The impact of plant breeders' rights in developing countries

Debate and experience in Argentina, Chile, Colombia, Mexico and Uruguay

by Walter Jaffé and Jeroen van Wijk

Inter-American Institute for Cooperation on Agriculture
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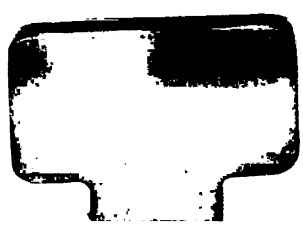

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Preface

This study has been carried out under responsibility of the Technology Generation and Transfer Programme of the Interamerican Institute for Cooperation in Agriculture (IICA), Costa Rica, and the Department of Political Science of the University of Amsterdam (UA), the Netherlands. Case studies were conducted in five Latin American countries in 1994. All information provided in this report about the five Latin American countries is based on the country studies, unless otherwise indicated. The country studies are included in the list of references as follows: Gutiérrez *et al* 1995, Moreno *et al* 1995, Solleiro *et al* 1995, and Blanco 1995.

The following persons have participated in the project:

Argentina	Marta Gutiérrez, in collaboration with Carmen Gianni and Gerardo Mujica
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Walter Jaffé
Jeroen van Wijk

Executive summary

Intellectual property protection has been considerably strengthened by the conclusion of a new GATT agreement in 1994. The new GATT obliges member states to stop unauthorized diffusion of innovations in a wide range of technological sectors, including those of biotechnology and plant breeding. Plant varieties must be protected either by patents or by plant breeders' rights. What are the implications of this provision for the plant breeding and farming sectors in developing countries? Empirical evidence of the socio-economic impact of intellectual property rights in agriculture is almost non-existent, and this situation has allowed a highly politicized international debate on the issue to take place.

The lack of evidence has been the reason for the Inter-American Institute for Cooperation on Agriculture and the University of Amsterdam to initiate the present study which was sponsored by two development organizations: the Special Programme Biotechnology and International Cooperation, of DGIS in the Netherlands and IDRC, Canada. The study examines the (expected) impact of plant breeders' rights (PBR) on developing countries with respect to: private investment in plant breeding, breeding policies of public institutes, transfer of foreign germplasm, and diffusion of seed among farmers. Case studies have been conducted in five Latin American countries, Argentina, Chile, and Uruguay, which are among the very few developing countries that have experience with PBR protection; and Colombia and Mexico, two countries which were about to introduce PBR legislation. The study is based on existing literature and on interviews with a total of 157 persons, representing 131 organizations, with an interest in PBR protection. It was carried out in 1994, in collaboration with five local research groups. Reports of the case studies were discussed during national seminars in the respective countries, while a draft of the present final report formed the basis for discussion during a two-days international seminar, organized in March 1995, in Bogotá, Colombia. Many of the comments expressed during these seminars have been used to improve this final report.

Plant breeders' rights (PBR) legislation was introduced in Argentina, Chile, and Uruguay in the 1970s and 1980s, basically as a response to an internal and general drive to modernize the agricultural sector. In the 1990s, these three Southern Cone countries have strengthened and enforced their PBR protection, while Colombia has enacted PBR legislation and Mexico is expected to do so in 1995-1996. All five countries will be members of the *International Union for the Protection of New Varieties of Plants* (UPOV) during the second half of the 1990s. **These recent changes in the legal protection of plant varieties are the result of a combination of both domestic and foreign demands** from:

a domestic and foreign private seed companies who want a better return on their investments,

b domestic cultivators of fruit and ornamental plants who feel pressured by foreign breeders to improve legal protection as a condition for getting better access to foreign varieties,

c public agricultural research institutes seeking additional sources of income to compensate for budget reductions, and

d governments of industrialized countries which aim at an overall strengthening of intellectual property rights protection in Latin America. All five countries are committed to providing legal protection of plant varieties under the new multilateral trade agreement concluded under the aegis of GATT. Mexico, moreover, is obliged to enact PBR and accede to UPOV under the *North American Free Trade Agreement*.

Opposition to PBR protection has come from some public sector researchers and agricultural NGOs, but is generally weak. **Only in Colombia has opposition developed some strength,** but this has not prevented the adoption of PBR legislation.

Argentina is the sole country in Latin America where PBR have been effectively enforced for a number of years. The predominant effect has been a considerable reduction in the unauthorized marketing of seed of protected wheat and soya bean varieties. The share of seed supply that is now controlled by the breeders increased to a total of 55 percent for wheat and 40 per cent for soya bean. These figures come close to the achievements of breeders in the USA. Because the wheat and soya bean seed markets are dominated by local companies and a public agricultural institute, **the domestic Argentine seed industry has been the main beneficiary of the PBR system so far.**

The experiences with PBR in Argentina, Chile and Uruguay **indicate that adequate implementation of PBR legislation requires specialized capabilities as well as specific institutional and legal strategies,** such as:

a A structure that has proven to be capable of controlling the seed market. It is difficult to conceive that in countries where such a structure is absent, PBR protection can be implemented.

b An adequate system of variety registration, recognized by the seed industry.

c Initiatives by breeders to collectively exercise their rights. PBR are private rights and it is up to the breeders themselves to enforce these rights. Absence of collective action by title holders has been an important cause of the limited effect of PBR protection in Chile and Uruguay.

It is almost impossible to assess, in isolation from other causes, the precise effects of PBR protection on private investment in plant breeding. However, R&D behaviour of 11 of the 50 plant breeding companies in Argentina and the views expressed by representatives of the seed industry indicate that **PBR have probably prevented the local wheat companies from reducing or even terminating their breeding activities and triggered the reactivation of some soya bean breeding programmes.** In other words, PBR protection in Argentina seems to have prevented a reduction in R&D expenditure in soya bean and wheat, rather than having stimulated additional R&D expenditure for these crops. But other factors, such as macro-economic changes, may have played a role too. The increase in R&D expenditure by seed multinationals, which are predominantly involved in the markets for hybrid crops, can largely be attributed to these changes in the general economic environment in Argentina.

Although PBR legislation has the explicit goal of stimulating *private* plant breeding, the preliminary evidence indicates that PBR protection also supports public institutes, which are the major plant breeding organizations in all five Latin American countries. Budgetary pressures are forcing the institutes to take advantage of PBR protection as a means of developing new sources of revenue. In Argentina and Chile, PBR have permitted the institutes to establish more formal and commercial relationships with the private sector and to increase their income. This orientation has not yet had an impact on the public sector plant breeding agenda. At the time of the survey, none of the institutes had a formal programme in which marketing and breeding objectives were integrated.

Breeders and managers still seem to act rather independently. However, with respect to the availability of the institutes' genetic resources, changes were observed. **The budget pressures, which oblige the institutes to market new plant varieties in a more profitable way, enhance the strategic importance of their germplasm and reduce its public availability.** Joint germplasm improvement programmes with the private sector restrict the free availability of parts of the germplasm even more. On the other hand, several companies favoured formal rules for access to public germplasm, because these would replace the often arbitrary decisions concerning availability of germplasm taken by individual employees of the institutes.

Whether the introduction of PBR protection improves access to foreign genetic material depends on the intellectual property policy of the supplier. Access to germplasm available at the international agricultural research centres will not change, because these centres generally do not seek protection. PBR protection may improve access to germplasm that is concentrated with private seed companies in OECD countries. **Growers, propagators and breeders in Latin America probabaly benefit from better opportunities to collaborate with foreign breeders when PBR protection in their country proves to be adequate.** However, PBR may at the same time be used to impose restrictions on the exploitative use of that germplasm. Many forms of exploitation of the foreign germplasm obtained require permission of the breeder. Even though it is unlikely that he will object to the use of his material if that is additional to existing use, **the breeder or his licensees may exercise the right to restrict production in, or export from, developing countries if this substitutes for exploitation elsewhere.** Argentinean nurseries, for example, faced such a situation when they tried to export strawberry plants to Europe. The nurseries were licensed to produce plantlets from US strawberry varieties and paid royalties for that, but the import of these plantlets into Europe was blocked by European licensees of the US breeder on the basis of PBR legislation in Europe.

The way farmers are affected by PBR is not similar for all of them, but depends on the way they acquire their seeds. The study focused on:

a farmers who swap their grain for seed with dealers or grain elevators, and

b farmers who save a portion of their harvest to be used as seed to resow their land.

It is generally assumed that, overall in developing countries, 80 per cent of the seed requirements are met in these ways.

No direct negative effects of PBR legislation on seed diffusion were observed in the three Latin American countries that have had an operational PBR system for some time. In Argentina, where PBR have reduced unauthorized seed trade in two important crops, seed dealers now have to pay royalties and taxes on the seed they used to swap for grain without authorization. The extra costs have not been passed on to farmers, but that may take place in the future. Neither have PBR affected farmers who save their own seed from protected varieties because farmers, in all five Latin American countries, are exempted under PBR legislation. Nevertheless, the introduction of PBR causes a change of principle. When farmers start to use protected varieties, their natural right of seed saving becomes a legal right, or even less, a 'privilege'. Such a legal right is subject to political decision-making and possibly prone to restrictions in the future.

A large group of farmers in the Latin American countries work with little resources and often under difficult ecological conditions. PBR protection does not seem to affect this group negatively, because of the farmers privilege, because they may use modern but public varieties, or because they use landraces. These traditional varieties cannot meet the criteria for PBR protection and are necessarily in the public domain. On the other hand, it is difficult to conceive how this group of farmers can *benefit* from the technological progress that PBR

legislation aims to support. **Since many modern plant varieties are not appropriate for resource-poor farmers, PBR predominantly favour plant breeding for those farmers who operate under relatively prosperous conditions.** Besides PBR legislation, additional strategies need therefore to be maintained or developed to support breeding activities for resource-poor farmers in which the objectives of sustaining living-conditions for the rural population as well as conserving traditional plant varieties are combined. Implementation of the farmers' rights concept is among the options that need to be further explored to this end.

Recent amendments to the (utility) patent laws in Latin American countries will soon allow for protection of plant material. Except for Colombia, plant varieties are excluded from protection in the countries under study, but genomic material and transgenic plants are not. Very few of the more than 150 interviewees in the survey were informed about these developments, let alone their consequences. **The effects of patent protection will be significantly different from the protection conferred by PBR.** Patented material cannot freely be used as source of breeding by other breeders, and farmers are not allowed to save seed from patented plant varieties.

The experience in Argentina, and to a lesser extent in Uruguay and Chile, indicates that, until now, PBR seem to have supported the domestic plant breeding industry. The main losers are seed dealers involved in unauthorized seed trade. **Whether PBR will have similar effects in other countries remains to be seen.** Especially in countries where certification and variety registration schemes are not effective, where no or few plant breeders are active, or where plant breeders have less access to genetic resources, the effects of PBR may be different. It seems to be worthwhile for all countries who (have to) consider the introduction of PBR protection to study the likely effects of this protection prior to the adoption of legislation. Early identification of potential winners and losers enables the design of PBR or similar legistation that is consistent whith national agricultural policies. Moreover, additional measures could be considered to mitigate or prevent some undesirable effects of PBR protection.

Abbreviations

ARPOV	Asociación Argentina de Protección a las Obtenciones Vegetales (Argentina)
ASSINSEL	International Association of Plant Breeders for the Protection of Plant Varieties
CIAT	International Center for Tropical Agriculture
CIMMYT	International Center for the improvement of Maize and Wheat
CPRO	Centre for Plant Reproduction Research (the Netherlands)
DUS	Distinctness, Uniformity and Stability
EDV	Essentially derived variety
IARC	International Agricultural Research Centre
ICA	Instituto Colombiano Agropecuario (Colombia)
IICA	Inter-American Institute for Cooperation on Agriculture
INASE	Instituto Nacional de Semillas (Argentina)
INIA	Instituto Nacional de Investigación Agropecuaria (Chile and Uruguay)
INIFAP	Instituto Nacional de Investigaciones, Forestales, Agrícolas y Pecuarias (Mexico)
INTA	Instituto Nacional de Tecnología Agropecuaria (Argentina)
IPGRI	International Plant Genetic Resources Institute
IPR	Intellectual property rights
MGAP	Ministerio de Ganadería, Agricultura y Pesca (Uruguay)
MNEs	Multinational enterprises
NAFTA	North American Free Trade Agreement
NGO	Non-governmental organization
PBR	Plant breeders' rights
PRONASE	Productora Nacional de Semillas (Mexico)
PVPA	Plant Variety Protection Act (USA)
SAG	Servicio Agrícola Ganadero (Chile)
UC	University of California
UPOV	International Union for the Protection of New Varieties of Plants
VCU	Value for cultivation and use

Introduction

Ever since the mid-1980s, the main industrialized countries have initiated international negotiations to encourage or to force the rest of the world to reduce unauthorized diffusion of medicines, computer software, video tapes, designs, and other innovations or cultural expressions. The background for this search for stronger protection was the losses that innovators in the USA, Europe and Japan said they incurred because of piracy in developing countries. The risk of having their intellectual property pirated elsewhere would deter companies from exporting their products, and so it was concluded that the absence of strong intellectual property protection acts as an effective trade barrier. This relation with trade enabled the inclusion of intellectual property rights into the Uruguay Round of multilateral negotiations under the aegis of GATT.

The protection of biological innovations emerged in the GATT talks around 1990 and has become the subject of specific provisions in the final agreement. The new GATT obliges each member country to consider patent protection for genomic material[1], while plant varieties must be protectable either by patents or by plant breeders' rights.[2] This obligation, as well as the prospect of their review within a few years, raises the question about the impact of these forms of protection on developing countries.

This study is confined to plant breeders' rights (PBR). PBR are rights granted by the state to plant breeders to exclude others from commercializing material of the plant varieties they have developed. These rights can only be exercised within the state's boundaries and generally have a minimum duration of 15 to 20 years. According to the 'theory' of intellectual property protection, the prospect of a return on investment will stimulate breeders to invest in developing new plant varieties, or encourage the import of new foreign varieties. Whether these assumptions are justified with respect to developing countries is subject to debate. Some years ago, a World Bank study concluded that there was some evidence that introducing plant breeders' rights in developing countries would yield substantial benefits, but that more research should be carried out to ascertain the precise effects of PBR in the development process (Siebeck *et al* 1990).

Apart from the question of whether PBR protection does what it is supposed to do, there is the question of whether PBR have a negative impact on the domestic seed industry, germplasm exchange, seed supply, and biodiversity in developing countries. In several developing countries concern exists that worldwide recognition of PBR will lead to control by multinational seed companies over the world's agricultural production. Legal protection of plant varieties consequently has provoked considerable international controversy within the United Nations' Food and Agriculture Organization (FAO) and during the preparation and implementation of the Convention of Biological Diversity.

1. According to the agreement, patents shall be available for any inventions in all fields of technology. Excluded from patent protection may be: plants and animals other than micro-organisms, and essentially biological processes for the production of plants and animals, other than non-biological and micro-biological processes. However, protection for plant varieties shall be provided either by patents or by an effective *sui generis* system or by any combination thereof. It was further stipulated that this provision would be reviewed four years after the entry into force of the agreement (GATT 1994).

2. The GATT agreement speaks of an 'effective *sui generis* system', because plant breeders' rights were never included as negotiation topic in the Uruguay Round. At the time the talks commenced, in 1986, piracy of plant varieties was not considered to pose a serious trade problem that required negotiations in GATT.

The lack of evidence which could support either the positive or negative assumptions about the impact of PBR has been the background of the present study. Its objective was to examine (a) the reasons certain developing countries have adopted PBR legislation, (b) the way these countries had implemented the legislation, and (c) the impact of PBR on private investment in plant breeding, on the breeding policy of public institutes, on international transfer of plant germplasm, and on seed diffusion among farmers.

The study is confined to Latin America. Argentina, Chile, Uruguay were selected because they were the sole countries on the continent which had enacted and implemented PBR legislation some time ago. They were complemented by Colombia and Mexico, two countries which were about to introduce PBR and where the study would focus on public debates and expectations on the impact of PBR. The two other developing countries which have enacted PBR legislation, Zimbabwe and Kenya (whose PBR legislation was dormant), were not included for practical reasons.

This study is based on existing literature and interviews with a total of 157 persons, representing 131 organisations, with an interest in PBR protection. The availability of quantitative data on the seed industry was limited. It was originally proposed to collect data on R&D expenditure and annual sales of all institutes and companies with breeding programmes in the sample over the past 20 years, at intervals of 4 years. This objective proved to be unfeasible. Neither public institutes nor subsidiaries of foreign companies publish (separate) annual reports, and most domestic seed companies are strictly private companies. They are owned by one person or a family, and they have no obligation to publicly give account of their policies and finances. Moreover, companies and institutes were generally highly reluctant to provide financial data for reasons of confidentiality. Even when they were willing to cooperate, data collection was hampered because most organizations have not systematically kept up financial data on various expenditures over long periods. All respondents assured us that information on R&D and sales over the period before 1985 was not available at all. One respondent commented that for her institute it would require archaeological rather than socio-economic research to dig up boxes with the relevant papers stored in obscure places within the institute's building. Finally, it was decided to concentrate efforts to obtain quantitative data on R&D expenditure on the seed industry in Argentina, the country with the longest experience with PBR, and for two points in time: 1986 and 1992.

The results of the study are laid down in the present report which is subdivided into seven chapters. The performance of the agricultural sector in each of the five countries, as well as the legal framework that regulates the seed market is, examined in the first chapter. It provides the background for the description of the public debate, the main characteristics, and (expected) effectiveness of the PBR systems in the Latin American countries described in chapter two. The impact of PBR on research expenditure by the private seed industry and of the relationship between local and foreign seed companies is discussed in chapter three. Chapter four discusses the way in which public institutes employ PBR protection, and the consequences for the their research direction and availability of their germplasm. The fifth chapter deals specifically with the way PBR influence access to foreign germplasm and the restrictions that PBR may impose on the exploitation of this material. The way PBR affects seed saving and unauthorized trade in seed of protected varieties is debated in chapter six. The final chapter contains conclusions.

1 The development of the seed industry

Seed[1] is the most important input for agriculture. It allows the crop to reproduce year after year, and it contains the genetic information controlling its yields, disease and pest resistance, stress tolerance and quality. Breeding plants, producing, multiplying, storing and distributing seed - all functions of the seed industry are integral parts of agriculture. Consequently, the starting point of any characterization of the seed industry is the description of agriculture in general and, particularly, its economic importance in the country.

1. In this report seed is broadly defined as all living materials used to plant a crop, including dry seeds, cuttings or vegetative parts.

1.1 Importance of agriculture and its main tendencies

All five countries included in this study are considered to fall into the category of developing countries by the World Bank, but they present large differences in size, importance of agriculture, degree of industrialization and integration with the world economy. Mexico has a large economy, in contrast to the small one of Uruguay and the intermediate ones of Argentina, Chile and Colombia. Argentina and Mexico are relatively more developed than the rest, considering the importance of manufacturing within their economies.

Agriculture and agro-industry, although declining, are still the most important economic sectors in Argentina, Uruguay and Colombia. The first two are typical agro-exporting countries which traditionally have based their economy on the export of some few commodities (wheat, maize, soya bean, beef in Argentina; wool, beef, milk and rice in Uruguay). The traditional importance of coffee in Colombia has been reduced in the last ten years by the surge of oil and coal exports. All three countries have diversified their economies in the last 20 years, reducing their traditional reliance on agriculture.

Chile's economy historically depended heavily on mining. The last 20 years have seen important growth in export agriculture, principally fruit, tobacco, sea-food and wood. In contrast, the economic importance of agriculture in Mexico has been reduced greatly in the last twenty years, because of the growth of manufacturing and energy production. But agricultural exports, mainly vegetables, fruit and coffee, still represent around 10 per cent of total exports, a significant portion.

From the point of view of employment, agriculture is very important in Mexico and Colombia, where about a third of the employed population still are agricultural workers. This reflects the continuing importance of the peasant sector in both countries.

These aggregated economic indicators hide large differences between sectors and regions within the countries. All of them, with the exception of Uruguay, have dualistic agricultures, characterized by a traditional sector, mainly composed of

peasants, but also by some large and extensive, traditional farms (*'latifundio, haciendas'*), and a more modern entrepreneurial agriculture. These sectors are concentrated in different regions, which therefore present important differences in wealth and economic dynamism. For example, the entrepreneurial agriculture in Argentina concentrates on export crop production in the Pampa region, whereas peasant agriculture is dominant in the north-east of the country. The production of maize, beans and potatoes in Colombia, all traditional staples for the population, is dominated by peasant agriculture, characterized by small-scale and relatively less technical production. The same is true for Mexico.

Table 1.1 **Economic importance of agriculture in five Latin American countries (1992)**

	Argentina	Chile	Colombia	Mexico	Uruguay
% of agriculture[1] in GNP	7.1	8.7	17.9	7.3	14.7
% agricultural exports[2] of total exports	58	16.2	36.6	10.8	38.6
% of work-force in agriculture	9.9	11.9	26.0	28.7	13.2

1. Agriculture, forestry, hunting and fisheries
2. Primary and processed products

Sources: CEPAL, Anuario Estadístico de América Latina y el Caribe, 1993.; FAO, Anuario de Producción 1992, Vol. 46.

The use of improved or certified seed is a good indirect indicator of the type of agriculture which characterizes specific crops, as table 1.2 shows. Entrepreneurial agriculture, in the development stage characteristic for most Latin American agriculture, generally uses improved seed, either bought or saved, while peasant agriculture relies mostly on land races or seed obtained through traditional, more informal, channels. When there is a well developed seed industry and farmers are well-informed, seed marketing starts to be deregulated, and certification becomes less important. Among the countries studied, only Argentina is starting to enter this new phase.

The agricultural sectors of all selected countries are in the midst of profound changes, the consequence of structural economic adjustments brought about by new development strategies and policies. Their central features in all of Latin America are the opening of the economy to the international market and the redefinition of the role of the state in the economy. The economic stabilization programmes that have been implemented seek to reduce public deficits, deregulate the economy, privatize public companies and reduce the protection of local production. Tariffs have been lowered unilaterally, and regional and bilateral free trade pacts have been signed, creating free-trade zones. Those between Mexico, the USA, and Canada (NAFTA); Venezuela, Colombia, Ecuador, Peru and Bolivia (Andean Pact); and Brazil, Uruguay, Paraguay and Argentina (MERCOSUR); Mexico, Colombia and Venezuela (G3) are among the most important ones.

The new rules of the game force primary agriculture to compete on the world markets, in many cases against subsidized production of OECD countries. The tendencies towards export production of non-traditional crops, increased integration of primary production with processing, and export of agro-industrial products, have been strengthened by the elimination of export taxes and other measures. Entrepreneurial agriculture has been better able to adapt to the new conditions, in contrast to peasant agriculture which has been, in general, negatively affected.

Table 1.2 **Certified seed use in five Latin American countries**
(% of total area planted)

	Argentina (1994)	Chile (1993)	Colombia (1992)	Mexico (1993)	Uruguay (1994)
Barley	50	50	5.2	70	15
Beans	5	1	0.7	2.1	–
Cotton	70	–	100	–	–
Maize	100	0[1]	12.7	34.2	50
Potato	n.d.	9	0.8	20	80.5[2]
Rice	n.d.	4	96.2	5.9	75
Sorghum	100	–	100	30	80
Soya bean	30	–	96.6	45	–
Sunflower	100	0[1]	–	–	55
Wheat	30	30	6.5	70	11.5

1. More than 90 per cent of the area sown with hybrids, which are not certified.
2. fall planting
Sources: Argentina (INASE); Chile (ANPROS); Colombia (ICA estimates); Mexico (SNICS estimates); Uruguay (MGAP)

Argentinean agriculture has been in a profound crisis since the mid-eighties, because of low prices of its principal export commodities. Primary production has lost its dynamism, which is now located in agro-industry (Obschatko 1992). Primary exports have been falling in relative terms, but agricultural manufacturers have partly been able to compensate this loss. The agricultural crisis has been counterbalanced by the success in overcoming the hyperinflation characteristic for Argentina until 1990. The stabilization of the economy is the result of a programme based on the tying of the local currency to the dollar, together with the opening of the economy, privatization and deficit reduction. The advent of MERCOSUR is expected to help agriculture achieve good positions in the large Brazilian market.

Chile's agriculture has been restructuring itself for the last decade, with basic food production losing importance against export and animal production. Cereals and food legumes have been especially affected by this trend. The rapid rise of the export of fruit, sea-food, and wood has decelerated significantly in recent years, signalling the exhaustion of what were until recently, successful strategies (IICA 1994).

Colombian agriculture, traditionally export-oriented because of the importance of coffee, has been weakening for more than 15 years. The fall of coffee prices and the surge of energy exports have reduced the relative importance of agriculture in the generation of foreign exchange. Food imports have risen. The traditional crops have lost importance to modern agro-industrial crops, better suited to new consumption patterns. Agricultural exports have been diversifying, increasingly including processed products (IICA 1994). The opening of the economy, elimination of subsidies, drastic reduction of international prices of basic exports, severe climatic conditions, reduction of credit, as well as the problems caused by the guerilla war in some regions, have, in the last five years, created a critical situation for the sector, which a new government seeks to address from 1994 onwards.

Mexico has witnessed a drastic reduction of the importance of its agriculture in the last 20 years. Agricultural imports have risen dramatically, but agricultural exports are still a small, but significant, fraction of total exports (IICA 1994). Commercial liberalization and the elimination of governmental supports to agriculture seek to strengthen commercial, large-scale production and agro-industrialization. The production of fruit and vegetables for export in the north

has benefitted most from this policy. Peasants are expected to participate in this development through associations supplying agro-industry. Government is leaving the production of fertilizers and seeds, which it practically monopolized until the recent past, creating opportunities for the private sector. These policies have created a critical situation for large groups of peasants, who were unable to adjust at the speed required by the reforms.

