduction was well on its way to design a global conservation system.

Although the World Bank group favoured the FAO Panel's ambition to think in global terms, the proposed broad, 'generalist' conservation strategy did not fit the more 'crop specific' model of the IARCs. The specialization of the IARC on one or two major food crops (CIMMYT on maize and wheat, IRRI on rice) was more in line with the crop development policies of the USA and other industrialized countries. From this point of view, the generalist approach as proposed by the FAO Panel, would have resulted in much broader and diverse collections than was ne-
cessary to pursue the Green Revolution. The Panel’s idea to let each seedbank operate as an independent unit also failed to meet the World Bank’s preference for a centrally controlled conservation system (Fowler and Mooney, 1990:152).

Nevertheless, the Panel’s status as an FAO/UN expert group made it difficult to ignore their ideas. In 1972, the World Bank decided to invite the Panel to present its plans, in Beltsville (Maryland, USA). The outcome of this meeting would be decisive for the creation of the global conservation system. Because most Panel members had become sceptical about the FAO’s ability to finance their plans, they agreed to integrate their ideas with those of the World Bank and the foundations (Pistorius, 1997:55). The resulting cooperation between the FAO and the financially much stronger World Bank reduced the status of the Panel to an advisory team, and eventually erased the FAO as a leading actor in the creation of the global conservation system.

Soon after the Beltsville meeting, the World Bank, and the Rockefeller and Ford Foundations accelerated their efforts to set up a network of research institutes and seedbanks. An important role was played by Robert McNamara who, during the first years of his appointment as World Bank director, simultaneously ran the Ford Foundation. McNamara proposed to establish a “consortium” or “consultative group” of OECD donor countries, and large donor organizations: the Rockefeller and Ford Foundation, and the Inter-American Development Bank. The donors would meet periodically with agricultural experts from developing countries to develop policies for the consortium. The choice of a consortium, referred to as the Consultative Group on International Agricultural Research (CGIAR), served the World Bank’s ambition to play a more prominent role in agricultural research (Baum, 1986:35-38). Besides, it allowed Canada, Germany, the United Kingdom, Japan and France to become more involved in the hitherto U.S. dominated long-term international agricultural research infrastructure.

The CGIAR had won a battle but not the war over the global conservation system. Due to its status as a non-governmental organization, a formal relationship with the FAO in conservation was still required in order to have unhindered access to seed stocks in developing countries. At the cost of another diplomatic fight that lasted throughout 1973, a rather peculiar compromise between the World Bank and the FAO was struck. It was agreed that the CGIAR would create and finance a new conservation institute. This institute would function independently from the FAO but, nevertheless, be located at FAO headquarters in Rome. The institute, named the International Board for Plant Genetic Resources (IBPGR), was established in 1974 and was entirely dedicated to the international exchange of seed. Under supervision of the IBPGR, the CGIAR conservation system grew into a global exchange system of seed and plant material, and one of the main institutional pillars supporting the Green Revolution.21

As a scientific, autonomous and politically ‘neutral’ organization, IBPGR aimed at operating within the FAO bureaucracy, but beyond the political reach of FAO member countries. It was this shielded position, in combination with the
secure flow of finance from the World Bank/CGIAR headquarters, that allowed IBPGR to set up an international seed exchange network that went far beyond the CGIAR seedbanks. In 1984, only ten years after its establishment, the IBPGR network bound together about 40 national collections in 30 countries (FAO, 1985:2).

IBPGR, in spite of its modest financial resources, was soon able to play a primary role in the international exchange of seed and plant material. One of the main reasons was that IBPGR capitalized on existing national plant and seed stocks. Some of these collections dated back to colonial times, but most had been established shortly after the Second World War, to support the export-oriented agricultural policies of developing countries (Pistorius, 1997:1-3). Many of these collections suffered from neglect when national agricultural policies shifted away, either to bulk food production (wheat, rice), or to other export crops. IBPGR’s modest financial and technical aid (often not more than several tens of thousands of dollars), frequently rescued national collections. The resulting durable contacts allowed IBPGR to set up a very cheap, but nevertheless global system in which national collections were gradually linked to those of the CGIAR.

The other pillar supporting IBPGR’s key position in international conservation was its early development of crop descriptor lists to characterize germplasm accessions, some of them computerized, and the linkage of these lists with existing characterization methods used in OECD countries and CGIAR centres. The control over the design of these descriptor lists offered IBPGR the opportunity to design world-wide standard procedures for data collection and information exchange. Guidelines for the exchange of seed, plants and plant material, International Genebank Standards, and the development of more advanced conservation methods, all played a role in exchanging and conserving material around the world.

