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

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Chapter 2

The First Agro-Food Order (1870s-1930s)
Crop Development to Improve Agricultural Competitiveness

This chapter discusses plant conservation policies and the legal protection of plants in the period between 1870 and 1930, to which we refer as the First Agro-Food Order. This period is characterized by a specific international division of labour in agriculture, consisting of the traditional colonial trade, complemented by a cereal trade flow from the settler states and Russia to Europe. The international division of labour gave rise to new forms of social regulation in agriculture. The competitive prices for which the American cereals were offered in Europe revealed the dissimilarity of production capacity among different countries. Farmers, landed aristocracy, and industry in most countries needed intervention by the government, particularly during periods of overproduction. In most core capitalist countries, Ministries of Agriculture were founded to organize agricultural production and crop development, with the objective of improving national competitiveness.

The ministries began to encourage plant breeding efforts and the conservation of seed in order to speed up the improvement of temperate crop varieties. The intensity of the support differed widely per country. The U.S. government, for example, undertook systematic efforts to collect foreign plant material, and was directly involved in plant breeding, while in various European countries, such as Great Britain and the Netherlands, the government was less dynamic. These countries still trusted on the competitiveness of their colonial empire, and until well into the 20th century most public research continued to focus on tropical agriculture.

The changes in the organization of agriculture also raised legal questions. Private investment in crop development gave rise to private seed producers and seed distributors. The private plant-breeding firm also became a new economic and political actor that had to be reckoned with. Plant breeders suffered from the unauthorized exploitation of the new varieties they released. By comparing themselves with inventors, the new professionals demanded that the state grant patent protection on their plant varieties.

The conservation and plant patent issues are dealt with in the sections 2.2 and
2.3. We begin this chapter, however, with a discussion of the regulation of the seed market, one of the first progressive interventions of governments in Europe and the USA to facilitate the industrialization of crop development.

2.1 Agricultural competitiveness as a new political issue

The First Agro-food Order is characterized by a major change in the international division of labour in agriculture. Towards the end of the 19th century, the newly independent settler colonies, particularly the USA and Russia, began to export bulk quantities of cereals to the European metropolises (Figure 2.1). These cereal exports initiated a pattern of agricultural trade that was fundamentally different from colonial trade.

The 'vertical trade' within the colonial empires was managed in the European metropolises and based on a complementarity of products that resulted from differences in climate and social organization. During the late 19th century, the metropolises imported tropical products from colonial plantations. Rubber, sisal, jute, indigo, and cotton were the raw materials in an emerging agricultural processing industry, while oils, tea, coffee and sugar were imported as luxury products for mass consumption by the growing industrial labour force. Production in the colonies, however, could not yield sufficient grain to feed the urban masses in the metropolises, and neither could the surrounding rural population in the metropolises, at least not at the price of the settler states. The settler states, with the USA in the lead, would become Western Europe's main grain suppliers (Friedmann and McMichael, 1989:97). This transatlantic trade flow implied that a new international market of temperate agro-food products was complementing the traditional colonial trade.

The emergence of a world market in temperate agricultural products through the cheap cereal exports to Europe revealed the competitiveness of American agriculture. The strong U.S. position was primarily due to the specific way in which American agriculture was industrializing. Land was readily available in the USA, but labour was not. Replacement of human and animal labour by mechanical devices was therefore the focal point of capital investment. This mechanization altered the organization of agriculture by reducing absolute labour requirements (especially for harvesting) and generated impressive gains in on-farm labour productivity. In Europe, mechanical equipment was adopted at a far lower pace due to the abundant labour supply, the small size of the farms (preventing the successful application of machinery) and the lack of credit facilities in rural areas. The development of commercial and capital-intensive agriculture in Europe would not depend on mechanical equipment, but on techniques allowing for a more efficient use of existing land (Goodman et al., 1987:24).
The import of cheap cereals induced a deep agricultural crisis around 1870, which affected all European metropolises, prompting them to intervene in the agricultural sector. In those countries where landed aristocracy and farmers could generate enough political strength vis-à-vis industrial interest groups, such as in France, Germany and Italy, the government erected tariff walls for the protection of its national producers (Gourevitch, 1986). More progressive measures to improve the national competitiveness in food production were also considered, and led to the design of crop development policies for temperate agriculture in most European countries.

The first step taken in Europe involved the regulation of seed supply. An increase in the demand of seed in the 19th century had created a powerful stimulus for farmers, traders and governmental institutions to become involved in plant selection, introduction, and conservation, as well as the production and distribution of seed. The result was a wide diversity of plant varieties in the farmers’ fields: old landraces, newer regional farmer selections, new selections that were released by specialized private enterprises, and varieties bred by scientists at public research institutes. Foreign seed enlarged the plant diversity as soon as improvements in transport and communication systems enabled commercial seed to be traded inter-regionally and internationally.

This situation, which was referred to in Europe as ‘varietal jumble’ facilitated fraud and swindle. Inferior seed was misleadingly offered under the name of a reputable variety and high quality seed could be mixed with worthless weed seed. Fraud in seed sales could be rewarding because the quality of the seed was assessed only months after the purchase, by which time it was too late. Farmers used to rely on the reputation of “the man behind the seed” (NTZ, 1992:42), but the growing number of varieties and seed sellers at the end of the 19th century made this rule obsolete.

The uncontrolled seed market did not only upset farmers and landed aristocracy: it was also resented by breeders and seed production firms who were trying to establish a business. Reliable seed is the basis for a competitive agricultural sector. However, the chaotic situation in seed supply at the end of the 19th century hampered the rise in agricultural production that was required to feed the expanding...
The First Agro-Food Order (1870s-1930s)

urban industrial labour force, and to meet foreign competition. This was the reason that in the major European countries a political majority accepted governmental control of the seed market. The basis for seed regulation was laid in the 1870s, when governmental seed testing stations emerged in most West European countries (Addens, 1952:52). In the early 20th century, they extended their involvement in agriculture to seed certification, which gave farmers a guarantee about some essential qualities of the seed they purchased.

Far more than European governments, the U.S. government had traditionally played a pivotal role in plant introduction and seed distribution. Like other settler states, the USA was poor in native genetic resources. The seeds that European settlers had brought with them performed poorly in the new country.

"[T]he wheat and small grains that were intended to grow in America failed so miserably that, except for their discovery of Indian corn, everyone would have starved." (Crabb, 1947:7).

Thus the introduction of new plants from all over the world and seed supply within the USA had been a political priority for a long time. In order to speed up the distribution of seed, the Agricultural Division of the U.S. Patent Office set up a 'free seed' programme as early as 1839. Through this programme American farmers were stimulated to grow a large variety of plant material and to report back the results. In 1897, over 1.1 billion seed packages had been freely distributed by the state (Busch et al., 1995:76; Kloppenburg, 1988a:60-63). The free seed distribution, however, was direct competition for the commercial seed trade of the private seed firms that had entered the market. The private industry was increasingly concerned with the state's involvement in seed supply. In 1883, the seed industry founded the American Seed Trade Association (ASTA) and set itself the task of eliminating free seed distribution and amending seed legislation so that it would facilitate private capital investment in crop development. The free seed programme was terminated in 1924 (Kloppenburg, 1988a:73).

