The Effects of Strengthened IPR Regimes on the Plant Breeding Sector in Developing Countries

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Contributed paper prepared for presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia, August 12-18, 2006

Abstract: This paper analyzes the effect of intellectual property rights (IPR) regimes on the plant breeding sector in developing countries. Most of these countries have implemented a system of plant variety protection (PVP), or are in the process of doing so, generally as part of their obligations under the Agreement on Trade Related Aspects of Intellectual Property (TRIPS) of the World Trade Organization (WTO). This paper presents the results of research on the initial effects of IPRs on the plant breeding sector in five case study countries (China, Colombia, India, Kenya and Uganda). Three of the countries have PVP systems in place and the other two are in the process of either developing or implementing legislation. But the ease of implementing PVP seems to have been overestimated. Opportunities to minimize the transaction costs of acquiring and enforcing rights are being missed. Detailed interviews with both domestic and international seed companies suggest that PVP can not be expected to initiate the development of a commercial seed sector. But a well functioning system can play a role in stimulating further development of the sector, although a measured approach to increasing the scope of protection will probably better balance interests than rapid adoption standards of industrialized countries. The results also highlight the particular challenges facing national agricultural research institutes in determining how to best make use of IPRs, such as PVP, particularly given broader changes in publicly-financed agricultural research.

JEL Codes: L3 Nonprofit organizations and Public Enterprise, O3 Technological Change; Research and Development, Q16 R&D; Agricultural Technology; Agricultural Extension Services

Introduction

This paper analyzes the effect of intellectual property rights (IPR) regimes on the plant breeding sector in developing countries. Most of these countries have implemented IPR protection for plant varieties, or are in the process of doing so, generally as part of their obligations under the Agreement on Trade Related Aspects of Intellectual Property (TRIPS) of the World Trade Organization (WTO). TRIPS Article 27(3)b obliges member countries to offer patent protection and/or a *sui generis* form of intellectual property protection for plant varieties (PVP[1]). Many countries in the South have consequently been developing and implementing (PVP) systems as a form of sui generis protection and choosing not to make patent protection available for plant varieties. WTO members are however still required to offer patent protection for inventions and these are also relevant for the plant breeding sector,

[1] A system of plant variety protection (PVP) is also referred to by the specific name of the right conferred, namely Plant Breeder's Right (PBR).

particularly given the increasing application of modern biotechnology to plant breeding. The implementation of such patent protection is lagging though relative to PVP.

There have been several studies that have attempted to analyze the issue in industrialized countries, primarily focussing on the effects of PVP. As might be expected, it is often difficult to separate the effects of other economic and policy changes from those of IPRs. Several studies document an increase in private sector breeding for a number of non-hybrid crops in the US since the PVP Act of 1970, but most attribute only a modest role to PVP for these changes (Butler, 1996; Lesser, 1997). Alston and Venner (2002) show that private sector investment in US wheat breeding has remained static while that of the public sector has increased since the introduction of PVP. Penna (1994) shows an increase in breeding investments in the UK for some horticultural crops, but not others. These and other mixed results lead some to conjecture that PVP may not be strong enough to encourage investments in plant breeding (Alston and Venner, 2002; Lence et al, 2005; Srinivasan and Thirtle, 2003). On the other hand, the overall inconclusiveness also lends support in some circles to general skepticism about the role of IPRs in economic development (Chang, 2002).

In this paper we present the results of research on the initial effects of IPRs on the plant breeding sector in five case study countries (China, Colombia, India, Kenya and Uganda).[2] The research methods, which are by necessity primarily qualitative in nature, are described in the next section. This is followed by a summary of the effects on plant breeding and seed companies. In almost all developing countries and economies in transition, the public sector has historically played an important role in the plant breeding sector. We therefore also assess the initial effects of IPRs on their behavior. The concluding section identifies some lessons for developing countries and other stakeholders supporting the

[2] This paper is based primarily on a study commissioned by the World Bank under grant # 8001817. The authors would like to gratefully acknowledge very useful comments on this research by World Bank specialists D. Byerlee and E. Pehu, as well as the contribution of other members of the research team: V. Henson-Apollonio, R. Hu, M. Mendoza, F. Muhhuku, S. Pal & J. Wekundah. But all responsibility for the interpretations contained in this paper lies with the authors.

implementation of IPRs, and also attempts to draw some general conclusions concerning the effect that PVP in particular has on plant breeding.