IBPGR’s role in global conservation would nevertheless remain vulnerable. The quasi-independent status of IBPGR - being hosted by the FAO in Rome, but financed and controlled by the CGIAR - started to attract criticism from the Group of 77 only a few years after its establishment. IBPGR’s staff knew that any political uproar over the exchange of seed and plant material would have severe repercussions for frequent users, particularly breeders in public and private institutes in industrialized countries and other CGIAR institutes. This explains IBPGR’s minimal interference with national agricultural politics in developing countries, as well as its self-declared political ‘neutrality’. Many developing countries accepted this policy as long as IBPGR and CGIAR policies indicated that the free exchange of seed would eventually contribute to food security. However, the status of the IBPGR vis-à-vis the FAO as a multilateral institution was one of the causes for the ‘PGR conflict’ in the early 1980s, which we describe in the first chapter of this book.

In our view, the global conservation system under guidance of the CGIAR is a true characteristic of the Second Agro-Food Order, despite the fact that the system has continued to function in the subsequent Agro-Food Order. An important reason is the main object of conservation. CGIAR’s collections mainly consist of landraces, which were the main source of germplasm for breeders using conventional breed-
ing techniques during the Second Agro-Food Order. As we show in chapter five, conventional breeding is no longer the typical tool for crop development in the Third Agro-Food Order. Rapidly evolving genetic engineering techniques instigate new conservation strategies in which landraces no longer play a key role.

Summary

The FAO was the first international organization to set quality standards for seed in developing countries in the 1950s. Seed quality standards were meant to establish controllable seed distribution systems to secure the distribution of uniform and high yielding varieties. Although the FAO was instrumental in setting the new standards, its impact on research and conservation in developing countries remained limited. Partly, this was related to the limited economic resources of the FAO, partly also to the fact that uniformity and high yields were not criteria set by the receiving farmers in developing countries.

A second and more important factor of the limited success of the FAO was that the USA put most energy into an alternative route. Rather than seeking to transplant crop development policies through multilateral aid programmes, the U.S. government established long-term bilateral agricultural programmes in countries that served American geopolitical interests most closely. The clear and pragmatic structure of the American conservation system, which was highly centralized, crop specific, and closely connected to crop development projects, allowed for a quick replication in developing countries. This asset, in combination with strong capital injections from the World Bank, the Rockefeller and Ford Foundations, created the basis of an international network of agricultural research stations under CGIAR. The establishment of the IBPGR as a ‘traffic agent’ for the ‘seed-flows’ within the CGIAR system completed the system.

Conclusions

In this chapter we have explained how, in advanced capitalist countries, the state grew out into the key organizer of crop development during the Second Agro-Food Order. The main goals for crop development were set by the strong governmental emphasis on productivity increase, while most governments actively promoted private investment in plant breeding. Apart from an intensification of seed market controls, which had begun in the First Agro-Food Order, the government initiatives in crop development concentrated on two areas:

Funding basic and pre-competitive breeding research

Governments in most advanced countries invested substantially in basic research, such as genetics, because this was beyond the financial reach of the generally small, family-owned breeding firms. Particularly the American private breeders have
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relied heavily on the parental lines developed by public institutes. Undoubtedly, the government support for breeding research greatly contributed to the tremendous yield increases of the main crops. A similar picture can be offered for conservation in the USA. The establishment of a large-scale and centrally organized conservation network could never have been carried out by the private breeding firms. The public investments prepared the area of crop development for private investment. In other words, public investment in breeding conservation helped to make plant breeding a more controllable industrial sector, attractive to private capital.

Reducing unauthorized propagation

Another way to promote private investment in crop development was the assistance offered to private breeders in reducing unauthorized propagation of their varieties. The hybrid varieties, which were developed with strong support from the USDA, effectively diminished this problem for plant breeders involved in various crops. For crops in which hybrid varieties were not developed the system of plant breeders' rights (PBR) was created by governments in Western Europe. PBR legislation offered a legal means to reduce unauthorized propagation for a broader range of crops, but was less effective than hybridization and prone to political decision making.

In an effort to eradicate hunger and prevent communist influence in the newly independent countries, the state-led crop development policy was expanded to the Third World, on the initiative of the U.S. government and the FAO. Seed market regulation, as it had evolved in Europe and the USA since the end of the 19th century, was introduced in developing countries, and so was the policy of public investment in breeding research and in conservation. The diffusion of hybrid varieties sufficed as protection against unauthorized propagation in developing countries during the Second Agro-Food Order. Domestic private investment in crop development was marginal if it existed at all, while the Third World was generally not an attractive market for private European and American breeders. Most foreign varieties that were sold involved hybrids.