2.2 Using Mendel in improving agricultural competitiveness

The emergence of an international market for temperate agricultural products was closely related to the rapidly increasing demand for food for the labour forces in urban areas. In particular, grains and other staple-crops (such as potatoes) were required because they formed the basis of the traditional diet, were relatively high in protein, and were easily storable and transportable. European countries could meet the growing urban demand with grain imports, but these also made them increasingly dependent on world market prices. The USA on the other hand had become too dependent on wheat exports, as it first experienced during the wheat crisis in the 1880s.
It was against this background that crop development became a national priority, particularly in the USA. State involvement in crop development induced biological research and enabled the rediscovery of the findings of Gregor Mendel which eventually formed the basis for a new paradigm in biology: 'Mendelian genetics'. The new insights into heredity would lead to a change in research criteria in crop development research that eventually proved to be of great importance for the international competitiveness of the USA. During the heydays of the colonial powers, crops were improved by selecting and propagating individual plants that had a better overall performance. This strategy required the continuous collection of individual plants in various places of the world, a strategy which is known as 'botanical exchange'. The benefit of Mendelian genetics was that it enabled the targeted transfer of specific characteristics from the one plant to another through crossing. With the change in research strategy, the focus of plant collection shifted accordingly, from whole plants to plant characteristics.

The speed and intensity with which these changes occurred differed per country, however. There was a notable difference between the USA, on the one hand, and the European colonial powers, on the other. The U.S. plant introductions immediately served American competitiveness in temperate agriculture, whereas the plant improvement activities in the European metropolises remained predominantly focused on the competitiveness of tropical agriculture in their colonial territories.

2.2.1 The end of the botanical chess game

For centuries, plant collection and introduction of new plants predominantly took place within and among the colonial territories. A key role in this collection and shipping of plants was played by botanical gardens, of which the Royal Kew Gardens in London is perhaps the best known. The Kew Gardens were established in 1841 and formed the centre of a virtually global network. In 1889, the number of 'satellite gardens' attached to Kew was no less than 56, spread over South and Central America, West Africa and East Asia as well as the settler states. The gardens contained hundreds of thousands of (potentially) useful plant varieties of new tropical plantation crops.

Plants were transferred within botanical networks for two reasons. In the first place, throughout the 19th century, plant improvement in the colonies mainly involved the selection of individual plants on the basis of visible characteristics (Sneep et al., 1979:191,204). The resulting 'new' varieties were propagated in infinite numbers. The combination of selection and propagation was agronomically and economically precarious, however. Plantations were filled with the direct descendants of very few crop plants which, because of the limited genetic variation, were highly susceptible to pests and diseases. Hence, a constant exchange of plant material within colonial botanical networks was necessary to reduce susceptibility to local pests and diseases. If the material required could not be found within the network, adventurous voyages to rival colonies or non-colonial territories
were required. In addition, the risk of infection by pests and diseases required the botanical network to organize transfers of plant material to remote geographical areas where they were not endemic and where natural enemies were absent.

The other main reason for plant transfers was related to the immobility of labour force. In spite of the slave trade, labour was not always located in the countries where plants with economic potential originated. Only in a few exceptional cases, both the enslaved or indentured labour force and the plants could be shipped to new areas, e.g. in the case of sugar production in Cuba. Promising plant material was thus constantly and systematically shipped from one garden to another, a practice Lucile Brockway has coined the "botanical chess game". Brockway (1979; 1988) has extensively described how Kew officials searched for or stole useful plants, particularly in Latin America, and how they selected the best plants and transferred them to Asia. The Kew botanical garden thus played a central role in extending the plantation system to Asia. By the mid-19th century, Kew had perfected its taxonomic knowledge with the help of botanists, such as Charles Darwin. Other colonial powers had institutes equivalent to Kew Gardens. France had the Muséum National d'Histoire Naturelle, Germany the Botanische Zentralstelle für die Deutschen Kolonien, the Netherlands the Botanische Tuin van Leiden, Spain the Jardín Botánico del Soto de Migas Calientes, and Sweden the Linnaeus garden.

As access to good plant material was essential for plantation economies in the colonies, rival colonizers, predominantly the Dutch, Spanish, Portuguese, and French, were eager to get hold of each other's material. The quest for good plant material could have a profound impact on the inter-colonial competition, as is shown in the often-quoted case of the 'rubber coup'. Access to rubber became of vital importance in the late 19th century, because of the emergence of motorized vehicles in Western Europe and the USA. After several unsuccessful attempts, Kew officials in 1876, managed to smuggle 70,000 rubber seed out of Brazil, at that time the world's largest rubber exporter. The seed was transported via the Kew Gardens network to Malaysia, where they became the basis of a newly established rubber industry that challenged the traditional producer. By 1919, the Brazilian rubber industry was virtually dead (Brockway, 1979:141-165; De Souza Silva, 1989:213-222).

The example of rubber illustrates the profound impact that individual plants and related botanical knowledge had on the colonial division of labour. The success of plant transfers could make or break plantation economies. Botanical exchange and military power were closely related. The export of plant material was often forbidden and controlled by military means. Botanical knowledge could also support military interests. In 1820, it was discovered that alkaloids isolated from the bark of the Cinchona tree, called 'quinine', could help to cure and prevent malaria. Malaria was one of the most devastating diseases among troops stationed in tropical regions, particularly West Africa and India. The growing of Cinchona was able to start in India after Kew officers had smuggled seeds out of the Andes region (mainly Peru and Bolivia). A British monopoly was not to emerge, however. The Dutch on Java managed to obtain Cinchona seeds from an English trader. On the
basis of these seeds, the Dutch managed to establish a monopoly on quinine by 1890, forcing many planters in India and Ceylon to turn to coffee and tea (Brockway, 1988:55-57).

2.2.2 The discovery of the gene

Ever since men started to plant and harvest crops, plant characteristics have been adapted to serve specific aims. By continued selection of promising individual plants generation after generation, better varieties were developed. By experience it was known that selecting for visible characteristics (such as size or colour) was ‘easier’ than invisible features (such as resistance to pests and diseases). Similarly, plant developers knew that improving self-pollinating plants had a more predictable outcome than cross-pollinated plants, because the latter were liable to be polluted by unwanted characteristics transferred from other plants. In the 19th century, experts in ‘economic botany’ were the main actors in crop development in the colonies. Trained in the metropolises, they spent most of their time in the colonies selecting and ‘discovering’ new species and varieties.

Although at the end of the 19th century, selection of plants had become less an art and more a profession, plants remained ‘black boxes’ as far as inheritance was concerned. Biologists in Western Europe, equipped with increasingly advanced microscopes, had been able to understand how cells and their nuclei divided and reproduced. As early as 1883 it was understood that the mechanism of inheritance was to be found in a ‘hereditary substance’ called “germ plasm” located in the nucleus of a cell (cf. Stubbe, 1971; Mayr, 1982:679). At about the same time it was understood that minute threads, called “chromosomes”, contained this hereditary substance. But the big question, especially for agriculture, remained how the process of inheritance precisely worked. Breeders knew that the answer to this question would allow for a targeted transgression of both visible and invisible characteristics (such as disease resistance) from one plant to another.

In the context of his evolutionary theory, Charles Darwin had been puzzled by the mystery of inheritance almost all his life. In 1868 he concluded that two types existed: “soft-” and “hard inheritance”. Soft inheritance supported the idea that plants could, and eventually would “acquire external characters”. In this idea, climate, nutrition, or other environmental factors could change the genetic constitution of a plant. The theory of hard inheritance, suggested the opposite: the genetic make-up of a plant would not, or would hardly, be affected by its environment. The theory was based on the premise that plant characteristics constituted a “fixed set of factors”, but that environmental factors could change the expression of these characteristics (Mayr, 1982:687).