Uruguayan agriculture has been showing dynamic behavior in recent years. Agricultural GNP has been expanding, although deregulation has permitted a large increase in agricultural exports. This has been compensated by the elimination or drastic reduction of export taxes for agriculture (IICA 1994). Export agriculture is expected to be a key element in the success of the new development strategy seeking a more diversified economy, also based on deficit reduction, down-sizing of government and opening of the economy. The impact of MERCOSUR for this small country will be considerable.

1.2 History of the seed industry

The initiation of the seed industry has been historically directly linked to modern plant breeding. This is also true for Latin America, where the start of formal breeding programmes led firstly to production of improved seed, and later to the establishment of seed quality control programmes.

1.2.1 Plant breeding

Plant breeding and seed production started in Argentina quite early, with wheat (table 1.3). Foreign experts, brought into the country by the government, created the first breeding programme. Soon after, this public sector initiative was joined by two private breeders, who started their own companies, still active today. Also in Uruguay the first breeding programme, again quite early, was a government one in wheat, started by a foreign expert. Modern plant breeding began later in Chile, Colombia and Mexico, from the twenties to the forties. In the two latter countries they were joint programmes between the government and the Rockefeller Foundation, centred first on maize and later wheat, in Mexico; and on maize, in Colombia. In Chile, from the outset, one private company participated in wheat breeding.

Table 1.3 History of the seed industry in five Latin American countries

	Argentina	Chile	Colombia	Mexico	Uruguay
Initiation of modern plant breeding	1912 (wheat)	1925 (wheat)	1950 (maize, potato)	1932 (maize, wheat)	1912 (wheat)
Initiation of seed production by public sector	1920	1940	1930	1947	1935
Initiation of private seed industry	1919 (wheat)	1936	1960	1960	1970
Arrival of multinational seed companies	1950 (maize) 1970 (sunflower)	1956	1975	1960	None
Creation of seed certification programmes	1935	1943	1966	1961	1964

The creation of national agricultural research institutes in all countries, in the fifties and sixties, expanded the breeding activities, and the concomitant seed production, to other crops. Plant breeding was, and to a great extent still is, the most important activity of these institutes. The development of the 'green revolution' varieties of wheat and rice in the sixties and seventies had a powerful influence on breeding programmes in all countries. Close relations with the international agricultural research institutes have benefitted the consolidation of breeding capabilities in all countries, through the supply of basic genetic materials and lines, training of personnel, and technical assistance.

In summary, plant breeding, and agricultural research in general, was initiated by governments in all the five countries studied. It first addressed the most important food crops. This was part of strategies seeking to modernize agriculture, an important goal for all governments. Foreigners, immigrants and international cooperation programmes played a crucial role in the early history of breeding in the countries. This confirms that the development of plant breeding was a typical case of an international diffusion of a new generic technology, from some more advanced countries to other less advanced ones. The introduction or breeding of improved varieties led governments to produce the seed required to diffuse them to farmers. In Argentina, special circumstances permitted this function to be shared from the outset with private industry in one key crop (wheat).

1.2.2 Seed multiplication and commercialization

The creation of new plant varieties or their import was followed some years later by the establishment of public sector seed production and distribution facilities. Only Argentina followed a different strategy. Given the early development of private breeding and seed production, it never created a government company to produce and distribute seed, as did the rest. In Chile, these functions were assigned jointly to the *Empresa Nacional de Semillas*, a government owned company, and to the State Bank, during the first phase of its seed industry development. Similarly, Colombia chose a public sector bank specialized in agricultural credit, for production and distribution of seed, tied to credit. The Caja Agraria was the most important public-sector player in the industry until the beginning of the nineties when, by governmental decision, it retired from this activity.

Seed production and distribution were first carried out by the National Maize Commission in Mexico, which was later succeeded by a public company, called *Productora Nacional de Semillas* (PRONASE). It had the monopoly on varieties developed by the public sector, which permitted it to dominate seed markets in Mexico for many years. Only recently, as a consequence of its gross commercial and management errors, as well as liberalization policies, has this company lost its control of the Mexican seed market. In Uruguay, production and distribution of seed was first in the hands of the Ministry of Agriculture, and later assigned to the national research institute upon its creation.

These public companies dominated the markets for periods of varying length, to be then privatized or joined by private industry in a more mature stage of development of the seed industry. A private, locally-owned seed industry began multiplying seed from public varieties or distributing imported seed. Later, private foreign varieties were added to the product lines, and some links were established with international companies. Domestic companies specialized in self-pollinating varieties, with the sole exception of an Argentinean maize hybrid company (Santa Ursula S.A.). In Colombia, producer associations established their own breeding and seed production programmes by themselves, in the case of coffee and sugar-cane, or in association with the public sector, in the case of rice.

Multinational companies entered the industry from the fifties onward, in those countries and crops with sufficiently large and attractive markets, and with products guaranteeing adequate returns. These were principally hybrids, because of their intrinsic protection against propagation, yearly purchase requirement, added value and facility for incorporation of new traits. The companies established seed production facilities in Argentina, Chile and Mexico in the fifties, to exploit the maize and sorghum hybrid markets. Later, in Argentina, sun-flower hybrids were added, as well as some self-pollinating crops like soya beans. In this country, multinationals initially associated with domestic companies, which distributed or licensed their products. Cargill was the first one. Later, local partners were bought out and the most important international (mostly US) companies established a direct presence in the country (Asgrow, Ciba-Geigy, Cargill, Dekalb, Northrup King, Pioneer Hi-Bred and Continental). Multinationals expanded their presence in Chile significantly in the eighties, producing seed for export to the northern hemisphere.

In Mexico, multinationals set up facilities in the early sixties, mainly to import and distribute seed from the USA (Barkin and Suarez 1985). Asgrow, Northup King and Dekalb were the first ones. Shortly after their arrival they started breeding programmes, to generate locally adapted varieties from their imported lines. They have been successful in dominating the local market, vis-à-vis the national private seed industry, and have taken most advantage of the new, more liberal conditions of the last six years. In Colombia, three multinationals arrived in the eighties, concentrating on maize, sorghum and cotton for the local market. No multinational company operates directly in Uruguay. The Uruguayan market is covered by multinationals from their subsidiaries in Argentina.

1.2.3. Model of seed industry development

From this schematic history, it is evident that the state played a crucial role in the establishment and consolidation of a seed industry in all countries studied. In addition to plant breeding and direct seed production, seed regulation and technology diffusion activities should be counted as influential interventions. Agricultural extension programmes first, and later quality control programmes (variety registration and seed certification) created and expanded seed markets in the first place. The consolidation of the seed industry was closely linked to the existence of an adequate regulatory framework, as well as the corresponding technical capabilities in regulatory bodies. Private industry followed the public sector initiatives. Domestic industry concentrated on self-pollinating varieties, while multinationals specialized in hybrids.

The role of international agricultural research centres also went beyond the supply of basic genetic materials and lines. The *International Center for Tropical Agriculture* (CIAT), located in Colombia, for many years directly supported seed activities through training and technical assistance in seed production technology, carried out by its Seed Unit.

The evidence from the five countries studied fits into the general model of seed industry development proposed by Douglas (1982). In stage one, no seed industry exists because no improved varieties exist. In the second stage, farmers begin to use varieties developed by formal research and development. Most seed is still produced by farmers themselves, but the new varieties are produced and distributed by government or commercial seed companies. In stage three, the use of improved varieties spreads, as the private sector begins to be a significant source of new technology. Both public and private enterprises produce and market seed. The Latin American countries studied are in more or less advanced degrees of this stage. In Douglas' fourth stage, most of the varieties planted by farmers are bred in private research programmes and all of the commercial seed is produced and marketed by private firms. This stage reflects the situation of the seed industry in most highly industrialized countries, and is possibly, but not necessarily, the future situation in some Latin American countries.

1.3 Characteristics of seed markets and industry

1.3.1 Seed markets

Seed markets in Argentina and Mexico are significant, in comparison to international standards. Colombia, Chile and Uruguay have relatively small markets, as shown in table 1.4. The value of sales for Argentina in 1993 does not reveal the historical importance of maize in this market. Maize hybrid seed sales have declined by half in the last 6 years, which represents a contraction in the market of US$ 30 to 40 million. Similarly, hybrid sorghum sales declined by approximately US$ 20 million. But it must be remembered that the available statistics on seed markets do not include clonal propagation, as well as in-house or within-industry seed production. These activities are important in some countries, such as flower, fruit-tree, wood-tree, and sugar-cane propagation, and coffee-seed production in Colombia, Chile and Mexico.

Table 1.4 **Some indicators of the seed markets in five Latin American countries** (only true seed)

	Argentina (1993)	Chile (1993)	Colombia (1992)	Mexico (1993)	Uruguay (1992)
Local sales (million US$)	521	60	145	675[3]	40
% (sales) of most important crops	Soya 28 Wheat 17 Maize 13	Wheat 30 Maize 18	Rice 62 Sorghum 26.5 Soya 10	Maize 40 Beans 20 Wheat 15	Rice 22 Wheat 6.2 Barley 4.4
Production (tonnes)	90,912	n.d.	58,062	119,400	47,000
% (prod.) of most important crops	Wheat 50 Soya 40 Maize 6.5	n.d.	Rice 83 Sorghum 8.1 Soya 5.4	Wheat 60 Maize 20	Rice 32 Wheat 26 Barley 21
Value of seed exports (million US$)	4.1[1]	62.5	0.56[2]	Insignificant	4.1
Value of seed imports (million US$)	21.4[1]	10.5	5.3[2]	120	9.1

1. January-November 1994
2. Values for 1990
3. Does not include vegetable seed

Sources: Argentina (INASE); Chile (ANPROS); Colombia (ICA); Mexico (PRONASE); Uruguay (MGAP)

Seed markets in the countries are composed of the following segments: hybrids grain crops, generally dominated by multinationals, a smaller one of (hybrid) vegetables, also dominated by imports and multinationals, and self-pollinating crops, in which domestic companies are most active. Hybrid seed sales are very important in Argentina, in contrast to the rest of the countries where self-pollinating crops are more important. The markets of grain crops are supplied principally by local production, because of ecological constraints and local quality preferences. Vegetable and forage seeds are supplied both by imports and local production. Colombia imports all of its needs of these types of seed. Mexico imports substantial quantities of seed from the USA, principally maize, sorghum and vegetables.

Only Uruguay and Chile have significant seed exports. In the former, forage and rice seed have been produced for export since 1983 and this activity is growing. Chile has an important counter-season seed production activity since 1984. Taking advantage of favourable climate and costs, a number of mostly

multinational companies have been producing seed (principally maize and vegetables) exclusively for export to northern-hemisphere markets.

1.3.2. Industrial structure

The industrial structure of the seed industry in the five countries is a mix of public institutes, private domestic companies, multinational companies, cooperatives, and farmers associations (table 1.5). The plant breeding function is dominated by public research institutes. The most important ones are the national agricultural research institutes, with some universities and provincial experimental stations having small breeding efforts in a few crops. The research institutes have broad programmes covering most economically important crops. Relatively few private companies have breeding programmes, and they concentrate on a few profitable crops (hybrids). Locally owned companies specialize in self-pollinating varieties, while multinationals dominate hybrids. Only Argentina has a significant private sector breeding activity.

Seed production is done by a multiplicity of private companies and cooperatives. They license varieties from the breeders or buy foundation seed for propagation. Some of them sell seed directly to farmers, but most of the distribution is done through commercial networks of outlets offering a whole range of agricultural inputs and services to farmers.

Argentina has the most developed plant breeding industry of the five countries, composed of 8 public sector breeding institutes and more than 50 private breeding firms with some varieties on the market. But only 15 firms are significant, accounting for more than 85 per cent of the total seed market. These breeders license their varieties to propagation companies for the production of seed. The yearly sales for a succesful hybrid company in Argentina ranges from US$ 10 to 40 million, while the most succesful firm dealing with self-pollinating varieties never exceeds US$ 6 million, with an average of US$ 2 million for most of these companies. The seed multiplication companies segment includes some large co-ops, multinational companies and smaller private seed companies. The national research institute INTA stimulated the creation of a large seed production co-op, called PRODUSEM, as an outlet for its varieties. Grain elevators participate in the market, retaining portions of the harvest to be later sold as seed.

Table 1.5 **Composition of the seed industry in five Latin American countries**
(Number of organizations by type)

	Type of organization	Argentina	Chile	Colombia	Mexico	Uruguay
Plant breeding	Public	8	3	2	7	2
	Private	50 (active)	5	7	14	6
	Total	58	8	9	21	8
Seed production	Public	40[1]	n.d.	–	1[3]	1
	Co-op	200	n.d.	14	3	8
	Private	950	110**	43	13	36
	Multinational	7	14	9[2]	6	–
	Producers association	–	n.d.	9	up to 50	1
	Total	>1197**		75*	>73**	46**

1. Includes companies which produce for public institutes
2. 4 operate directly and 5 through joint-ventures with Colombian companies
3. Additional organizations linked to the public research system (*patronatos*) produce seed

* Certified seed

** All types of seed

The breeding sector in **Chile** is also dominated by the national agricultural research institute INIA, with two universities playing a minor role. Around 130 companies multiply seed, among them 14 multinationals. Only five companies have breeding programmes. In **Colombia,** public research institute ICA concentrates most of the plant breeding efforts in the country. The National University has a small programme in sorghum, and 3 farmer associations have breeding programmes in rice, coffee and sugar-cane. Seed multiplication is done by a large group of relatively small organizations. 72 of them were officially registered as certified seed producers by the regulatory authority in 1994. Multinationals have a relatively small direct influence in this industry.

The seed industry in **Mexico** is experiencing a rapid expansion. The public sector, through national research institute INIFAP and some universities, is still an important plant breeder, but multinationals are increasing their investments in this activity. The private sector now clearly dominates production and marketing, with PRONASE, the public company formerly leading seed production, now having a small share of the market. Companies able to take advantage of the retreat of PRONASE are mostly multinationals. Some few locally owned companies also participate in the markets.

Uruguay has a relatively large breeding sector, taking into account the size of the country. Its national research institute is also the most important breeder. Private companies breed barley, forage crops and rice. Seed was produced by 46 companies, 36 of them registered as certified seed producers, in 1994. No multinational company operated directly in this country.

In contrast to the propagation and distribution stages, in all five countries only a small number of companies is involved in plant breeding. A few breeders dominate a large share of the variety markets of specific crops. However, this dominance can be shorthived, especially for companies lacking a broadly based breeding programme, which can provide new varieties when the older ones begin to be exhausted. Seed production and marketing is less concentrated. Many companies multiply public varieties or license ones from breeding companies.

Private involvement in the seed industry is highest in Argentina. Production and marketing is completely in private hands, but the public sector still dominates the breeding activity, although its behaviour is more like a private industry. The situation in Chile, Colombia and Uruguay is similar, but there public sector breeders are only beginning to adopt commercialization policies. Mexico, as a result of its drastic and rapid liberalization policies, is leap-frogging to a stage dominated by private, mostly multinational, companies.

1.4 Development of seed regulations

What is the importance of seed regulations for the development of a seed industry? Historically, the first important effect of seed regulations surely is the creation and consolidation of commercial seed markets as such. By establishing minimum quality standards for seed production and marketing, the basic rules are set for the definition of products and markets, permitting the development of private sector firms. Since regulation always trails behind production and marketing, the effect is not so much the creation of products and markets *de novo* but the organization, formalization and 'technification' of existing productions and markets. In this sense, regulations are an expression of national agricultural 'modernization' agendas in many countries.

The importance of new varieties for local agriculture drives the expansion of regulations from limited quality and sanitary objectives to broader control of new

varieties and the stimulus of their local introduction. Intellectual property considerations become important in this context. The importance of local breeding and of access to new varieties are factors in this qualitative change in seed regulations. Conversely, the consolidation of a domestic breeding industry could depend significantly on the existence of an adequate regulatory framework.

This general model is borne out by the history of seed regulations in the five countries studied. Seed regulations, and the corresponding institutions created to enforce them, were established some 10 to 20 years after the start of breeding and of production of improved seed, as the comparison of tables 1.3 and 1.6 shows. They seem to coincide with one important step in the development of national seed systems, that is, the entry into seed production of private sector actors on a significant scale. Seed regulations were the way in which the state tried to guarantee certain quality standards for the consumer, that is, the farmer. For this reason, the first regulations all had the objective of safeguarding agricultural health and of establishing some standard of agronomic performance. In the cases where the origin of varieties is mostly domestic public sector breeders, regulations concentrate on the production and marketing of seed. When varieties are mostly imported, the control of the release of new varieties may also be included in the regulations.

Table 1.6 **Development of seed regulations in five Latin American countries**

	Argentina	Chile	Colombia	Mexico	Uruguay
Important milestones	First seed law in 1935, based on European models (quality objectives)	First seed law in 1944 (sanitary objectives) Modified in 1970	Committee for seed control created in 1965	First seed law of 1961 (quality and sanitary objectives)	First seed law in 1968, (quality objectives)
Current legal basis	Law of 1973, by-law in 1978 (quality and PBR objectives), three other by-laws (last 1991)	Law of 1977, various later by-laws (quality and PBR objectives) National variety list created in 1993	Collection of ministerial and seed authority decrees and resolutions, starting in 1965 (quality objectives only)	Law of 1991, by-law in 1993 (quality objectives only)	Law of 1981 and later by-laws (quality and PBR objectives)
Current seed authority	Auto-financed public agency, INASE, created in 1991	Seed Department within agricultural health authority, SAG	Office for seed certification established in 1966 within agricultural health and research authority, ICA	National seed inspection and certification service within Secretary of Agriculture (created in 1961)	Seed unit within Ministry of Agriculture created by 1981 law

In Argentina, and later also in Chile and Uruguay, the existence of significant private breeding activity or the commercial orientation of public sector breeding programmes gave rise to the enactment of seed laws encompassing quality, sanitary, and marketing controls, as well as the protection of breeders' rights. Colombia and Mexico have only very recently expanded their seed regulations to include PBR objectives. In contrast to the Southern Cone countries they choose to deal with breeders' rights from a more genuine intellectual property perspective, that is through the introduction of specific PBR legislation. This is an indication that the origin of this development is not the maturation of the seed and breeding industry but other factors, external to the domestic industry. Chile very recently (November 1994) enacted a special PBR law, which demonstrates that these external factors (international pressures and recent multilateral trade agreements) are also important in the other countries.

The characteristics of the current seed regulations are shown in table 1.7. Colombia and Uruguay have stricter regulations, similar to those in Europe. In both countries, official tests assess the value of a new variety before its registration in the national list, which is a requisite for seed production and commercialization. These growing trials take between two and three years and are carried out in different regions of the country. Seed certification is optional in Uruguay, however. Argentina and Chile have a European influence in their seed regulations, but combined with some more US-style features. For example, both accept the description provided by the breeder for the registration in the national list. Certification is mandatory for a small number of the most important crops in Argentina. In Chile it is optional.

Table 1.7 **Characteristics of seed regulations in five Latin American countries, in 1994**

	Variety release	Seed certification	Seed marketing
Argentina	• Mandatory registration of new varieties in national list DUS information provided by breeder • Mandatory varietal certification for wheat, oats, barley, rice, maize, linseed, sunflower, soya bean, peanut, potato, cotton and tobacco (VCU data provided by breeder)	• Mandatory for maize, sorghum, sunflower and potato, optional for rest of crops • Includes VCU (for some crops) and seed quality criteria (all crops) • Inspections by seed authority	• Mandatory registry of seed dealers • Non-certified seed (*semilla identificada*) has to be identified regarding its origin
Chile	• Mandatory registration of new varieties • DUS information provided by breeder	• Optional • Seed quality criteria only • Inspections by seed authority	• Mandatory registry of seed producers and dealers • Mandatory quality, labeling and identification standards
Colombia	• Mandatory registration for 12 crops included in certification system • VCU tests done by seed authority	• Mandatory for 12 crops • Inspections by seed authority • VCU and seed quality criteria	• Mandatory registry of seed producers • Mandatory quality, labeling and identification standards
Mexico	• Optional registration in national list • DUS information provided by breeder	• Optional • Inspections by seed authority or authorized persons	• Mandatory labeling standards • Mandatory registry of producers and dealers of certified seed
Uruguay	• Mandatory registration for cereals, oilseeds and forage crops • VCU tests done by seed authority and national research institute	• Optional • Inspections done by seed authority • Quality criteria	• Mandatory registry of seed producers and dealers • Mandatory quality, labeling and identification standards

DUS = Distinctness, Uniformity and Stability
VCU = Value for Cultivation and Use

Mexico has recently substituted its restrictive 1961 seed legislation with a very liberal seed regulation system. The new system is limited to the establishment of some commercialization standards, leaving other controls to the market. Even seed certification can be done by private industry. This is a radical departure from its former approach, which gave the national research institute and the public seed production company a virtual monopoly in the most important staple crops.

1.5 Perceptions of seed regulation

Effective seed regulations in any country should produce transparent and efficient seed markets, permit efficient seed production, protect agriculture from the sanitary and agronomic point of view, and stimulate local plant breeding. The perception of its effectiveness, independently of the actual working of the system, varies depending on the interest of the actor and his ideological orientation on the role of the state in the economy. Farmers often support seed regulations, in contrast to breeders and seed producers, many of whom are against state regulations in principle.

This came out clearly in the survey carried out in this study. In **Argentina,** almost all interviewed persons recognized the positive results of the radical restructuring of the national seed authority done a few years ago. They valued its small size, private sector participation in its administration, and efficient response. The national registry of varieties was generally supported. The certification system is accepted by breeders of self-pollinating varieties, although criticized in its operation as too slow and cumbersome. Breeders of hybrids, by contrast, are philosophically opposed to this system. Seed producers and private plant breeders in **Chile** generally perceive the national certification system as efficient. As certification is optional, firms use the system only in case they can use it for their own purposes.

There is a political debate also in **Colombia** on the role of the state in regulating the seed industry. The farmers' organizations consulted were critical of the seed industry in general and, consequently, of seed regulations. There was a general dissatisfaction with ICA, the national seed authority, although many blamed its shortcomings on the insufficient support it gets from the government.
In **Mexico** there is a generally critical opinion of seed regulations and seed authorities. Some think they have been insufficiently implemented, because of lack of political will and technical weakness on the part of the seed authority. Others, mostly from the seed industry, see the regulations as a problem per se. All agree that there are important technical and institutional shortcomings in the national seed authority.
The different actors of the **Uruguayan** seed industry were, in general, also critical of the national seed authority in this country. Most seed industry representatives base their negative opinion on ideological reasons, wanting to see less state intervention in seed production and marketing. Some expressed dissatisfaction with the operation of the system.

1.6 Perspectives of the seed industry

The international seed industry has undergone profound changes in the last 20 years. It is evolving rapidly from an industry characterized by small and medium size domestic firms, many family-owned, depending on public-sector varieties, into a national and global industry, integrated by large firms with important proprietary breeding programmes. The development of breeding capabilities by private industry and the redefinition of the role of public sector institutions in plant breeding and seed production is one important reason for this long-term trend.

Another important, and more recent, force behind this evolution has been the interest of large multinational, principally chemical, companies, in diversifying and complementing their agricultural inputs product lines. In this way, they have been positioning themselves to exploit the future promises of biotechnology. In the opinion of William Teweles, respected US seed industry consultant, the result of this consolidation process will be a maximum of 12 leading international seed companies, of which only 4 will be from the USA (Seed Ind. J., 1990).

These large companies will share the markets with many small and medium size companies, 2400 in North America and Europe and 800 in Latin America and Asia, catering for special and local needs.

This consolidation process will be fuelled by the trend towards identity preserved production, proprietary crops, and prescription farming. Close cooperation between seed production, farming, biotechnology, and food processing is a requirement, calling for joint ventures or close cooperation between different companies. Food processors will join agri-chemical companies in controlling the seed industry (Seed Ind. J. 1990).

These international developments deeply influence the seed industry in Latin America. The opening of the economies increases their sensitivity to outside events and trends. The presence of leading multinationals in most countries guarantees that new technologies, products and production and marketing strategies are introduced quickly. The five countries studied clearly have advanced significantly in the transition towards a more private seed industry, with less public sector presence. Breeding by private companies is still weak, particularly by locally owned companies. The difficulties and costs in breeding will limit this development to relatively larger companies, unless stable long-term joint-ventures between the public-sector breeding institutes and some domestic companies are consolidated.

The advantages of multinationals in breeding and, especially in the near future, their dominance of biotechnology, could lead to a greater transnationalization of the seed industry in the region. Their current dominance of hybrid crops could be extended to self-pollinating crops, if hybrids are developed in more crops and if adequately protected transgenic varieties become important. But the advantages of multinationals do not automatically or necessarily lead to domestic market shares. Many other production and marketing factors are important, and national companies often have more flexibility and can take advantage of local knowledge. Particularly important is their experience and position in self-pollinating varieties. Opportunities therefore exist for national or regional companies to consolidate into medium and even large-scale firms. The larger markets created by the recent free-trade agreements could be an important factor in this consolidation.

This underlines the importance of the general development strategies being adopted by the countries in Latin America. The creation of a favourable macro-economic climate for the development of a competitive plant-breeding industry is only a necessary, but not sufficient, condition. Finer, more sophisticated, policies supporting this potential development will be of crucial importance. The critical factor in the future perspectives of the domestic industry is their breeding capability. The role of the public sector in their consolidation or expansion on the national level, be it in public institutes or in private domestic industry, is central. For example, at present only the state can make the required investments in Latin America to develop biotechnology capabilities for plant breeding, and therefore create potential for competion with the multinationals. The creation of the required general conditions (availability of trained personnel, regulatory and legal framework, financial conditions, etc.) for a competitive national or regional seed industry is another task crucially dependant on public sector action. In this context, the introduction of a specific incentive for plant breeding, like plant breeders rights, is certainly an important option which merits careful analysis.

