SSOAR

Open Access Repository
www.ssoar.info

Intellectual property rights and innovation around the world: evidence from panel data

Léger, Andréanne

Arbeitspapier / working paper

Zur Verfügung gestellt in Kooperation mit / provided in cooperation with:
SSG Sozialwissenschaften, USB Köln

Empfohlene Zitierung / Suggested Citation:
Léger, A. (2007). *Intellectual property rights and innovation around the world: evidence from panel data.* (DIW Diskussionspapiere, 696). Berlin: Deutsches Institut für Wirtschaftsforschung (DIW Berlin). https://nbn-resolving.org/urn:nbn:de:0168-ssoar-110710

Nutzungsbedingungen:
Dieser Text wird unter einer Deposit-Lizenz (Keine Weiterverbreitung - keine Bearbeitung) zur Verfügung gestellt. Gewährt wird ein nicht exklusives, nicht übertragbares, persönliches und beschränktes Recht auf Nutzung dieses Dokuments. Dieses Dokument ist ausschließlich für den persönlichen, nicht-kommerziellen Gebrauch bestimmt. Auf sämtlichen Kopien dieses Dokuments müssen alle Urheberrechtshinweise und sonstigen Hinweise auf gesetzlichen Schutz beibehalten werden. Sie dürfen dieses Dokument nicht in irgendeiner Weise abändern, noch dürfen Sie dieses Dokument für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, aufführen, vertreiben oder anderweitig nutzen.
Mit der Verwendung dieses Dokuments erkennen Sie die Nutzungsbedingungen an.

Terms of use:
This document is made available under Deposit Licence (No Redistribution - no modifications). We grant a non-exclusive, non-transferable, individual and limited right to using this document. This document is solely intended for your personal, non-commercial use. All of the copies of this documents must retain all copyright information and other information regarding legal protection. You are not allowed to alter this document in any way, to copy it for public or commercial purposes, to exhibit the document in public, to perform, distribute or otherwise use the document in public.
By using this particular document, you accept the above-stated conditions of use.

gesis Leibniz-Institut für Sozialwissenschaften

Mitglied der Leibniz-Gemeinschaft

ICAR

INSTITUTIONAL
CHANGE
IN AGRICULTURE AND
NATURAL RESOURCES

INTELLECTUAL PROPERTY RIGHTS AND THEIR IMPACTS IN DEVELOPING COUNTRIES

An Empirical Analysis of Maize Breeding in Mexico

ANDREANNE LEGER

ICAR Discussion Paper 5/2005

Discussion Paper

Institutional Change in Agriculture and Natural Resources (ICAR) Discussion Papers

Edited by Volker Beckmann and Konrad Hagedorn

Humboldt-Universität zu Berlin
Institut für Wirtschafts- und Sozialwissenschaften des Landbaus
Fachgebiet Ressourcenökonomie

Humboldt University Berlin
Department of Agricultural Economics and Social Sciences
Chair of Resource Economics

Luisenstr. 56, D-10099 Berlin
Germany

Phone: ++49 30 20936305
Fax: ++ 49 30 20936497

Email: k.hagedorn@agrar.hu-berlin.de
v.beckmann@agrar.hu-berlin.de
http://www.agrar.hu-berlin.de/wisola/fg/ress/

Managing Editor: Volker Beckmann

Editorial Board: Markus Hanisch
Martina Padmanabhan
Christian Schleyer

ICAR Discussion Papers are reports prepared by members of the Chair of Resource Economics, Humboldt University Berlin or external authors working on topics of institutions and institutional change in agriculture and natural resource management. The papers have received limited reviews. Views and opinions expressed do not necessarily represent those of the Chair of Resource Economics. Comments are highly welcome and should be sent directly to the authors.

ISSN 1613-3455 (Printausgabe)
ISSN 1613-4862 (Internetausgabe)

Intellectual Property Rights and their Impacts in Developing Countries

An Empirical Analysis of Maize Breeding in Mexico

Andréanne Léger

DIW Berlin, Dept. International Economics and
Humboldt University of Berlin, Faculty of Agriculture and Horticulture
Dept. Agricultural Economics and Social Sciences
Chair International Agricultural Trade and Development
Koenigin-Luise-Str. 5, 14195 Berlin
Tel: +4930 89789 328; Fax: +4930 89789 108
Email: aleger@diw.de

ICAR Discussion Paper 5/2005

January 2005

Abstract
There is little empirical evidence concerning the effects of intellectual property rights (IPR) on a technologically advanced developing country. Complete enumeration of the Mexican maize breeding industry showed that, contrary to the hypothesis that IPR would provide, in a technologically advanced developing country, incentives for R&D and innovation, IPR play no role for the industry in general, but that they are important for certain breeders' categories. The paper presents the theory on IPR and a short background on the Mexican maize breeding industry. The analysis of the interviews with maize breeders leads to the conclusion that the theory on IPR should be revised and take into account the characteristics of developing countries critical for the good functioning of IPR, especially the quality of the institutional environment and the judiciary system, and the importance of transaction costs related to IPR protection. The level of technological development also determines the extent to which actors can benefit from IPR protection. Given the relatively good score of Mexico on these two critical factors, IPR are likely to play an even smaller role for other developing countries.

Keywords: Intellectual property rights; Developing Country; Empirical Evidence; Transaction costs; Mexico; Maize.
JEL Codes: O34, Q16, O31, Q17

Acknowledgements
Comments of Tilman Brück, Paul R. Gregory, Philipp J.H. Schröder, Shubha Gosh and Matin Qaim on earlier versions of this paper are gratefully acknowledged. I would especially like to thank Martina Padmanabhan, Catherine Murray and Volker Beckmann for their extremely valuable comments and suggestions.

© Andréanne Léger

1 Introduction

Intellectual property rights (IPR) are generally considered an efficient institution to stimulate innovation. Strong IPR should provide incentives for innovation and expand investment and technology flows to developing countries (Maskus 2000). Although granting monopoly rights on an invention would impede its dissemination, under-provision of protected goods and monopoly distortions are usually considered acceptable costs in order to promote the creation of new knowledge and the increase in societal welfare that it brings (Gaisford et al. 2001).

Growing numbers question this position and maintain that IPR do not play an important role in stimulating innovation in developing countries (CIPR 2002) and that the strengthening of IPR benefits industrialized countries while hurting developing countries (Panagariya 1999). There is considerable uncertainty on the effects of strong IPR in developing countries (Tansey 2004).

This paper examines the impacts of IPR on a technologically advanced developing country, Mexico, to determine their role for the different stakeholders of the maize breeding industry. Little empirical evidence exists on this subject and the conclusions are often uncertain.

Mexico was one of the first developing countries to effectively strengthen its intellectual property (IP) legislation: In order to comply with the North American Free Trade Agreement (NAFTA), Mexico enacted a new law in 1991. Its maize breeding industry is well developed and maize is subject to different types of IP protection: IPR are likely to play a role in this industry. As IPR are meant to support research and development (R&D), firms and public institutes involved in breeding should be the first actors to perceive their impacts. Interviews with maize breeders were carried out to gather information concerning the impacts of stronger IPR, complemented with interviews with representatives of IP regulatory agencies.

Complete enumeration of the industry[1] showed that IPR are not important for breeders in general, but that they are important for certain breeders' categories. Even though they exist on a formal level, IPR are in most cases ignored by breeders in their day-to-day activities. Therefore, IPR do not provide incentives for R&D and do not affect the concentration of the industry nor seed prices, while the lack of data does not allow determining the effects on the diffusion of germplasm, new varieties and inventions. The analysis indicates that the quality of the

[1] I surveyed all companies and public institutions performing maize breeding except for two. One breeder, in a remote region, did not send the questionnaire back, and one company did not have a breeder at the time of the survey.

institutional environment and the confidence in the judiciary system, the importance of transaction costs related to obtaining and securing protection, as well as the level of technological development of the country are important factors affecting IPR's use and perceived efficiency. These factors should be considered when predicting the impacts of IPR on developing countries.

The paper is divided into seven sections. The next section reviews IPR and their expected impacts, followed in section 3 by background information on the Mexican maize breeding industry. The fourth section presents the methodology used, followed in section 5 by the presentation of the data gathered through the interviews. Finally, section 6 discusses the findings and derives implications for the relevance of IPR implementation in developing countries and section 7 concludes.