With the publication of Factors of Inheritance in 1866, Mendel was the first to discover the mechanism of hard inheritance. It was, nevertheless, only in 1900 that his theory was fully appreciated. In that year, Hugo de Vries (the Netherlands), Erich von Tschermak (Austria), and Carl Correns (Germany) carried out experi-
ments very similar to Mendel’s, and while their “work was well under way” they simultaneously became acquainted with Mendel’s paper of 1866 (Stubbe, 1971:265). The re-discovery of Mendel’s laws caused a revolution in biology. Between 1900 and 1910 an international scientific ‘gold rush’ took place in which scientists in virtually all West European countries, the USA and Russia searched for a theory which would connect the phenomenon of chromosomal division to Mendel’s laws of inheritance.

The British scientist R.H. Biffen, in his paper Mendel’s Laws of Inheritance in Wheat Breeding of 1906, was the first to apply Mendel’s work to crop development (Robinson, 1996:16). Biffin’s discovery was truly seminal as it not only showed that resistance to a described disease was inherited in a Mendelian fashion, but also that this process was controlled by individual “factors of inheritance” carried on a chromosome. In 1909 these factors were coined ‘genes’. This discovery gave plant breeders a very precise selection criterion for plant improvement. The discovery of the gene is generally regarded as the starting point of modern genetics and even of modern scientific breeding. Subsequent progress in genetics was made at a different pace in different countries. Great Britain, without any question, assumed leadership in Mendelian genetics in the 1910s and 1920s, soon to be followed, and eventually overtaken, by the USA (Mayr, 1982:731-734).

Mendelian genetics offered new opportunities for plant development. Rather than laborious selection work on the basis of trial and error, the development of new plant varieties became a scientific activity with a more predictable outcome. ‘Scientific breeding’ can be considered as a breeding method in which individual plant characteristics can be identified and selectively transferred by crossing two plants. The basis of this practice was laid in 1909 by a Danish scientist, W.L. Johannsen, who developed ‘pure lines’ of self-pollinating crops. The economic significance of pure line breeding was tremendous. While Mendelian breeding allowed for a controlled mixing of genetic characteristics, pure line breeding offered a practical method to ‘fix’ them in succeeding generations.

The opportunities for more effective plant breeding, offered by Mendel’s laws, required a plant and seed introduction system that differed from the botanical exchange system. Plant material that would have been of value for selection in the colonial period could, according to the new genetic criteria, be ignored. Rather than collecting individual plants that were selected for their overall performance, the collector’s task was to supply breeders with a useful ‘genepool’, a group of genetically related plants that carried various characteristics, some of which may be useful for and transferable by breeders. The application of Mendelian genetics on plant improvement induced “gene hunting” (Juma, 1989) and implied a tremendous expansion of plant collection activities.

The search for genes relied on an even more sophisticated apparatus than the botanical network. Exchange of plants and seeds containing potentially useful germplasm among breeders became much easier, because professional breeders emerged with a comparable scientific background in Mendelian genetics, who
started to communicate outside the traditional colonial institutional settings. Furthermore, in contrast to the importance of individual plants in the botanical system, the exchange of seeds and plant material containing specific known genetic characteristics was less of a threat for agricultural production. Where single plants could make or break an entire tropical plantation economy, genes rather became one of the inputs of crop development. Hence, seed and plant material with agronomically useful 'germplasm', the physical expression of chromosomes and genes, started to circulate among international scientific communities that were less constrained by political barriers.

Below we explore how the European metropolises, their colonies and settler states attempted to benefit from modern genetics by adjusting and implementing research and conservation policies. Although they were implemented practically everywhere, the impact on food production as a whole differed substantially. As we will show, the USA was far more successful in integrating modern genetics into their research and conservation policies than the European metropolises.

2.2.3 Public research system increases U.S. competitiveness in agriculture

After the 1870s, large-scale and mechanized production, and the widespread distribution of improved plant varieties, allowed the USA to become the world's largest wheat producer and exporter (Figure 2.1). The role of the U.S. government had been instrumental in achieving this leading position. As one of the first countries, the USA, in 1863, established a Department of Agriculture (the USDA). A little later, the State Agricultural Experiment Stations (SAES) were founded. They were complemented by the so-called Land-Grant Universities (LGUs), which taught modern genetics to agricultural scientists (Busch et al., 1995:79). In 1878 the USDA was spending a third of its budget on the collection and distribution of plant material (Kloppenburg, 1988a:60).

Considering these vast investments in agricultural research, the question rises why it took four decades before Mendel’s publications were appreciated by agronomists. Mayr's (1982:722-726) explanation is that Mendel was so far ahead of his time, that other biologists were simply not able to understand the relevance of his findings. We propose an additional explanation that attributes the 're-discovery' of Mendel to the changing international division of labour in agricultural production. Mendel's laws were re-discovered in Europe at a time that colonial tropical agriculture was still unrivalled. This allowed European scientific circles, particularly at Cambridge University in Great Britain, to treat Mendel's laws as 'pure science' and difficult to apply. In the USA, however, there was an explicit need to employ the new insights to crop development. American farmers were just recovering from the wheat crisis. It was therefore the USDA, and not a European agricultural research centre, which first attempted to apply Mendelian principles in order to strengthen national agricultural production. Soon news of Mendel’s work and the experiments and controversies it prompted was available to experiment-stations in every

The re-discovery and application of Mendel’s laws put U.S. agricultural research and seed collection in a higher gear. The main impetus came from the government around 1900 when a new special USDA unit, the Office of Foreign Seed and Plant Introduction, was created. In the following twenty years, four Federal Plant Introduction Stations were built, which would store the hundreds of thousands of plants and seeds that were collected in the subsequent century (Hyland, 1961:471,478-479). The stations still perform a key role in U.S. collection and conservation.

Sustained support for public agricultural research came not only from the government. The country’s most important industrial capital groups, such as the railroad companies and banks, also had an interest in expanding public agricultural research.

"[A] deteriorating agricultural trade balance raised fears as to the capacity of the United States to sustain its position in international trade. The Country Life Movement is probably the most widely known and studied response to what was perceived as a problem of national significance. Organized around prominent agricultural scientists such as Cornell’s Liberty Hyde Bailey and Gifford Pinchot of the USDA, the movement was funded and supported by urban-based interests and industries that depended on the flow of agricultural commodities for their revenues. What these groups shared was an interest in rationalization of agriculture through science. If the agricultural scientists were motivated by a vision of a transformed and improved rural society, the business interests were unambiguously interested in restoring productivity advance as a necessary condition for their own continued capital accumulation.” (Kloppenburg, 1988a:74)

Despite the institutionalization of a federal agricultural research and extension system, it took some decades before the knowledge of Mendelian genetics could generate large improvements in disease resistance. Research remained focused on selecting plants for yield and adaptation (Hyland, 1961:472). It was only in the 1930s, during the advent of the Second Agro-Food Order, that experiments in scientific breeding began to be translated into significant increases in productivity, especially in maize.