The supply of adequate varieties and seed for resource-poor farmers is a special problem within this general context. Its satisfactory solution will remain an important public sector and NGO responsibility.

2 Introduction and enforcement of plant breeders' rights

Protection of intellectual property has always been a subject of political dispute. The theory of intellectual property rights is that the prospect of a monopoly granted by the state will encourage investment in innovative activities and consequently result in more technology available to society. It is especially in an international context that this supposed 'win-win' situation has raised controversy. Ever since the early 1960s, developing countries have had a very critical attutude towards strong legal protection of technology, which resulted in their attempts to revise the system of patent protection in the 1970s. The developing countries argued that there was little innovative activity in their countries that could be patented. The patents that were actually granted in their countries predominantly favoured multinational enterprises who used the patent monopoly to restrict diffusion of their technology (United Nations 1975).

The attitude of many developing countries towards intellectual property protection has shifted profoundly in recent years. Developing countries have been confronted with a widening of the technology gap vis-à-vis developed countries. The need to participate more intensively in the international technology system and to improve access to advanced foreign technology, compelled developing countries to lift technology import controls and to strengthen intellectual property protection legislation. Political and trade pressures by foreign governments and industry organizations have speeded up the process of change, and were instrumental in imposing specific international norms for the protection of intellectual property (Van Wijk and Junne 1993).

The recent introduction of, or amendments to, plant breeders' rights (PBR) legislation in the five Latin American countries must be assessed against this background. Even though protection of PBR has never attracted the same attention as the legal protection of pharmaceuticals or computer software, feelings about PBR are mixed. Some prefer the adoption of a PBR system to stimulate plant breeding in their country; others perceive the system primarily as a necessity and practically imposed by foreign forces. This variance in accepance of PBR has influenced both the introduction of the PBR system and the way it has been or will be implemented and enforced.

The PBR system was first introduced in Latin America in the three Southern Cone countries: Argentina, Chile, and Uruguay, where the protection of plant breeders' rights formed part of general seed laws promulgated in the 1970s and 1980s. Colombia introduced genuine PBR legislation in 1994, while Mexico is expected to do so in 1995. The objectives have been more or less similar in all five countries and basically include the fostering of private plant breeding and the improvement of access to foreign high quality varieties. Despite the similarity in objectives, the political constellations under which PBR has been introduced differs for each of the countries.

2.1 The politics concerning intellectual property protection of plant material in five Latin American countries

The first initiative to establish legal protection for plant varieties in the five Latin American countries dates back to 1936 when, in **Argentina,** a proposed *Ley de Patentes de Plantas* was submitted to Congress by a ministerial *ad hoc* commission. The bill was never discussed, however. PBR would only be introduced in Argentina some 40 years later as a result of lobbying by some influential breeders. The *Ley de Semillas y Creaciones Fitogenéticas* (No. 20.247) was promulgated in 1973 and regulated in 1978. In **Chile,** PBR protection was established under the Ley *'que fija normas para la Investigación, Producción y el Comercio de Semillas'* (Decreto No. 1764), promulgated in 1977 as a response to demands by domestic and foreign seed companies. The first talks about plant variety protection in **Uruguay** were initiated in the mid 1970s by the Shell oil company, which had seed activities in the country at that time. Other advocates of PBR were the larger seed companies which maintained relations with, or represented, multinational seed companies. A major reason for Uruguay to enact PBR legislation was its close economic relationship with Argentina. Lack of PBR protection could have had adverse effects on regional seed trade. PBR legislation was established under *Ley de Semillas* (No. 15.173), enacted in 1981, and modified and regulated by Law No. 15.554 in 1984, as well as by various subsequent by-laws.

In neither Argentina, nor in Chile or Uruguay, has PBR protection been publicly debated. The absence of an open discussion may be partly due to the military governments in Argentina and Chile which prevented any public debate at the time the PBR laws were adopted. But later, when civil governments had returned, PBR did not become a politically sensitive issue. On the contrary, in Argentina for example, it is generally recognized in the agricultural sector that the breeders *Klein* and *Buck* have bred famous grain varieties without being sufficiently remunerated. Moreover, PBR protection was perhaps not an important item for farmers and propagators, considering their low participation in the committee that designed the PBR law and in which they were represented. The precise reason for the five year gap between promulgation and regulation of the law in Argentina is not clear. Some say that the civil government, which came into power in 1973, 'forgot' the law in an attempt to save it from repeal because it was a law adopted by the militaries. Others maintain that the new government just had other priorities. In Uruguay, there have been individual dissenting voices, but they have not been powerful enough to influence governmental policy.

Alleged insufficient legal protection for advanced technology in various areas in **Mexico** has resulted in years of conflicts with the US government. Mexico was one of the first countries put under considerable US pressure to strengthen its intellectual property laws (Bennet 1989). The country began to strengthen protection of intellectual property in 1990 when the liberalization programme was launched and plans for the Mexican partnership in the *North American Free Trade Agreement* (NAFTA) began to materialize. Under this agreement, Mexico is obliged to adopt PBR legislation before the end of 1994. The PBR Bill, the *Ley Federal del Derecho del Creador de Variedades Vegetales*, was still under discussion in early 1995, however.

Protection of plant breeders' rights has not aroused much controversy in Mexico. Adoption of a PBR system has been advocated by the seed companies association, led by the president of *Hybridos Mexicanos*, a subsidiary of the US company Pioneer Hi-Bred. Other supporters of PBR legislation are cultivators of fruit and ornamental plants who meet increasingly with demands from foreign breeders for stronger protection of their varieties in Mexico. Opposition has mainly come from the public sector. Interviews conducted during this project

showed a general antipathy towards privatization of public sector research among Mexican breeders and researchers in the public sector. Farmers associations and NGOs which work with small-scale farmers appeared not to be very well informed. The only issue that received public attention in this area was the opportunity, created in 1991, to protect plant varieties under the new Mexican patent law. The challenged provision was never regulated, however. The patent law was amended in August 1994 and does not provide protection for plant varieties any longer. Varieties must be protected under PBR legislation.

In **Colombia** PBR protection was introduced when the Andean Pact countries decided to establish a common regime on PBR. In October 1993, the Junta of the Cartagena Agreement adopted Decision 345 on a *Régimen Común de Protección a los Derechos de los Obtentores de Variedades Vegetales*. The Decision was based on the draft PBR law proposed to the Colombian Senate. At the same time, another Decision (No.344) on a *Régimen Común sobre Propriedad Industrial* was adopted. The latter enabled the protection of plant material, plants, or plant varieties under patent law. The PBR Decision was regulated in Colombia by Decree 533 (March 1994); the Decision on industrial property was regulated by Decree 2679 (December 1993) and Decree 117 (January 1994).

Advocates of PBR are *Acosemillas*, an association of Colombian seed companies, ICA, the main public agricultural research centre in Colombia, the Ministry of Agriculture, and *Asocolflores*, the association of cut flower producers and exporters. The first initiative of Asocolflores to introduce PBR dates back to the 1970s. Cut flower producers in Colombia said that access to advanced foreign varieties was denied due to the lack of legal protection in Colombia. Domestic demands for PBR were accompanied by foreign pressure for stronger intellectual property protection, mainly from the US government. Opponents of PBR in Colombia include members of the academic community, indigenous groups, several agricultural NGO's, and the Ministry of Environment (previously INDERENA). These organizations are concerned that PBR law will predominantly serve the seed industry and cut flower producers, and may harm local farming communities and biodiversity.

PBR has caused considerable debate in Colombia. During the period 1991-1993, various political meetings were organized with seed companies, public institutes, NGOs and governmental departments to discuss the implications of PBR for Colombian agriculture. A compromise resulting from these meetings was worked out in the Congress in 1993. The Ministry of Commerce, however, followed its own route to have PBR legislation enacted and prepared an Andean Pact Decision, the implementation of which by member states is mandatory. The Andean Pact Decision took the organizations involved in the Congress Bill by surprise and provoked considerable resentment from them. The content of the Andean Pact Decision and the Congress Bill differ in some important respects. Although the duration of PBR is shorter in the Decision, the scope of protection is much wider, and includes harvested material and essentially derived varieties.

In sum, all five Latin American countries have recently enacted or strengthened PBR legislation. This development is the result of both domestic and foreign demands from:

a (domestic seed companies which want to protect their own plant varieties;

b domestic seed companies and cultivators of fruit and ornamental plants which felt pressure from foreign breeders to improve the legal protection in order to get better access to foreign breeding lines and varieties;

c subsidiaries of foreign seed companies which want protection of their varieties and breeding lines in order to enter the Latin American seed markets,

d public agricultural research centres which are in need of additional income to compensate budget cuts, and

- foreign governments aiming at an overall strengthening of intellectual property rights protection in Latin America. In addition to this, all countries are committed to provide for legal protection of plant varieties under the new multilateral trade agreement, concluded under the aegis of GATT.

Opposition to PBR has come from the side of some public sector researchers and agricultural NGOs, but has generally been weak. Only in Colombia did the opposition develop some strength, but that could not prevent the adoption of PBR legislation.

2.2 Accession to UPOV

The PBR laws that were in force in Argentina, Chile and Uruguay were inspired by, but not fully in harmony with, the convention of the *International Union for the Protection of New Varieties of Plants* (UPOV).[1] When these countries decided to become members of UPOV, they had to amend the existing laws (Uruguay and Argentina) or adopt a new one (Chile). The laws in Colombia and the proposed law under discussion in Mexico have been directly designed according to the principles of UPOV.

1. As from May 1995, UPOV has 27 member states: Argentina, Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Poland, Slovakia, South Africa, Spain, Sweden, Switzerland, United Kingdom, United States of America, and Uruguay. The deposit of instruments of accession of Colombia, Chile, Portugal, the Russian Federation and Ukraine are expected in 1995 (Communication with UPOV).

Table 2.1 **Plant breeders' rights in five Latin American countries.**
Situation January 1995

	Year of adoption and regulation PBR law	Year of accession to UPOV	UPOV act adhered to
Argentina	1973/1978	1994	1978
Chile	1977, new law in 1994	1995*	1978
Colombia	1993/1994	1995*	1978*
Mexico	1995*	1995*	1978*
Uruguay	1984/1987	1994	1978

* To be expected

The main reason to accede to UPOV is more or less the same for all five countries. Having a PBR legislation without being member of the international union of countries with a PBR system would generate distrust and a lack of credibility of the system with the foreign seed industry. Mexico is, moreover, obliged to accede to UPOV under the NAFTA agreement.

Until the 1st of January 1996, UPOV offered two options to new developing country member states. They could either adhere to the act of 1991, or to the previous act of 1978. Argentina, Uruguay and Colombia have opted for the latter act, because this act was considered to be adequate and most feasible to implement, even though elements of the 1991 act have been already included into their laws. Argentina and Uruguay deposited their instrument of accession in October 1994. In 1995, the legislation which enables Colombia to become party to UPOV was in preparation, while Chile had requested the advice of the UPOV Council concerning the conformity of its law with the 1978 act. Mexico was expected to adhere to the 1978 act also.

2.3 Comparison of protection provided

The PBR laws in Argentina, Chile, Colombia and Uruguay, the proposed PBR law in Mexico, as well the patent coverage for biological material provided in these countries differ in several aspects (see tables 2.2 and 2.3). The most salient differences and similarities are the following:

a Among the five countries, only Uruguay uses the opportunity provided by the 1978 act of UPOV to protect, for the time being, a limited number of plant species.

b Argentina also includes 'discovered' new varieties in its law. The objective of this inclusion is to enable protection of 'sports' (plants that deviate from the variety) of fruit-tree varieties. This has never happened, however. Species that are found in nature or have not been planted or created by man are specifically excluded from protection in Mexico and Colombia. The proposed Mexican law also excludes protection of landraces ('criollos').

c Three countries have included elements of the UPOV 1991 act, even though they have adhered to, or are planning to adhere to, the 1978 act. Argentina and Mexico provide for a protection of a minimum of 20 years; the scope of PBR in Colombia includes both propagating and harvested material of the variety; and Colombia and Mexico (implicitly) have included the principle of essential derivation into their PBR legislation and PBR Bill respectively.

d All five countries specifically lay down the farmers' privilege in their laws.

e In Argentina, Chile, Mexico and Uruguay, plant varieties cannot be protected by patents. In Colombia, plant varieties are not specifically excluded from patent protection. However, according to the Colombian Patent Office, patenting of plant varieties is not considered. Moreover, if the country indeed will accede to the UPOV act of 1978 it will be bound to the ban on double protection which is part of this act. It provides that in countries where plant varieties are eligible for protection under both patent and PBR legislation, one and the same botanical genus or species may be protected by only one of these forms. Plant material, other than varieties, seems to be patentable in the Latin American countries, except for Uruguay.

Table 2.2 **Protection of plant material under patent law in five Latin American countries**
Situation 1995

Argentina	Plant varieties are excluded from patent protection in the new patent law, that has been adopted by Congress in Spring 1995.
Chile	The 1991 patent law excludes from protection plant varieties and animal races.
Colombia	The common patent regime for Andean Pact (Decision 344, 1993) excludes from protection (among other things): **a.** Inventions which are evidentially contrary to: the health or to the life of persons or animals, the preservation of plants, or the preservation of the environment. **b.** Animal species and races and essential biological procedures to obtain them.
Mexico	The 1991 patent law, amended in 1994, excludes from protection (among other things): **a.** Essential biological processes for production, reproduction and propagation of plants and animals; **b.** Biological and genetic material as found in nature; **c.** Plant varieties and animal races.
Uruguay	The patent law of 1941 does not explicitly exclude plant material from protection. It is, however, not possible to protect such material because of specific patent requirements concerning the industrial nature of the subject matter.

Table 2.3 **Main characteristics of PBR protection conferred in five Latin American countries in comparison with UPOV**
Situation in August 1995

	UPOV 1978 act	UPOV 1991 act	Argentina
Subject matter	Plant varieties of nationally defined species	Plant varieties of all genera and species	Created or discovered new cultivars of all species
Duration	Min. 15 years	Min. 20 years	20 years
Scope of PBR	Propagating material	Propagating and under some circumstances harvested material.[5] Optional: Products made directly from harvested material.[6]	Propagating material
Protection of F1 hybrids	Yes	Yes	In practice: no
Breeders' exemption[7]	Yes	Yes. Marketing essentially derived varieties requires permission.[8]	Yes
Farmers' privilege[9]	Yes, implicitly	Optional and under conditions[10]	Yes, explicitly included[11]
Compulsory licence[12]	Yes	Yes	Yes

1. Proposed PBR law.
2. Species or individual plants which have not been planted or improved by man do not fall within the ambit of the law.
3. Excluded from protection are plant species as found in nature as well as plant varieties in the public domain ('criollos' or native varieties).
4. Alfalfa, rice, oats, barley, dactyle, fescue, *Lotus comiculatus, Lotus subbiflorus,* ryegrass, serradela, soya bean, white clover, red clover, wheat, achicoria, oil seed rape and rescue grass. No protection is granted for horticultural, ornamental, and fruit species, or for trees.
5. Commercialization of harvested material of a protected variety does only require authorization if it is obtained through the unauthorized use of propagating material of the variety and if the breeder has had no reasonable opportunity to exercise his right in relation to the propagating material.
6. Where a State so opts, commercialization of products made directly from harvested material of a protected variety does require authorization, only if the harvested material is obtained through the unauthorized use of propagating material and if the breeder has had no reasonable opportunity to exercise his right in relation to the said harvested material.
7. The protection of a variety does not impede its utilization as source for further breeding.
8. A new variety will be considered to be essentially derived when the new variety retains the essential characteristics that result from the genotype of the source variety (see also paragraph 5.2.1).
9. Farmers may save seed from their own harvest for uses other than commercial marketing. This exemption does not apply to ornamental plants and cut flowers (see also paragraph 6.1.2).
10. Farmers may be allowed to save seed within reasonable limits and subject to the safeguarding of the legitimate interest of the breeder.
11. This privilege does not apply to plants or parts of plants of fruit, ornamental and tree species.
12. Only in the public interest, in case the produce of a crop is absent in the country and the beneficiary of the property right does not supply the public need of the seed of the cultivar in reasonable quantity and price. The rightholder must be adequately compensated.
13. The proposed law speaks about 'emergency licences'.

Chile	Colombia	Mexico[1]	Uruguay
Plant varieties of all botanical species	Varieties of all botanical genera and species[2]	Varieties of all plant species[3]	Plant genetic creations or cultivars of 17 species[4]
Min. 15 years	Min. 15 years	Min. 20 years	Min. 15 years
Propagating material	Propagating and harvested material[5]	Propagating material	Propagating material
In practice: no	Excluded	Yes	Excluded in regulation
Yes	Yes. Marketing essentially derived varieties requires permission	Yes. Marketing essentially derived varieties requires permission	Yes
Yes, explicitly included	Yes, explicitly included	Yes, explicitly included	Yes, explicitly included
Yes	Yes	Yes[13]	Yes

2.4 PBR enforcement

Medio 1995, the PBR systems in Colombia and Mexico are not yet in operation. In Colombia the law is only regulated at a general level, while in Mexico a law has not yet passed Congress. This section on enforcement consequently deals with Argentina, Chile and Uruguay.

2.4.1 Private action

As PBR are private rights of property, it is up the individual right holders to enforce and exercise their rights, i.e. to control the multiplication of their varieties and to collect royalties. Breeders can exercise their rights either individually or collectively. The experience in Latin America, especially in Argentina, indicates that the latter approach can be most effective.

Although the first plant varieties were inscribed in the *Registro Nacional de la Propiedad de Cultivares* in 1981, the Argentine PBR law remained a dead letter for many years. This situation had various causes. First, a lack of information prevented title holders from exercising their rights properly. The typical situation was that the authorization of seed propagation relied on initiatives by the propagator, rather than on action by the breeder. Second, high inflation during the 1980s forced breeders to develop other strategies to obtain income; royalties were less important. Third, lack of credit and high interest rates prevented many farmers from buying fresh seed and this situation gave way to the replacement of professional seed companies by grain elevators or cooperatives as non-official

providers of seed. The latter organizations offered farmers grain for seeding purposes in exchange for a double quantity of grain from the farmer's harvest, a method which is referred to as *canje* (swap).

The first effort to defend PBR was realized around 1990 by the three Argentine wheat breeders: two private companies *Buck* and *Klein*, and *Produsem*, a private cooperative which had been created by the public research institute *INTA*. Produsem is INTA's main licensee for seed multiplication. The wheat companies launched a joint campaign to defend their plant breeders' rights by encouraging those dealers who were trading seed that was produced without authorization to change over to an official system including the registration of seed transactions, licensing contracts and royalty payment. The wheat breeders' initiative was followed by the creation of an association of plant breeding organizations: the *Asociación Argentina de Protección a las Obtenciones Vegetales* (ARPOV). ARPOV started in 1991 with 13 companies. Three years later the association represented 45 organizations of various kinds: national seed companies, public institutes, universities, cooperatives, and subsidiaries of seed multinationals. A condition for membership is that the organization maintains a plant breeding programme or a programme for adaptation of foreign varieties.

ARPOV has designed a successful administrative system to control the licensing of seed production. The organization developed a licensing contract that requires:

- registration and protection of the variety,
- an agreement between the breeder and the producer,
- the licensee to offer information upon request
- penalties for non compliance with the Seed Law,
- the licensee to maintain a seed book
- the licensee to authorize ARPOV to realize audits at the licensee's premises

Seed bags that are traded through the ARPOV system carry a special stamp with a code number that refers to the names of the breeder, the licensee, contract number, and the variety. These stamps and the seed books are regularly audited by ARPOV employees. Licensees can announce their adherence to the ARPOV system in their publications; ARPOV periodically publishes in the main journals the names of companies who are authorized to sell seed of protected varieties. The strength of the ARPOV system is based on the mutual cooperation of its members in imposing commercial sanctions in case of unauthorized seed production. When one licensee does not respect the rights of a member company, the licensee will automatically lose the opportunity to enter into a licensing contract with another member company.

ARPOV has a staff of nine people: a director, a manager, three auditors, three office staff and a part time lawyer. The organization is financed through sales of the ARPOV stamps to its members. The more they use the system, the more the members pay. Companies who deal with hybrids also participate, even though they do not face a market of seed produced without authorization. ARPOV offers hybrid seed companies the opportunity to keep general control of the multipliers and users of their hybrids. Actually, by participating in the ARPOV system the hybrid seed companies support the breeders of self-pollinating varieties in defending their rights. Half of ARPOV's annual budget of about US$ 800,000 is contributed through stamps for hybrids (maize 30 per cent, sunflower 20 per cent of total budget). The contribution of soya bean is 30 per cent, of wheat 10 per cent, and of other seed also 10 per cent.[2] By mid 1994, ARPOV had managed about 5000 seed multiplication contracts, with more than 1000 seed producers. The association sold more than 10 million stamps in 1993 and this figure grew to 12 million in 1994.

2. The price of the ARPOV stamp varies per crop and corresponds to the price of the produce. In 1994, the price was highest for a bag of sunflower seed (US$ 0.142) and lowest for linseed (US$ 0.015).

In contrast to the situation in Argentina, the control of protected varieties by the breeders in **Chile** and **Uruguay** has been less effective. These title holders have been following an individual strategy with results that differ per company. In both countries the breeders have recently changed their policies. Inspired by the effectiveness of ARPOV, several Chilean breeders created the *Comité de Obtentores Vegetales,* in November 1994, while Urugayan breeders founded *URUPOV* in January 1995. Both new organizations intend to issue stamps in order to exercise better control of the multiplication of protected plant varieties.

2.4.2 Government action

Even though PBR are private rights, the State may also take an interest in their enforcement. It is usually the seed authority that is also involved in the detection of PBR infringement. In **Uruguay** this is presently the *Unidad de Semillas,* which comes under the Ministry of Agriculture[3]. As inspections started only in 1994, no data on infringements were available. In **Chile,** the *Departamento de Semillas,* part of the *Servicio Agrícola y Ganadero* (SAG) and the Ministry of Agriculture, is responsible for infringement detection. The department has 24 seed specialists. They, together with some 50 inspectors of the SAG, monitor the seed market and check the seed for breeder's authorization.

3. In a Bill submitted to the Assembly, a new para-governmental institution is envisaged which should be better equipped to control the seed market for infringement.

Infringement detection in **Argentina** has been very weak for a long time, partly because of a lack of means. For example, the former PBR administering body (SENASE) had only four inspectors employed to control the seed trade in the entire country. This situation changed with the creation of the *Instituto Nacional de Semillas* (INASE) in 1991. INASE has about 70 employees, among them 20 inspectors. It is a self-financing organization, relying entirely on income from tariffs, which makes the institute unique within the Argentine public administration.[4] INASE comes under the Ministry of Agriculture, but its management board includes ample representation of the seed industry.[5] The institute supervises the trade in seed and must, among other things, secure the rights of PBR title holders and apply administrative sanctions. For this purpose, the institute has a police status for inspecting and analysing seed that is transported or offered for sale in the country. INASE checks the compliance with the license contracts and the presence of the ARPOV stamp. Inspections commenced in 1993 with the focus on wheat, soya bean, and forage seed. By May 1994, 163 fines had been imposed for violations of PBR. The sanctions that are involved in Argentina and the two other Latin American countries are presented in table 2.4.

4. There are doubts, however, whether the institute will be able to remain self-financing in the future. Tariffs as sole source of income is considered to be a narrow financial base.

5. The management board of INASE includes three representatives from the private seed industry and three from the public seed sector. Farmers organizations and the Ministry of Agriculture have one seat each.

Table 2.4 **Sanctions against infringement of PBR in three Latin American countries**

	Penalties in US$	Other sanctions
Argentina	Between 200 - 1,000,000	Closing down of establishment, temporarily or permanently.
Chile	Between 250 - 2,500	Confiscation of merchandise. Imprisonment.
Uruguay	Up to 530	Confiscation of merchandise. Closing down of establishment for 90 days.

Sources: INASE (Argentina), SAG (Chile), Unidad de Semillas, MGAP (Uruguay)

2.5 Effectiveness of PBR

2.5.1 The use of the PBR systems

One measure of the effectiveness of a PBR system is the use that is being made of it. In table 2.5 it is shown that, until 1994 in Argentina, 622 titles had been granted, of which 79 per cent were for self-pollinating varieties and 21 per cent for parental lines of three cereal hybrids. Of all titles granted, 31 per cent were for wheat and soya bean varieties, and 14 per cent for maize lines. In Chile, 231 titles have been granted, 26 per cent for wheat varieties, and 22 per cent for foreign fruit plants. In Uruguay, 25 PBR titles have been granted until February 1995. PBR in Uruguay can only be used to protect cereal varieties and some forages.

2.5.2 The decline of the black market

The second and main measure of effectiveness of PBR is the amount of seed that is produced with authorization of the breeder. Does the PBR system do what it is supposed to do, i.e. reducing what breeders call the black market?[6] This black market refers to all trade in seed of protected varieties that has been produced without authorization of the breeder. This market is fuelled by seed dealers (including grain elevators and cooperatives) who purchase grain from farmers and sell this grain as seed to other farmers. By doing so, they avoid the breeders interference and the payment of royalties and taxes. Taxes constitute a far higher burden for dealers than royalties. It has been estimated by INASE that the losses by this form of tax evasion for the Argentine state amount to as much as US$ 40 to 60 million annually.