The central role of the state in the organization of crop development during the Second Agro-Food Order was not a predetermined and uniform phenomenon. Governments in the various countries entered the area of agriculture and crop development because they were supported by their national political constituency. State interventions in crop development were generally shaped by political disputes. The main controversies in crop development during the Second Agro-Food Order were over the legal protection of plant varieties and on plant conservation.

While governmental support for creating hybrid varieties did not provoke major opposition, legal protection for plant varieties was controversial, particularly in Europe. Throughout the entire Agro-Food Order there was a tug-of-war between private plant breeders, the general industry sector, and agricultural authorities over the most appropriate legal way of helping private breeders to reduce unauthorized propagation of their varieties. The result was a compromise. Although PBR legislation provided far less protection than the breeders had envis-
aged, it was accepted, since the Western European and U.S. governmental authorities were not willing to offer more, while industry did not want patents for plants to affect 'its' patent system.

The second controversial area was conservation. In the USA plant conservation has traditionally been centrally organized by the state. In Western Europe, however, a tradition existed that breeders, private and public alike, maintained their own working collections. This decentralized, or rather fragmented, manner of plant conservation induced several attempts to organize conservation at a common, European level. These attempts came to nothing, however. Intra-European controversies, even among the members of the EEC who had established a Common Agricultural Policy, prevented working collections and seedbanks from being organized more centrally. The lack of political support for a central conservation approach presumably results from the availability of landraces of most commercial crops in or near Europe.

Another controversy that influenced governmental intervention in conservation, this time at an international level, was the dispute over the control of the global conservation system. While developing countries favoured worldwide conservation through the FAO, this was not acceptable for the USDA and for some organizations related to the U.S. government, such as the World Bank, the CGIAR, and the major American philanthropic foundations. The global conservation system under guidance of the U.S. government not only served the exchange of seed and plant material among developing countries, but also between developing and industrialized countries.

Notes

1 Figures on public agricultural research expenditures in the main industrialized countries during the post-war period are hardly available. An authoritative research group in this area reports a "massive wave of public investment in science and technology research in general and agricultural research in particular" after the end of the Second World War. Only for a few countries is more specific data given. Between 1950 and 1970, in real terms public agricultural R&D expenditures increased at annual average growth rates of about 7 per cent in Australia, about 7.4 per cent in the United Kingdom, and about 2.8 per cent in the USA. For New Zealand and the Netherlands similar data are not available, but for these countries substantially increased public investments in agricultural R&D in the same period have also been reported (Alston et al., 1998:55).

2 It should be noted here that a calculation of the 'net' contribution of breeding work to yield increase (or "genetic contribution") is very difficult to assess because of the interplay between the new genetic constitution of a variety and other production factors. The yield increases can partly be attributed to the improved nitrogen uptake of plants.

3 In the 1950s American farm employment was reduced by 28 per cent in the 1950s and 37 per cent in the 1960s (Cochrane and Ryan, 1976:13). The reduction of farm employment in the initial six EEC countries in the 1960s was 38 per cent (Commission of the EEC, 1988).

4 The national plant variety catalogue (also referred to as Variety Register or Variety List) could vary from a simple registration merely of variety names, to a register that included judgements about the
variety’s value for cultivation and use, based on tests carried out by agricultural authorities.

5 Some years after its introduction in 1937, the Dutch breeders’ remuneration system received government support through the adoption of the ‘Breeder’s Decree of 1941’ (Board for the Plant Breeder’s Right, 1946). The Decree put the seed market under strict governmental control, but this was unrelated to the fact that at that time the country was occupied and ruled by the German Nazi regime (Addens, 1952:185-187).

6 In 1948, seed firms from 13 countries participated in ASSINSEL: Belgium, Czechoslovakia, Denmark, France, the Netherlands and Sweden. Representatives from Austria, Great Britain, Hungary, Italy, Luxembourg, Spain and the United States had an observer status (ASSINSEL, 1948).

7 The German seed industry began to participate in ASSINSEL in 1950 (ASSINSEL, 1950:4).

8 While explaining the working of the Dutch breeders’ right system during the 1950 ASSINSEL Council meeting, a representative of the Dutch horticultural industry, Mr. Ruys, argued that the Dutch law “is only adapted to the interior, Dutch regulations; it is a state-organism which functions in a very rigorous way.” (ASSINSEL, 1949b:10).

9 The Danish, French and Italian lawyers preferred patent protection for plant varieties. The groups of Luxembourg, the Netherlands, Switzerland and the United Kingdom advocated a specific protection system for plant varieties. The German group was in favour of a mixed system: patents for major breakthroughs in plant breeding and special protection for “ordinary” new varieties (Heitz, 1987:78).