2.2.4 Changing interests in Europe: from tropical to temperate agriculture

The European metropolises had great difficulties in competing with the cheap American grain. They constituted the political and economic heart of colonial powers and were preoccupied with the competitiveness of their tropical agriculture in view of inter-colonial rivalry. International competition in temperate agricultural
production in the home countries was a new phenomenon for which a response was not immediately found. Research efforts in temperate agriculture remained limited in comparison to that in the tropical territories. Numerous experiment stations were established after 1850 to sustain the production in the colonies of export crops such as sugar, tobacco, coffee, tea, spices and fruits. Of the French empire’s 115 experiment stations, only 40 were located in France itself in 1930. At that time, the British empire had 450 experiment stations, of which only 30 were located in the home country (Busch and Sachs, 1981:134-135). These stations replaced the botanical gardens as central actors in tropical plant improvement. Production of staple crops in the colonies to supply the urban labour in the metropolises hardly occurred, as no colony was able to compete with the cheap grain production of the settler states. The British considered an increase in wheat production in India only after the opening of the Suez canal in 1869, which allowed Indian wheat to be marketed in Europe at competitive prices (Figure 2.1) (Busch and Sachs, 1981:136).

While most of the tropical research stations were state-funded, the sugar stations in Java, part of the Dutch East Indies, were in private hands. The crisis in the sugar industry and the subsequent sereh disease in 1883 instigated the Dutch sugar planters to invest in research in order to protect their market share. They built three experiment stations which would merge into the Java Sugar Industry Experimental Station (KAW, 1923:13-14). In the mid-1920s, this private sugar station was the largest of its kind in the world, with an annual budget of US$ 500,000 (Busch and Sachs, 1981:138).

Even though the new, tropical experiment stations were concentrating on a single crop and were staffed by botanists, Mendelian genetics was hardly applied. The stations continued to rely on ‘economic botany’, i.e. crop development through selections of introduced plants on the basis of taxonomic and botanical knowledge (Busch and Lacy, 1981; KAW, 1923; Masefield, 1972). Real applications of pure line breeding were not available in the tropics until the late 1920s. As a consequence, the need for a change of plant collecting strategies remained absent.

In none of the West European countries was the new knowledge employed to increase competitiveness in temperate agriculture. This is surprising since modern genetics originated in Europe and was also first applied to wheat, a temperate crop. The reason for the incompatibility of developments in Mendelian genetics and crop development, at least in comparison to the USA, may be sought in the attitude of the European governments, which remained relatively aloof in respect of agricultural research.

In France, “not much happened until the 1930s” in terms of studies on genetics (Mayr, 1982:732). In the late 19th century the annual agricultural research budget in the USA was already 20 times that of France (Paul, 1985), despite the fact that promising developments in French plant improvement research had occurred in the mid-19th century. For example, the Vilmorin brothers had developed an at that time revolutionary breeding method which replaced the traditional more imprecise mass selection technique with that of “family selection” (Sneep et al., 1979:204).
The First Agro-Food Order (1870s-1930s)

In Great Britain, a Parliamentary decision in 1909 to revitalize and modernize agriculture had resulted in the foundation of four primal agricultural research institutions (Palladino, 1996:118-119). Two of these institutions were later headed by W. Bateson and R.H. Biffen, leaders in the new field of genetics. But in spite of the early theoretical insights and the research capacity available, Great Britain could in no way measure up to agricultural research in the USA. Since there was little agreement among governmental, private and academic circles about the importance of the Mendelian breeding for plant breeding, no real plan existed that linked agricultural research to agricultural production. The research stations operated more or less on their own, both financially and intellectually. In the period 1920-1929, only 40 per cent of the funds for plant breeding research came from public sources (Palladino, 1996:124). As far as practical usage of Mendelian insights was concerned, breeding work focused on quality improvement. In 1916, Biffen managed to produce a 'hard wheat' variety that could compete with wheat varieties imported from North America. Biffen's wheat, however, could not curb the transatlantic wheat flow. At the University of Reading, where agricultural science was traditionally put more at the direct service of agricultural production, Mendelian genetics was dismissed as a useful basis for plant breeding (Palladino, 1993:312,319). The first British state-funded breeding research project would occur only after the Second World War (Thirtle et al., 1997:24,37).

In the Netherlands, most crop development activities have been carried out by private seed producing family firms and farmer-breeders. Renowned are the achievements of farmer G. Veenhuizen, who developed numerous new potato varieties (Addens, 1952:93,100). Public money for agricultural research became available in 1912 when the national Plant Breeding Institute (IVL) was established in Wageningen. The IVL was added to an existing network of provincial experiment stations. In contrast to most other Western European countries, the Dutch public research centres merely enforced existing private breeding activities rather than forming an alternative to them. The IVL predominantly monitored existing cultivars, most of which had been produced by private breeders (Addens, 1952:93-95). The Dutch government's limited involvement in agricultural research was directly related to a traditional non-interventionist policy in agriculture in the Netherlands itself. The IVL was financed by the Directorate of Agriculture, which was part of the Ministry of Water Management, Manufacturing and Trade. A genuine Ministry of Agriculture was founded only in 1935.

Germany held a somewhat exceptional position in Europe. The country was the forerunner in the agricultural experiment station movement during the second half of the 19th century. In 1900, 75 stations were operational in Germany and in its African colonies (Busch and Sachs, 1981:134). Governmental support for crop development was expanded after the First World War. The Germans had suffered seriously from the food blockades during the War and urgently required quality seed. In order to become more self-supporting in food, the Research Institute for Plant Improvement was founded in 1917, while a handful of regional seed research facilities were built to improve seed supply. In the 1920s, at least five
important botanical expeditions were made to Turkey, Spain and South America for the collection of species of wheat, maize, and various other temperate crops (Flitner, 1995:41,49,278). In spite of these investments, German research in the early 20th century continued to work in the tradition of the 1880s (Mayr, 1982:732) with a strong emphasis on (advanced) selection methods. In 1914, Erwin Baur, Germany’s most prominent geneticist, would still conclude that “it will take years of intensive labour before also practical plant breeders can start working on a large scale” (translation RP/JvW) (Flitner, 1995:41). Public spending on agricultural research and modern genetics would expand only in the 1930s (see section 3.3).

Thus, governmental interest in agricultural research in Europe was relatively weak compared to the USA. Mendelian genetics was hardly related to crop development, and consequently plant-collecting activities hardly changed until the 1930s. The main task the governments assumed was that of testing foreign plants and seeds. Throughout the 19th century, the introduction of new plants in Europe, however, remained an arbitrary activity of often large farmers with foreign connections. The exception was Germany, whose government was heading for food autarky. German collection activities were resumed on a large scale as soon as the First World War had ended.

Summary

During the First Agro-Food Order, a shift took place from intra-colonial trade based on the complementarity of products resulting from different climates, to international trade among core capitalist countries in temperate zones. Concern for national competitiveness instigated states to become involved in crop development. This formed a major prerequisite for the re-discovery in 1900 of several insights into the heredity mechanism of living organisms. The ‘promise of Mendel’ was that breeding based on genetic principles could enhance the production potential of temperate crops in the core industrial countries.

Between 1900 and the 1930s, Mendel’s laws were gradually worked out within academic circles on both sides of the ocean. The USA would be the first to employ genetics for the rationalization of its crop development policies and infrastructure. Incentives came both from the U.S. government and from industrial organizations. While the government’s direct intention was to stimulate diversification in order to curb overproduction in wheat, the industry saw opportunities in increasing food processing and transport. In Europe, crop development did not receive such firm public or private backup. The European metropolises were still more directed towards the inter-colonial competition of tropical agriculture. During the First Agro-Food Order, they shifted their research focus to temperate agriculture, but did not keep the pace that was set in the USA.