6. A colourful variety of names is used on the American continent for the trade in unauthorized produced seed. In Argentina the reference is 'white bags' *(bolsa blanca)*, in Mexico the expression 'painted seed' *(semilla pintada)* is used, while in the USA the seed industry speaks of 'brown bags'. All expressions have the same meaning, however: the black market.

Reliable data on legally produced seed was publicly available only in Argentina. In this country, in 1989, 90 per cent of the seed dealers were not registered. In 1994, this figure was reduced to 40 per cent. INASE registered about 2500 seed dealers, together covering 70 per cent of the seed trade in Argentina. During 1993, 30 per cent of the soya bean and 25 per cent of the wheat market of certified and identified seed was inspected. The remaining unregistered dealers are difficult for INASE to trace, but are detected by the sector itself. Registered companies commence to persuade dealers who are not yet registered to become part of the legal system in order to avoid unfair competition with those who work with contracts. In the words of a respondent: 'If we have to play the game, then we all have to use the same rules'.

Argentine breeders started controlling wheat seed in 1990, and soya bean seed two years later (see figure 2.1 and table 2.6). For both crops the total annual seed consumption in the period 1990-1994 has been estimated at about ten million bags each. Around 30 per cent of the required seed, both in soya bean and in wheat, are legally provided by farmers themselves through on-farm seed saving. The remaining **wheat** market consists entirely of protected varieties. Of this market, 5.5 million bags or 80 per cent were authorized in 1994, against 1.2 million bags or 20 per cent in 1990. In 1994, half a million bags traded on the **soya bean** seed market, consisted of seed from public varieties that can be legally reproduced without authorization of the breeder. Another three and a half million bags of seed bags were authorized by ARPOV and a breeding organization that is not a member of ARPOV. This means that around 57 per cent of the actual soya bean seed market was authorized in 1994, while this figure was 28 per cent in 1992. Most of the soya bean seed that is traded without authorization is presumably from protected varieties, because the share of public varieties in the market is small. In sum, the enforcement of PBR in Argentina has increased the share of the seed supply that is now under control of the breeders, to 55 percent in wheat and 40 per cent in soya bean. These figures are nearing those in the USA where the share of authorized wheat and soyabean seed were respectively 60 and 54 per cent in 1986 (OTA 1989, p.55).

Table 2.5 **PBR titles granted in three Latin American countries by crop and by origin of right holder, up to 1994**

	Argentina				Chile				Uruguay[1]			
	National	Foreign	Total	%	National	Foreign	Total	%	National	Foreign	Total	%
Self-pollinating varieties												
Alfalfa	25	25	50	8	4	5	9	4				
Barley	7	2	9	1	10	1	11	5	7		7	28
Bean	10		10	2	17	2	19	8				
Linseed	14		14	2								
Maize	11		11	2	8		8	3				
Oats	7		7	1	8		8	3	1		1	4
Potato	19	1	20	3	9	22	31	13				
Rice	7		7	1	8		8	3	4		4	16
Rye	5		5	1		2	2	1				
Sorghum	15		15	2								
Soya bean	87	27	114	18								
Sunflower	15	2	17	3		1	1	1				
Tomato	16	2	18	3								
Wheat	78	10	88	14	61		61	26	1	7	8	32
Fruit						51	51	22				
Other	82	25	107	17	16	6	22	10	3	2	5	20
Total	**398**	**94**	**492**	**79**	**141**	**90**	**231**	**100**	**16**	**9**	**25**	**100**
Parental lines of hybrids												
Maize	11	76	87	14								
Sorghum	1	16	17	3								
Sunflower	6	20	26	4								
Total	**18**	**112**	**130**	**21**								
Total var. and lines	**416**	**206**	**622**	**100**	**141**	**90**	**231**	**100**	**16**	**9**	**25**	**100**

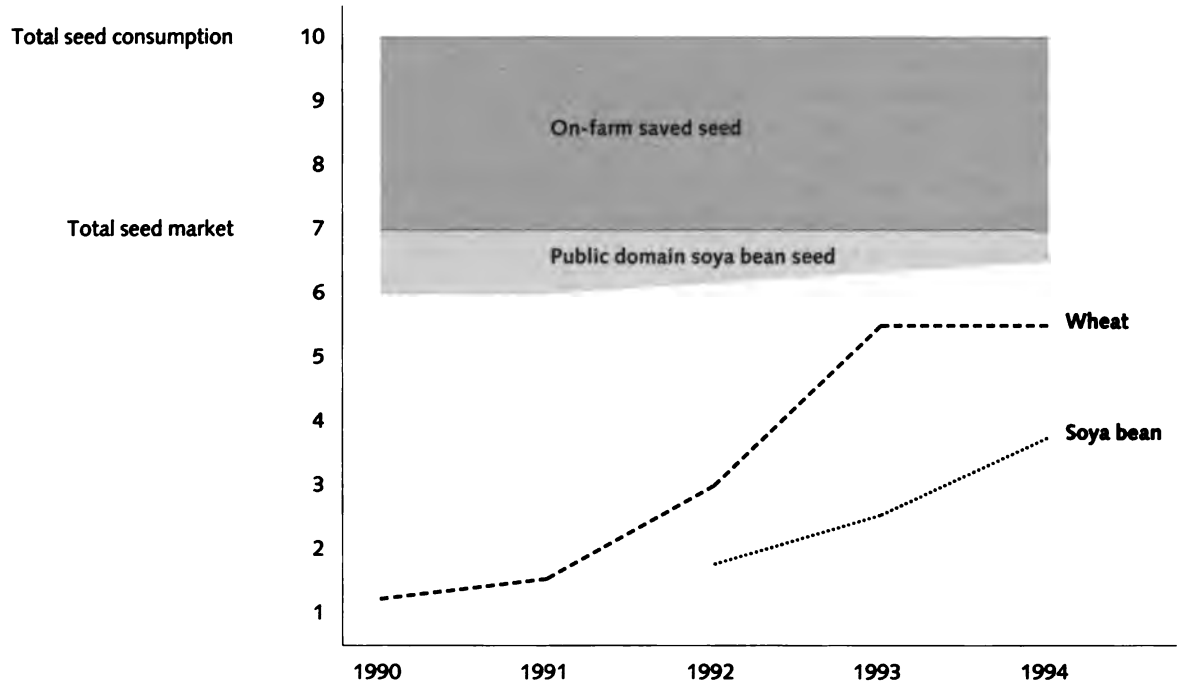
1. Data up to February 1995
Sources: INASE (Argentina), SAG (Chile), Unidad de Semillas, MGAP (Uruguay)

Table 2.6 **Authorized wheat and soya bean seed traded in Argentina**
(in million 50 kgs seed bags)

	Organization	1990	1991	1992	1993	1994
Wheat	ARPOV	1,200,000	1,500,000	3,000,000	5,500,000	5,500,000
Soya bean	ARPOV			1,600,000	2,200,000	3,130,000
	FACA			150,000	320,000	550,000
	Public domain seed	1,000,000		750,000	625,000	521,000

Source: ARPOV, INASE, and FACA. The figures are based on both official statistics and estimations.

Figure 2.1 **Authorized wheat and soya bean seed in Argentina as share of total seed consumption** (in million 50 kgs seed bags)



2.6 Opinions on enforcement and effectiveness of PBR

Of the 14 seed companies interviewed in **Argentina,** 11 companies said that the PBR system supported their business and that PBR had become indispensable for the development of the seed industry. Six companies used to encounter serious competition from the black market. At present, however, royalties make up an important part of their sales, between 15 and 60 per cent. In the opinion of the leading wheat and soya bean seed companies the enforcement of PBR in Argentina has been functioning excellently since the founding of ARPOV and the creation of INASE a year later. Nearly all seed producers accept working under license contracts.

Some shortcomings were mentioned too. Several companies pointed out that it is quite costly to monitor the market continuously and to control and detect infringements. The penalties against infringement, provided for in the Seed Law, were not considered to be severe enough, while they disapproved of the impossibility of imposing criminal sanctions. On the other hand, it was generally recognized that the working of PBR could be more adequate if more farmers and potential licensees were better informed about the PBR system and the risks of working illegally. Overall it was concluded that it was better to take some time for such an 'education process' than to forcefully repress illegal dealers.

But not everyone is happy with the enforcement of PBR in Argentina. The legal action against infringement by INASE is a source of permanent conflict and political pressures, and a seed dealers association has criticized what it calls the 'oligopoly of ARPOV'. This opposition has consequences for ARPOV. Within the breeders' organization some conflicts of interest exist between those companies who are entirely devoted to the markets of self-pollinating varieties on the one hand, and companies who are active in both the varieties and in the hybrids markets on the other. The former are more inclined to take a stronger stand against violators of PBR, because the seed of their self-pollinating varieties can easily be propagated and traded. Seed saving of hybrids occurs on a far

smaller scale and the breeders of hybrids are more concerned with the maintenance of a good relationship with those dealers who sell their hybrids. Some cases have been reported where breeders terminated successful programmes of self-pollinating varieties, presumably in order to avoid conflicts with the dealers about registration and royalty payments.

The **Chilean** law, as such, was not criticized by the nine breeding and seed producing companies and institutes; the enforcement was, however. Especially those breeders who are directed towards the national market said that the enforcement should be improved, because protection is 'actually non-existant'. The public understanding is considered to be poor. As one respondent put it: 'Laws that exist are not well known by plant breeders and even less by the farmers. Many are probably not aware that they are violating PBR'. It was notable that the causes for the inadequacy of PBR enforcement were laid at the door of the seed authority as being insufficiently equipped, rather than with the failure of the breeders themselves to exercise their rights. Various respondents said that the seed authority should receive sufficient budget to hire more, trained people. On the other hand, several companies said that they themselves should act more collectively in defending their rights, like ARPOV in Argentina. When companies have to keep control of the use of their varieties individually they have to take refuge in a reduction of licensing contracts, and in granting exclusive licenses only to some farmers who can be very well monitored. Another option, mentioned by some companies, is to avoid licensing at all and to carry out the seed multiplication yourself. Positive reactions on PBR enforcement in Chile came from some fruit cultivators and exporters. Because all seed laws in Chile seem to be more strictly applied with respect to export crops, they expected the same when it comes to fruit varieties protected by foreign breeders.

In **Uruguay,** about one third of the respondents (all companies) had no opinion about the PBR legislation, procedure or effectiveness, presumably because they lacked experience with the system. The remaining respondents found the law to a large extent adequate. Criticism was expressed on the sanctions, which some considered to be too weak to have an effect as deterrent. One company disapproved of the provision that only a limited group of species can be protected in Uruguay. The enforcement of the law was not effective according to 10 out of 25 respondents, while 8 respondents said that it was partially effective. The causes advanced included the lack of means and personnel of the PBR authority and the lack of organization among breeders themselves. Furthermore it was stressed that, because the PBR system is only starting to function, organizations need to be educated.
The majority of respondents in **Colombia** and **Mexico** considered the PBR law, respectively Bill, to be adequate. Some Colombian companies criticized the short duration of the right which in Colombia is 15 years for most species and 20 years for e.g. coffee and fruit varieties. Another company said that 15 years was more than enough, because its rice varieties are replaced every six years. Most opposition, in both countries, was encountered surrounding the provision on 'essential derivation', an issue which will be dealt with in chapter 5.

Expectations about enforcement and effectiveness differed widely among the respondents in the two countries. Two-thirds of the respondents in Colombia expressed the opinion that PBR would be enforceable, at least in the long term. The lack of infrastructure and knowledge was considered to be a temporary problem. Some companies stressed the role of the private sector in PBR enforcement and said that it is up to the breeders, rather than to the authorities, to defend their rights. With the law the breeders have a means to actively reduce unauthorized seed production.

The remaining respondents in Colombia and most in Mexico doubt whether PBR can be enforced in their countries, due to the lack of a sufficient technical and administrative infrastructure. It was pointed out in Colombia that the legal basis for protecting the seed quality and PBR consists of various decrees and resolutions and an integral Seed Law is lacking. In Mexico it was often stressed that the system of variety registration, certification, and inspection must be improved in order to make PBR work.

2.7 Opinions on UPOV

A large number of respondents had no opinion about adherence to UPOV, because they were not informed about the Union. One or two respondents in Chile, Argentina and Uruguay, and a quarter of the respondents in Colombia opposed accession, in most cases because they opposed the idea of intellectual property protection of plant material at all. The majority of those respondents that had an opinion supported the policy of their country to accede to UPOV. The reason that almost everybody gave was that the national PBR system would gain international recognition. This would encourage seed trade among Latin American countries with a PBR system (especially among Chile, Argentina and Uruguay) and would meet the demands of foreign breeders. Various respondents in Chile said that if the country wants to compete with e.g. South Africa or New Zealand in off-season seed production for foreign markets, membership of UPOV is a necessity.

Very few respondents in the five countries had any knowledge at all about the difference between the two UPOV acts from 1978 and 1991. Of those who knew the difference, most preferred the 1978 act. Reasons were that the existing legislation in their country was more harmonized with the 1978 act and that as yet no UPOV member country has any experience with implementation of the 1991 act.[7] A number of respondents found the 1991 act too restrictive as far as the essential derivation concept is concerned. One respondent, a NGO, preferred the 1978 act because this 'would just be less of a disaster'. Those respondents who were in favour of the 1991 act stressed better protection as the main advantage.

7. As from January 1995, no country has acceded to the 1991 act. Accession to the 1991 act of the European Union, the USA and the Russian Federation is expected during 1995 (Communication with UPOV).

2.8 Opinions on the protection of plants under patent law

The majority of respondents were not informed about the possibility for protecting plant material under (industrial) patent law. In Argentina and Colombia around a quarter of respondents were in favour; in Chile and Uruguay only two or three out of the whole sample. The main reason given for advocating patents for plant material was that patent law has clearer rules and less exemptions for breeders and farmers.

3 Private investment in plant breeding

The rationale behind the protection of intellectual property is encouragement of innovation. By awarding an innovator the right to exclude others from making unauthorized commercial use of the innovation, the state gives the innovator a prospect of a return on investment in an effort to stimulate him or her to continue the innovating activities or to employ the innovation. In the realm of plant breeding, PBR protection is expected to stimulate private plant breeders to invest in the development of new varieties.

The seed industry considers PBR protection as a necessity. Take, for example, the way a former president of the international breeders association, ASSINSEL, recalls the time that in Europe and the USA this protection did not yet exist. 'For lack of any legal protection, private breeders held back marketing their new materials in the past until a substantial stock of propagating material had been built up. Meanwhile trial data were collected and used to promote the variety. Then the variety was launched at an extra price. But two or three years later there were so many competitors in the market that the price of material, marketed by the originator could only be marginally higher than average. In many cases breeders, were not able to earn back the breeding costs. Such situations could not possibly have a stimulating effect' (Mastenbroek 1989, p.5).

The inconvenience of the above mentioned situation may be familiar or conceivable to many, it also raises some questions. It is obvious that when seed companies do not earn a penny, they will not invest in breeding. But may countries that introduce PBR protection therefore expect that the companies expand their R&D when sales increase? Secondly, the structure of the seed industry has changed considerably since the pre-PBR period in Europe and the USA, the period to which Mastenbroek is referring. Because of the seed multinationals which are operating worldwide nowadays, PBR will be filed for by both the domestic and foreign seed industry. Will they benefit equally from PBR?

The following two sections examine the experiences with respect to R&D behaviour of seed companies in the USA and Argentina. The third section discusses the relevance of PBR for seed multinationals. The effects of PBR on the relationship between domestic and foreign seed companies are debated in the final section.

3.1 Evidence from UPOV member countries

Empirical confirmation that PBR make seed companies invest in plant breeding is poor. Studies on the impact of PBR in UPOV countries have hardly been carried out. Some PBR experiences in the UK and New Zealand have been reported. For example, according to the then Controller of the Plant Variety Rights Office in the United Kingdom (Murphy 1980), direct private sector investment

in plant breeding increased by 500 per cent between 1975 and 1980, which was ten years after PBR enactment in 1964. In New Zealand, private investment in breeding in the arable sector, in 1990, was around 80 per cent higher than before 1975, when PBR protection was introduced. In forage crops, two public and four private groups are involved in breeding, while only one public group before 1975, and apple breeding has become more 'dynamic' (Whitmore 1991).

The only statistical analysis that has been carried out includes two studies conducted in the USA on the impact of the 1970 *Plant Variety Protection Act* (PVPA) (Perrin *et al* 1983; Butler and Marion 1985). From both studies it can be concluded that R&D expenditure in breeding in the USA grew some time before and during the 1970s. Perrin *et al* found that between 1960 and 1980 investment in breeding increased, especially in soya bean and cereals (see table 3.1). According to Butler and Marion, companies with older plant breeding programmes significantly increased R&D expenditure during the period 1967-70. A significant number of companies initiated plant breeding programmes in the 1970s, while in the same period R&D investments by the sample of firms examined increased. The evidence of increased plant breeding expenditure was particularly strong for soya bean. R&D expenditure on soya bean, the number of varieties released, the number of PBR certificates issued and advertising expenditure on soya bean all increased sharply between 1970-1980. The evidence was somewhat weaker for wheat although new varietial releases and PBR certificates issued indicated a moderate increase in R&D activity on wheat. There was little change in R&D input or output with respect to other self-pollinating crops. For all crops, R&D increased at about the same rate as the growth in sales; the R&D/sales ratio of these companies remained relatively flat during the 1970s. Other studies found that the number of companies with soya bean programmes and of soya bean breeders increased respectively from 6 and 6 in 1970 to 34 and 72 in 1988 (Schapauch 1989, p.34), while the share of acreage planted to private varieties tripled (to 86 per cent of total acreage) between 1977 and 1986 (Brim 1987, quoted in Lesser 1990, p.60).

Table 3.1 **R&D expenditure by US seed companies between 1960-1980**

Percentage of total R&D expenditure

Perrin et al. (59 firms)	**Current**	**Corn**	**Sorgum**	**Soybeans**	**Cereals**	**Grasses**	**Vegetables**	**Other**
1960	$ 3,572	52.4	12.5	0.0	0.2	7.2	27.4	0.2
1965	5,707	47.5	11.6	0.6	5.1	10.0	24.6	0.4
1970	11,293	43.5	10.6	2.4	9.6	9.5	22.3	2.0
1975	24,148	42.3	7.2	8.6	12.9	7.5	17.5	4.1
1979	42,630	46.3	6.6	10.1	10.2	7.2	17.6	2.1

Butler and Marion (14 older firms)		**Corn**	**Alfalfa**	**Soybeans**	**Wheat**	**Cotton**
1970	3,417	79	9	1	7	4
1972	3,943	77	8	2	9	5
1974	5,593	25	7	6	8	4
1976	8,390	23	6	7	11	3
1978	10,261	71	6	10	9	4
1980	12,131	71	7	11	9	3

Sources: Richard K. Perrin, K.A Kunnings and L.A. Ihnen (1983); Butler and Marion (1985)
Reprinted from: McMullen 1987, p.109

The general conclusion that can be drawn from the American studies is that more companies invested more in plant breeding, especially in soya bean, wheat and perhaps some other cereals after the PVPA was introduced. The crucial question that now emerges is: was the PVPA instrumental in triggering this increase in R&D expenditure? The answer is subject to dispute. Some are positive (see e.g. McMullen 1987, Schapauch 1989, Lesser 1990, Desprez 1991). These authors assume the relationship between PVPA enactment and R&D expenditure increase to be a causal one. Others doubt it. For example, Kloppenburg (1988, p.141) stressed the importance of the commodities boom in the 1970s. Between 1970 and 1979, the acreage planted to soya bean increased by two-thirds, and that planted to wheat jumped 47 per cent. The value of the annual production of wheat doubled, and the value of the soya bean crop more than quadrupled. The explosive growth in seed demand associated with these trends would have attracted private investment whether there was PBR legislation or not. Furthermore, Mooney (1988), has pointed out that a great deal of commercial cereal breeding in the USA is oriented towards the development of hybrids, for which PBR protection is less relevant than for self-pollinating varieties.

The American studies, indeed, do not specifically distinguish between those two types of cultivated plants as such. The overall increase in plant breeding following the PVPA included both breeding of self-pollinating varieties and hybrids. However, from table 3.1 it can be concluded that R&D expenditure on typical hybrid crops, such as maize, sorghum and most vegetables, has declined in relation to the expenditure on self-pollinating crops, such as soya bean and wheat, but not in relation to cotton and alfalfa. It can also be contended, as Mooney does, that a large part of the research on self-pollinating cereals, particularly on wheat, was used to develop hybrids. This argument certainly applies to the period before 1970 but to a lesser extent the subsequent period. Knudson and Ruttan (1988, pp.60–61) found that many seed companies working on hybrid wheat terminated their programmes in 1970, because semi-dwarf wheat varieties had emerged which were far more successful than the wheat hybrids that had been developed *and* because PBR offered them the mechanism to protect these varieties. Nevertheless, large seed multinationals (MNEs) like Cargill, Pioneer, Northrup King, DeKalb, and Nickerson continued to devote part of their wheat R&D to hybrid wheat. It is likely that the wheat breeding R&D of these companies was motivated by both the PVPA and the hybrid opportunity.

The discussion above makes clear that a certain part of the increase in breeding expenditure in the USA presumably is, while another part presumably is not, related to the introduction of PBR. It is, however, difficult to answer the question as to what would have happened to the seed industry's R&D investments if PBR legislation had not been enacted. The most satisfactory answer to the question whether PBR did play a role in the rise in R&D is to assume, as Butler and Marion do, that PBR have played a certain role, while some other events did as well. It is impossible to disentangle the effects of the Act itself from other significant changes which may have affected the seed industry.

3.2 Evidence from Argentina

Studying the relationship between PBR and R&D expenditure in plant breeding in the five Latin American countries was subject to a number of limitations. First, in the year the research took place, 1994, the PBR system was in force in three of the five countries involved in the project, while the enforcement of the law in two of these countries was either limited (Chile) or just commencing (Uruguay). Consequently, only the situation in Argentina justified further examination. Second, R&D in plant breeding can be measured in terms of R&D input or output. The input refers to R&D expenditure, including the number of plant breeders; the output is reflected in the number of new varieties released. As it takes

between 10 and 15 years to develop a new plant variety, the output measure was not yet relevant. An assessment in Argentina of the PBR impact in terms of R&D output should not be conducted before the year 2000. The present study, therefore, focuses on the input side of R&D. The third, more general, limitation in this type of research is related to the definition of the concept of R&D as such. As has been pointed out by Nelson and Rosenberg (1994, pp.10-11), the lines between R&D and other activities may not be clear. Many small innovating firms do not have a formally designated R&D department or facility, and their innovating work may or may not be accounted and reported as R&D. As this situation also applied to most plant breeding companies that were included in the sample, R&D expenditure was been defined in a very broad sense, including investments in all activities of plant breeding, experimental plants, and laboratories.

In Argentina, financial data was collected from 11 of the 50 plant breeding companies for two years, 1986 and 1992, respectively four years before and two years after the enforcement of PBR commenced.[1] Table 3.2 shows that, in terms of sales, companies who deal solely with hybrids (seed multinationals -MNEs) are on average 20 times larger than the companies who deal with self-pollinating varieties (mainly domestic companies). The average annual sales amount to US$ 20 million for the former and US$ 1 million for the latter. For all types of companies sales in 1992 exceeded sales in 1986. R&D expenditure (table 3.3) also increased for all types of companies after the enforcement of PBR. The increase was largest for companies who deal both with hybrids and self-pollinating varieties, and smallest for companies working solely in self-pollinating crops.

1. The arguments for choosing two years as points of reference have been explained in the introduction.

Table 3.2 **Average estimated sales of plant breeding companies in Argentina in 1986 and 1992**

Focus of company	Sales in (1992)	US$ 1,000	Variation in %
	1986	1992	
Hybrids almost exclusively[1]	16,400	22,900	+ 39.5
Hybrids and s.p. varieties[2]	5,000	11,100	+122.0
S.p. varieties almost exclusively[3]	725	1,000	+ 37.9

1. Average for five companies
2. Average for two companies
3. Average for four companies

Source: Interviews with Argentinean seed companies

Table 3.3 **Average estimated R&D expenditure of plant breeding companies in Argentina in 1986 and 1992**

Focus of company	R&D expenditure in (1992)	US$ 1,000	Variation in %
	1986	1992	
Hybrids almost exclusively[1]	1,286	1,900	+ 47,7
Hybrids and s.p. varieties[2]	370	851	+ 130,0
S.p. varieties almost exclusively[3]	180	186	+ 3,3

1. Average for five companies
2. Average for two companies
3. Average for four companies

Source: Interviews with Argentinean seed companies

Table 3.4 **Average variation in the R&D/sales ratio of plant breeding companies in Argentina between 1986 and 1992**

Focus of company	R&D/sales ratio		Variation in %
	1986	1992	
Hybrids almost exclusively[1]	7.8	8.3	+ 6.4
Hybrids and s.p. varieties[2]	7.4	7.6	+ 2.7
S.p. varieties almost exclusively[3]	24.8	18.6	- 25.0

1. Average for five companies
2. Average for two companies
3. Average for four companies

Source: Interviews with Argentinean seed companies

Table 3.5 **Average estimated number of professional plant breeding staff in seed companies in Argentina in 1986 and 1992**

Focus of company	Number of full time staff		Variation in %
	1986	1992	
Hybrids almost exclusively[1]	7.7	6.5	- 15.6
Hybrids and s.p. varieties[2]	3.8	3.8	–
S.p. varieties almost exclusively[3]	1.7	2	+ 17.6

1. Average for six companies
2. Average for four companies
3. Average for three companies

Source: Interviews with Argentinean seed companies

Calculated as share of sales, R&D differs widely among the three types of companies. Table 3.4 shows that for companies partly or exclusively dealing with hybrids this share varied between 7.4 and 8.3 per cent and slightly increased for both types of companies, mostly for the companies exclusively dealing with hybrids. The domestic companies dealing exclusively with self-pollinating varieties, mainly wheat and soya bean, spent a very large share of sales on R&D, about 24 per cent in 1986 and 18 per cent in 1992[2].