10 Art. 2.: “The Contracting States shall not be bound to provide for the grant of patents in respect of... plant or animal varieties or essentially biological processes for the production of plants and animals; this provision does not apply to micro-biological processes and the products thereof.” (italics added).

11 Article 52. “European patents shall not be granted in respect of: ... (b) plant or animal varieties or essentially biological processes for the production of plants and animals; this provision does not apply to microbiological processes or the products thereof.” (italics added).

12 From the historical review of the conference presented by Heitz (1987:82-84) it can be concluded that 13 of the 16 persons who “may be considered the founders of the UPOV Convention” represented a national Department of Agriculture or an agricultural research institute.

13 The concern by the U.S. seed industry was well expressed by John Carew, of the Department of Horticulture at Michigan State University, who noted in 1964: “Many commercial seed firms see a need for some form of breeder protection. But an overwhelming majority strongly oppose compulsory registration, particularly the idea of any group of men, government or industry appointed, making arbitrary decisions on the distinctness, homogeneity, or stability of any variety” (Carew, 1964:38).

14 Plant Breeders’ Rights (PBR) protection seems to be European wording of what in the USA usually is called Plant Variety Protection (PVP) rights. As both terms have essentially the same meaning they will be used interchangeably in this publication.

15 Doyle (1985:63-65) and Fowler (1994:115-118) describe in great detail the struggle about PVP that broke out among the various departments involved in the White House review process only a few days before the President had to act on the bill. The Bureau of the Budget and the President’s special assistant for consumer affairs advised the President to veto the bill because of concern for increased market power of seed producers, and the lack of evidence that PVP would stimulate plant breeding. Due to a not entirely open political lobby, the recommendation to veto was reversed at the very last minute.

16 The growing technical opportunities for industrial processing of crops after the Second World War induced plant breeders and seedbank curators to refer to landraces and wild relatives as “germplasm resources” or “germplasm” (cf. Hodgson, 1961). The term “germplasm” is confusing, however. It is commonly used in biological science, but the term has never been defined properly. The term basically refers to the physical basis of heredity, such as chromosomes and genes, cytoplasm and protoplasm. (cf. Witt, 1985:7-11; Somani, 1992:81).
The need for the establishment of temperate seed collections in Europe was already clearly voiced during the 1936 International Congress of Plant breeders, where chairman C. Broekema from the Netherlands remarked: "There should be in every country extensive living collections of varieties at the disposal of breeders.... This point is urgent since Russian expeditions have discovered rich centres of diversity in remote parts of the world, and everybody is doing his best to gather some of the genotypes from these centres.... An international list could be made, mentioning not only the varieties used in praxis, but also describing interesting biotypes ...." (Broekema quoted in Sirks, 1936:42)

Point-Four refers to the fourth issue of Truman's inaugural speech of 1949, which stressed the need for development aid for developing countries.

Information derived from a personal communication with D.N. Duvick, former vice-president of research, Pioneer Hi-Bred, August 1998. According to Duvick, Brown's initiatives in collecting maize landraces went far beyond the corporate interests of Pioneer Hi-Bred. Initially he attempted to get the American maize seed industry collectively to fund conservation facilities in Latin America to store maize landraces. The seed companies would not contribute. Nevertheless, Brown talked his company into donating the entire amount, and personally got the programme started. Once he left the management of the company, funds for the project were terminated.

After CIMMYT and IRRI four other centres were built: the International Center for Tropical Agriculture (CIAT) in Colombia in 1967, the International Institute of Tropical Agriculture (IITA) in Nigeria in 1968, the West Africa Rice Development Association (WARDA) in Ivory Coast in 1971, and the International Potato Center (CIP) in Peru in 1971. By the early 1990s, the total number of centres had risen to 16, spread over five continents.

Very likely, the conservation network of the COMECON countries, including the VIR or the French conservation system maintained by the French Office de la Recherche Scientifique et Technique d'Outre-Mer (ORSTOM) were, in terms of size, comparable with the CGIAR conservation system. The social-economic impact of these systems on crop development and agriculture in developing countries, however, was significantly smaller. COMECON's conservation system mainly serviced countries in the communist sphere of influence, while the collections of ORSTOM were (and still are) geared to consolidating the export of cash crops (notably fruit, coffee and tea) from former colonies (personal communication Ph. Auriau, INRA, 1997).

Particularly Colombia's national collection of native potatoes, grasses, pasture and legumes, Costa Rica's collection of cocoa, and India's collection of pulses, crucifers, grasses and forage legumes had a very high international reputation in the 1950s and 1960s (Pistorius, 1997:2).