2 Intellectual Property Rights and their Impacts

2.1 Knowledge as a Public Good

Knowledge is a public good, non-rival in consumption and non-price excludable. From economic theory, such goods will not be provided at an optimal, socially desirable level. A common intervention[2], to correct for this undersupply, consists in the definition of property rights that will allow private investors to harvest the profits generated by their effort rather than share those with free-riders. These property rights will provide incentives to achieve a greater internalisation of externalities (Demsetz 1967), ensuring that the benefits from the innovation are concentrated with the innovator, to provide incentives for further innovation. However, with any property rights structure transaction costs are positive, which implies that rights are never perfectly specified and enforced (North 1990), also affecting the extent to which externalities are internalised. The specific costs related to the breeders' transactions are discussed in the following section.

Still, the new knowledge produced by agricultural R&D is not always a pure public good: know-how related to breeding techniques is non-rival, while the seed produced is. Similarly, a

[2] Other interventions may consist for example of the creation of new public and private sector R&D institutions, enhanced incentives for private involvement and the provision of public funds for publicly or privately executed R&D.

maize hybrid variety[3] – i.e., that does not breed true - is excludable, while an open pollinated variety is not.

Figure 1 illustrates the roles and impacts or IPR in the research and seed industry research and production process. With IPR arises the dilemma of "access versus appropriability" (Alston, Norton and Pardey 1995). By granting temporary exclusive rights on inventions, IPR are intended to allow right-holders to price their products above marginal cost, and hence recoup their initial research investment. Such exclusive rights create incentives for the performance of R&D leading to innovation, while impeding the dissemination of new technologies and innovations. However, inventors have to disclose the details of their inventions in order to obtain protection. Finally, IPR tend to support the concentration of the industry but some innovations can also have deconcentrating effects (Lesser 1998). The theory does not offer clear indications as to which effect dominates: it is clearly an empirical question.

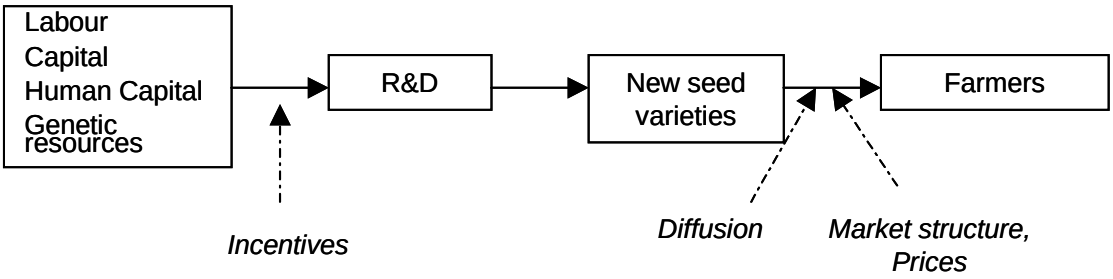

Figure 1: IPR in the Seed Industry Research and Production Process

Source: Adapted from Léger (2001)

Based on this framework, we can hypothesize the following impacts of IPR on the maize breeding industry:

1. IPR provide incentives for private R&D and innovation;
2. IPR restrict breeders' access to protected germplasm and inventions;
3. IPR foster the concentration of the industry and an increase in seed prices.

[3] A hybrid is the product of two inbred parental lines and is characterized by "hybrid vigour", i.e., superior yields. Yet these yields are not transferred to the subsequent generation, which implies that the farmer needs to buy new seed each year, creating a biological form of intellectual property protection. Only the holder of the parental lines can produce a certain hybrid, thus most companies protect these with Trade Secrets.

2.2 Strengthening of Intellectual Property Rights

Historically, national patent systems were developed to support domestic industrial development. However, the increase in international trade, and the advent of new, information-based products and services, led multinational companies to request international policies that would help protect their proprietary information. The WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPs) sets minimum standards for IP protection in WTO member states.

For the case of plant breeding, strengthening of IPR basically consisted of: i) Making patent protection available for all inventions in all fields of technology – plants and animals being exceptions; ii) Providing for the protection of plant varieties, for example using Plant Breeders' Rights, a specialized type of protection for plant varieties granted by the International Union for the Protection of New Varieties of Plants (UPOV); iii) Allowing for the protection of undisclosed information (Trade Secrets); and iv) Ensuring the adequate enforcement of the rights. The study focuses on three types of IPR relevant to innovation in maize breeding, namely Patents, Plant Breeders Rights (PBR) and Trade Secrets. Other types of IPR (e.g., trademarks, geographic indications) act as marketing tools rather than means to support technological advances (Perrin 1994) and will not be considered in the discussion. Definitions of rights and examples of uses for maize breeding are presented in Table 1.

Table 1: Intellectual Property Rights für Maize Breeding

IPR	Definition	Example
Patent	Right to exclude others from imitating, manufacturing, using or selling a product or process for commercial use for a 20 years period.	Genetic modification introduced into a variety
Plant Breeders' Rights	Right to exclude others from producing or commercialising material of a specific plant variety.	New maize variety
(UPOV 1978)[a]	Two exceptional uses of protected varieties are allowed: - *Research exemption*, under which third parties are free to use the protected materials to create new varieties or perform research; - *Farmers' Privilege* allowing farmers to save and re-use the seed obtained from the cultivation of protected varieties.	
Trade Secret	Legally enforceable protection against unauthorized disclosure of proprietary information through commercially unfair means.	Keeping secret the parental lines of a maize hybrid variety

a) There are two versions of the UPOV Act: Mexico is a member of the Act of 1978, which encompasses more flexibility in terms of the Farmers' Privilege and Research exemptions than the Act of 1991.

Source: CIPR (2002) and Maskus (2000)

Whether the assumptions of IPR theory are justified for developing countries is however subject to debate (Jaffé and van Wijk 1995). Technological capacities differ widely among developing countries, which implies that not all of them are able to assimilate technologies from other countries, let alone develop their own technologies. The dynamic gains due to IP protection leading to indigenous innovation would hence not take place, and the static costs of IPR summed to the costs of implementation of the system would lead to a net negative effect for most developing countries. Given this trade-off, this paper analyses the impacts of IPR on a technologically advanced developing country, using the Mexican maize breeding industry as a case study.

3 Maize in Mexico: Background

3.1 Actors and Transactions

The Mexican maize breeding industry is considered well-developed: research capacities are relatively high, breeding is performed by multinational and local companies as well as by the public sector, and breeders develop both hybrid and open pollinated varieties, which are subject to different types of IP protection. This industry is most likely to show changes following IPR strengthening.

Figure 2 illustrates the roles and interactions between the different actors of the industry, following the germplasm flows, showing the segmentation of the market along the types of farmers and seed providers. Multinational companies (MNC) generally supply the commercial farmers with hybrid varieties. They perform sophisticated breeding programs and possess their own multiplication and marketing facilities. National seed companies use germplasm from the public sector and universities to develop and commercialise their own varieties. Some cases of national companies selling MNC varieties under license have also been observed.

Small-scale farmers obtain modern varieties from small companies, cooperatives/ NGOs or the public sector, and their traditional materials are precious inputs in the R&D process of the breeding industry. Public research organizations comprise: i) INIFAP, the applied agricultural research institute, developing agricultural products; and ii) the universities, also under the auspices of the Ministry of agriculture, performing mainly basic research: new varieties are

only by-products of their activities. Lastly, CIMMYT[4] is an important source of germplasm for the industry: its materials were used in 33.3% of the cultivars released by public organizations between 1966 and 1997, while 81.3% of varieties released by the private sector in 1997 comprised such materials (Morris and López Pereira 1999).