2. In the European Union and the United States the R&D/sales ratio in the seed industry is between 5 and 6 per cent (Desprez 1991, p.88).

An additional insight into the development of R&D investment might be given by the change in number of professional plant breeding staff.[3] Table 3.5 shows that the average number of breeding staff has been reduced for the companies who work in the hybrids market, even though for this type of company the increase in R&D/sales ratio is largest. Staff of companies in the self-pollinating varieties market has slightly increased even though R&D as share of sales has been reduced. For these companies, the absolute rise in R&D apparently also included an extension of breeding staff.

3. During the interviews the companies and institutes were asked about the number of plant breeders in their company in the two years. But in order to avoid confusion and additional barriers in obtaining quantitative data, the term 'plant breeder' was replaced by 'professional plant breeding staff' which includes: staff with a university degree and employed as breeder, plant pathologist, or plant physiologist.

The relatively small number of companies involved, the fact that the figures are estimates, and the measurement of R&D and sales at only two points in time, call for care in drawing conclusions. Higher sales and higher R&D expenditure may indicate an increase in both, but may also merely reflect instability in the development of companies. Taking this into account, two conclusions can be drawn.

a The apparent increase in R&D with companies that breed hybrids is probably unrelated to the enforcement of PBR. The higher R&D outlays may just reflect higher costs. Several seed MNEs contended that the salaries (and internal costs in general) are very high in Argentina. This may also explain the decrease in plant breeding staff.[4] Moreover, the seed MNEs in Argentina themselves clearly stated during the interviews that the reasons for investing in Argentina had little to do with the presence of PBR, but rather with the changed economic policies and the necessity to improve their competitiveness by offering better seeds. The relationship between PBR and R&D investment by seed MNEs will be further dealt with in section 3.3.

4. A complicating factor in the measurement of breeding staff is that seed MNEs have experts travelling around the world who temporarily support research at the companies' subsidiaries. These staff were excluded from the calculations because no company was able to quantify this type of research support. If included, it would probably have resulted in higher R&D expenditures or plant breeding staff with MNEs.

b The PBR enforcement seems to have played a role in sales and R&D expenditure of domestic companies involved in markets for self-pollinating varieties. Referring to the enhanced control of the wheat and soya bean seed market by ARPOV and INASE, the common opinion of the respondents was that the domestic companies have benefitted most from the PBR system so far. But rather than encouraging additional R&D investment, PBR protection would have prevented these companies from reducing or even eliminating their breeding programmes and enabled the reactivation of soya bean breeding. The high R&D/sales ratio may be explained by the need of a minimum level of R&D/staff even when sales are low, while the decrease of this ratio may have been caused by the increase in sales and royalty income.

3.3 Determinants for R&D investment by seed multinationals

The strength or weakness of a country's system of intellectual property protection is usually considered to have an important effect on foreign direct investment decisions. A recent survey under US firms stressed that the relationship between intellectual property rights and foreign investments is not the same for all industrial sectors. Particularly research-intensive firms, dealing with products or processes that are relatively easy to imitate, assert that they will not make substantial investment or transfer advanced technology to countries with weak intellectual property protection (Mansfield 1994). Plant breeding is a research-intensive industry and plant varieties are easy to imitate. How decisive has PBR protection been for seed MNEs when they considered investing in one of the five Latin American countries?

3.3.1 PBR protection of hybrids

It it often assumed that seed MNEs, basically involved in hybrid markets, do not need PBR protection. The hybrid seed itself (the first generation: the F1) is considered to be protected against unauthorized propagation because a hybrid does not breed true to type. Yield of the seed borne by the hybrid plants (the F2) is significantly lower than that of the first generation and is less attractive for farmers to save for replanting purposes. The low priority of PBR in developing countries for MNEs was confirmed in a study among 28 of these seed companies from Europe, Japan and the USA (Wierema 1989).

In the survey, however, it was found that the (American) seed MNEs were among the strongest advocates of introduction or enforcement of PBR. In Argentina, the MNEs are in fact financing the larger part of the breeders association ARPOV which is a crucial factor in the enforcement of PBR. Although some MNEs in Chile and Argentina said that they never had their parental lines protected under PBR legislation, others asserted that they would not invest in countries where PBR protection is absent.

The reason that hybrid breeders have an interest PBR is the protection of parental lines. Although the inbuilt protection against unauthorized multiplication of the hybrid is not always effective[5], PBR would not be of any help because of the exemption of on-farm seed saving. The importance of PBR for hybrids lies in the protection of parental lines against theft by competitors. Breeders used to

5. Propagation of F2 seed appears to be more than an insignificant phenomenon. Especially farmers who lack the opportunity to buy fresh hybrid seed each year, use F2 seed. The lower yields may still outweigh the costs of obtaining fresh hybrid seed. In Argentina, it was estimated that up to 20 per cent of the hybrid maize seed may consist of F2 seed. No indications were found that a black market in seeds of hybrids exists, however.

protect their lines by keeping them as a trade secret. However, in-bred lines cannot be kept hidden in a company's safe, but must be planted outdoors where parental lines can be stolen. Furthermore, in a field sown with hybrids, self-pollinating plants may occur because of incomplete male sterility. US companies in particular have relied for a long time on trade secrecy for protection of parental lines. This changed in the 1980s when it was becoming evident that ethical standards within the seed industry that had previously prevented misappropriation and use of proprietary inbred lines were in decay. Through fingerprinting techniques it was found that several companies made unauthorized use of inbred lines from their competitors. Important case law in this respect was provided in *Pioneer Hi-Bred International vs. Holden Foundation Seed,* concerning the alleged unauthorized use by Holden of Pioneer's parental lines. This case, which was settled in court in 1991, affirmed that a competitor cannot take another's inbred line and convert it for commercial use. This ruling, the strategic importance of inbred lines, and the availability of molecular marker techniques that could be used in determining varietal identity and pedigree, prompted US companies to start protecting all their inbred lines.[6] European seed companies protect their inbred lines under PBR for similar reasons. In Argentina, seed MNEs commenced protecting their parental lines under PBR from 1992 onwards. In less than two years, 112 lines were registered for protection.

6. Private communication with L.J. Butler, University of California, and S. Smith, Pioneer Hi-Bred.

The UPOV Convention includes an explicit provision that authorization is required when the repeated use of the variety is necessary for the commercial production of another variety. Protected lines may not be used as parental line for producing seed of the same or another hybrid, but the use of these lines as source for further breeding is exempted. It is also possible to protect the first generation hybrid as such under PBR. In Europe, nearly all titles for maize, sunflower, rapeseed, and most vegetables are awarded to F1 hybrids. Such protection has been provided for by the UPOV acts since 1961.[7] Plant variety protection offices in European countries have awarded PBR titles to hybrids for many years. In the USA this became possible in October 1994, when the PVPA was amended.

7. To provide protection for hybrids UPOV designed a specific definition of the PBR requirement of stability. A variety is normally deemed to be stable if its relevant characteristics remain unchanged after repeated propagation. A hybrid cannot meet this requirement as it does not breed true to type. For this reason stability was defined as that a variety is also deemed to be stable if, in case of a particular cycle of propagation, its relevant characteristics remain unchanged at the end of each such cycle (Van der Kooij 1990, pp.168–169).

3.3.2 Market size and industrial regulations

Despite the apparent relevance of PBR for seed MNEs, in the survey they generally agreed that the presence of PBR is by no means a sufficient condition to determine their investment decisions with respect to plant breeding. Other important conditions are: (a) the size of the market, (b) special features of the country, and (c) the macro-economic situation in country.

Market size

The seed MNEs said that they were not interested in investing in breeding or in seed production for small markets, regardless of the presence of a PBR system. The size of the seed market is determined by many factors. First, the performance of the agricultural sector. The general crisis in agriculture (see chapter 1) was considered to be a limiting factor for investment by the seed MNEs in all five countries included in the project. When farmers cannot produce or cannot sell their products, they will not buy seed. Second, a national market may be subdivided into various climatic zones, limiting the area in which a particular variety can be grown. This was considered to be a limitation for investment in Chile, where various climatic regions exist because of differences in latitude and altitude. Third, the size of the country as such limits its market. Uruguay, for example, is the smallest of the five countries and lacks any direct presence of seed MNEs. These companies serve the Uruguayan market from their locations in Argentina.

Special features

The disadvantages of a limited seed market size may be (partially) counterbalanced by special features that make investment in breeding worthwhile. Countries like Chile, Mexico, and Colombia cover many different climatic zones which

make them suitable for breeding and testing of varieties under many different circumstances.

Macro-economic situation

The seed MNEs pointed out that decisions on investments are heavily influenced by foreign investment regulations. In all countries involved, the MNEs favoured the changes in these regulations which enable them to invest more easily, to convert local currency into hard currency and to repatriate capital. As stated above, the reasons for MNEs in Argentina to invest had little to do with the presence of PBR, but rather with the present economic policies and the necessity to improve their competitiveness. On the other hand, high internal costs (e.g. salaries) were considered to be a problem in Argentina, Mexico, and Colombia. Seed producers in these countries have to compete with cheaper seed that is imported.

It seems that investment in plant breeding R&D by MNEs cannot be predicted on the basis of the presence or absence of PBR. PBR could be decisive when R&D is considered in countries where a number of unfavourable conditions accumulate. This conclusion can be illustrated by the observation of a high executive of a seed MNE in Argentina who commented: 'Who would like to take the risk of having a new variety pirated in a country that lacks PBR, just because of an investment in a small market with the agricultural sector in crisis?' On the other hand, when the general conditions are favourable, PBR protection becomes less important. Even though several companies asserted that they would not invest in countries where PBR protection is absent, other companies said they certainly would if the market was interesting. For example, it was mentioned that in case of a very large market, such as Argentina and Brazil, piracy would be taken for granted because even a limited share of a large market could be good business.[8]

8. An example might be the alfalfa imports into Argentina. Around 70 per cent of the alfalfa seed demand in Argentina is met through imports. Half of the imported seed is from protected varieties, half is not, although the varieties could have been protected.

One final observation on the relationship between PBR and R&D expenditure by seed MNEs should be offered. Since these companies have the ability to centralize their basic laboratory R&D, changes in R&D by these companies may be partly invisible in the subsidiaries. PBR may increase R&D outlay by these companies without resulting in a significant increase in investments in all countries where PBR is present. In other words, it may well be that the remuneration, ensured by PBR in Latin American countries, partly results in increased plant breeding R&D, not in Latin America, but in the MNEs' home countries.

3.4 Division of labour between the domestic and foreign seed industry

The extensive political and economic pressure that has been exerted on developing countries to make them strengthen the protection of intellectual property, has fuelled concern that the PBR system will basically benefit the foreign seed industry.[9] The international seed industry in one way or the other expects to benefit from an extension of the geographical scope of PBR and this is not necessarily also to the benefit of the (developing) countries concerned.

9. An expression of concern for such a development is a recent publication of the Indian Public Interest Research Group (1993, p.3). It states: 'By bringing the issue of intellectual property on to the GATT negotiations agenda and extending the concept of ownership to every conceivable form of life, the American and developed countries' MNCs are preparing to storm the untapped markets of the Third World by gaining control over their genetic resources. A common strategy in this regard is to begin with the takeover of the seeds business in these countries'.

A look into the international seed market shows that seed production is highly concentrated within a small number of large companies. The world market of commercial seed is valued at about US$ 15 billion. There are approximately 1500 seed companies in the world, of which about 600 are based in the USA and 400 in Europe. The 26 largest MNEs have a combined turnover of about US$ 7 billion, representing nearly 50 per cent of the commercial market for agricultural and horticultural seed. Their market share is expected to increase because seed development has become a capital and knowledge intensive industry. Half of the largest MNEs are specialized seed companies. The others are owned by larger corporations involved in agricultural inputs, mainly agrochemicals. The 26 largest seed companies are based in the USA (6), Europe (17) and Japan (2)

(Rabobank Nederland 1994). Will these large companies use PBR protection in Latin America to expand their activities in the region at the expense of the domestic seed industry?

In Mexico and Colombia, the respondents in the survey thought that the introduction of PBR will affect the relationship between domestic and foreign seed industry. In **Mexico,** nearly all respondents expected that the foreign seed MNEs will be the main beneficiaries of the PBR system, since they have significantly greater capacity for breeding new varieties and in seed production. Various Mexican respondents foresaw only two options for the domestic seed companies: linking themselves to MNEs and becoming in fact distributors of their varieties; or specializing, with support of the public research system, in small market niches which are not interesting for MNEs. In **Colombia,** the vast majority of respondents expected that the participation of foreign companies in the national seed market will increase because of PBR, and about half of the interviewees said that it will increase the control of foreign companies over national companies and institutes.

The concern that these seed MNEs will become the main beneficiaries of the PBR system is not shared by respondents in the three **Southern Cone countries,** basically because of the *de facto* division of labour between domestic companies and MNEs in the seed market in Latin America. MNEs deal almost entirely with hybrids, while the markets of self-pollinating crops are served by domestic companies. Since PBR are considered to be especially useful for self-pollinating varieties, the PBR system was considered to benefit the domestic seed industry most.

The perceived division of labour in the seed market is confirmed by statistics available in Argentina and Uruguay. In Argentina, 112 out of a total of 130 PBR titles that were granted for parental lines of hybrids, are owned by MNEs (see table 2.5). In terms of market share: five leading maize companies, all subsidiaries of MNEs, cover 85 per cent of the Argentine hybrid maize seed market, while four MNEs provide 75 per cent of the hybrid sunflower seed market (Gutiérrez *et al* 1995). In Uruguay, 139 out of 145 registered hybrids of maize, sunflower and sorghum are bred by foreign companies. In contrast, 100 per cent of the Argentine seed market of various self-pollinating crops, such as wheat, beans, cotton, rice, winter cereals, barley, and linseed, are supplied by domestic companies. Of all PBR titles on self-pollinating varieties, up to 1994, less than 20 per cent was granted to foreign companies. This percentage was 36 for Uruguay (up to 1995) and 39 for Chile (see table 2.5).

Soya bean and alfalfa are the only self-pollinating crops in which MNEs play a significant role. But even in these crops, the local aspect is increasingly important. Soya bean has been cultivated in Argentina only over the past 20 years. The introduced varieties originated from the USA. But in the course of time, the breeding of soya bean has increasingly been done in the country itself. Today, 61 per cent of the protected soya bean varieties are bred in Argentina, while 76 per cent are protected by Argentine organizations. Only 6% of the soya bean varieties have a foreign title holder and are foreign in origin. A similar pattern can be depicted for alfalfa. When the US all-year-round alfalfa varieties were first put on the Argentine market, they were mainly imported. After a while, INTA and other Argentine breeders started to breed these varieties in Argentina. Today, 50 per cent of the PBR titles on alfalfa are owned by Argentinean organizations. That a large part of alfalfa seed is still being imported is caused by the high internal costs in Argentina which make seed produced abroad cheaper.

Does the introduction of PBR affect the division of labour between foreign and domestic companies and institutes in the Latin American seed markets? In other words, do seed MNEs become more active in the markets of self-pollinating

crops, and/or do domestic companies enter the hybrids markets? A conclusive answer to these questions cannot yet be given, due to the short period of PBR enforcement in Latin America. It seems unlikely that PBR is going to alter the present division of labour, but it can be expected that PBR do induce or support some changes in the Latin American seed markets.

Domestic seed companies and public institutes are not or only slightly involved in hybrids breeding and PBR protection will not change that. The legal protection will give better opportunities for access to parental lines of foreign companies, but the barriers for breeding hybrids are high compared to those for self-pollinating crops. Seed MNEs, however, may decide to expand their presence in the markets for self-pollinating varieties and cooperate or compete with domestic seed companies when adequate PBR protection is being provided. Some MNEs in Latin America are already involved in self-pollinating crops, but for reasons which are derived from their core activity, which is in hybrids. The companies are involved in some commercial self-pollinating crops, such as soya bean and alfalfa, to complement the range of hybrids they offer to the market. This situation may give opportunities for local companies as well. As was shown above, Argentine breeders have successfully entered the alfalfa and soya bean markets, which used to be the domain of foreign breeders.

The main function of PBR for seed MNEs, however, is the legal protection against unauthorized use of parental lines of hybrids, in addition to the biological protection against unauthorized multiplication of the hybrids themselves. One of the main reasons that the larger seed companies breed hybrids is this in-built control. The fact that the yield of hybrids decreases significantly from the second generation onwards, is an adequate protection mechanism, because it does not depend on changeable political will and on burdensome enforcement strategies. PBR may significantly affect the relationship between domestic and foreign seed companies, if the protection conferred for parental lines is considered to be adequate, and if in more crops (for example in soya bean and wheat) self-pollinating varieties were to be replaced by hybrids. The increased use of hybrids, rather than an expansion of foreign companies in self-pollinating crops, will lead to an enhanced presence of MNEs in the seed market of the Latin American countries.

4 Breeding policy of public institutes

In many developing countries plant breeding is predominantly carried out by national public agricultural research institutes. Enactment of PBR legislation may change this role of the public sector. Stimulation of private investment in plant breeding and a more prominent presence of private seed companies is the explicit objective of PBR protection. This chapter will examine how the main public research centres in the Latin American countries have responded (or will respond) to the introduction of PBR protection, and what the consequences of their attitudes have been for their research agendas and access to the germplasm they maintain.

4.1 IPR policy of the main research institutes

The role of private and public breeders has been a subject of debate for a long time in **Argentina** (Gutiérrez 1984 and 1985). The *Instituto Nacional de Tecnología Agropecuaria* (INTA) used to work in both hybrid and self-pollinating variety markets, but reduced its involvement in hybrids in the 1970s for a number of reasons. First, the production and commercialization of hybrids was considered to be too complex. Second, registration of new hybrids did not require the disclosure of the pedigree of the hybrid. This enabled private companies to use parental lines which were bred by the public sector without recognition or remuneration of the original breeder. Third, INTA suffered from a brain drain when the private sector required specialized personnel because of expanding markets.

These experiences in the area of hybrids obligated INTA to redefine its relationship with the private sector. A new policy of *Vinculación Tecnológica*, adopted in 1987, allowed the institute to concentrate on R&D and technical assistance, leaving the production and commercialization of its innovations to the private sector. Commercial aspirations were not abandoned, however. All INTA's varieties have been protected under PBR. Private companies can produce the varieties under a licence, on the payment of a part of the research, and on the condition of a royalty payment for commercialized products.

Up to 1994, 175 PBR titles were held by INTA, 28 per cent of all titles granted (see table 4.1). The enforcement of the system, in conjunction with the Vinculación Tecnológica, enabled the institute to collect US$ 5.2 million from breeding in about 20 species in the period 1987-1994. This budget has been employed to cover operational costs, and to improve the conditions for technology transfer. Royalty income also enables INTA to retain employees. The institute permits its researchers to benefit privately from their research results by distributing a part of the royalties collected among its professional personnel.

Table 4.1 **Number and proportion of PBT titles owned by the main research institutes in three Latin American countries, up to 1994**

	INTA, Argentina		INIA, Chile		INIA, Uruguay[1]	
	Titles	% of total	Titles	% of total	Titles	% of total
Self-pollinating varieties						
Achicoria					1	100
Alfalfa	9	18	3	33		
Barley	4	24	4	36	2	29
Bean	5	50	14	74		
Calebaza	3	100				
Camomile	1	100				
Chickpea			2	100		
Clover rosado			1	100		
Cotton	2	50				
Dactyle					1	100
Lentil	3	100	2	100		
Lettuce	4	100				
Linseed	12	86				
Maize	7	64	7	88		
Melon	2	100				
Oats	3	43	3	38	1	100
Onion	1	50				
Pasto miel	1	100				
Peanut	1	100				
Pea			2	40		
Pepper	1	100				
Phalaris Aquatica	1	33				
Potato	11	55	7	23		
Rape seed			1	14		
Rice	2	30	4	50	3	75
Rye	4	80				
Sorgo	12	80				
Soya bean	13	11				
Sunflower	8	47				
Tomato	16	89				
Tobacco	2	100				
Triticale	2	25				
Wheat	28	31	40	66	1	13
Total	**158**	**32**	**90**	**39**	**9**	**36**
Parental lines of hybrids						
Maize	11	13				
Sorghum	1	6				
Sunflower	5	19				
Total	**17**	**13**				
Total var. and lines	**175**	**28**	**90**	**39**	**9**	**36**

1. Data up to February 1995

Sources: INASE (Argentina), SAG (Chile), Unidad de Semillas, MGAP (Uruguay)

The *Instituto Nacional de Investigación Agropecuaria* (INIA) in **Uruguay** follows a policy that is similar to INTA in Argentina. The institute concentrates its breeding on wheat, oats, rice, forages and some fruit and horticulture species. INIA has no breeding programmes in species that compete with hybrid cereal crops and the majority of horticulture species. The institute adopted a formal IPR policy in 1991 and has protected all its varieties under the PBR system ever since. As of early 1995, INIA held 9 of the 25 titles granted so far (see table 4.1). The institute produces pre-basic and basic seeds. Production and exploitation of later generation seed is licensed out to the private sector. According to INIA, a new variety can be distributed more quickly when its production is exclusively licensed out to the private sector.

In contrast to INTA and INIA (Uruguay), the perception and use of the PBR system by the main institutes in the three remaining countries is significantly influenced by budgetary problems. Public funds for breeding in **Colombia** have steadily declined. Twenty years ago, the *Instituto Colombiano Agropecuario* (ICA) bred all national varieties, while today only half of the varieties registered in Colombia have been generated by the institute. The breeding and local adaptation of sorghum, maize, and sugar cane are done almost entirely by private companies. Rice breeding is carried out by both private and public organizations. With the liquidation of *Cresemillas* (an organization that was part of the *Caja Agraria*, the agrarian credit bank), the entire seed production passed on to the private sector.

ICA used to release its varieties to farmers free of charge, while licensing contracts could be obtained at a price below cost price, without further conditions. This policy was abandoned in 1993 because of the decline in the institute's budget. The new policy, still in design in 1994, envisages the protection of all new varieties under the PBR system. A part of the royalty income will be distributed among professional employees. A respondent from ICA said, however, that a shift in the licensing policy with respect to typical small peasant crops, such as beans, maize, vegetables and *caña panelera*, is unlikely.

Mexican public sector respondents showed an ambiguous attitude with regard to PBR. On the one hand, they are concerned with an increased privatization of agricultural research, but on the other hand it is realized that PBR can generate additional income for the public sector. Most public researchers said they would protect their new varieties as soon as the PBR system is implemented. The budget of the main agricultural research centre in Mexico, the *Instituto Nacional de Investigaciones, Forestales, Agrícolas y Pecuarias* (INIFAP), was halved between 1990 and 1993. Its financial situation is forcing the institute to abandon its current policy of non-exclusive licensing and increase royalty income. INIFAP respondents added, however, that the final decisions about an IPR policy would be taken at the level of the Ministry of Agriculture.

Budget cuts are also the reason for the *Instituto Nacional de Investigación Agropecuaria* (INIA) in **Chile** to develop a coherent intellectual property policy. Until the end of the 1970s, INIA relied mainly on governmental funds. By 1980, the institute's budget was reduced and programmes that could be taken care of by private sector research and by technology transfer had to be terminated. Among these programmes were hybrid maize breeding and most fruit research, because it was argued that this technology was available in the USA, especially in California (Pray 1989). In order to obtain external royalty income, all INIA's new plant varieties have been protected under the PBR system. The number of PBR titles held by INIA in 1994 was 90, 39 per cent of total titles that had been granted in Chile up to that time.

By 1994, only 40 per cent of INIA's budget was provided for by government support, while another 30 per cent was covered through the licensing of varieties and seed sales. Forced to seek additional income, the new administration, in office since the beginning of 1994, is designing a new and stricter strategy to protect its knowledge. According to an INIA respondent, 'anybody could take anything and we were losing money.' The policy of non-exclusive licensing of varieties in combination with a weakly enforced PBR system, meant that propagation was out of the institute's control from the second multiplication onwards. In December 1994, INIA announced in the newspapers that it is planning to control the use of its varieties better. The institute also intends to carry out multiplication and marketing of seed by itself.

In the survey, INIA's strategy was criticized as 'unfair competition' by domestic private companies who face the institute's competition in the markets of self-pollinating crops. Because of state subsidies, INIA can sell seeds at prices which would not reflect real costs, resulting in a downward pressure on seed prices. Also criticized was the special linkage between INIA and ANASAC, a private seed producing entity set up as a seed outlet by INIA. ANASAC can purchase C1 wheat seed from INIA at a far lower price than other seed producing companies and farmers.

4.2 Research priorities

One of the areas in which the impact of PBR on the relative position of the public centres vis-à-vis the private seed sector may become visible is the research agenda. Both in the USA and in Australia, concern was expressed about shifts in research priorities of public breeding, prior to PBR enactment (Senate of Australia 1984, p.17; Butler and Marion 1985, p.39). The increased prominence of private companies in the seed market could cause public institutes to back out of developing finished varieties and concentrate on a more facilitating role in breeding, shifting toward basic research. The US PVPA may indeed have induced a slight shift of the public plant breeding and genetic research budgets toward basic research (Butler and Marion 1985, p.39). Considering the current budgetary constraints of the public centres, however, the introduction of PBR may also have the opposite effect. PBR may induce a shift toward applied research. PBR could lead to a reallocation of resources in the sense that public breeders, trying to maximize royalty income, may give a higher priority to the breeding of commercial crops, than to basic research and the breeding of crops for marginal areas.