The new breeding paradigm had a profound effect on conservation strategies both in Europe and the USA, but again the impact was different. Although the metropolises continued to rely on the intra-colonial exchange of tropical botanical
plant species, botanical exchange became less relevant for the new breeding paradigm. This relevance further decreased because the application of Mendelian breeding techniques on tropical crops, many of which are non-seed propagated, is much more complicated than with seed propagated plants. The metropolises long experience with botanical exchange could not guarantee a successful switch from botanical exchange to plant and seed introduction based on scientific criteria. Not so in the USA, where initiatives were taken to tie the new research strategies to conservation of temperate seed and plant material.

2.3 Are plant breeders inventors?

The industrial revolution had shown how important technological progress was for economic development. With the expansion of the world market it was also realized that the continuous generation of new techniques was essential for achieving international competitiveness. Thus, support of inventors became a priority for governments both in European and settler states in the 19th century. The major policy to nurture technological innovation was the introduction of patent law.

Today it is often thought that the protection of plant varieties was among the objectives of that patent system. As soon as farmers became breeders specializing in the development of new plant varieties, they had to cope with competition from farmers, seed producers and other breeders, who freely propagated a new variety and used or sold the seed. The commercial problems arising from this competition were comparable to those of inventors, composers and authors. The state did assist them in curbing the unauthorized reproduction of their work by granting patents and copyrights. The emerging crop development industry envisaged similar protection for their plant creations.

In this section it is shown that plant patenting occurred only at the very end of the First Agro-Food Order. There was protection for fruits and flowers, crops in which a strong private sector had emerged, but which had little to do with innovation and national agricultural competitiveness. Incomplete botanical knowledge and insufficient technical control over biological reproduction processes of plants not only hampered private investment in crop development of staple crops, but also plant patenting.

Below we deal with the legal protection of plant varieties during the First Agro-Food Order from three angles. First, we examine the waning mercantilist form of plant protection that was employed by the European colonial powers. Then we examine the political dimension of patent law, and the initial plant patent initiatives by private American and European plant breeders in temperate agriculture.
2.3.1 Colonial botanical monopolies

For a long time the colonial economies had been highly concerned with the protection of individual plants of crops on which the plantation agriculture was based. As indicated earlier in this chapter, all European colonial empires collected and stole botanical species even in the most remote parts of the world. But as far as their own plant stock was concerned, they sought the protection of the 'botanical monopoly'. This monopoly refers to a ban on the export of propagating plant material, enforced by the government. Even though widely used, the botanical monopoly proved to be an instrument of little effectiveness. Only in some cases it was successful during a short period. Spices and cacao plants had a relatively small and circumscribed natural habitat, and had not already been widely diffused when the Europeans came upon them (Brockway, 1979:57). Nevertheless, the botanical monopoly remained in use until the late 1920s.

To illustrate the attitude of plant breeders and authorities as regards plant protection in the European colonial territories, we will briefly examine the Dutch sugar cane industry in Java. As mentioned earlier, the Java Sugar Industry Experimental Station was the largest private sugar experiment station in the world in the mid-1920s, with an annual budget of half a million dollars. The private breeders raised the question of unauthorized diffusion of newly released sugar cane varieties in the Java industry in the early 20th century.

The sugar breeders tried to raise their income by controlling the unauthorized use of their new varieties within the colony through purchase agreements. These agreements prohibited purchasers from distributing propagating material of the new variety among third parties. They also established a mutual and remarkably 'progressive' remuneration system in 1924. Several registrations were filed under the system, but the quick expansion of the successful variety POJ 2878 was the reason that few other clones were used. Royalty payment to other breeders was therefore very modest (Van Harreveld, 1934:123,126-128).

The mutual remunerating system only served a local function among the Dutch plantations in Java. For protection beyond its own circle, the industry relied on governmental support. In order to curb the diffusion of modern varieties among the indigenous population of Java, the Dutch sugar interests were protected through a police ordinance which prohibited local communities from using modern cane varieties developed by the Dutch. The indigenous population was only allowed to grow and market their landraces (Van Harreveld, 1934:112).

Foreign diffusion of propagating material of sugar cane and tobacco was restricted through a self-imposed export ban for which governmental backup was demanded. After the Java sugar clone POJ 2878 had attracted the attention of rival colonial empires because it raised annual sugar production in Java by 24 per cent, the Dutch authorities started to think of methods to prevent the use of the new varieties in other colonies. Are the Dutch Indies "suffering from their fame?", wondered the local newspaper, the Soerabayasch Handelsblad in 1928. How could the new Hevea-clones be prevented from spreading throughout Malacca, and the Java
The First Agro-Food Order (1870s-1930s)

sugar cane clones from spreading all over the world? (quoted in Van Harreveld, 1934:112).

The Dutch colonial authorities had already prohibited the export of tobacco seed in 1924. The government's response to the sugar interests came some years later. In 1927 the International Convention for the Abolition of Import and Export Prohibitions and Restrictions was ratified by the Dutch government only as far as Europe was concerned, thereby enabling the colonial authorities to ban the export of tropical plant material (Van Harreveld, 1934:129).

Protection of plants as intellectual property was apparently not relevant in inter-colonial competition. When in 1928 the sugar industry demanded an export ban on individual sugar canes in the People's Council, the authorities referred to intellectual property regulation, which was in the air. But such protection was not desired by the sugar industry. A member of the Council stated:

"Getting a high price for improved planting material is not what we want; we want to prevent its use by others, and that will never be possible under the measures for the protection of scientific property." (translation RP/JvW) (Handelingen Volksraad quoted in Van Harreveld, 1934:129).

The colonial sugar industry's outcry resulted from its concern that it was relatively easy for rival colonial industries to acquire the precious Dutch sugar varieties. Receiving royalties for the propagation of the sugar varieties was not relevant. The protection of the Dutch competitiveness in the sugar trade required protection against any exploitation of sugar cane varieties, be it for propagation or for breeding purposes, in other colonies. In the 1920s such protection could only be achieved by means of a total ban on the export of planting material.

2.3.2 The European patent controversy

The botanical monopoly as a mechanism for protecting tropical plant varieties and colonial competitiveness withered away during the First Agro-Food Order. Meanwhile, the changing international division of labour gave rise to new forms of protection, directed at temperate agriculture. The international patent system that was founded at the end of the 19th century harmonized national patent laws and raised the interest of plant breeders in the protection of their new creations by patents.

A patent involves the right granted by the state to an inventor, which gives the latter the legal opportunity to prevent unauthorized commercial use of his invention for a specified number of years. In order to be eligible for a patent, the invention has to fulfil specific requirements; for example, that it has to be novel worldwide. The patent is of European origin. The oldest examples of grants of exclusive rights by kings and rulers to private inventors to practice their new arts or skills go back to the 14th century, to the Republic of Venice, but spread in subsequent centuries to other countries on the continent and to Great Britain.
One of the features of the patent is its national scope: it can be enforced only within the territory of the state that has granted it. This limitation is disadvantageous for countries that export technology. Having no patent protection abroad, an exporting firm runs the risk of having its innovations freely imitated by foreign competitors. From the perspective of countries that import technology, the opportunity of imitation may be attractive, and may induce a state to deliberately refrain from enacting a patent law. Because of its impact on technology diffusion, patent regulation is not just a legal but also a political tool in the hands of governments.

In the mid-19th century, with the industrial revolution in full swing and the international market expanding, the role of technology in national competitiveness grew. It was in this period that for the first time patent law was considered as a national trade policy issue. Between 1850 and 1875, the patent system was intensely debated throughout Europe. It was a political controversy between free traders and protectionists, but it was also academic in character, as scholars tried to find a philosophical justification for patent law (cf. Machlup and Penrose, 1950:28). The academic side of the patent dispute remained inconclusive; the political side not.