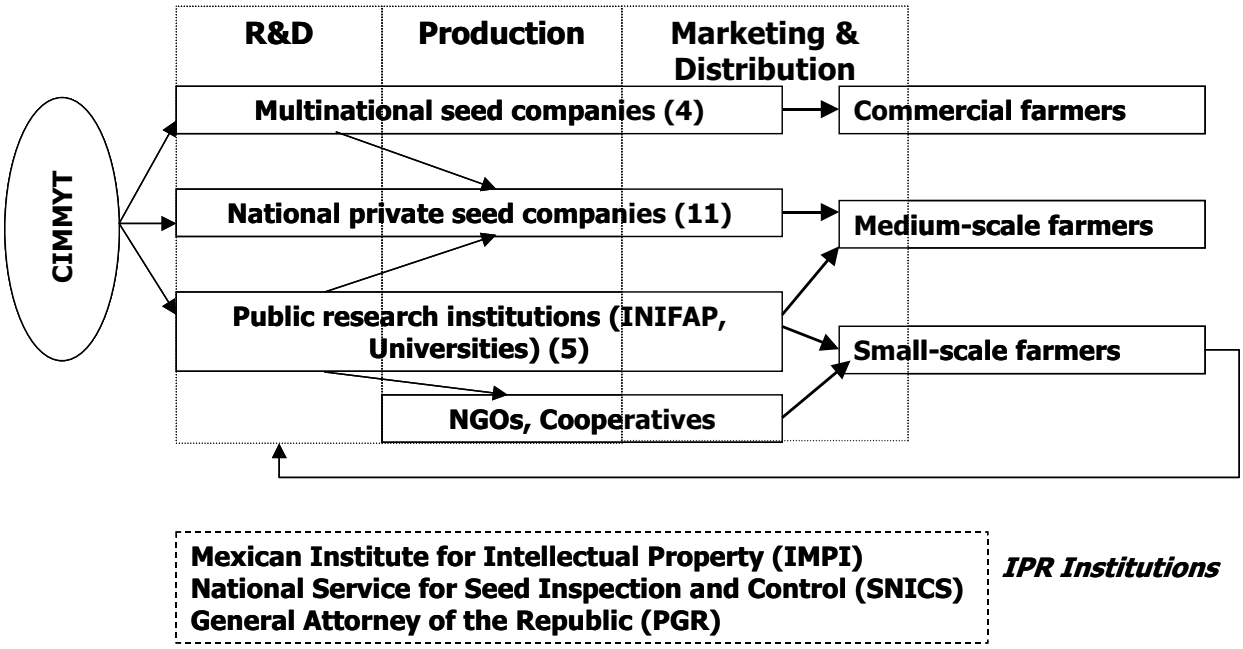

Figure 2: Structure of the Maize Breeding Industry and Germplasm Flows

Source: Adapted from López Pereira and Filipello (1995). Note: Number of companies in each category in brackets

Even though the Mexican maize breeding industry is generally perceived as well developed, the number of companies involved in breeding, and not only in multiplication and distribution of varieties, is still low. Only eleven companies would then be involved in maize breeding. They however present very different characteristics: products developed, resource endowment, technological capacities, organizational structure, etc. These diverse actors' groups are likely to identify different impacts IPR have on their activities and on the industry.

IPR regulatory agencies consist of i) the National Service for Seed Inspection and Control (SNICS), an agency of the Ministry of Agriculture, responsible for the application of legal dispositions concerning seed and plant varieties, in charge of the verification and certification of the origin and quality of the seed as well as of the registration and enforcement of PBR; ii)

[4] The International Maize and Wheat Improvement Centre (CIMMYT from its Spanish acronym) is one of the International Agricultural Research Centres. It conducts maize and wheat research to benefit developing countries.

the Mexican Institute for Intellectual Property, the agency of the federal government responsible for the protection of industrial property, i.e. registration of patents, examination of infringement suits and promotion of IPR; and iii) the General Attorney of the Republic, in charge of the legal actions for infringements on trade secrets.

3.2 Transaction Costs

Breeders hence face mainly two types of transactions: with public research organizations and other firms, and with IPR regulatory agencies. Table 2 summarises the different types of transaction costs.

Table 2: Types of Possible Transaction Costs

	Research Organizations and Other Firms	**IPR Regulatory Agencies**
Transaction between Breeders and…	- Exchange of technologies and genetic materials - Growing/ multiplication contracts	- Information on IP rules, procedures, policy - Examination and registration of rights - Enforcement of rights
Ex Ante	Information costs Negotiation costs	Information costs
Ex Post	Implementation/ Refining costs Monitoring/ Enforcement costs	Certification costs Monitoring/ Enforcement costs

Source: Authors' compilation

Among firms and research organizations, contracts covering exchanges of materials and information are subject to information costs related to the identification of the suitable partner and product. Costs are also associated to the negotiation of the contract, for example the uses allowed under the agreement and the associated costs. The implementation costs relate to the completion of the transaction *per se* while monitoring concerns the respect of the agreed contractual clauses and enforcement, the coercive measures taken in case of violation.

The situation is somehow different for the transactions with IPR regulatory agencies. The information costs concern the knowledge needed to abide the laws and understand the procedures, and negotiations are usually not needed. On the other hand, certification costs can be important and involve generating and compiling the information required for the registration of the rights, including the costs related to delays and uncertainty. Finally, monitoring relates to the identification of the illegal use of the protected variety or invention and enforcement, to the legal defence of these rights. As developing countries often face especially high transaction costs (Collier 1998) they must be taken into account.

3.3 International Environment and Hypotheses

The strengthening of IPR started in 1991, in anticipation of the NAFTA requirements, followed in 1997 by a second wave of reforms, through which the country introduced plant variety protection and committed to ensure that enforcement procedures were available and effective. These changes brought Mexican laws in line with international IP standards, including the TRIPs agreement. The implementation of NAFTA triggered several changes, for example a domestic agrarian reform including a new seed law allowing the full participation of the private sector in the seed industry. Private sector activities were before closely monitored.

Based on the institutional structure of the maize breeding industry, a fourth hypothesis can be added to the three developed following IP theory:

1. IPR provide incentives for private R&D and innovation;
2. IPR restrict breeders' access to protected germplasm and inventions;
3. IPR foster the concentration of the industry and an increase in seed prices; and
4. IPR play different roles for different breeders' groups.

4 Data and Methods

In the fall of 2000, interviews with a total of 25 breeders from 18 maize breeding companies and public institutes were conducted. The interviewees were identified from the lists of Mexican seed companies provided by the Mexican seed industry association and the SNICS. In addition, data on IPR were collected to identify their patterns of use.

All companies and public organizations performing maize breeding were surveyed except for two: one breeder in a remote area never responded and one company did not have a breeder at the time of the survey. Interviews with managers of the three IPR regulating agencies were also conducted, to obtain data on IPR use, information related to registration and enforcement procedures and complement the information obtained from industry stakeholders.

The breeders interviewed were in general the main breeders of their company: the assumption was that such breeders would have a better overview of R&D programs and would possess the knowledge required to answer all questions, especially those related to the orientation of research and budget changes over time. I conducted all the interviews personally except for two firms located in remote areas, to whom the questionnaires were sent by fax.

The questionnaires used[5] were designed to inquire about the effects of IPR on the seed industry research and development process, following the hypotheses, namely incentives for R&D, diffusion of knowledge and inventions, market structure and price effects. Given the relative novelty of the subject area in the industry and the lack of guidance of the theory, the questionnaires included several exploratory questions through which breeders could elaborate on their perceptions without being bound to a pre-defined set of answers. These questions allowed identifying preoccupying issues and clarifying certain positions.

There are two main ways of quantifying the impacts of IPR on R&D and knowledge creation (Jaffé and van Wijk 1995):

- R&D inputs, e.g., investments, number of research programs and human resources devoted to plant breeding; and
- R&D outputs, e.g., number of new varieties developed and agricultural productivity.

Although most respondents were very cooperative, they were in general highly reluctant to provide precise information on such aspects and gave, at best, indications on the direction of change in seed sales, number of breeders and R&D expenditures. For some organizations, the information was simply not available. I therefore used the information available on R&D inputs as indicators of the trends in the industry. Given the time needed to develop new varieties (average of 7 years) and the lack of data, indicators related to the R&D output were not considered.

This study hence represents a complete enumeration of the Mexican maize breeding industry. However, given the small number of observations a statistical analysis cannot be performed and the results obtained reflect the opinions and perceptions of the interviewees at this point in time.

5 Breeders' Perception of Intellectual Property Rights: Results

5.1 IPR Use in Mexico

Because they perform different activities and serve different markets, the interviewees are separated into three actors' groups: local companies, MNC, and public sector. Such grouping allows comparing their perceptions and investigating hypothesis 4, following which IPR

[5] The questionnaires are comparable to those used in similar studies (Jaffé and van Wijk 1995; Butler and Marion 1983) and are available from the author upon request.

would play different roles for different actors' groups. Table 3 presents some of their characteristics.