Collecting data on the (re)direction of public R&D expenditure in the Latin American countries turned out to be extremely difficult. During the interviews the centres were asked about the general trend of expenditure for applied and basic research at the institute.[1] The decision as to what part of the institute's budget falls within these categories was left to the respondents. The response was poor, however, primary for two reasons. In the first place, the definition of 'basic' research was not well understood by all respondents, presumably because the definition does not fit the research that most institutes carry out in the realm of genetics, plant physiology or plant pathology. The respondents preferred to speak of 'strategic' rather than 'basic"'research. Strategic research is not innovative in itself but has the objective of keeping pace with plant technological innovation generated elsewhere. In the second place, most of the institutes had great difficulty in providing the information requested, because they have not recorded data on outlay differentiated to strategic or basic and applied research.

Estimates about the two types of research were only given in **Colombia** and **Mexico.** The applied/strategic research distribution in the R&D budget of ICA (Colombia) would have been around 85 and 15 per cent respectively in the

1. Following the definition used by Butler and Marion (1985), 'applied' plant breeding research was broadly defined as research which potentially culminates in the development of a new, improved, or adapted plant variety. 'Basic' plant breeding research was defined as research which does not specifically lead to the development of a new plant variety.

period 1986–90. In 1994 the distribution would be 70 to 30 per cent. The institute's respondents did not expect that the introduction of PBR would induce a change in this distribution. At INIFAP (Mexico) it was estimated that the applied/basic research distribution would be around 75 to 25 per cent. Various respondents of the Mexican public sector, however, expected a small shift toward applied research away from basic research because of the possibility of protecting varieties.

Respondents at INIA in **Chile,** said that PBR has had no impact on its research direction, because the commercial management and the breeding departments within the institute have been operating quite independently. Although royalties have become increasingly important as a source of income, this has not yet influenced the research direction. To date, the breeders within INIA could follow their own logic which was not necessarily related to commercial logic.

The research direction of INTA, **Argentina,** seemed not to be affected by the use of PBR either. The relative budgets for the breeding of most cereals and oilseed crops remained more or less the same between 1984 and 1992. The budget for sorghum was reduced and that for soya bean increased, but these changes merely reflected the change in crop demand in Argentina. INTA's criteria for priority setting are determined by other factors than financial remuneration. They include, among other things, the value of the production, the value of exports, future demand, distribution among regions and among the various types of farmers, and employment. Financial benefits from PBR have not yet been a factor in assigning resources in plant breeding.

4.3 Access to germplasm of public institutes

The availability of germplasm[2] has been perhaps the most critical issue in the debate on intellectual property protection of plant material during the past 20 years and was highly contested during the preparation of the *Convention on Biological Diversity*, concluded in 1992. The free exchange of germplasm and related technology is considered to be the foundation of agricultural development. Legal monopolies on the use of genetic resources are thought to harm the breeding of improved plant varieties.

Germplasm and knowledge exchange was also a topic debated prior to the introduction of PBR in Australia and the USA (Senate of Australia 1984, p.20; Butler and Marion 1985, p.67). Later it was confirmed that the PBR system in the USA has probably had a negative impact on the flow of information and germplasm from companies to universities. PBR, however, had either a neutral or a positive impact on such a flow in the opposite direction. Private companies found the exchange had increased since the introduction of PBR protection (Butler and Marion 1985, p.70).

In **Argentina,** the availability of germplasm has been disputed as an element in the ongoing debate about the division of labour between private and public breeders (Gutiérrez 1984 and 1985). The private sector, in general highly dependant on the germplasm collections of public institutes and especially of INTA, advocated a specific division of labour. It was felt that the public sector should concentrate on the basic steps of genetic improvement, including improvement of populations, crossing, and various generations of segregation, while the final steps of breeding, culminating with a finished variety, should be left to the private sector. This division of labour has always been rejected by INTA for two reasons. In the first place, it is argued that in such a division the value of the final phase of breeding for public breeders would not be recognized. The finished variety is the intellectual compensation for all research carried out, permits identification of the breeders' role, and puts his work to the test on the

2. Germplasm of cultivated crops includes:
(a) *Modern cultivars:* high-yielding elite varieties which have been developed by scientific plant breeding for modern intensive agriculture;
(b) *Special genetic stocks:* advanced breeding lines and stocks which have been developed for use in modern scientific plant breeding, but which are not ready for release to farmers;
(c) *Genomic material:* cloned genes, probes and nucleotide sequences;
(d) *Obsolete varieties:* varieties left over from early plant breeding and which are now mainly found in germplasm collections;
(e) *Landraces:* local crop varieties developed mainly by selection in traditional agriculture systems;
(f) *Wild relatives:* plants that live in the wild and share common ancestors with cultivated crops.
(Based on Hoyt 1988, p.13; FAO 1989, and Baenziger et al 1993, p.141)

market. Second, it would make a few private organizations the sole direct beneficiaries of public funds.

The polemic intensified when PBR law was regulated in the second half of the 1970s. Seed companies questioned the role of INTA and recommended that the institute abstain from releasing commercial varieties and limit itself to delivering segregated material and populations to the private sector. In 1979, INTA's administration during the military government responded by issuing Resolution no.310 which obliged the institute's breeders to make available segregated material, mass populations, advanced plant material that could be used as genitor, populations in the process of selection, and parental lines of registered hybrids. The resolution was not acceptable for the breeders of INTA but was replaced only in 1987. In this year, Resolution no.99 established a new regime of germplasm access which is still in force today. Material that is the object of breeding in the institute's programmes, material which is part of accessions, landraces, clones, and populations are not available. Varieties, lines, material in the process of selection and evaluation, and the entire product of a breeding programme are available under conditions established by INTA.

Interviews with companies revealed a general acceptance of INTA's policy. None of the respondents from the public or private sector thought that the availability of germplasm had been hampered by the introduction of PBR. On the contrary, the companies found that clearer rules on access and ownership, the possibility of joint PBR titles, and royalty sharing had stimulated joint breeding research and exchange of germplasm.

The policy of INIA in **Uruguay** is similar to that of INTA. The institute provides free access to germplasm that has not been modified, because this is not considered to be property of INIA. Material that has been modified is only accessible through exchange agreements which are based on the principle of reciprocity.

Improvement in access was also expected by half of the respondents in **Colombia.** Some companies said that access to material of ICA had not always been very open. Rather than making material available, the institute was even 'hiding' its germplasm because of concern that it would be used by the private sector without compensating the institute. With the emerging recognition of property protection of plant material, such as PBR or Material Transfer Agreements, clear rules have developed about the rights and obligations of the parties involved. It is felt that such rules will encourage the institute to offer better access.

Public sector respondents in Mexico and Colombia thought that PBR would reduce access to germplasm available at public institutes, because protection stimulates the centres to embark on a commercial course. An ICA spokesman explained that the institute used to follow a policy of open access to third parties, but admits that it is presently very cautious about making its research publicly available. The main reason is uncertainty: 'Nobody knows what the national and the institute's policies on access will be in the near future'.

Various respondents in Argentina, Colombia and Mexico pointed out that increased research cooperation between the public and private sector requires more confidentiality or protection. This results in a reduced access to germplasm and information at the public centres. The companies generally favoured this tendency because private sector funds were involved. One Colombian private sector breeder claimed that cooperation with ICA would remain difficult if plant material that has been developed in a joint programme were available to third parties. Payment for germplasm that is maintained by public institutes was not considered to be a problem for any of the companies involved in the survey.

4.4 Towards commercial public plant breeding?

The experiences and strategies of the main agricultural research centres in Mexico, Colombia and Chile are essentially similar. These centres used to release their new varieties at a low price or free of charge to farmers and licensed out their varieties on a non-exclusive basis to the private sector. But budget reductions, in combination with the knowledge that the private sector was benefitting from their work, made the institutes try to retain the commercial benefits of their work. INTA in Argentina, and to a lesser extent INIA in Uruguay, also work on commercial terms but seem to have a more facilitating role in relation to the private sector. INTA has used the PBR system primarily to strengthen its breeding research programmes. In the case of ICA, INIFAP, and INIA in Chile, PBR protection seems to be considered as an important tool to defend the very existence of the institutes as such. The PBR system has the additional effect of keeping the public institutes competitive with the private sector.

All public centres seem to accept the division of labour between the domestic seed industry working with self-pollinating varieties and the MNEs which dominate the breeding and production of hybrids. The single public centre that was involved in hybrid breeding in the five countries, INTA, backed out in the 1970s. However, none of the centres seems to accept the concept of an additional division of labour in which public institutes concentrate on pre-competitive breeding steps, leaving the final breeeding phases and commercialization to the private sector. All institutes presently act, or intend to act, as potential competitor for private breeders in specific markets, particularly in that of wheat and other cereals.

Little evidence on changes in research priorities could be collected. Taking into account the opinions that have been expressed, the impact of PBR on the public research agenda seems to be insignificant to date. In the first place, a shift to basic or strategic research is unlikely because of the cost involved. Research that culminates with a commercial product in the short or medium term may be preferred over investment in long-term basic research with an uncertain outcome. On the other hand, part of the institutes' budget will remain devoted to strategic research in order to maintain the ability to apply modern breeding technology. Secondly, none of the institutes had a formal programme in which marketing and breeding objectives were integrated. Breeders and managers in public centres still seem to act rather independently. This may change in the near future, however, when a further decline in budgets makes imposition of the commercial logic inevitable for all departments.

Rules for access to the centres' germplasm seem to become dependent on the strategic importance of this material for the centre's own breeding programmes. The PBR system as such is not a determining factor for access, but budgetary constraints may incite institutes to define more material as 'strategic' and thus unavailable. Collaboration with private companies poses a dilemma. If the policy of unrestricted access were maintained, private companies would be reluctant to enter into research agreements with institutes. On the other hand, joint research programmes with companies will certainly restrict public availability of that part of the institute's germplasm which is developed with private funds.

Several companies were of the opinion that PBR protection has a positive effect on the availability of public germplasm, which was a bit surprising. Even though a similar effect was also perceived in the USA after the introduction of PBR, the centres in Latin America currently have a more commercial interest than the US universities had in the 1970s. One reason for the private sector opinion may be that access to public germplasm in the past was not as free as is often assumed. In the absence of a formal procedure for germplasm transfer, it is the personal

attitude of the institute's breeder that determines how open or restricted the access to germplasm actually is. These breeders have the capacity to assess the value of the material for the institute as well as for the receiver, and therefore, occupy a key position in the germplasm exchange. Taking into account the fact that many public breeders were, for political reasons, reluctant to collaborate with the private sector, it may well be that companies found access to germplasm restricted in the past.

PBR is obviously not an independent variable initiating a change in the relationship between the public and private seed sector. PBR is a tool that is being used both to support and resist changes in the traditional role of public institutes. In chapter three it was pointed out that in Argentina, PBR protection presumably prevented some domestic private breeders from reducing their activities. A similar effect may occur with respect to the public sector. PBR may help the public institutes with declining budgets to survive. This also may ensure that the public centres remain active in breeding of marginal crops which are not interesting from a commercial point of view.

5 Transfer of foreign germplasm

One of the objectives of the enactment of PBR legislation in the Latin American countries has been the stimulation of the transfer of foreign germplasm. Foreign germplasm is important for domestic breeding, propagating, and cultivating companies especially in countries that rely for the greater part of their crop production on introduced crops. Generally in Latin America, less than one-third of the value of the crop production is from local origin (Wood 1988). Foreign breeders may be reluctant to send their varieties or other plant material to firms or institutes in countries where legal protection is absent, because of the risk of unauthorized propagation. Introduction of PBR legislation and entry into UPOV should convince foreign breeders that protection of their varieties is ensured. Anecdotal evidence from Australia has demonstrated that the lack of PBR was the reason for foreign breeders denying access to a number of plant materials by Australian companies. In some cases the variety requested was sent from overseas but could only be used for experimental purposes (Senate of Australia 1984, pp.94-97). Several breeding and cultivating companies involved in the survey in Colombia and Chile could also cite one or two examples of European or North American varieties that were refused to them because of the lack of an effective PBR system in their countries. Generally, the share of foreign holders of PBR titles is relatively low compared to (other) UPOV member countries. The percentage of all PBR titles granted to foreign companies, up to 1994, was 33 in Argentina, 36 in Uruguay (up to 1995), and 39 in Chile. The average share of foreign title holders in 21 UPOV countries was around 50 per cent, in 1993, ranging from 31 per cent in the Netherlands, to 94 per cent in Canada (see Appendix II).

The question which comes to the fore now is whether the adoption of PBR in Colombia and Mexico and the enforcement of the laws in Argentina, Chile and Uruguay indeed improves the transfer of foreign germplasm. This transfer involves two steps: (a) the physical access to the germplasm, and (b) the authorization for its exploitation. In this chapter it will be argued that PBR may stimulate access to foreign varieties, while the legal protection, at the same time, may be used to restrict their exploitation.

5.1 Access to foreign germplasm

Having access to germplasm actually means having the opportunity to physically obtain seed or other plant material. It is obvious that such access is not always depending on intellectual property protection. A Latin American breeder could just purchase a bag of seed of a plant variety on a foreign market in order to get access to a modern variety. This is a completely legal way, and whether or not legal protection is conferred to the variety in his home country is irrelevant. But not all plant material is readily available on the market. Breeding lines, genomic material, or high quality virus-free propagating material of a variety are kept on

the premises of specialized companies or institutes abroad, and can normally only be obtained with the consent of the breeder. Whether an operative PBR system is necessary to encourage breeders to make available their germplasm depends on the type of breeder or, to be more precise, on their intellectual property protection policy type. The differences in IPP policy between three major types of international germplasm suppliers will be discussed below: (a) international agricultural research centres (IARCs), (b) private seed companies in OECD countries, and (c) breeding organizations in tropical countries. Because these three types of organizations have different interests as far as protection of their germplasm is concerned, they will respond differently to PBR protection conferred in the Latin American countries.

5.1.1 The international agricultural research centres

A great deal of germplasm and related staple crops information is generally freely available at the international agricultural research centres (IARCs). The IARCs are public institutions, financed by international donor agencies. The fundamental position of these donors is that developing countries should have free access to the centres' knowledge, technology and germplasm (CGIAR 1992), but the policies may differ per centre. Two IARCs which are based in Latin America, CIAT in Colombia and CIMMYT in Mexico, do not seek intellectual property protection for their materials and attempt to keep their germplasm in the public domain. The centres protect improved material when this is required for collaboration with the private sector, or when protection is a means to keep the material publicly available. From these policies it can be concluded that access to material from IARCs does not depend on the introduction of PBR in the Latin American countries.

In order to obtain germplasm from the centres, material transfer agreements must be concluded which set conditions for exploitation of the germplasm by the receiver. These conditions are intended to prevent the total privatization of the previously public material. Germplasm generated by CIMMYT is available to, and may be protected by, others under the condition that this protection "is compatible with the mission of the centre" (CIMMYT 1994). CIAT's policy, still under discussion in 1994, is to offer access to its material under two conditions: receivers must inform CIAT about the uses of the material provided, and they are not allowed to protect a variety containing the CIAT material outside the country in which they obtained the material. For example, a Mexican company may protect a variety that includes CIAT material in Mexico, but not in Venezuela (Communication with CIAT).

5.1.2 Private seed companies in OECD countries

Access to germplasm held by private companies in OECD countries is important for Latin America because it includes advanced breeding lines of hybrid grains and vegetables, as well as the main commercial fruit and cut-flower varieties. In particular, access to varieties of the latter two crops is important for some countries because of their export interests.[1] Advanced germplasm of fruit and ornamentals is not available at public or private organizations in Latin America or at IARCs. Colombian flower growers, for example, use varieties obtained from breeders in the USA, Europe, and some other UPOV countries. A similar situation exists for the Mexican flower growers as well as for most export fruit producers in the other Latin American countries. Despite the fact that many of the herbaceous ornamentals under cultivation, or their progenitor species, are endemic to Latin America (Boyle 1991), the type of breeding that takes place domestically is in fact selection and multiplication of outstanding individual plants of commercial foreign varieties.

1. The value of the Colombian cutflower export was nearly US$ 400 million in 1993, which made cut-flowers the third biggest agricultural export crop, after coffee and bananas (Asocolflores 1994). The Chilean fruit export amounted to more than US$ 900 in 1992, which was equal to 75 per cent of the value of total agricultural exports (EIU 1993).

Absence of PBR protection in Colombia and Mexico, or the lack of effective protection in Chile, Uruguay, and Argentina has generally not prevented access to foreign materials in the past. Relying on contract law and gentlemen's agreements, propagation and cultivation of all these crops have been licensed to Latin Americans for many years. Foreign flower breeders have even organized annual fairs in Colombia to show their produce to cultivators. Nevertheless, access to foreign breeding lines and ornamental and fruit varieties will presumably become improved with an operative PBR system. PBR will predominantly impact the licensing conditions and the type of breeding lines and varieties that can be obtained. Access to new varieties may be quicker, the quality of the germplasm higher, royalties lower, and the annexes to licensing contracts shorter.

5.1.3 Public and private breeding organizations in tropical countries

A third category of foreign germplasm suppliers includes both private and public plant breeding organizations in tropical developing countries, who hold most of the germplasm of the traditional tropical export crops, such as coffee, tea, sugar cane, oilpalm, and cacao. Banana and plantains are exceptions since an important collection is available at an international centre. Germplasm from these private and public centres used to be freely available, but many organizations are revising their traditional attitude at present, primarily for two reasons: (a) the necessity to generate additional income through royalty collection, and (b) the competition among tropical developing countries for outlets of traditional export crops. Although international efforts are under way to keep the germplasm and technology at the public institutes 'freely' available[2], PBR protection may increasingly become a condition for licensing out this germplasm.

2. The *International Plant Genetic Resources Institute* (IPGRI, formerly IBPGR) has concluded agreements with different institutions to hold a base collection for specified crops. The germplasm at these institutes is in principle 'freely' available. In addition to this, the FAO has an International Network of Ex Situ Collections. This material is not yet covered by any agreement with FAO and consequently it is not necessarily freely available. It seems, however, that access to the materials for all these national institutes has not been seriously hindered to date (Communication with IPGRI).

5.2 Authorization for exploiting foreign germplasm

An operative PBR system may enhance opportunities for access to foreign plant genetic material. But having access to germplasm is one thing, the use that can be made of it is another. PBR protection makes foreign breeders less reluctant to license out their varieties, precisely because it offers them the opportunity to control the exploitation of the varieties. Table 5.1 presents the various types of exploitation of plant varieties for which permission of the breeder is required. In this paragraph it will first be argued that the scope of control by the breeder has been enlarged by the UPOV act of 1991, due to the extension of the forms of exploitation that require permission of the breeder. Secondly, there will be an examination of how the obligation to obtain permission may restrict the receiver in exploiting foreign varieties.

5.2.1 Strengthening the position of the breeder

Table 5.1 shows that the use of protected germplasm for research purposes and as source for breeding is free. These are crucial elements of PBR. No permission of the (foreign) breeder is required for a close examination of a protected plant variety, or for crossing the variety with another variety. The resulting new variety is in principle eligible for protection itself. However, the 1991 act of UPOV, which provides the new international standard for PBR protection, has strengthened the position of the breeder in a number of respects. Two of them will be discussed in this segment: (a) the introduction of the essential derivation principle, and (b) the extension of the scope of protection onto the harvest of the protected variety.

Table 5.1 **Forms of exploitation of protected plant varieties which require permission by the breeder, under two acts of UPOV**

	UPOV 1978 act	UPOV 1991 act
Use for research	Free	Free
Use as source for further *breeding* with commercial purpose	Free	Free. Marketing essentially derived varieties requires permission
Use for *multiplication* with commercial purpose	Permission required	Permission required
Use for *growing* and marketing harvest	Free	Free. Permission required if multiplication was unauthorized

a. Essentially derived varieties

Under the former UPOV acts, it was possible for a person to make a small change in an existing variety and to protect the resulting changed variety under PBR, without any obligation to the breeder of the initial variety. There are a number of ways to create such new varieties. They may be found by chance as a natural mutant of an existing variety, they may result from a reselection of plants of existing varieties, or they may be created through research: back-crossing, genetic engineering, induced mutation, changing chromosome numbers, or cell fusion. In all of these cases the new varieties may differ only little from the initial variety, and their commercialization could seriously interfere with the business of the breeder of the initial variety.

In order to curb the marketing of what breeders call 'parasitic' varieties, the principle of essential derivation has been introduced in the 1991 act of UPOV.[3] A variety will be considered to be essentially derived when the variety, although distinguishable from other varieties, is predominantly derived from another variety, and retaining the essential characteristics which result from the genotype of that other variety.[4] The costs incurred in the creation of the new variety are not relevant. What counts in determining whether or not a new variety is essentially derived is the genetic similarity with the initial variety. If the right holder of the presumed initial variety can demonstrate that a new variety is indeed essentially derived from his variety, this breeder's authorization is required for the marketing of the derived variety.

An assessment of the impact of the introduction of essential derivation as yet is necessarily speculative. Any previous experience with dependent plant breeders' rights in UPOV countries is absent and the UPOV act is silent on several important aspects. For example, how to determine whether a new variety is essentially derived or not? And what happens if a variety right holder refuses to authorize the commercialization of a new variety that is essentially derived from his variety? Some of these questions are presently the subject of studies by ASSINSEL, the international organization of commercial plant breeders and the main proponent of the inclusion of the essential derivation concept, and by an *ad hoc* committee of UPOV member states. The studies focus on the molecular marker technologies and the threshold values that could be used to prove and determine genetic similarity between varieties.

Which threshold values will eventually be considered to be appropriate has not yet been determined. The following opinion of a US seeds man may give an idea of what can be expected: There would be no essential derivation if two new lines were less than 75 per cent similar to each other and to either parent line of the source hybrid. If either line were 90 per cent or more similar to one of the parent

3. 'Article 14(5): [*Essentially derived and certain other varieties*] [...]
(b) For the purposes of subparagraph (a)(i), a variety shall be deemed to be essentially derived from another variety ('the initial variety') when
(i) it is predominantly derived from the initial variety, or from a variety that is itself predominantly derived from the initial variety, while retaining the expression of the essential characteristics that result from the genotype or combination of genotypes of the initial variety,
(ii) it is clearly distinguishable from the initial variety and
(iii) except for the differences which result from the act of derivation, it conforms to the initial variety in the expression of the essential characteristics that result from the genotype or combination of genotypes of the initial variety. [...]' (UPOV 1991).

4. Distinctness and essential derivation are two different concepts. The assessment of distinctness is based on difference, by the expression of at least one characteristic. The assessment of essential derivation is based on conformity, based on almost all the genome and on most of the essential characteristics resulting from that genome (ASSINSEL 1994).

lines, then the new line would be essentially derived, even though there was no intent to plagiarize by the breeders. What should happen when the two new lines were 75-90 per cent similar to each other, or to one of the parent lines of the source hybrid, is unclear. This is a 'grey zone' where further steps would be needed to resolve the situation (Geadelmann 1993, p.7).

Disputes on essential derivation should be resolved by the breeder, i.e. the rightholder, himself. Unlike the question of distinctness, which is a question of granting the right and will be decided upon by the official PBR authorities, the question of essential derivation is a question of the scope of protection and must be demonstrated by the rightholder of the presumed initial variety. Eventually, however, the question whether or not a variety is essentially derived will be determined by a court on the basis of the provisions in the UPOV act and/or the national law.

The PBR laws in Argentina, Uruguay and Chile do not include provisions concerning essential derivation, but in Colombia and Mexico they do. In Colombia, the concept has been introduced by Article 25(c) of Andean Pact Decision 345. This article provides for a protected variety to be used to obtain and exploit a new variety, 'except in case of a variety which is essentially derived from a protected variety'. In Mexico, the proposed law provides, in Article 8, that if a new variety presents 'identifiable characteristics' of a protected one, authorization of the breeder of the original variety is required for the filing for PBR. In the survey it was found that most respondents were confused about the concept of essential derivation, if they were familiar with it at all. Among those who were informed in Mexico and Colombia, essential derivation was the most contested issue of PBR law. Whether or not seed companies are in favour of the concept seemed to be related to their breeding capacities and their source of germplasm. Established seed companies with access to public domain germplasm, such as many cereal breeders, could possibly benefit from the strengthening of protection, because their breeding *output* is better protected, while their breeding *input* remains unaffected. For starting companies relying heavily on private foreign germplasm, such as many fruit and cut-flower companies, the situation may be different. A Colombian company pointed out that nearly all his costly effort in the realm of plant breeding (consisting of reselection and adaptation) ends up in varieties that will probably be defined as essentially derived. The marketing of these varieties, i.e. the export of cutflowers of these varieties to the main markets in the USA and Europe, may consequently become subject to authorization by foreign breeders. However, when it comes to export, the Colombian PBR law is less relevant. Access to foreign markets will finally be determined on the basis of the PBR legislation of the importing country. The effect of the inclusion of the concept of essential derivation in Colombia's PBR law is that it enables the foreign breeder of the initial variety to exercise his right at an earlier stage.

b. Protection of the harvest

Under the previous acts of UPOV, the minimum scope of protection gave the breeder a right only in relation to the propagating material of his variety. The 1978 act expressly permitted member states the option of granting rights for the harvested material, but few did so. This situation enabled companies to circumvent PBR protection by locating the multiplication stage abroad, in a country where PBR legislation was absent. The multiplied material could then be grown-out in the same country, while the final produce was imported back. As the harvest of a protected variety fell outside the scope of PBR, no permission of the breeder was required to market the produce of his variety. For many years this situation has been challenged by breeders, especially those involved in the cut-flower sector. In 1991 it was decided to enlarge the scope of PBR under the new UPOV act. Under this act, the breeder has a right in relation to the harvested material when (a) the harvested material has been produced by the

unauthorized use of propagating material, and (b) the breeder has had no reasonable opportunity to exercise his right in relation to the said propagating material. The act also offers the opportunity to member states to further extend the scope of protection to products directly obtained from harvested material.