At issue after 1860 was the establishment of a convention that would provide a minimum standard of patent protection among the then industrializing countries. The convention was a priority for the advocates of a protectionist trade policy, but was opposed by an anti-patent movement of 'free traders'. The latter comprised a host of individuals and organizations across Europe, including trade associations, Chambers of Commerce, organizations of economists and the influential London Economist, who opposed patent protection as a new type of monopoly or tariff protection. Many liberals were concerned that patents would hamper the prompt general utilization of useful inventions, although some of the classical English economists, among them Adam Smith, Jeremy Bentham and John Stuart Mill, defended the patent system (Machlup and Penrose, 1950:3-5; Machlup, 1958:19).

The anti-patent movement was strongest in two countries with a relatively late industrial development: Switzerland and the Netherlands. The former lacked a patent law throughout the 19th century, the latter had its inadequate 1817 patent law repealed in 1869. The 'patentless' period had a beneficial impact on the development of some industrial sectors in both countries (Schiff, 1971). Only a few years after the abolition of the patent system in the Netherlands, the patent advocates all over Europe started a massive counteroffensive to prevent their countries from following the Dutch example.

"New societies were formed, resolutions were drafted and distributed to the daily press, speakers were delegated to professional and trade association meetings, floods of pamphlets and leaflets were released, articles were planted in trade journals and reproduced in daily papers, public competitions were announced with prizes for the best papers in defense of the patent system, petitions were submitted to governments and legislatures, international meetings were arranged and compromises were made with groups inclined to endorse liberal patent reforms." (Machlup and Penrose, 1950:6).
The idea of patent protection in Europe regained its public appeal when, after the crisis of 1873, protectionists won out over the free-traders in many countries. Instrumental to this was the “strategic compromise” between patent advocates and opponents on compulsory licensing (Machlup, 1958:5). Inclusion of this principle in patent law offered the state the opportunity to break patent monopolies if patentees abused their rights and in case the public interest was at stake.

Patent law could now firmly take root in all major countries. The drastic patent reform bill that had been passed by the British House of Lords was withdrawn in the House of Commons in 1874. In Germany, a patent law for the entire Reich was adopted in 1877. Switzerland adopted a patent law in two phases, in 1887 and 1907, and also Japan, which had adopted its first patent law in 1872 only to abolish it again in 1873, enacted another law in 1885 (Machlup, 1958:5). Finally, the Netherlands, “the last bastion of ‘free trade in inventions’”, reintroduced a patent law in 1910 (Machlup and Penrose, 1950:6). The victory of patent advocates was sealed by the conclusion, in 1883, of an international treaty, the Paris Convention for the Protection of Industrial Property.17

2.3.3 Protection of plants under the Paris Convention

Today it is generally thought that the protection of plants by patents was already sanctioned in 1883, when the Paris Convention was adopted. This assumption would be confirmed by the Convention’s explanatory note, which explicitly refers to agricultural products. In reality, however, the inclusion of agriculture was related to trademarks, not to patents.

The objective of the Paris Convention was to constitute minimal international unification in the protection of ‘industrial property’, covering patent protection of inventions, and protection of tradenames, trademarks, industrial designs, utility models, service marks, and indications of source or appellations of origin. These forms of industrial property suggest that the term industrial only refers to manufacturing activities in the factory. During the preparatory meeting in 1880, this provoked the Portuguese delegate to propose the explicit reference to “industrial activity in all classes”, so that agricultural products were also eligible for protection. The delegate said that there was considerable counterfeiting of agricultural products, especially wines (Bureau International de L’Union, 1902:27-28). In response to this request, the closing protocol of the 1883 Act provided that:

“The words ‘industrial property’ have to be understood in a broad sense and apply not solely to the products of industry in the strict sense but also to agricultural products (wines, grains, fruit, cattle, etc.) and to mineral products which are put into trade (mineral waters, etc.).”

During subsequent conferences for the revision of the Convention, this definition of industrial property was confirmed and further specified. The term “agricultural
industries" was introduced in 1911 (Bureau International de L'Union, 1911:245). During the 1925 conference, the range of designated protectable subject matter was expanded to include tobacco leaf, at the request of the Cuban and Brazilian delegates (Bureau International de L'Union, 1926:517,535). Nine years later, Czechoslovakia proposed the inclusion of beer, Hungary put forward flour, and Belgium wanted to have flowers explicitly mentioned (Bureau International de L'Union, 1934:341-342). Even though the protectability of these products was not disputed in 1934, some delegates stated that the inclusion of such a rather arbitrary list could give the false impression that other agricultural product groups were excluded from protection. For this reason, the International Chamber of Commerce proposed the addition that industrial property referred “to all natural and manufactured products” (Bureau International de L'Union, 1934:342). The final text, which to this day remains unchanged, says that:

“Industrial property shall be understood in the broadest sense and shall apply not only to industry and commerce proper, but likewise to agricultural and extractive industries and to all manufactured or natural products, for example, wines, grains, tobacco leaf, fruit, cattle, minerals, mineral waters, beer, flowers, and flour.”

The broad interpretation of the term industrial property and the explicit reference to a list of agricultural and food products have recently induced authoritative patent lawyers to conclude that the original signatories to the Paris Convention “signalled their conviction that patent protection for agricultural living-matter inventions, plants and animals alike, was a desired objective” (Bent et al., 1987:41). This is incorrect, however.

During the Paris Convention's preparatory meetings, as well as during the conferences on its revision, it was confirmed that the scope of the Paris Convention included agricultural industries, not in terms of patents, but rather in view of trademark and tradename protection. Some countries wished to ensure protection of the trade names of important national agricultural industries and therefore requested an explicit mention of these sectors. This is confirmed by French participants in the preparatory process. They state that the incorporation of the explanatory note on industrial property ensured that “the name or mark of a farmer, a cattle breeder, or a mineral water spring owner would be protected in the same way as was the mark or name of a factory.” (translation RP/JvW) (Pouillet and Plé, 1896:14). Even when in 1934 plants were discussed for the first time, because of the Belgian proposal that flowers be included, there was no reference to patents. Not that plant varieties were excluded from patent protection in the Paris Convention, but until the 1930s, the patenting of plants was generally not a realistic option for patent lawyers.

The legal and technical obstacles to plant patenting envisaged by the lawyers played an important role in the national disputes on the issue in the 1920s and beyond. Below we will examine these disputes in the four countries where the legal protection of plants was most topical: Germany, France, the Netherlands, and the USA.
2.3.4 Practical hurdles hamper plant patents in Europe

As indicated above, during the First Agro-Food Order the ‘botanical monopoly’ remained the sole protection mechanism for colonial breeders to prevent their varieties from being propagated and used as source for further breeding in rival colonies. The monopoly could be combined with mutual protection and premium systems to encourage plant breeding, as has been illustrated by the sugar industry initiatives in the Dutch East Indies. In Europe, however, the breeders opted for patents, granted and enforced by the government.

The horticultural industry was the first to raise the issue of plant patents in Europe. As fruit, nut and ornamental varieties could easily be cloned, the nurseries had a great interest in legal protection against unauthorized propagation by competitors. Some resort was provided by trademark law. A trademark protects a word, such as the company name or a logo, under which a plant variety can be sold. The usefulness of trademarks is limited, however. The variety itself is not protected and can freely be commercialized by others under another name.