Table 3: Characteristics of the Actors' Groups

	Type of varieties	Other crops	Alliances/ Foreign Partners	Stated Use of IPR
Private				
Local (11)	Open Pollinated Varieties (OPV) sometimes hybrids	Sorghum, wheat, red beans	Not common (1)	PBR: (3); Patents: (2) Trade Secrets: (3)
MNC (4)	Hybrids	Sorghum, cotton	Headquarters (4)	PBR: (2); Patent: (1) Trade Secrets: (1)
Public				
INIFAP	OPV and hybrids	All	Not common (0)	PBR, Patent
Universi-ties (4)	OPV and hybrids	All	Not common (1)	Nothing

Note: numbers in parenthesis refer to the number of firms in each category, the number of alliances or foreign partners, and the number of companies stating to use this type of IPR for all crops, respectively.

Source: Interviews

The use of IPR reported by public and MNC breeders is consistent with the data obtained from official sources (SNICS, IMPI). Three local companies had applied for PBR, but none for maize varieties (see below), and 2 companies declared stated to own patents. This contradicts the information gathered from IMPI, according to which none of the local companies possess patents on plants at the time of the study. The breeders might have confused using a patent under license and holding a patent.

At the time of the research, the PBR system was not yet completely functional in Mexico: however applications had already been received by the SNICS. Most applications originated from Mexican companies (42%) while other applications came mainly from the US, France and the Netherlands (see figure 3). Maize and flowers represented the bulk of applications (56%), and three organizations had filed applications for maize: INIFAP (46.1%), Pioneer (32.5%) and Asgrow (21.4%), two MNC.

It is a surprising outcome and contradicts hypothesis 1: IPR are meant to provide incentives for private breeding and its main user is a public research institute. Moreover, the varieties developed by the two MNC are hybrids, for which PBR protection is superfluous given their biological characteristics. The interviewees revealed that PBR protection of all new varieties has been imposed by the high management/ headquarters of the company, irrelevant of the real need for protection. It was not clear if such policy was applied to all crops: If so, the importance of Mexican applications could reflect mainly INIFAP's activities. These patterns

of use support hypothesis 4, according to which IPR play different roles for diverse actors' groups.

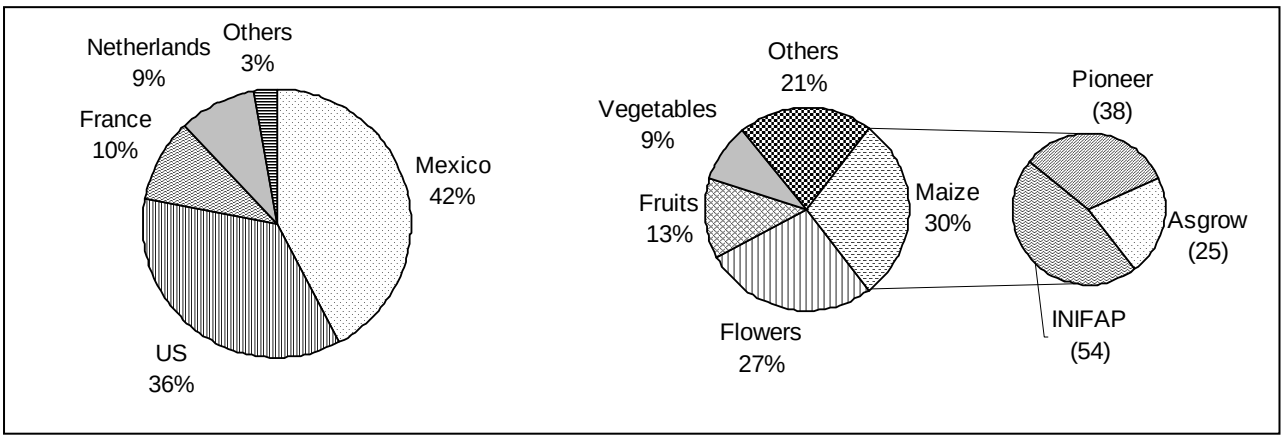

Figure 3: Plant Breeders' Rights Applications by Country of Origin and by Crop

Source: SNICS (2000).

For the case of patents, although the total number of applications in the country has increased over time, the number of applications filed by Mexican inventors actually decreased. Out of 4,144 patent applications in the country in 1978, 787 (18,9%) originated from Mexican inventors, whereas in 1999, the total number of applications had raised to 12 110 and Mexican applications were down to 447 (3,9%). Patent applications related to maize and maize breeding were likewise scarce in the country: In October 2000, only 5 such applications had been filed, all related to genetic engineering and originating from MNC involved in the life sciences industry. The information given by local companies on their use of patents contradicts the data obtained from the patent office, possibly indicating a confusion between using a patent under license and holding a patent. In this case also hypothesis 4 is supported by the patterns of use.

Finally, from their nature trade secrets are not registered, data on their use are therefore not available. From the interviews, they seem to be mainly used in the private sector for establishing contracts and alliances, but the concept is in general not very well understood.

The level of knowledge concerning the types of IPR was generally low, but varied among breeders' categories. MNC breeders were well aware of IPR, while local and some university breeders did not know much about it and needed basic background information about IPR to understand and answer the questions. This supports hypothesis 4 and reflects, on the one hand, the information costs prevailing in the industry and, on the other hand, the relative novelty of these tools for the industry and their lack of relevance for the activities performed. In

fact, the relative indifference and lack of knowledge of most actors supports the results found in other Latin American countries (Jaffé and van Wijk 1995) that IPR were not introduced following pressures from the industry, but rather to comply with trade agreements.

5.2 Impacts of IPR: Breeders' Perceptions

Table 4 summarises the results from the interviews, by actors' groups, including also the perceptions of representatives of the regulating agencies, in order to highlight their potential divergences of opinions and perceptions. The different aspects investigated are discussed in greater detail in the following sub-sections.

5.2.1 Procedures and Effectiveness

Local and MNC breeders had opposite opinions concerning the procedures needed to obtain PBR protection and the effectiveness of their protection. While MNC breeders positively considered the procedures, local breeders found the registration process cumbersome and costly, especially compared to its expected benefits. The time needed for obtaining protection was in general longer than the commercial life of the varieties, hence for these breeders the certification costs rendered protection irrelevant. This discrepancy in the opinions could be related to the different resources, human and financial, allocated to PBR protection and to the expected profitability of the varieties. Public sector breeders had a negative perception of PBR protection. They believed it was not needed and that PBR had been implemented following international pressures.

Concerning the procedure to obtain patent protection, only two respondents were satisfied with it: It is worth mentioning that both had never applied for patent protection. Most private sector respondents were dissatisfied with the patent application procedures and thought that patents and trade secrets protection was not efficient in reality, due to corruption in the legal system and the general lack of knowledge prevailing among industry stakeholders. However, MNC breeders still believed that such tools were necessary and insisted on the importance of raising awareness and advocating IPR use among breeders. Public breeders expressed concerns related to the relevance of protecting living organisms with IPR: They believed that patents and trade secrets were industrial tools, and that they should not be used for agricultural innovations.

From these perceptions one can conclude that the costs of the different transactions taking place between breeders and the IPR regulatory agencies impede the good functioning of the IP system. The lack of knowledge prevailing among breeders could be related to the informa-

tion costs; the certification costs could, for the case of PBR, render protection irrelevant, while the enforcement is deficient, due to the flawed legal system and to corruption.

Table 4: Perceptions of IPR impacts: Summary

	MNC (4)	Local (11)	Public (5)	IP Regulatory Agencies (3)
Procedures and Effectiveness				
PBR				
Procedures for obtaining protection	+	-	**?**	**n/a**
Effectiveness of protection	-	+	-	**n/a**
Patents				
Procedures for obtaining protection	-	-	**?**	**n/a**
Effectiveness of protection	-	-	-	**n/a**
Trade Secrets				
Effectiveness of protection	**?**	+	**?**	**n/a**
Incentives for R&D and Innovation				
PBR	**?**	**0**	**0**	**?**
Patents	+	+	**0**	+
Trade Secrets	**0**	**?**	**?**	**?**
Provide incentives for private investments?	**?**	**0**	+	**?**
Provide incentives to international firms for local innovations?	+	**0**	+	**?**
Diffusion : Information and Germplasm Flows				
PBR	**0**	+	-	**?**
Patents	-	**?**	-	-
Public-private information/ germplasm flows	-	-	-	+
Market Structure and Prices				
Supporting private breeding	+	+	+	**?**
Seed Prices	**0**	**0**	+	**0**
Concentration of the Industry	**0**	**0**	+	**?**
Opinions on Policy Issues				
Plants should be patentable	+	+	-	**n/a**
In favour or UPOV Act of 1991	+	-	-	**n/a**

Legend (opinion of the majority): **+**: positive impact/in favor; **-** negative/against; **0**: no impact; **?**: do not know n/a. : not applicable

Source: Interviews

5.2.2 Incentives for R&D and Knowledge Creation

Only a minority of breeders considered that IPR provided incentives for maize breeding activities, while approximately half thought IPR had no influence. The same opinion prevailed concerning the impact of IPR on private investments, even though almost half of the breeders – including all MNC breeders – believed that IPR would be more important for foreign com-

panies and could provide them with incentives to develop products adapted to the Mexican conditions.