5.2.2 Restrictions imposed by the breeder

PBR legislation bestows on the breeder the right to permit or refuse various forms of exploitation of his material. For a period of minimally 15 to 20 years the breeder can control the marketing of: (a) the propagating material of his variety, (b) the propagating material of the variety that is essentially derived from his variety, and, in some occasions, (c) the produce of his varieties. The breeders' position is justified by the necessity of earning royalties. The breeder, however, can employ his rights for objectives other than royalty collection. He may impose additional conditions in the licensing contract, such as restrictions on export of material of his variety, or he may refuse exploitation of the variety altogether. In this way, PBR protection may enable breeders to influence particular agricultural markets. Below, two examples will be described to demonstrate this effect of PBR.

Example 1: *Strawberry plants*

Production of strawberry plants is considered to be a small but profitable business. The main markets for these plants are the USA and Europe. The USA is the world's leading strawberry producer with California producing approximately 80 per cent of the US crop. Japan ranks second and is followed by several European countries, such as Poland, Italy, France, Russia (Hancock et al 1991, p.491).

The number of strawberry breeders in the world is small. The breeders of the main commercial varieties are the *University of California* (UC) in the USA and the *DLO Centre for Plant Breeding and Reproduction Research* (CPRO) in the Netherlands. Both organizations are semi-private organizations.[5] The Dutch varieties are adapted to temperate zones and are grown in Northern Europe; the Californian varieties are grown in subtropical regions, including California, Florida, and Southern European countries. Multiplication of strawberry plants is licensed to nurseries in the regions where the varieties are cultivated. Since the beginning of the 1990s, however, Chilean and Argentine nurseries have taken advantage of their counter-season production opportunities and emerged as strawberry plant propagators for the Northern hemisphere.

5. The Californian strawberry industry finances half of the strawberry breeding at UC; the other half is provided for by federal and state funds. CPRO is a semi-governmental institute on its way to becoming auto-financed in the future.

The initial objective of the nurseries in Chile and Argentina was to provide strawberry plants to the Latin American market. Since strawberry breeding is absent in Latin America, they began to propagate older foreign varieties from UC and CPRO which were not protected in Latin America. The Northern breeders had not anticipated the multiplication of their varieties in this region, and had therefore never considered filing for PBR protection in Argentina and Chile, although this would have been possible. At the time the nurseries started their propagating activities, the varieties were already on the market and not eligible for PBR protection any longer. The nurseries could multiply the strawberry plants without royalty cost or restriction.

Nevertheless, a Chilean nursery was willing to enter into a licensing agreement with UC and to pay royalties in order to get access to high quality meristem (F1) material for propagation. According to the nursery, the company had no other choice than to agree with UC in this way. It had previously obtained mother plants from US nurseries (licensees from UC), but their plants had become infected with *Xanthomonas*. The company then tried to obtain plants from UC's Spanish licensee but that company was not allowed to comply with the request. UC has forbidden all its master licensees in the world to provide protected varieties to propagators and growers in countries where PBR protection is absent.

As production grew relative to their market, the Chilean licensee sought to expand its territory beyond that specified in the licensing agreement and started to make sales into Europe. This sale led to a European demand for Latin American plants. The reasons are two-fold. The plants tend to be cheaper, and have a qualitative advantage.[6] Because of the demand, Argentinean nurseries also became interested in the European market. The main strawberry nurseries, in cooperation with INTA, IASCAV, and INASE, formed the *Asociación de Viveristas de Frutilla de Argentina* (AVIFRUAR). They implemented a certification system for strawberry plants and aimed at the licensed propagation of new strawberry varieties from UC and CPRO. UC felt it had no other option than to accept the Argentinean production and proceeded licensing the newer and protectable strawberry varieties to the association of strawberry nurserymen. AVIFRUAR was also prepared to pay royalties on the older varieties that were not eligible for protection any more, provided that they could get access to European markets (Gerlach 1993).

6. In the Northern hemisphere strawberry plants are stored at -1°C around December/ January. These cold-stored plants are planted in shifts, starting with the first lot in April to the last lot in September. The quality of these cold-stored plants remains good until July. Then, the quality decreases dramatically. This results in a low yield and poor fruit quality. The problem can be solved with plants coming from the Southern hemisphere, which are cold-stored in May. These plants are more vigorous, more apt to flower, and fruit earlier.

This situation posed a problem for the Office of Technology Transfer of UC. The policy at UC is to have Master Licensees in all foreign markets. These licensees represent UC in their respective countries and defend their national market against unauthorized propagation and trade of protected strawberry plants. If UC allowed Latin American nurseries to import plants into Europe, these plants would form direct competition for plants produced by other UC licensees in Europe. In the end, UC did not oppose a limited transfer of plants as long as the import would take place in agreement with the Master Licensees, and provided moreover that the prevailing European royalty rates were paid and the plants were delivered to, or through, authorized parties (Gerlach 1993).
While the Chilean nursery succeeded in obtaining an agreement with UC's Spanish licensee and now exports plants to Europe, negotiations between AVIFRUAR and the Italian Master Licensee of UC were not realized in 1994. The Argentine nurserymen did not accept the conditions for entering the Southern European market as set by the Master Licensee, under which all imported plants would have to be marketed through the Master Licensee or sub-licensees in quantities and at prices set by these parties (AVIFRUAR 1994).

Meanwhile, the Argentine companies have imported plants of Dutch strawberry varieties into Northern Europe. The breeder, CPRO, is only starting to establish a more commercial licensing policy. Royalty rates are presently three times as high as in 1990 and compliance of licensing contracts will be more vigorously enforced in the near future. The centre will not license out multiplication in countries where its varieties cannot be protected. Import of the Latin American plants is accepted as long as these plants meet a demand. If the European markets become saturated and the imported plants form competition for locally produced plants, PBR protection will be invoked to the restrict the import of Latin American plants (Communication with CPRO).

Example 2: *Sugar cane*

Colombian sugar cane varieties are presently also grown in other countries in the region, such as Guatemala. This is a completely legal affair. Since the varieties are not protected in Colombia or in Guatemala, there is no legal barrier to Guatemalan sugar cane growers to acquire, multiply and grow Colombian canes. This situation may change, however, as soon as sugar cane varieties become eligible for protection in both countries. The Colombian breeder is an institute financed by the private sugar mills and the sugar cane growers. The breeder is therefore part of what can be called the Colombian sugar industry. The Guatemalan producers are potential competitors for the Colombians: Guatemala is closer to the USA, which is the main export market; the country may become participant of the NAFTA; and Guatemala has lower labour costs. When Guatemalan producers exploit Colombian varieties, the Colombian growers would *de facto* subsidize their foreign competitors. Export restrictions in a

licensing agreement are irrelevant since it is not the canes, but processed sugar which is exported to the USA. Determination of the varietal origin of sugar is impossible. The Colombian breeder, however, has the right to block the entire exploitation of his variety, if it is protected in Guatemala. In 1993, a request of a Guatemalan institute to the Colombians for improved varieties was refused.

5.3 Are PBR helpful in the transfer of foreign germplasm?

Whether PBR protection improves access to foreign genetic material depends on the IPR policy of the supplier. Offering PBR protection will not result in better access to germplasm available at the major public suppliers of germplasm, such as the international agricultural research centres, but may improve access to germplasm that is concentrated with private seed companies in OECD countries. The better access to foreign private germplasm may be limited, however, because several forms of exploitation of the obtained germplasm require permission of the breeder. For obvious reasons it is unlikely that the breeder will object to exploitation that is additional to the existing use that is being made of his variety. But when the exploitation interferes with, or substitutes for, existing exploitation, the breeder may employ his right to limit or prevent exploitation. Export restrictions may be imposed upon receivers of foreign varieties to prevent parallel imports of material of these varieties into the main markets. This may happen, for example, with the emerging cut-flower and fruit exports from developing countries, because this growing production competes with production that takes place within the USA or the EU, the main markets itself. PBR protection may also be used to prevent exploitation of the variety altogether. This is a likely scenario when the breeder is not an independent entity, but is also involved in the propagating and growing stages of the chain of production. The breeder's interest is then linked to that of the whole (national) industry, as is the case in many traditional tropical export crop sectors. In this sense, PBR may become a tool among developing countries which compete for the same export markets.

6 Diffusion of seed among farmers

The basic rationale of the PBR system is to make private plant breeding and seed production a more profitable business. The ultimate objective of PBR is, however, not a flourishing plant breeding industry, but advanced agricultural production. Farmers in the first place should benefit from PBR, because of the expected increased availability of improved varieties and because of an expected better production and distribution of seeds.

Farmers have basically three options to acquire their seeds: (a) they may obtain high quality seed for every crop cycle from public institutes, seed companies or their dealers; (b) they may save a portion of their own harvest to be used as seed to resow their land; or (c) they may swap grain for seed with cooperatives, grain elevators, or other dealers. All three channels are often used simultaneously by farmers. As each of the channels may be affected by PBR protection in its own way, the consequences of PBR for individual farmers will be determined by the extent to which they rely on them.

This chapter focuses on the impact of PBR on the latter two forms of seed supply, rather than on the effects of PBR on the number, quality and price of newly developed varieties.[1] In developing countries, most seed is diffused through grain/seed swaps or seed saving. It is generally assumed that, in developing countries overall, more than 80 per cent of the seed requirements are met in this way (Groosman et al 1991; Srivastava and Jaffee 1993; Rabobank Nederland 1994). Will enactment of PBR restrict seed saving and grain/seed swaps, and what consequences will this have for farmers?

1. Since PBR protection has only recently been enforced in the Latin American countries, and since it takes 10–15 years to develop a new plant variety, an examination of number and quality of newly developed plant varieties was not possible. The effect of PBR on seed prices has been dropped from the project because of time limits. Such an examination requires a comparison of seed prices of protected varieties with those of alternative non-protected varieties. In order to find out whether eventual higher prices are justifiable, the yield and quality of the varieties should be examined. Moreover, the additional inputs which are required to obtain these yields and quality should also be taken into account. These calculations were far beyond what could be achieved within the four month period available for the case studies.

6.1 On-farm seed saving

Rather than purchasing fresh seed for every new crop cycle, many farmers, especially in developing countries, use seed that they have saved on their own farm or that has been produced by other farmers in the region. The best opportunities for seed saving are given by self-pollinating crops, such as wheat and soya bean, or vegetative reproducing crops, like potato and cassava. Only when the vigour declines, when the plants become susceptible to insects and diseases, or when a much better variety is released, are the seed or vegetative parts of these crops replaced by fresh, certified seed from official seed distributors (Srivastava and Jaffee 1993, p.3).

As the economic and political importance of seed saving was recognized by plant breeders and those who designed PBR legislation, all UPOV countries have exempted farmers from the obligation to ask permission and pay royalties for on-farm propagated seed of protected varieties. However, this attitude toward what is called the *farmers' privilege* has changed during the last decade. Large scale on-farm propagation with commercial purposes was among the reasons to revise the UPOV Convention in this respect.

6.1.1 Extent and benefit of seed saving

As seed saving and trade in on-farm saved seed takes place largely outside the official channels, statistical data on these practices barely exist. The estimates that have been published show that the use of saved seed differs widely. In the USA, seed saving is most important for crops such as wheat, barley and soya bean and is of little importance for alfalfa, forage seed and many vegetables (Butler and Marion 1983, p.55). A USDA survey of 1986 plantings showed that the share of saved seed in the soya bean seed planted was 46 per cent, ranging from 20 to 68 per cent among different growing regions. In wheat the percentage of saved seed was 40 per cent (OTA 1989, pp.79,83). In cotton, saved seeds may be important too. In large areas of the cotton belt, especially Texas, weather is so severe at cotton planting time, that many have to resow two or three times, making seed a big factor (Cook 1992, p.13). In countries belonging to the European Union, seed saving is common practice in protein crops, oil seed, potato, and especially cereals. Saved seed is used more in the southern countries (Spain, Portugal, Italy, Greece) than in the north (United Kingdom, Denmark, the Netherlands). It is generally assumed that in the north 5 to 35 per cent of the non-hybrid cereal seed supply has been saved on-farm, while in the south of Europe this percentage is around 90 (Rabobank Nederland 1994, p.14).

Statistical evidence on the use of saved seed is also absent in the five Latin American countries. The only information that could be collected during the survey were rough estimates by seed companies and PBR authorities. In the three Southern Cone countries the main commercial crops with a significant share of saved seeds include soya bean, some grains (notably wheat) and potato. Argentinean respondents estimated that the share of saved seeds in the wheat and soya bean seed supply is around the 30 per cent. In Uruguay it was estimated that 60 per cent of the wheat and oats seed supply consists of saved seed. Seed saving is also common in potato, and some forages, especially raigrass. Uruguayan farmers usually buy fresh seed potatoes for only one of the two production cycles in the year. When production is under contract by the processing industry, as in the case of barley and rice, farmers will -or are obliged to- buy fresh seed for every crop. Use of saved seed in Chile would be high in wheat -between 50 and 74 per cent-, and in rape seed -around 75 per cent. Table 6.1 shows the estimates for Colombia. On-farm multiplication seems limited or absent in ornamental crops and in sorghum, which is a hybrid crop. In several cereal and tuber crops, the rate of replacement of seed is extremely low. Sugar cane is not included. On-farm propagation of sugar cane is the traditional way to diffuse fresh canes and new varieties and is therefore encouraged by breeders. Farmers pay for the sugar cane research and breeding at the mills where the farmers have to offer their produce.

The economic benefits for farmers who use saved seed are difficult to assess. Differences may occur per crop, per year, per country, and even per region. Although various factors seem to play a role, the gain derived from the use of saved seed is basically determined by two variables: (a) genetic deterioration of the seed and (b) the difference between prices for the seed and the produce.

a Farmers who use saved seed may incur yield losses due to genetic deterioration of the seed. Seed companies often point out this factor in order to stress the higher quality of fresh first multiplication seed. Genetic deterioration is especially important with respect to hybrids where the yields of second and subsequent generations are significantly lower than the first. In the case of self-pollinating varieties, studies which compared differences in yield of fresh and saved seed had mixed results. An American study found indications that purchased winter wheat seed, on average, generated higher yields than did saved ('bin run') seed (Knudson and Hansen 1991). However, in German studies with winter wheat no differences in yields between saved and purchased seed were found that could be attributed to genetic deterioration, although in trials with other grains such differences did occur (Keitlinghaus 1993).

Table 6.1 **Estimated use of saved seeds for some crops in Colombia in 1994**

	% saved seeds in total seed supply		
Ornamental plants	0	Maize (varieties)	85
Sorghum	5	Wheat	95
Banana	10	Barley	95
Cotton	20	Potato	95
Rice	30	Beans	95
Soya bean	70	Cassava	100

Source: Estimates by seed companies and institutes in Colombia

b By setting aside part of their land for propagation purposes, farmers lose part of their harvest which otherwise would be sold. The extent of this loss depends on the difference between the market price for the harvest and the price of seed. The wider the gap between these prices, i.e. the higher the seed price in relation to the price for the harvest, the more farmers will be inclined to use saved seeds. This is the reason that many farmers in Latin America even use second generation seed of maize hybrids. In Argentina, respondents estimated that up to 20 per cent of the hybrid seed supply may consist of F2 seed. Because of the relationship between harvest and seed price, seed saving acts as a check on seed prices. When the prices for the produce decrease, the seed industry has to lower its seed prices in order to prevent seed sales from dropping (Van Wijk 1993).

In the survey, the views on gains derived from seed saving differed greatly. The economic importance of saved seed for farmers in marginal areas was stressed -in all countries- by public institutes, farmer's organizations and especially NGOs which work with small-scale farmers. It was contended that farmers producing their own seed have lower costs, are less dependent on external seed supplies, and are more secure in the availability of seed in time. A lower rate of replacement of varieties or seed would also enable local adaptation of the variety which would perhaps not result in maximum yield but in more yield security. On the other hand, most seed companies and many public institutes in the sample denied the advantages of seed saving for farmers who work under more favourable conditions. They pointed out the risks farmers incur when they do not replace their seed regularly. Their crop will become susceptible to pests and diseases, resulting in lower yields.

Table 6.2 **Estimated seed cost savings by using saved seed of wheat and soya bean in Argentina in 1994**

Type of seed supply	Seed cost per ha in US$	
	Wheat	**Soya bean**
A. On-farm saved seed	17.51	19.82
B. Certified seed 1st multiplication	27.72	32.25
C. Seed obtained through canje	26.40	31.50
Benefit A over B	37 %	39 %
Benefit A over C	34 %	37 %

Source: Gutiérrez *et al* (1995)

In order to get some idea about the cost reduction resulting from seed saving, some calculations have been carried out for wheat and soya bean seed saving in Argentina. The costs of saving seed on-farm were compared with costs of certified seed and seed acquired through *canje* (swap). In the latter transaction the farmer receives seed from a co-op or grain elevator as a credit at planting time in exchange for a double quantity of that seed in grain at harvest time. Table 6.2 shows that considerable seed cost reduction can be achieved by saving seed, between 30 and 40 per cent for both wheat and soya bean. From the point of view of those farmers who predominantly use on-farm produced seed, the cost of *canje* or certified seed is between 50 and 60 per cent higher. The eventual effect of seed saving for the farmer will also depend on the yield differences among the three categories of seed, which were not measured. According to Argentinean farmer's organizations and public institutes, the differences would not be very large. They asserted that certified and identified seed often do not meet the standards they should, and that the chances of having bad quality seed are equal for all types of seed supply.

6.1.2 The farmers' privilege

In order to let farmers produce their own seed, on-farm seed saving from varieties protected by PBR has traditionally been allowed in UPOV member countries. This 'privilege' granted to farmers used not to be explicitly mentioned in the UPOV convention, but was derived from the wording in the convention on the scope of the breeder's right. PBR protected breeders against unauthorized 'production for purposes of commercial marketing' of propagating material of their varieties.[2] This implied that production of propagating material for sowing the private land of the farmer was not within the scope of the breeder's right, and thus allowed.

2. Art.5, 1978 Act of UPOV (UPOV 1991a).

Seed saving by individual farmers as such used not to be disputed in UPOV member states because denying farmers the right to produce their own seed was considered to be undesirable, politically untenable, and in practice unenforceable since breeders would have great difficulty in providing proof of alleged infringements. The only exception was made for ornamental plants and cut-flowers (Van der Kooij 1990, pp.300-312). What has been disputed, ever since the founding of UPOV, is the sale of saved seed among farmers and the use that some canneries made of the farmers' privilege to avoid procurement of seed. International breeders' organizations such as ASSINSEL and FIS have argued that such an exploitation of the farmers' privilege resulted in unfair competition to breeders who had to cover development costs and had -unlike the on-farm seed producer- to comply with increasing cost requirements with respect to the seed quality (Van der Kooij 1990, pp.304).
Strong demands from the seed industry to curb the alleged abuses of the farmers' privilege have resulted in explicit provisions in this respect in the 1991 act of UPOV (UPOV 1991b). In Art.14 of this act, the farmers' privilege is actually eliminated as it provides that 'production or reproduction (multiplication)' of propagating material of a protected variety requires authorization of the breeder. In an additional optional clause however, member states are allowed to exempt farmers under certain conditions.[3] In a specific recommendation made at the Diplomatic Conference in 1991 it is stated that the intention of this clause is to legalize the existing situation, not to enlarge the use of the farmers' privilege.[4]

3. Article 15 (2): '[Optional exception] Notwithstanding Article 14, each Contracting Party may within reasonable limits and subject to the safeguarding of the legitimate interest of the breeder, restrict the breeder's right in relation to any variety in order to permit farmers to use for propagating purposes, on their own holdings, the product of the harvest which they have obtained by planting, on their own holdings, the protected variety or a variety covered by Article 14(5)(a)(i) or (ii).' (UPOV 1991b).

4. 'The Diplomatic Conference recommends that the provisions laid down in Article 15(2) [...] should not be read as to be intended to open the possibility of extending the practice commonly called 'farmers" privilege" to sectors of agricultural or horticultural production in which such a privilege is not a common practice on the territory of the Contracting Party concerned.' (UPOV 1992, p.63).

Besides the disputes within UPOV, the farmers' privilege also aroused controversy between various of its members. For example, the creation of a PBR system for the European Union[5] showed that the EU member states are strongly divided on the issue. There are not only dividing lines between farmers and breeders, but also between the main EU bodies as well as between EU member states. The Council Regulation, adopted in July 1994, provides for the inclusion of a farmers' privilege for specifically defined species, including fodders, cereals, oil and fibre plants and potato. Farmers must remunerate breeders for the seeds

5. This system of 'Community plant variety rights' complements the PBR systems in the individual EU member states.

they have saved, but the royalty for on-farm saved seed will be lower than that for certified seed. Only small farmers will be exempted from royalty payment (Council Regulation 1994).

US farmers have traditionally been permitted more room for manoeuvre with respect to seed saving because they were allowed to sell saved seed 'over the fence' to neighbours. As this 'brown bag' trade has grown considerably, reforming the farmers' privilege of the Plant Variety Protection Act was the goal of the US seed industry for many years. The industry finally succeeded in 1994, when the American Congress amended the PVPA to repeal the farmer sales provision of the farmer exemption. The amendment is effective for new varieties certified after April 4, 1995. Furthermore, the right to sell saved seed of existing varieties has been greatly restricted by the US Supreme Court, in January 1995. In a highly publicized case of Asgrow Seed Co v. Winterboer, the Supreme Court ruled that sales were limited to seed saved for replanting by the producer (Hamilton 1995).

The PBR laws of Argentina, Chile, Colombia and Uruguay, as well as the latest PBR bill of Mexico specifically exempt farmers from PBR protection. In all five countries farmers are permitted to save seed of protected varieties to resow their own land. The survey showed an overall acceptance of these provisions, because of a combination of political and practical considerations. On the other hand, most seed companies in the sample pointed out that the farmers' privilege also facilitates unauthorized seed trade, or black market of seeds.

6.2 The consequences for farmers

6.2.1 Marginalization of an unofficial credit system?

Seed companies in Argentina contended that the main problem with the farmers' privilege is distinguishing seeds saved by the farmer to resow his own land, which is allowed, from saved seeds that are exchanged or marketed, which is not allowed. As farmers normally lack equipment to dry and disinfect the seed they have saved, the common practice is to transport saved seed to the local cooperative or grain elevator where equipment is available. Consequently, these places store both bags of seed and bags of grain destined for consumption. This makes it difficult for PBR authorities or auditors of the breeders association to make sure that consumption grain will indeed be sold as grain and not as seed. The non-transparency of this situation has been responsible for a great deal of unauthorized seed trade.

The backbone of this form of seed supply are seed dealers (including grain elevators and cooperatives) who are involved in grain/seed swaps (*'canje'*). In these transactions, grain is purchased from farmers, conditioned and subsequently handed over as a credit in kind to other farmers who use the grain as seed. Occasionally the dealer is informed about the origin of the grain, for example whether or not the grain is produced from certified seed and whether the field condition was suitable for harvesting the grain as seed. The advantages for the dealer are that two bags of grain can be obtained for the price of one, while the required breeder's authorization for seed sales, cost raising quality requirements, royalty payment, and, above all, taxes, can be avoided. Taxes (18% VAT, municipality tax, income tax) constitute a far higher burden for dealers than royalties. It has been estimated by the Argentinean PBR authority, INASE, that the losses by this form of tax evasion for the Argentine state amount to as much as US$ 40 to 60 million annually.

In order to curb the unauthorized seed trade, INASE has established certain limitations on the farmers' privilege:

a the seed that is propagated must have been legally acquired
b the seed must have been produced on the farmer's land
c the farmer must plant the saved seed back on his land

The farmer must further prove that the transport of saved seed to another place is for preparation purposes, since the Argentine Seed Law prohibits transportation of seed outside the farmer's premises if it is not identified or certified.

The effect of these limitations and of the PBR enforcement strategies by ARPOV, the association of breeders in Argentina, have been indicated in chapter 2. Around 60 per cent of the seed dealers were registered by INASE in 1994, while the amount of wheat and soya bean seed that was diffused without authorization decreased significantly between 1990 and 1994. The black market in wheat and soya bean seed was less than 15 and 28 per cent respectively of total seed supply in 1994 (see table 2.6 and figure 2.1).

What for breeders is a black market in seeds is also an unofficial credit system for farmers and a major channel for seed diffusion. The grain/seed swap has certain advantages for farmers. They can obtain a bag of seed as a credit in kind during planting time. The credit is paid off at harvest time with the double quantity of grain. The final price for the seed is beneficial, while the payments in kind provide farmers some protection against currency fluctuations. When the unauthorized seed trade is reduced, seed dealers have to pay royalties and taxes on their sales. One would expect that these additional costs are passed on to the farmers, with higher seed prices and more on-farm seed saving as the likely outcome. This, however, has not happened in Argentina. During the interviews, farmers organizations did not mention an impact of PBR on the diffusion of new wheat and soya bean varieties. The grain/seed swap still exists as a means of seed distribution, with the same price as during the period before PBR enforcement: one bag of seed for two bags of grain. It seems that the cost increase of seed, caused by PBR protection, hase been borne by the middlemen, at least for the time being.