The horticultural industry expected more from patent protection. The first demands in this direction were voiced in France during the Fruit Growing Congresses of 1904 and 1911 (Heitz, 1991:20). In 1921, Deputy Ricolfi drafted a bill to allow horticultural patents. His initiative was a reaction to a negative decision of the Commercial Tribunal in Nice, in the same year, on a case involving the unauthorized reproduction of a carnation. Ricolfi’s bill did not pass, however, and neither did the bills he subsequently tabled in 1925 and 1928 (Hermitte, 1988:42).

In the Netherlands too, patents were not awarded to plants. When submitting the new Dutch patent bill in 1910, the government had already showed its reluctance to accept patent coverage for biological material. It indicated that in areas such as soil cultivation and cattle breeding “where the results depend less on human will than in industry”, novelties could not usually be considered as inventions (translation RP/JvW) (Memorie van Antwoord, 10-11 May 1910, quoted in Verhuist, 1947:79). Apparently it was commonly accepted among the Dutch that plant patenting was inhibited by insufficient biological and taxonomic knowledge.

In 1920 the Dutch Horticultural Council advised against the plant patent, basically because a “Botanical Patent Bureau” would not be able to examine the novelty aspect of a variety. At the end of the 1920s, reference collections of fields crops were still in their infancy, while detailed descriptions and photographs of plants in subsequent stages of their development were incomplete, and adequate identification techniques unavailable (Van Harreveld, 1934:59-62).

Legal protection for plant material was also topical in Germany. In order to offer breeders some support, the German Ministry of Agriculture and Nutrition prepared a Plant Breeders Protection law in the early 1930s. The bill did not survive the Reichsrat, however. The proposed restrictions on the marketing of on-farm saved seed were unacceptable to farmers, and not effective enough for breeders (Van Harreveld, 1934:102; Flitner, 1995:83). At the same time, efforts were under way to have plant varieties protected by patent law. The first positive decisions
The Exploitation of Plant Genetic Information

were issued by the German patent office in the mid-1930s in relation to seed of tobacco, lupin, and garden pea (Heitz, 1991:28-29). Since then, "over 100 new plant varieties managed to obtain patent protection in Germany" (Lange, 1985:30-31). However, the patent route in Germany would later in the 1930s be interrupted by the Nazi regime, a development we will deal with in the next chapter.

2.3.5 The ‘try-out’ of legal plant protection in the USA

Like the German breeders in Europe, American breeders were also successful in persuading the national patent office. Similarly to Europe, the earliest calls for legal protection of plants came from the American horticultural industry, and can be traced back to the 1870s (Fowler, 1994:80). Plant patenting, however, was discouraged at the end of the 19th century. In 1889, the U.S. Commissioner of Patents upheld an earlier rejection of a patent application for a fibre identified in the needles of a pine tree. The formulation of the Commissioner, which became a "landmark doctrine", noted that ascertaining the composition of the trees in the forest was:

"not a patentable invention, recognized by statute, any more than to find a new gem or jewel in the earth would entitle the discoverer to patent all gems which should be subsequently found." (Ex Parte Latimer, March 12, 1889, quoted in Bugos and Kevles 1991:5).

As a result, it became a fundamental tenet of American patent law that, in general, no protection could be obtained for products of nature, either inanimate or living (Bugos and Kevles, 1991:5).

In 1906, U.S. Congress considered a bill that originally aimed at the strengthening of plant trademarks, but had been revised to allow patents for horticultural plants, trees, and vines. Neither this bill, nor several others tabled in subsequent years, survived Congress (Fowler, 1994:81). The reluctant attitude of Congress induced the horticultural industry to create a lobby group, the National Committee on Plant Patents. Ever since, the interest of the horticultural industry in patent protection only grew, as did the U.S. market for horticultural products. In 1928, the market for ornamental plants alone was estimated at one billion dollars (Bugos and Kevles, 1991:6).

In the late 1920s, the nurseries' efforts had more success. A plant patent bill was tabled by Paul Stark, principal of the largest American horticultural breeding company, the Stark Brothers Nursery. The bill was introduced in Congress by a senator who also was one of the country's largest fruit growers, and fell in fertile ground (Bugos and Kevles, 1991:6). The industrial lobby pointed out the positive impact that plant patenting would have on the development of innovative varieties, resistant to pests and diseases. The nurserymen equated plant selectors and breeders with great American inventors, such as Thomas Edison and Henry Ford. Edison, who had been a friend of the renowned American breeder Luther Burbank,
personally sent a telegram to Congress in support of plant patents (Fowler, 1994:80-84). The innovation-encouragement argument was nonsense, however. The alleged breeding of the nurseries consisted largely of propagating or crossing plants, using techniques that were well known. Practically all new varieties of fruits were the result of chance discovery of seedlings and naturally occurring bud mutations (Fowler, 1994:74,76-77).

Most scientific breeding research was taking place in field crops, but these were not covered by the patent bill. The bill provided patent protection only for new a-sexually (vegetatively) reproducing plants, which generally encompass varieties of fruit, nuts and flowers. As most field crops, such as cereals, were not eligible for protection, the American seed industry had little to win from the PPA. Nevertheless, it supported the bill as a tactical move. Stark had convinced the American Seed Trade Association (ASTA) to establish first the principle of property rights for plant breeders. Later it could be attempted to widen the scope of protection to include all seedpropagated plants (Fowler, 1994:83).

Legal obstacles to plant patenting were removed by the House Committee on Patents. In a report on the bill, the Committee delivered a new interpretation of the prevailing "product-of-nature" doctrine. It stated that, while a new plant variety found in the field was a product of nature and, hence, not patentable, a new variety arising from cultivation was patentable since it was created by "human agency". The committee compared a plant originator with a chemist developing new compositions of matter. Both take the materials of nature, exploit its laws, and devise a new and useful product (Bugos and Kevles, 1991:7).

The accommodation of patent law to plants implied that several of the key requirements for protection had to be weakened or dropped. For example, rather than a worldwide novel invention, the bill specified that the new variety had to be 'distinct' from existing varieties, but it failed to define this term (Fowler, 1994:90). As a result, patents were allowed on plants, even naturally-occurring ones that were hardly different from others. As long as human intervention had been required to reproduce the plant asexually, the plant was eligible for protection. Neither did the patent bill contain the standard patent requirement of disclosing the invention sufficiently to enable someone skilled in the art to reproduce it. The bill only required that the description be as accurate as was reasonably possible (Bugos and Kevles, 1991:9-10).

The bill eventually passed Congress in 1930 without significant opposition (Fowler, 1994:87) and became known as the Plant Patent Act (PPA). The act appealed as a farmers' and plant breeders' relief measure, but did nothing for direct farm relief. Important for the Republican majority in Congress was the prospect that stimulation of private breeding activities could reduce the direct governmental involvement in plant breeding and agriculture (Doyle, 1985:51; Bugos and Kevles, 1991:7). It is doubtful whether the PPA has ever met this objective, however. The combination of a weak law, the limited scope, and the absence of a strong examination system hindered the PPA in stimulating innovation. An evaluation of the PPA, 57 years after its adoption, concluded that the act has had very little impact on
private investment in fruit breeding (Stallmann and Schmid, 1987:434). Nevertheless, the adoption of the PPA was a historic event in the sense that it was the first time that plant varieties were legally protected as intellectual property.

Summary

Born out of a protectionist trade ideology, the international patent system was founded in 1883 with the conclusion of the Paris Convention, which harmonized national patent laws and enabled an extension of the territorial scope of patents to all member states. In a political environment that was generally favourable to technological innovation in view of national economic competitiveness, new plant varieties began to be appreciated as innovations.