Local company breeders agreed in theory that patents would be useful and important in providing incentives for innovation, yet they believed that the current patent system definitely needed to become more efficient. Most breeders were not familiar with trade secrets and therefore could not evaluate their impact.

As explained in section 4, a quantitative indicator of the impact of stronger IPR is the creation of new private breeding programs. Figure 4 shows that breeding programs from the surveyed companies started at the beginning of the 1980s. The arrow indicates the occurrence of the first changes in IP laws, in 1991. The end of the 1980s indeed witnessed a high number of companies starting breeding programs. However, it is difficult to relate this change to the strengthening of IPR as several policy changes took place in 1991, namely a domestic agrarian reform and the enactment of a new seed law removing the restriction to private sector participation.

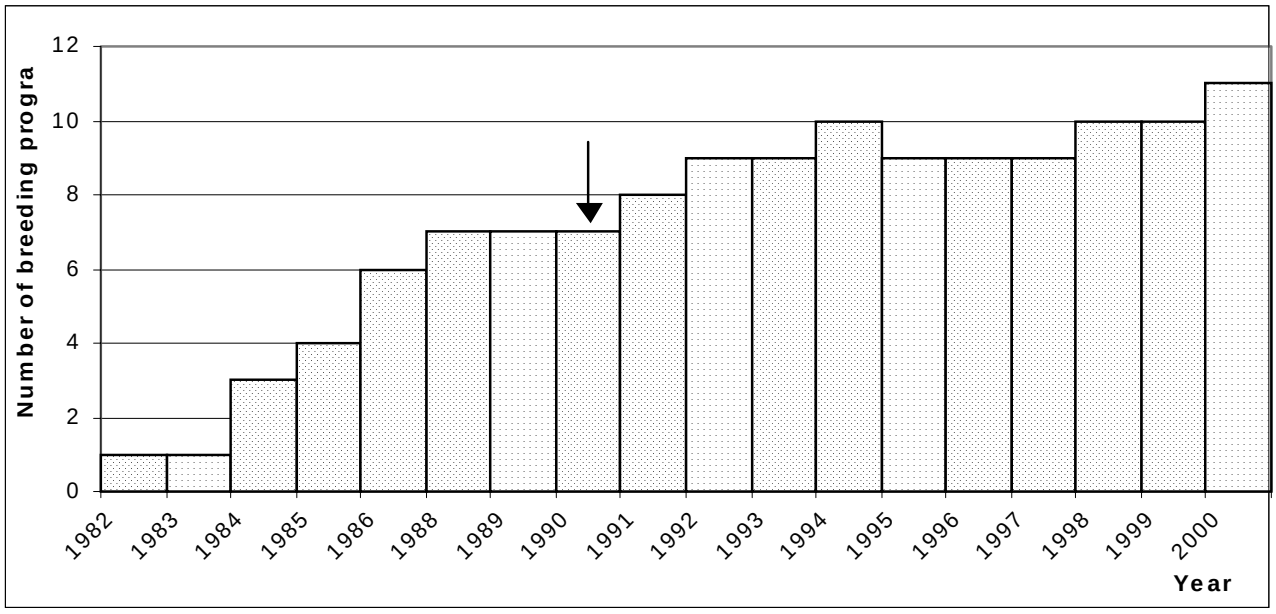

Figure 4: Number of Breeding Programs over Time

Source: Interviews with maize breeders

A second quantitative indicator is the number of breeders involved in maize breeding (see figure 5, presented by type of organization and level of education). The numbers increased between 1990 and 1999, for each type of organization. The number of highly educated breeders also rose with time: while technicians were the most important group in 1990, MSc breeders dominated in 1994 and 1999. This is probably related to the availability of educated

breeders: The interviewees mentioned this factor as limiting the development of the industry, and that the number of graduates had increased in the last years. Relaxing this constraint, rather than stronger IPR, might have contributed to an increase in the number of breeders in the industry. Finally, the information on R&D investments indicated that these had not increased over time, but rather decreased in real terms: In the public sector, the budgets had stayed the same in nominal terms since 1985, even though the financial crisis of 1994-1995 led to a severe devaluation of the Peso. Local companies affirmed they maintained a budget allowing to sustain a constant level of innovative activity, while MNC had seen their budgets reduced.

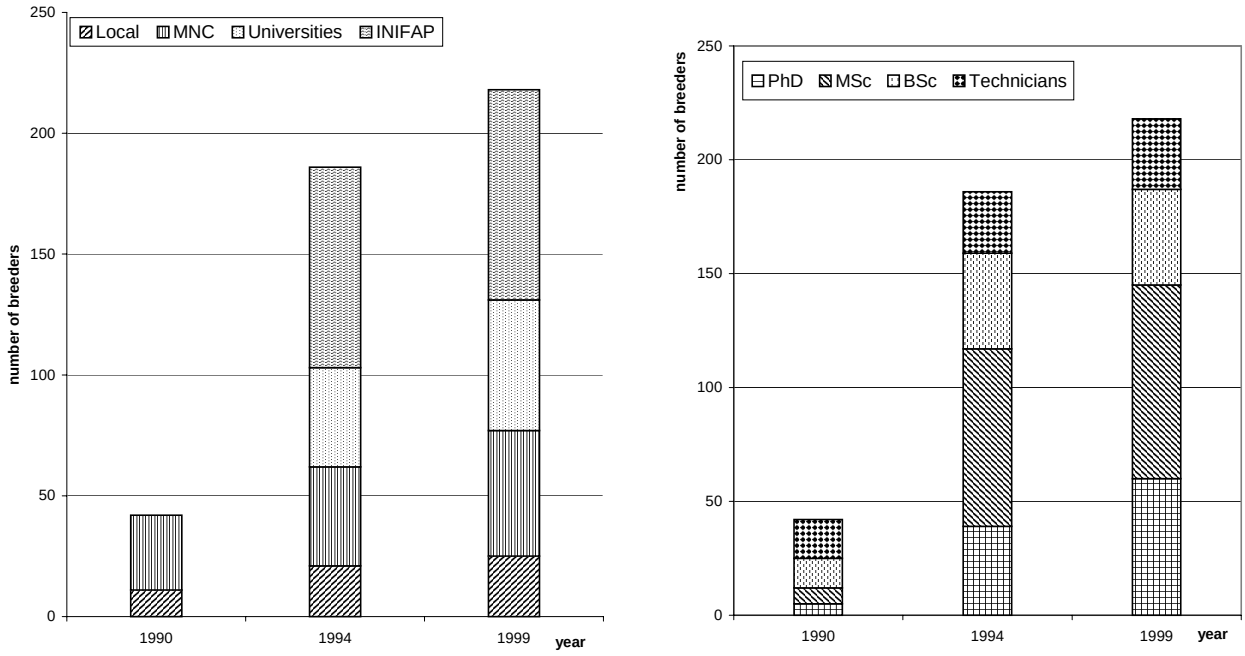

Figure 5: Number of Breeders, by Sector and by Level of Education

Source: Interviews with maize breeders. Note: Data not available for public sector for 1990

The evidence gathered does not support the hypothesis that IPR provide incentives for innovation and R&D. Yet half of the breeders believed that stronger IPR would provide incentives to foreign enterprises for the performance of R&D adapted to Mexican needs, somehow in line with the fourth hypothesis. In general, transaction costs and corruption in the legal system affect the efficiency of the system: Several breeders thought that stronger IPR would, in theory, support innovation but that, in the Mexican institutional environment, they could not play their role. *Ex ante* information costs seem to be so high that the breeders have only little knowledge of IPR. *Ex post*, the importance of certification costs would render protection irrelevant, and the deficient enforcement, related to the corrupt and flawed legal

relevant, and the deficient enforcement, related to the corrupt and flawed legal system, would render protection inefficient in reality. Finally, quantitative indicators such as the number of breeding programs and the number of breeders cannot be related to the strengthening of IPR. Other policy changes, such as the enactment of the new seed law and the increased availability of educated breeders, are much more likely to have had an impact.