6.2.2 Diminished use of traditional varieties

Especially in less favourable environments and remote areas, farmer households and communities still grow traditional varieties or landraces. The importance that is often attributed to these traditional varieties is two-fold: lively hood security and conservation of genetic diversity (see e.g. Brush 1992; Hardon 1993; Crucible Group 1994). By using their own locally-bred varieties and their own seed, farmers may increase yield security and diminish their dependence on external deliveries of agricultural inputs, while the continued use and innovation of landraces by communities in marginal areas may be relevant for the conservation of genetic diversity of the world's food crops. The communities do not just preserve specific genotypes, but generate diversity as they enable hybridization between cultivars, and between domesticated and wild and weedy crop populations.

The use of traditional, locally-bred, varieties is not restricted by PBR. Traditional varieties cannot meet the requirements for PBR protection, and are consequently in the public domain. Indirectly, however, PBR will affect their use and diffusion. The existence of farmers who are still growing traditional varieties is often seen as a sign of backwardness of a country's agricultural sector. The reason for the adoption of PBR legislation is precisely to stimulate the private sector to breed more productive varieties, while a combination of seed laws and additional policies are intended to make farmers shift over from traditional to these modern varieties. In most developing countries, the use of certified seed of modern varieties is either recommended by extension services, linked to credit facilities, or is obliged by the processing industry. The marketing of seed of traditional varieties may also be reduced by mandatory registration of varieties.[6]

6. In Argentina, for example, seed of forage landraces (*ecotipos*) can still be commercialized under the *Clase Indentificada Común*, which is a class of seed for which the quality requirements are less strict compared to those for certified seed. One of the features of this class is that indication of the variety name on the bags is not obligatory. An alfalfa landrace known as *alfalfa pampeano* can therefore still be sold under the general denomination of *alfalfa seed*. For most other species it is no longer permitted to market seed without a clear varietal indication. Since landraces do not meet the requirements of variety registration (which are the same as for PBR protection: distinctness, uniformity and stability), the obligation to indicate variety names in fact terminates the official trade of this seed. Farmers' communities then maintain the opportunity to grow and exchange landraces but only outside the official channels.

Considering the rapidly increasing global food demand, the need for the breeding and distribution of more productive varieties is beyond discussion. However, these modern varieties often do not redeem their promises in areas where growing conditions are different from those in the research stations, or where farmers cannot afford the required additional inputs. Furthermore, in order to be commercially viable, modern varieties must have a high degree of genetic uniformity, a requirement that is at odds with the need to preserve genetic diversity. The conclusion that should be drawn here is that PBR is a mechanism to generate new plant varieties for a specific group of farmers who can operate under more favourable conditions. PBR legislation, however, is not designed to support the breeding of varieties for resource-poor farmers or varieties that are useful in the preservation and further generation of genetic diversity. These objectives require additional approaches. The International Gene Fund, which will be discussed below, may be a suitable option.

6.2.3 Farmers' rights

Since the early 1980s, a South/North controversy over genetic resources has centred on questions of equity in the distribution of benefits arising from the use of plant genetic resources. On the one hand, developing countries have questioned the fairness of assigning intellectual property rights to those who breed new plant varieties, while the work of generations of farmers who have generated the plant diversity that constitutes the basis for modern breeding is not legally recognized. On the other hand, industrialized countries have stressed that PBR and patents are not a form of compensation but rather an incentive for innovation.

The dispute was partly resolved in 1987, when, within the FAO, the rights of farmers in developing countries were acknowledged in order to counterbalance the plant breeders' rights granted in industrialized countries. Farmers' rights were defined as rights arising from (past, present and future) contributions of farmers in generating plant genetic resources, particularly in the centres of diversity, and have the purpose of ensuring full benefits to these farmers and supporting the continuation of their contributions (FAO 1989). An International Gene Fund would give a concrete and substantial basis to the farmers' rights.

Although the Fund failed to materialize in the subsequent years, farmers' rights remained on the international political agenda. The concept was further developed during the Keystone International Dialogue on Plant Genetic Resources (Keystone Center 1991), and was a subject of discussion during the Earth Summit on Environment and Development in 1992. The Convention on Biological Diversity, however, follows the principle of national patrimony, and recognizes sovereign rights of States over their natural resources. Although the issue of farmers' rights is included in the 'Agenda 21', it seems that national sovereignty principle runs counter to the idea of an international fund linked to farmers' rights. The 'original advocates of farmers' rights' stress that these rights should not be considered as another effort to claim monopoly control over living materials. By recognizing farmers' rights, the international community acknowledges the historic and continuing role of farmers in generating biological diversity, and is committed to raise an International Fund of minimally US$ 300 million per year. This Fund should not be used to assign benefits for the commercial use of farmers' varieties to individual countries or farmers, but for encouragement of conservation and germplasm enhancement (Crucible Group 1994, p.34).

The main impact of the introduction of PBR in the Latin American countries on the farmers' rights concept may be that it contributes to the dilution of the North/South dichotomy that has been fundamental to it. The survey showed that all domestic breeding organizations in the Latin American countries favoured PBR. Most of them utilize germplasm that is available at international

and national research centres, while domestic seed companies utilize traditional varieties and wild relatives available in the farmers' fields for the breeding of modern varieties also. Several local companies and institutes said they had used traditional varieties (*criollos, variedades autóctonas, ecotipos*) in their breeding programmes. Half of the breeding organizations interviewed in Colombia had used traditional varieties, such as: *papa tucarreña, yuca amazónica, sorgo de natagaima, arroz miramano*, several varieties of beans, such as *cabecita, negra, cargamento, calima* and *carmen de Viboral*, and various traditional maize varieties such as *carioca, brisa, vela*, and *negrito*. A rice breeder said that the collection and study of landraces was an explicit goal of his organization. Around 50 traditional varieties had been collected, because these plants have interesting characteristics, such as the limited number of leaves which enable an efficient energy conversion. Argentinean breeders said that, in the past, landraces of sunflower and maize were used for breeding. Some respondents in Uruguay could give examples of sunflower, lotus, oats, maize and onion landraces that had been used in breeding programmes.

When domestic breeding capacity in developing countries increases, the North/South dichotomy in utilizing of genetic resources becomes less prominent. Traditional varieties which have been nurtured by local farming communities are being used by domestic breeders in Latin America, who also intend to protect their modern varieties by PBR. This underscores that the transfer of genetic resources from farming communities to private seed companies is not necessarily international in character, but also takes place within developing countries themselves.

6.3 Perspectives for farmers

No direct negative effects of PBR legislation on seed diffusion were observed in the three Latin American countries that have had an operational PBR system for some time. In Argentina, where the unauthorized seed trade has been considerably reduced in two important crops, the raised costs for the middlemen have not had a negative impact on the grain/seed swaps. Taxes and royalties may be forwarded to farmers in the future, however. Also the seed saving by farmers has not been affected, since the PBR laws in all countries have included an exemption for farmers. Nevertheless, the introduction of PBR causes a change of principle. When farmers start to use protected varieties, their natural right of seed saving becomes a legal right, or even less, a 'privilege'. Such a legal right is subjected to political decision-making and possibly prone to restrictions in the future. Finally, PBR legislation has not been designed to support plant breeding for the large group of resource-poor farmers in developing countries. Implementation of the farmers' rights concept is among the additional strategies that could be more appropriate in this respect.

7 Conclusions

1 Plant breeders' rights (PBR) legislation was introduced in Argentina, Chile, and Uruguay in the 1970s and 1980s, basically as a response to an internal and general drive to modernize the agricultural sector. In the 1990s, these three Southern Cone countries have strengthened and enforced their PBR protection, Colombia has enacted PBR legislation, while Mexico is expected to do so in 1995-1996. All five countries will be members of UPOV in the second half of the 1990s. These recent changes in the legal protection of plant material do in part meet demands of domestic and foreign seed companies, of public research institutes, and of producers and exporters of fruit and ornamental plants. Especially in Colombia and Mexico, the direct cause for introducing PBR is international political and economic pressure. In none of the countries have the changes in legal protection of plant material been the result of deliberate public policy for the long-term, based on a perspective on the role of the seed industry and the role of the different sectors involved.

2 Argentina is the sole country in Latin America where PBR have been effectively enforced for a number of years. During the first five years of its enforcement, the predominant effect of PBR has been a considerable reduction in the unauthorized marketing of seed of protected wheat and soya bean varieties. Because the domestic industry dominates these seed markets, local companies and the public agricultural institute have been the main beneficiaries of the PBR system in Argentina so far.

3 The experiences with PBR in Argentina, Chile and Uruguay indicate that adequate implementation of PBR legislation requires specialized capabilities as well as specific institutional and legal strategies. These are principally the following:

a Sufficient quality control of the seed market by a qualified governmental authority. A structure that has proven to be capable of controlling the seed market is an indispensable basis for the implementation of PBR legislation. It is difficult to conceive that in countries where such a structure is absent, PBR protection can be actualized.

b An adequate system of variety registration, which is recognized by the seed industry.

c Initiatives by breeders to collectively exercise their rights. PBR are private rights and it is up to the breeders themselves to enforce these rights. Absence of collective action by title holders has been an important cause of the limited effect of PBR protection in Chile and Uruguay.

4 PBR protection in Argentina seems to have prevented a reduction in R&D expenditure in soya bean and wheat, rather than having stimulated additional R&D expenditure for these crops. Other factors, such as macro-economic changes, may have played a role too; it is almost impossible to assess the precise effects of PBR protection on private investments isolated from other

determinants. However, within the seed industry in Argentina a broad consensus exists that PBR have enabled domestic wheat and soya bean companies to increase their sales and royalty income and to survive difficult economic periods. The preliminary evidence also indicates that PBR protection has strengthened plant breeding programmes by public institutes in Argentina and Chile.

5 A division of labour exists in the seed markets of the five Latin American countries: the domestic breeding industry is almost entirely devoted to self-pollinating crops, while seed multinationals (MNEs) predominantly operate in hybrid crops. It is unlikely that PBR will profoundly change this structure. PBR, as such, will not induce domestic seed companies and public institutes to become involved in hybrids breeding, as the barriers for this type of breeding are high compared to those for self-pollinating varieties. For seed MNEs, the legal protection complements the biological protection against unauthorized multiplication of the hybrids themselves, which is one of the main reasons for the larger seed companies to breed hybrids. PBR may affect the relationship between domestic and foreign seed companies, if the protection for parental lines is proven to be adequate, and if in more crops (for example in soya bean and wheat) self-pollinating varieties are replaced by hybrids. The increased use of hybrids, rather than an expansion of foreign companies into self-pollinating crops, will lead to an enhanced presence of MNEs in the seed market of the Latin American countries.

6 In Latin America plant breeding is predominantly carried out by public agricultural research institutes. Although PBR legislation has the explicit goal of stimulating private plant breeding, none of the main research institutes in the five countries accepts a role in plant breeding which is subordinate to the private sector. Budgetary pressures are forcing them to take advantage of PBR legislation as a means of developing new sources of revenue. In Argentina and Chile, PBR have permitted the institutes to increase their income and establish more formal and commercial relationships with the private sector.

7 PBR seem to have both a negative and a positive effect on access to the germplasm at public institutes. The necessity to commercialize their new plant varieties, has raised the strategic importance of 'public' germplasm and reduced its availability for other users. Joint germplasm improvement programmes with the private sector restrict the free availability of parts of the institutes' germplasm collections even more, because of the conditions for cooperation stated by the private counterparts. On the other hand, access to 'public' germplasm has improved for private industry, because of the more formal and transparent procedures under which germplasm can be obtained. They replace the former discretionary and often arbitrary decisions on access made by individual employees of the institutes.

8 PBR have not yet had an impact on the research agenda of the main public institutes in Argentina and Chile. In general, none of the centres in the five countries had programmes integrating breeding and marketing objectives. Breeders and managers still seem to act rather independently.

9 PBR play an ambiguous role in the international transfer of plant material. It can be expected that growers, propagators and breeders in Latin America benefit from better opportunities to collaborate with foreign breeders when PBR protection in their country proves to be adequate. It will encourage private foreign breeders to make available advanced material of their varieties and parental lines of hybrids. On the other hand, PBR may restrict exploitation of that material. It is unlikely that the foreign breeder will object to exploitation that is additional to the existing use of his variety. But the foreign breeder or his licensees may employ the right to limit or prevent exploitation in, or export from, Latin America when it substitutes for existing exploitation elsewhere.

PBR may also be used by organizations in different Latin American countries which compete for the same export markets. When a Latin American breeder is not an independent entity, but is also involved in propagation and production, as is the case in many traditional tropical export crop sectors, the breeder's interest is linked to that of the whole (national) industry. Such breeders may employ PBR in competing countries to prevent exploitation of their varieties altogether.

10 No direct negative effects of PBR legislation on seed diffusion were observed in the three Latin American countries that have had an operational PBR system for some time. In Argentina, where the unauthorized seed trade has been considerably reduced in two important crops, the raised costs for the middlemen have not had a negative impact on the grain/seed swaps. Payment of taxes and royalties may be passed on to farmers in the future, however. Also the seed saving by farmers has not been affected, since the PBR laws in all countries have included an exemption for farmers. Nevertheless, the introduction of PBR causes a change of principle. When farmers start to use protected varieties, their natural right of seed saving becomes a legal right, or even less, a 'privilege'. Such a legal right is subjected to political decision-making and possibly prone to restrictions in the future.

11 Recent amendments to the patent laws in most of the Latin American countries will soon allow protection of plant material. Very few of the more than 150 interviewees in the five countries were aware of these developments, let alone their consequences. The effects of protecting plants by patents on the relationship between the domestic and foreign seed industries, as well as on the diffusion of seed, will be significantly different from those of PBR protection. Patented material cannot freely be used as a breeding source by other breeders, and farmers are not allowed to save seed from patented plants.

12 The experience in Argentina, and to a lesser extent in Uruguay and Chile, indicates that, until now, PBR seem to have favoured mainly the domestic plant breeding industry. Whether PBR will have similar effects in other countries remains to be seen. Especially in countries where no or few plant breeders are active, or where plant breeders have less access to genetic resources, the effect of PBR on plant breeding may be different. The main losers of PBR protection, however, seem to be the same everywhere: seed dealers involved in unauthorized seed trade. In the future, farmers may be affected too, if opportunities to swap grain for seed are reduced, or when they must pay more for their seed.

13 The limitation of the PBR system is that it has been designed to support the production of those farmers which have the opportunity to operate under relatively favourable circumstances. In developing countries in general this is a relatively small group of farmers; the majority of farmers work in marginal areas under often adverse conditions. PBR legislation is not a suitable instrument to make breeding technology available for these farmers. Other, additional, measures are necessary to support the breeding for resource-poor farmers.

14 It seems to be worthwhile for all countries who (have to) consider the introduction of PBR protection to study the effects of this protection on the seed industry, seed diffusion and technology transfer, prior to the adoption of legislation. Early identification of potential winners and losers enables the design of a PBR law, or a law which resembles such, that is adjusted to national needs. Moreover, additional measures could be considered to mitigate or prevent some undesirable effects which result from PBR protection.

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I Notes on the methodology

1 Research strategy

The present study has been carried out in five countries by five different research groups. All groups followed the same strategy which was discussed during a workshop of all groups in October 1993. The strategy included: (a) establishing Advisory Committees in each country, (b) sending out letters of recommendation, (c) interviewing organizations with an interest in plant breeders' rights (PBR) protection, (d) preparing case study reports, and (e) organizing seminars on PBR.

Advisory Committees
In order to gain national support for the project, the research groups, with the support of the local IICA office, convened Advisory Committees. Although the objective was to have all different organizations with an interest in PBR protection represented, farmers organizations were under-represented in most committees. In Chile an advisory committee has not been established.

The Advisory Committees met twice in most countries. They have successfully contributed mainly in:
- suggesting additional organizations that should be interviewed,
- facilitating contacts between the consultants and respondents,
- commenting on the draft report of the case study in their country,
- supporting the organization of the national seminar on PBR.

Letter of recommendation
IICA and the University of Amsterdam sent a joint letter of recommendation to organizations selected for interview in the five countries. The letter contained a short summary of the project's background, its objectives and strategy, and encouraged the organization to collaborate in the research project.

Interviews
A total of 157 interviews were carried out in the period February to May 1994 in the five countries. All interviews took place on the basis of similar questionnaires consisting of both closed and open-ended questions. In order to provide flexibility and allow for unanticipated responses, it was agreed that the questionnaires should be used as a guide for a semi-structured interview. The interviews took place with those persons within the organization who were most informed about intellectual property right matters and included chief executives, presidents, directors, and sales or research managers.

Case studies
Every research group prepared a separate report on the findings in the particular country. The draft reports as well as the general conclusions were discussed during a second workshop in June 1994, in Bogotá.

National seminars

With the exception of the Chilean study, all case studies were discussed during national seminars which took place in September 1994. The seminars were attended by 40-80 representatives of interested organizations and generally served two functions: a) validation of the research results, and b) clarification of aspects of PBR, such as the principle of essential derivation. In Mexico, the only country in the project where PBR logislation was not yet adopted, the seminar was used as an input for further discussions on the design of the PBR system.

2 Sample of respondents

The total sample of respondents by country and type of organization is shown in the table below.

Number of interviews by country and type of organization

	Gov[1]	Breeder			Propagator			Cul[8]	Association		NGO[11]	Other[12]	Total[13]
		PrD[2]	PrF[3]	Pu[4]	PrD[5]	PrF[6]	Pu[7]		I[9]	F[10]			
Argentina	1	7	7	4					5	5	3	1	33 (40)
Chile	1	2	-	2	3	2	-	-	1	-	1	2	14 (15)
Colombia	2	4	-	2[14]	5	2	-	3	6	1	3	1	29 (29)
Mexico	5	2	3	7[15]	-	-	1	1	2	1	-	4	26 (37)
Uruguay	2	6	-	1	11	-	-	-	2	3	1	3	29 (36)
Total	11	21	10	16	19	4	1	4	16	10	8	11	131 (157)

1. Governmental department
2. Private domestic seed company with breeding activities
3. Private foreign seed company with breeding activities in the country
4. Institution with a public goal which undertakes plant breeding
5. Private domestic seed company with propagation activities
6. Private foreign seed company with propagation activities in the country
7. Institution with a public goal which undertakes propagation activities
8. Private cultivating companies
9. Associations of breeders, propagators, or cultivators
10. Associations of farmers
11. Non-governmental organizations working with small-scale farmers
12. Other organizations with an interest in PBR, such as distributors, companies specialized in variety registration
13. Total of interviewed organizations (and persons)
14. Includes CIAT
15. Includes CIMMYT

Two comments on the categorization of respondents must be made.

a) Some organizations undertake various activities such as breeding, propagation, or propagation and cultivation. In these cases the respondents are categorized in the earliest stage of the chain of production. For example, breeders/propagators are classified as breeders; farmers associations with their own breeding programmes (as is the case in Colombia and Chile) are classified as breeders; seed multinationals who only produce seed of varieties they have bred in another country are classified as seed producers.

b) A company is considered to be a domestic company when 51% or more of the capital is owned by national shareholders. Foreign companies are those companies of which 51% of the capital is owned by foreign shareholders. The indication whether or not a company is considered to be national or foreign according to our criterion was left to the respondent.

The relative representation of the sample should be judged on face value. With respect to relevant governmental departments and associations of seed companies, the representation is around 100 per cent. In all five countries all organizations in these categories were included in the sample. In Colombia, Chile, Mexico, and Uruguay, most or nearly all plant breeding companies and institutes were included in the sample. In Argentina, 18 out of 58 plant breeding organizations were included. The selection of propagators has been somewhat arbitrary, because in most countries it was impossible to obtain data about the sales or market share of individual companies. Attempts have been made to include both foreign and national companies. Only in the case of Argentina was it possible to calculate that the private and public organizations included in the sample cover more than 80 per cent of the official seed supply in the country. In all countries at least the largest farmers associations were included in the sample. In Mexico it was difficult to get an interview with any of the farmers associations, as intellectual property protection was not an important for them. NGOs, working with small-scale farmers, form a minority in the entire sample. The reason is that only a few exist in Uruguay, Argentina, and Chile, while in Colombia and Mexico, where many agricultural NGOs are active, it was extremely difficult to find an NGO who was informed about and interested in PBR.

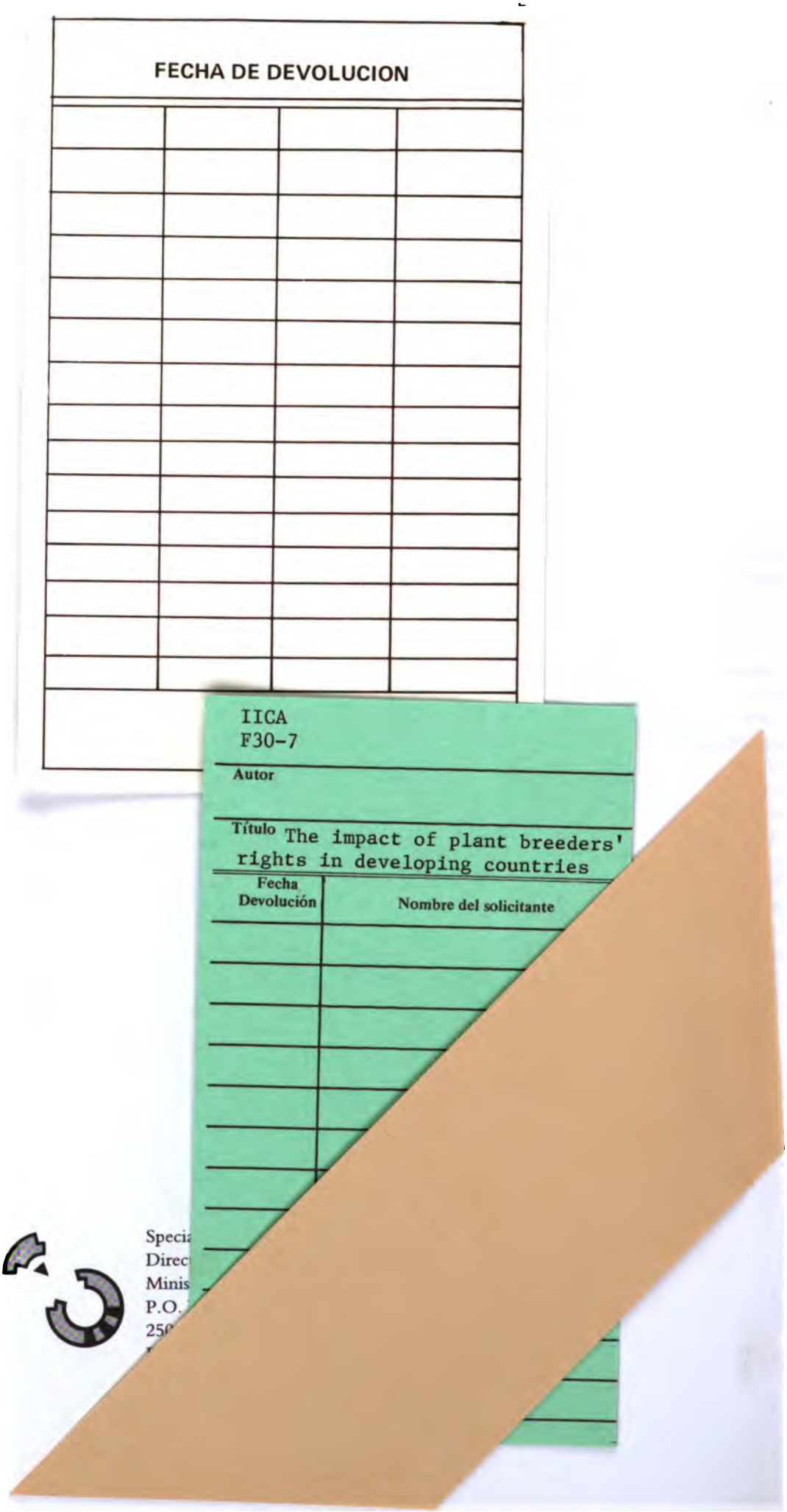
Added to the sample were professional individuals and organizations who appeared to have a specific interest in, or play(ed) a specific role in the design and use of PBR. Examples are ex-officials, companies specialized in PBR procedures, large cultivating companies, and university departments. In any case, nearly all organizations or individuals which had previously expressed an opinion on IPR in agriculture were included in the sample. In four of the five countries very few or none of the organizations in the sample refused to cooperate. Only in Mexico was the number of refusals high: 12 out of a sample of 49.

II PBR titles in UPOV countries

Number of PBR titles issued in 21 UPOV member countries in 1993 by origin of title holder

	Residents	Non residents	Non residents in %	Total titles
Austria	117	55	32	172
Australia	32	67	68	99
Belgium	14	70	83	84
Canada	3	48	94	51
Switzerland	9	56	86	65
Germany	409	274	40	683
Denmark	84	190	69	274
Spain	61	112	65	173
France*	355	211	37	566
United Kingdom	132	174	57	306
Hungary	42	33	44	75
Ireland	3	17	85	20
Israel	42	61	59	103
Italy*	31	72	70	103
Japan	319	149	32	468
Netherlands	885	398	31	1,283
New Zealand	26	46	64	72
Poland	63	124	66	187
Sweden	23	57	71	80
USA**	463	219	32	682
South Africa	94	49	34	143

* Data for 1992
** Data include titles under PPA and PVPA
Source: UPOV Newsletter No.77, 1995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