The interest in legal protection of plant varieties during the First Agro-Food Order was most pronounced in the horticultural industry. Competition in this sector was intense, cloning of fruit and ornamental varieties was relatively simple, and purchase contract and trademarks were inadequate to curb unauthorized exploitation of plants for propagation or for producing new varieties.

Practical reasons, however, hampered the protection of plants under the patent system during the First Agro-Food Order. Taxonomic and descriptive data to categorize plants were deficient, while techniques to control the design of plants fully were not mastered. Eventually, only fruit and ornamental plants were to become patentable in Germany and the USA, and this was not until 1930.

Conclusions

During the First Agro-Food Order, the international division of labour in agriculture consisted of two different trade patterns. On the one hand, there was the traditional intra-colonial trade, based on the complementarity of products resulting from different climates, within and between the European colonial empires. On the other hand, international trade in temperate agricultural products emerged among core capitalist countries. Concern for competitiveness of the agricultural sector in their homeland instigated governments to support producers, basically by laying the foundation for a rationalization of crop development.

Governments in the then industrializing countries began their interventions by regulating the national seed market. The establishment of seed testing stations and seed certification procedures was to the advantage of farmers and private firms involved in plant breeding and seed production. The reduction of fraud in the seed sector raised the quality of seed, and facilitated opportunities for further capital investment in crop development. On the other hand, the seed market regulating measures also limited commercial freedom and provoked the seed industry to challenge too strict governmental control. Due to the stronger private seed industry lobby in the USA, the American seed market regulation was less strict than in most
European countries.

Governmental involvement in crop development was a major prerequisite for the re-discovery in 1900 of Mendel's insights into the heredity mechanism of living organisms. The new genetic principles offered the prospect of more effective control in the design of new plant varieties, and an expansion in the production of temperate crops. Between 1900 and the 1930s, Mendel's laws would gradually be elaborated within academic circles on both sides of the ocean. In the USA, genetics was first employed to crop development with the intention to curb surplus production of wheat through crop diversification. The new research initiatives induced the USDA to augment investments in the conservation of temperate seed and plant material. However, the application of Mendelian genetics had no direct effect on the competitiveness of the U.S. agricultural sector. The American efforts in research and conservation would contribute to the dominance of the American farm sector only after the First Agro-Food Order.

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

With the expansion of capital investment in crop development, a new interest group emerged that required governmental support in the legal protection of its creations. By drawing a comparison between inventors and plant breeders, the breeding and seed-producing firms in Europe and in the USA justified their demands. The interest in legal protection of plant varieties became most pronounced in the horticultural sector. Competition in this sector was intense, and the cloning of fruit and ornamental varieties was relatively easy. Due to the lack of technical control in the biological reproduction process, and the inability to distinguish adequately among varieties, legal protection of plants would become available only in the early 1930s, in Germany and the USA.

Notes

1 Hyams (1971:89) for example, offers an overview of the continuous infection of introduced Coffea arabica selections after 1650 in practically all colonies where it was introduced. Best known is the infection of coffee plantations in Ceylon around 1700 by coffee rust, which induced a change over to tea production (Monaco, 1977:59).
2 By 1900, the French organization consisted of 84 agricultural experiment stations, a number that rose to more than 115 in 1930 (Busch et al., 1995:133).
3 Germany did not rely on intra-colonial plant transfers as much as other colonial powers, because its colonial possessions were limited. Rather, material was collected from other (rival) colonies (e.g. in Central America), or from non-colonized areas (Flitner, 1995:37).
Cinchona seeds had earlier been introduced in Java in 1854 by the former Superintendent of the Dutch Botanic Gardens on Java, J.K. Hasskarl. One year earlier Hasskarl had entered the Caravaya region of Bolivia and Southern Peru searching for Cinchona plants. He travelled under an assumed name and conducted his business “in secret and through bribery” (Brockway 1988:114). Knowing the importance of Hasskarl’s activities, the Dutch government sent a special naval ship to Peru to pick up Hasskarl and his bounty (Van Harreveld, 1934:135). However, all but two of Hasskarl’s specimens died before they reached Java, and the seeds he brought out yielded valueless trees, so that Dutch interests in Cinchona were frustrated for a decade (Brockway, 1988:114).

A pure line consists of a series of descending plants in which a breeder is able to maintain specific genetic characteristics after crossing.

By 1880, 40 LGUs were operational (Doyle, 1985:352), while the USDA maintained about 85 experiment stations in 1930 (Busch and Sachs, 1981:135).

The John Innes Horticultural Institution (established in 1910), the Plant Breeding Institute (1912), the Welsh Plant Breeding Station (1919), and the Scottish Plant Breeding Station (1921).

In 1929, two-thirds of the total Dutch potato acreage was planted to Veenhuizen’s varieties. Most successful has been Bintje, a potato variety released in 1905 and exported to many countries (Addens 1952:78,100).

The system was administered by the ‘Society for granting premiums for sugar cane breeding’ (Vereeniging voor het verleenen van premies voor het kweeken van suikerrietvarieteiten). In order to be eligible for the premium, sugar cane breeders had to register and deposit their new varieties with the experimental stations. Cane growers had to report the size of the area planted to each variety. They could use registered varieties freely for three years. For the next two years, a fee per ha was payable, and half of that amount in subsequent years (Van Harreveld. 1934:128).

Sugar cane variety POJ 2878 was so successful that it was eventually grown in almost every cane producing country in the world, and it became an ancestor of every modern cane variety (Robinson, 1996:227).

In fact, there was no reference to patent law, and the Paris Convention of which the Dutch East Indies was a member, but to the ‘Treaty on the Protection of Scientific Inventions’. This treaty, approved in the League of Nations in 1923 was submitted to all nations involved in the League in 1930.

The official name of patent is “letters patent”, a literal translation from the Latin litterae patentes. Letters patent are official documents by which certain rights, privileges, or titles are conferred. Among such open letters is the ‘patent for invention’, in short: patent (WIPO, 1988:19).

The absence of a patent law in the Netherlands enabled the butter industry (that would later merge into Unilever) to produce margarine after 1872 by freely using an invention by the French chemist Mège.
Mouriès. This invention was patented in France, Great Britain (Europe’s main margarine market), and Prussia. In another industrial field, Gerard Philips in 1891 was able to start the production of incandescent lamps on the basis of Edison’s technology without having to remove the obstacle of an existing patent. This was an advantage vis-à-vis foreign competitors, such as the Allgemeine Elektrizitäts-Gesellschaft (A.E.G.) in Germany, which had to cope with restricting licensing conditions imposed by Edison (Schiff 1971:5268). In Switzerland, the silk-dying factory Clavel (later CIBA) in Basel could freely start the production of an aniline dye ("mauve") based on an invention of Perkin, only three years after this invention was patented in England. Also the founders of the Swiss firm Buergin & Alioth had freely used basic inventions patented abroad for building generators (Schiff, 1971:98-106).

17 When the Paris Convention came into effect in 1884, 11 states had adhered: Belgium, Ecuador, France and its protectorate Tunisia, Great Britain, Italy, Portugal, Serbia, Spain, Switzerland, and the Netherlands. The USA, Japan and Germany would follow in 1887, 1899 and 1903 respectively (United Nations 1975, Annex 1).

18 One Senator justified his support for the Plant Patent Bill by pointing out the years of effort necessary to develop the ‘Delicious’ apple variety, while in fact this apple was a naturally-occurring mutated plant, simply found in his field by a farmer who had sold it for a few thousand dollars to Stark Brothers (Fowler, 1994:74,86).