5.2.3 Diffusion: Information and Germplasm Flows

Local breeders generally considered PBR to favour access to maize materials, while public breeders thought it would restrict their access and MNC breeders did not identify any impact. Even though none of the local companies had filed for PBR protection, some considered PBR more like a marketing device and as such, perceived it would facilitate the transfer of information and diffusion of varieties, hence reduce information costs associated to transactions between breeders. Patents, on the other hand, were perceived by MNC and public breeders as potentially reducing their access to genetic materials and technologies, while most local breeders could not forecast the impact.

According to the interviewees, the germplasm flows between public and private entities were not affected by the new IP laws, nor were international flows. It is worth mentioning that only the MNC were involved in international material transfers - from their headquarters – the other breeders were hence not speaking from experience. Quantitative data on germplasm flows and exchanges of varieties were not available, given the small number of transactions and their private character.

The information gathered on the diffusion of germplasm reflects the different protection levels offered by the different types of IPR. On the one hand, PBR would facilitate the transfer of information and varieties, while on the other hand, patents would reduce access to technology and germplasm. The lists of new varieties protected by PBR are probably more accessible compared to the information concerning patented processes and products, and exemptions exist for the use of protected varieties, which do not exist for patented inventions. Yet on basis of the little data on information and germplasm flows and technology transfer, it is impossible to determine the general impact of IPR on diffusion of information and materials.

5.2.4 Market Structure and Prices

A majority of respondents thought that private companies had become more important in the performance of breeding, especially MNC. These perceptions were especially strong for public sector breeders, who also thought, contrary to private sector breeders, that IPR had con-

tributed to increasing the concentration of the industry. A new seed law, enacted in 1991, allowed complete participation of the private sector in the industry, making it difficult to distinguish the impact of stronger IPR in this new policy environment. Yet at the international level several mergers and takeovers have occurred between the companies of the "life science industry", which also affected the number of companies operating in the Mexican market[6] but was not related to the national strengthening of IPR.

Public sector breeders believed that the strengthening of IPR had contributed to the increases in seed prices over time. However, real seed prices, for both open pollinated and hybrid public varieties, stayed more or less constant over time (see figure 6). The prices of private varieties were not available: breeders did not have the information and it is not compiled by the government. Even though public and private varieties are usually sold in different markets and therefore cannot be considered perfect substitutes, prices of public varieties still provide an indication of the evolution of seed prices during this period.

Given the changes that occurred in the 90s in the country (e.g., policy reforms, exchange rate fluctuations) it might be difficult for the breeders to relate the phenomena to a given cause. Conversely, these changing conditions make evaluating the impact of a single policy change equally difficult. In the Mexican context, the industry in fact became less concentrated than it was, therefore the information gathered does not support hypothesis 3 that IPR would support the concentration of the industry and increases in seed prices.

5.2.5 Breeders' Opinions on Policy Issues

The questions on policy issues allowed investigating hypothesis 4 - that IPR play different roles for diverse breeders' groups and hence, that they have diverging perceptions of IPR. The issue of plant patents really separated the sectors: a strong majority (83%) of local private breeders and all MNC breeders, were in favour of patents on plants, while 72% of public sector breeders were against the idea. Patenting plant materials is allowed under the Industrial Property Law, but several public breeders thought it should be removed.

In certain countries, seed industry stakeholders lobby the government to strengthen IP protection for plant varieties by adopting the UPOV Act of 1991[7]. Conversely, most Mexican

---

[6] See Byerlee and Fischer (2000) for more information on mergers and acquisitions in the biotechnology industry.

[7] The Act of 1991 goes beyond the scope of right foreseen by the Act of 1978 and brings the protection more into line with patent law (Leskien and Flitner 1997) by extending the length of protection and the number of

breeders did not know the difference between the two Acts, it is not an issue of concern in the industry. After a short summary of the two Acts' characteristics, three out of the four MNC breeders considered the Act of 1991 as more appropriate for the country because of its longer length of protection and the stronger protection it grants (royalties for the use of essentially derived varieties, restrictions of Farmers' privilege). Yet local breeders were in favour of the Act of 1978: 20 years of protection would be too long and the Act of 1978 would be more appropriate for small farmers. Likewise, public breeders considered that the Act of 1978 allowed for more flexibility in policy design, which would be more suited to the Mexican reality. This supports hypothesis 4: for plant patents, the discrepancy follows the line private against public sector, while for the UPOV Acts it goes along local organizations against multinational companies. On the other hand, the private-public divergence is probably related to the goals and missions of the organizations.

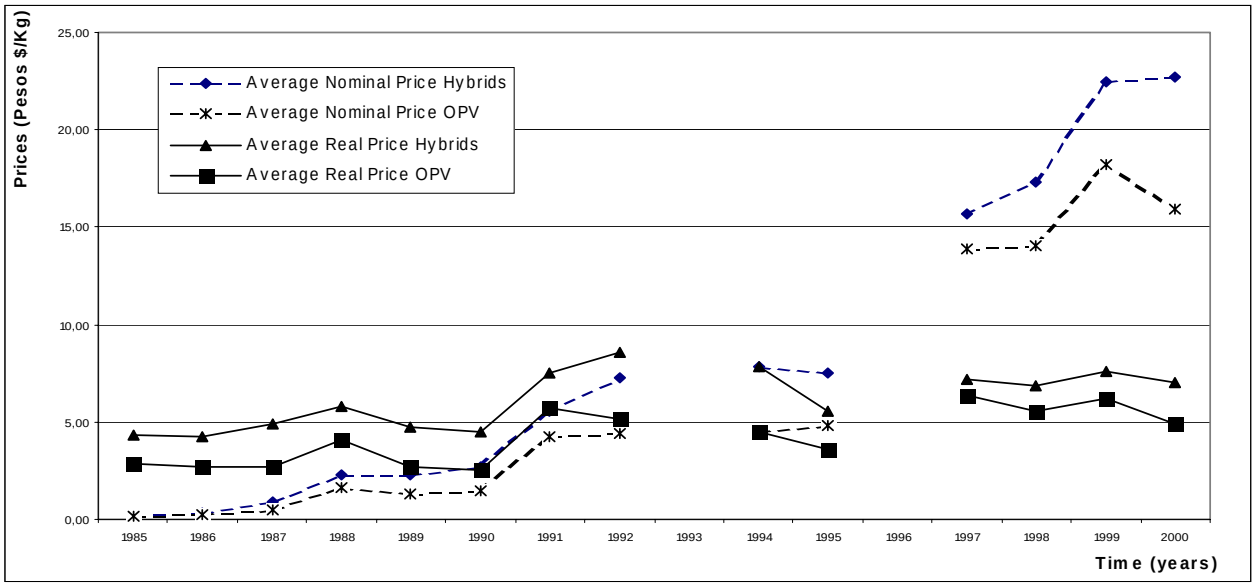

Figure 6: Evolution of Maize Seed Prices over Time

Source: PRONASE and SECOFI: Indicadores Económicos de Conyontura (2001). Data for 1993 and 1996 not available.

The sharply differing opinions on these two issues reflect the diverging interests of the breeders' groups: the innovative firms, bringing inventions to the market, see the need for stronger IP protection in order to secure their markets and reap the benefits from their inventions. On the other hand, the followers put more emphasis on the diffusion of the information and hence want to keep the protection levels lower. This situation reflects to a certain extent the one pre-

species covered, restricting the farmers' privilege to save seed and including the payment of royalties for essentially derived varieties.

vailing at the international level and the influence of the level of technological development on the use breeders make of IPR (see Chen and Puttitanun 2002).

5.2.6 Regulatory Agencies

The general level of knowledge among representatives of the regulatory agencies was rather low: each of them could answer almost exclusively the questions related to their type of IP protection. There was a general lack of communication between the different agencies, coupled to a certain indifference for issues related to plant breeding from the part of the patent and trade secrets agencies. This can be explained by the relatively novel introduction of plants as protectable subject matters and the low level of patents and trade secrets in this area.

The respondents were only partially satisfied with the real-life protection granted through patents. They mentioned red tape, high transaction costs and a lack of awareness concerning patents among the population as factors hindering patent protection. The enforcement of trade secrets was described as problematic, again due to stakeholders' lack of knowledge and the high associated legal costs. As PBR had not been granted yet in the country, their real life efficiency was not discussed. The negative perceptions on enforcement measures and procedures were however solely based on perceptions of the Mexican judiciary system, as no case for the infringement of patents, PBR nor trade secrets had been brought to court at the time of the study. These perceptions underline again the relevance of information, certification and enforcement costs for the efficiency of the IP system. However, no solution was envisaged to remedy this situation.

Representatives from regulatory agencies believed that IPR would support innovation but did not relate them to the negative impacts discussed in the literature, such as reduction in diffusion and concentration of the industry. They acknowledged that IP protection systems needed to be adjusted to local characteristics in order to contribute to the economic development of the country.

6 Discussion

6.1 Summary of the Results

The results of this study do not support the general expectation that IPR would play a role for innovation in a technologically advanced developing country. The evidence gathered and the perceptions of the breeders do not support the hypotheses under study, except for the last one:

IPR do play different roles for the diverse actors' groups. Table 5 summarizes the results of the study.

Table 5: Summary of the Results

	Hypothesis	Breeders' perceptions	Evidence
1	IPR provide incentives for private R&D and innovation	- IPR do not provide incentives for maize breeding - IPR do not support higher investments in R&D	- Main user is a public organization - Evidence from number of breeding programs, number of breeders and R&D budgets not supportive - Other changes (e.g. policy, availability of educated breeders) might have had greater impact
2	IPR restrict access to germplasm, new varieties and inventions	- No effect - PBR reduce transaction costs and favour access to maize materials - Patents reduce access to germplasm and technologies	- No evidence
3	IPR foster the concentration of the industry and an increase in seed prices	- IPR favour MNC and private sector - IPR foster the concentration of the industry - IPR support increases in seed prices	- Number of companies involved in maize breeding increased - Prices stayed constant in real terms
4	IPR play different roles for diverse breeders' groups	- IPR favour MNC - Public breeders: IPR on plant unethical - MNC believe IPR are necessary for the development of the industry - MNC favour UPOV 1991, local breeders favour UPOV 1978	- Only MNC possess patents - MNC second and third most important PBR owners

Source: Authors' compilation

Hypothesis 1 is not supported by the evidence gathered: Breeders did not perceive stronger IPR as providing them with incentives for maize breeding, nor did they invest more in these activities due to their presence. The main user is a public institute, while IPR should provide incentives for **private** breeding, and data on R&D budgets and number of breeding programs and breeders did not offer strong support for this hypothesis.

The agrarian reform and the introduction of the new seed law, along with the increased availability of educated breeders have played important roles in supporting breeding activities. It is difficult to identify the role IPR played since the industry underwent several reforms simultaneously. The respondents were also very critical of the procedures and enforcement of IPR: this lack of confidence helps to explain the low level of IPR use and the negative perceptions prevailing in the industry. Moreover, the little knowledge most breeders have of IPR reflects their minor role in their activities. Transaction costs in general, and more specifically

information, certification and enforcement costs play an important role: This is further discussed in the following section.

Local breeders identified different impacts for PBR and patents: PBR reduce information costs in transactions between breeders while patents, on the other hand, reduce access to germplasm and technologies. The unavailability of data and the little experience the breeders have with transactions involving material and technology transfer did not allow identifying impacts and therefore supporting or rejecting hypothesis 2.

The evidence gathered contradicts hypothesis 3 that IPR foster the concentration of the industry and support an increase in seed prices. The number of companies increased during the period under study, and the prices of public seed stayed constant over time, but given the number of policy changes in the 90s, it is difficult to identify the impact of IPR. The breeders perceived however the reality to be different: the inflation/devaluation of the peso in the 90s, the approval of private participation in the seed industry and the merger/acquisitions movements at the international level might have influenced these perceptions, even though they are not related to the domestic strengthening of IPR.

Finally, the only hypothesis supported by the results is that IPR play different roles for diverse breeders' groups. This is first illustrated by the patterns of use: only MNC possess patents in the country, and along with INIFAP, MNC are the only users of PBR for maize. They also perceive their impacts differently and opinions diverge on issues such as the relevance of plant patents and PBR protection levels.

The level of awareness of the breeders' groups, their resource endowment but also their interests and the products they develop are important explanatory factors. MNC breeders knew in general a lot more about IPR and their impacts and were more familiar with their use. These companies possess more human and financial resources and develop high-quality, modern products for bigger markets. IP protection can make economic sense for such companies and products. Indeed, IPR are only relevant for companies and breeders possessing inventions worth protecting. They have an interest to protect this knowledge and reap all the benefits associated to it, while other breeders would prefer keeping the materials and technologies unprotected, and benefit from the knowledge spillovers. This reflects the situation at the international level that led to the implementation of the TRIPs Agreement.

6.2 Discussion

The importance of IP protection has to be put in perspective: in most countries, viable maize breeding industries have existed before the presence of enforced IPR. They are hence not a necessary condition for the performance of maize breeding. Yet the case of maize is a special one since hybrid varieties have an "in-built" protection – and commercial breeding focuses almost only on hybrid varieties. However, similar results were obtained in studies looking at the impact of PBR on innovation for wheat, an open pollinated crop, in the United States (Alston and Venner 2002), and on all crops in Argentina (Jaffé and van Wijk 1995). Even though more empirical evidence would be needed before these results can be generalized to other countries and crops, the similitude for hybrid and open-pollinated crops and developing and industrialized countries are worth being noted.

The relatively short time period between IPR strengthening in Mexico and the study also has to be taken into account. Plant breeding, and R&D in general, are long-term processes and the impacts of a new incentives scheme would probably take more time before it is identifiable. For this reason the emphasis was put on R&D input rather than output, as an indicator of higher innovative activity.

Finally, the "real-world" effects of IPR are difficult to evaluate in the context of several simultaneous adjustments and policy changes. The low level of IPR use in the industry did not offer strong support to refine the theory and determine the dominating effects. The study however provides early evidence of the impacts of IPR in a technologically advanced developing country and finds that they do not play an important role.

6.2.1 IPR and Development

The low level of IPR use can also be related to the generally low innovative level prevailing in the industry. It is difficult for a country to produce inventions qualifying for patent protection when the level of technological development is relatively low. Developing countries' preferred level of IP protection would follow a U-shaped curve with respect to its level of economic development (Maskus 2000; Chen and Puttitanun 2002). Countries like Mexico, who can benefit, in certain sectors, from imitating advanced technologies but cannot develop these yet, would benefit from weaker IPR. The optimal strength of protection would increase with technological development and the type of product developed.

The link between IPR and the level of development was obvious during the Uruguay Round of negotiations, which led to the TRIPs agreement. IP protection was an issue of con-

cern for industrialized countries, i.e., technology exporters. Developing countries, on the other hand, knew they would lose from the inclusion of TRIPs in the WTO, but accepted in exchange for concessions in their areas of interest, namely agriculture and textiles (Watal 1999): The expected benefits have not yet been realized. Hence, IPR are still new tools that do not respond to needs expressed by the industry but had to be implemented to comply with NAFTA and WTO requirements.

6.2.2 Transaction Costs and Institutional Environment

On the other hand, transaction costs can sometimes be high enough to hamper the incentive effects. Comparing the effects of IPR and hybridisation on private plant breeding investments and innovation rate leads to this conclusion: the impact of IPR is not strongly supported by the data, whereas hybridisation's role is (Léger 2001). The main difference between these two ways of appropriating returns from innovation is that hybridisation does not involve the transaction costs legal forms of protection are subject to. It also provides the same level of protection across countries, and therefore does not depend on the legal system in place.

This last aspect also affects the efficiency of the system: Several breeders thought that stronger IPR would, in theory, support innovation but that, given the Mexican institutional environment, they could not play their role. This reveals the importance of the regulatory and institutional environments for the protection and enforcement of IPR and innovation, as supported by the empirical evidence of Alfranca and Huffman (2003). The representatives of the regulatory agencies admitted that there was a need for better coordination among agencies and greater efficiency in the procedures to obtain IP protection and enforce the rights.

6.2.3 Implications

The different transaction costs discussed have distinct impacts on the IP system, which deserve separate treatment. Information costs appear especially important, at least in two aspects relevant for the analysis: The difficulty to access information concerning IPR directly affects the level of IPR use, and hence the possibility to benefit from them. On the other hand, the lack of knowledge about IPR prevailing in the industry increases the difficulty of monitoring the use of the protected invention or variety, under the right holder's responsibility, which in turn reduces the perceived efficiency of IPR. The low level of use can also be related to the certification costs, whose height can render protection irrelevant.

The monitoring costs could be considered high given the low level of knowledge concerning IPR prevailing in the industry. Several breeders however mentioned that the small size of

the industry, and the concentration of companies in the same region, lead to the informal monitoring of breeders' activities and *de facto* reduce the need for PBR[8]. Breeders know each other and each others' varieties: The unauthorised use is hence easy to detect and the associated costs very high in comparison with the potential benefits. Conversely, the enforcement costs, with IPR, can be important, and the defects and corruption of the legal system reduce the confidence breeders place in this organization, and further in IPR.

These observations highlight the need for IPR regulatory agencies, if they want to increase the knowledge about and use of IPR, to reduce breeders' information and certification costs. Finally, the informal monitoring system seems to function for maize varieties at this stage of development of the industry, but its expansion will eventually render this system obsolete, hence the need to reform the legal system.

7 Conclusion

There is little empirical evidence concerning the effects of intellectual property rights (IPR) on a technologically advanced developing country. Complete enumeration of the Mexican maize breeding industry showed that, contrary to the hypothesis that IPR would provide, in a technologically advanced developing country, incentives for R&D and innovation and stimulate diffusion of new knowledge and information, IPR play no role for the industry. This can be explained by the short time period between IPR strengthening and the study, but especially by the high information, certification and enforcement costs related to IP protection.

From the results and discussion above, qualifications to IPR theory and policy can be formulated for the case of developing countries. The all-positive assumptions at the basis of the TRIPs agreement (e.g., Article 7) should be put in perspective and characteristics of the countries should be taken into account in evaluating the role stronger IPR could play for their economy.

The quality of the institutional environment, i.e., the agencies regulating and enforcing IPR, is an important aspect to take into account. The presence of efficient and reliable institutions is key to the proper functioning of IPR and it is a weakness in several developing countries. In the same perspective, the costs of registration of the IPR, as well as the potential litigation costs have to be bearable for the local inventors, in order for them to obtain added value from IP protection.

[8] Such informal monitoring system has not been observed for the case of patents.

Finally, the level of technological development prevailing in the country also has to be taken into account. When local inventors do not develop inventions qualifying for protection, the relevance of IP protection for the local industry can be questioned. Even though the countries benefit from protected products developed by MNC and brought into the country, this represents only one aspect of the potential benefits the countries could derive from IPR. Given the relatively good score of Mexico on these two critical factors, IPR are likely to play an even smaller role for other developing countries.

References

Alfranca, O. and W.E. Huffman. 2003. Aggregate Private R&D Investments in Agriculture: The Role of Incentives, Public Policies and Institutions. *Economic Development and Cultural Change* 52(1): 1-22.

Alston, J.M., G.W. Norton and P.G. Pardey. 1995. *Science under Scarcity: Principles and Practice for Agricultural Research Evaluation and Priority Setting*. ISNAR and Cornell University Press, Ithaca, N.Y.

Alston, J.M. and R.J. Venner. 2002. *The effects of the US Plant Variety Protection Act on wheat genetic improvement.* Research Policy vol. 31(4): 527-542

Byerlee, D. and K. Fischer. 2000. *Accessing Modern Science: Policy and Institutional Options for Agricultural Biotechnology in Developing Countries*. Paper presented at the 24th Conference of the International Agricultural Economics Association (IAAE), Berlin, Germany, August 14 -18, 2000.

Chen, Y. and T. Puttitanun. 2002. *Intellectual Property Rights and Innovation in Developing Countries.* Paper presented at the conference "Innovation Policy in International Markets", October 25-26, 2002, Berlin.

Collier, P. 1998. *The Role of the State in Economic Development: Cross-Regional Experiences*. Journal of African Economies 7(0): 38-76.

Commission on intellectual property rights [CIPR]. 2002. *Integrating Intellectual Property Rights and Development Policy*. Report of the Commission on Intellectual Property Rights, London.

Demsetz, H. 1967. *Toward a Theory of Property Rights*. American Economic Review 57(2): 347-359.

Gaisford, J. D., J. E. Hobbs, W. A. Kerr, N. Perdikis and M.D. Plunkett. 2001. *The Economics of Biotechnology.* Edward Elgar Publishing Ltd.

Jaffé, W. and J. Van Wijk. 1995. *The Impacts of Plant Breeder's Rights in Developing Countries: Debate and Experience in Argentina, Chile, Colombia, Mexico and Uruguay*. Inter-American Institute for Cooperation on Agriculture and University of Amsterdam.

Léger, Andréanne. 2001. *Strengthening of Intellectual Property Rights in Mexico: Case Study of Maize Breeding.* M.Sc. Thesis, Department of Development Economics, Wageningen University, The Netherlands.

Leskien, D. and M. Flitner. 1997. *Intellectual Property Rights and Plant Genetic resources: Options for a Sui Generis System*. Issues in Genetic Resources No. 6, June 1997. IPGRI, Rome, Italy.

Lesser, William. 1998. Intellectual property rights and concentration in agricultural biotechnology. AgBioForum, 1(2), 56-61. http://www.agbioforum.org (28 July 2004)

López Pereira, M.A. and M.P. Filippello. 1995. *Emerging Roles of the Public and Private Sectors of the Maize Seed Industries in the Developing World*. CIMMYT Economics Program Working Paper No. 95-01. Mexico, D.F.: CIMMYT.

Maskus, Keith E. 2000. *Intellectual property rights in the global economy*. Institute for International Economics, Washington, D.C.

Morris, M.L. and M.A. López Pereira. 1999. *Impacts of Maize Breeding Research in Latin America, 1966-1997*. Mexico, D.F.: CIMMYT.

National Law Center for Inter-American Free Trade [NLCIAFT]. 1997. *Strong Intellectual Property Protection Benefits the Developing Countries*. http://www.natlaw.com/ (28 July 2004)

North, D.C. 1990. *Institutions, Institutional Change and Economic Performance*. Cambridge University Press.

Panagariya, A. 1999. *TRIPs and the WTO: An Uneasy Marriage*. Paper presented at the World Trade Organization, July 20th, 1999.

Perrin, R.K. 1994. Intellectual Property Rights in Agricultural Development. In: Anderson, J.R. (Ed.) *Agricultural Technology: Policy Issues for the International Community*. CAB International, University Press, Cambridge.

Tansey, G. 2004. Global Intellectual Property Rights: A New factor in Farming". In: Ingco, M. and Nash, J.D., (eds.): *Agriculture and the WTO: Creating a Trading System for Development*. World Bank: Washington, DC, pp.255-270.

Watal, J. 1999. *Future Issues on IPRs at the WTO*. Indian Council for Research on International Economic Relations, New Delhi, 17 p.

World Trade Organization. 1995. *Agreement on Trade-Related Aspects of Intellectual Property Rights*. (28 July 2004).

Institutional Change in Agriculture and Natural Resources (ICAR) Discussion Papers

Edited by Volker Beckmann and Konrad Hagedorn

5/2005 Andréanne Léger: Intellectual Property Rights and their Impacts in Developing Countries An Empirical Analysis of Maize Breeding in Mexico, January 2005.

4/2004 Jörg Eggers, Lutz Laschewski and Christian Schleyer: Agri-Environmental Policy in Germany. Understanding the Role of Regional Administration, December 2004

3/2004 Annette Hurrelmann: Analysing Agricultural Land Markets as Organisations. An Empirical Study in Poland, November 2004

2/2004 Stefan Jungcurt: The Politics of Incoherence: A Framework for the Analysis of Functional Overlap in International Governance as Two-Level Game, August 2004

1/2003 Benedikt Korf: Conflict - Threat or Opportunity? War, Livelihoods, and Vulnerability in Sri Lanka, Oktober 2003.
Published as Korf, Benedikt (2004) "War, Livelihoods and Vulnerability in Sri Lanka", Development and Change 35(2), 275-295

ISSN 1613-3455 (Printausgabe)
ISSN 1613-4862 (Internetausgabe)
http://www.agrar.hu-berlin.de/wisola/fg/ress/icar