Methods

The wide variation in plant breeding capacities and seed industries among developing countries demands a case study approach for this research. In this approach, we attempted to assess the general behavioral responses of stakeholders to the (potential) introduction of IPRs. The range of types of IPRs in force or contemplated, as well as the great variation in local institutions and farming systems, adds to the justification for a careful examination of a relatively few cases in terms of countries and crops. The choice of examples is constrained, however, by the fact that many countries have yet to establish an IPR regime for plant varieties.

Because an assessment of the limited but varied experience requires in-depth fieldwork, a wide range of evidence had to be sought in a small number of developing countries that have started implementing IPR regimes in agriculture. Five case study countries were chosen to represent major segments of developing country agriculture, geographical spread, and level of experience with IPRs: China, India, Colombia, Kenya and Uganda. A common set of interview protocols were developed for the case study countries in order to obtain comparable information. Interviews were conducted with large numbers of stakeholders in each country, representing public plant breeding and seed production, the private seed sector (including representatives and IP specialists of major multinational companies), IPR and regulatory agencies, and farmers and farmer groups. Table 1 details the number of breeding organizations interviewed by country and according to whether these were private or public sector (but omits the other stakeholders). In many cases, numerous

individuals were interviewed within each organization Local data and reports were also collected and analyzed.

Implementation of IPRs in case study countries

In terms of IPRs, most of the experience to-date in the case study countries has been with plant variety protection (PVP). Three of the countries have PVP systems in place and the other two are in the process of either developing or implementing legislation (see Table 2), while there is much less experience with patents for biotechnological inventions. But the ease of implementing PVP seems to have been overestimated in several countries. Countries require considerable time to experiment with the implementation of PVP and to understand the consequences

The manner in which PVP is designed and implemented affects bot the scope of protection provided and the transaction costs of acquiring and enforcing this protection. These two characteristics appear to be the key factors influencing to what extent breeding companies will make use of PVP. The scope of protection determines, in general terms, the degree to which breeders can appropriate benefits from new varieties. This is the subject of regular debate, particularly with respect to issues such as whether protection extends to harvested products and possible restrictions to the “farmers’ privilege” of saving, replanting and possibly exchanging or selling seed. The interviews undertaken highlight though how the transaction costs deserve more attention (see alse Léger, 2005).

The transaction costs associated with acquiring PVP consists primarily of application and renewal fees paid to the authority. There is not much difference in the costs of PVP between the 3 countries in the sample, despite significant differences in potential market size. (For the 3 countries it costs between $1,200 and $2,400 to register and protect a variety for five years; see Table 3.) In addition, the countries take quite different approaches to the

adjustment in fees during the period of protection; in some cases fees are lower in the earlier years (presumably to encourage testing the market).

Discussions about the level of fees charged for PVP are related to the question of whether a PVP authority can or should be expected to be self-supporting. If it cannot, then justifications for public investment are required. It was not possible to assess the degree of financial sustainability of the 3 case study PVP authorities in their early years of experience. The rapidly expanding Chinese PVP system is certainly not self-financing at this early stage (despite the claim that the fees are relatively high; see Koo et al. 2003), while the Colombian system (which does its own testing on a very limited number of crops and earns substantial revenues from the protection of foreign-origin IP) would appear to be viable.

The primary expenses incurred by PVP authorities is testing which involves trial plantings to evaluate a new variety against the criteria of distinctness, uniformity, and stability (DUS). This is one of the common elements of the UPOV system, which has provided for a harmonization of the technical guidelines for such testing. In Kenya, the application costs can be reduced by submitting test reports from, for example, a European PVP authority. Such reductions in transaction costs from acceptance of foreign reports are being missed in countries such as China where local testing is required.

The other principal transaction cost consists of resources devoted to enforcing one's exclusive right to produce and market seed of a protected variety. The PVP agency itself is rarely the body responsible for enforcement. If PVP is to function efficiently concomitant enforcement capabilities and resources must be developed, particularly in the legal system. The few infringement cases described in Colombia indicate that sanctions for violations are not defined and that the courts are not well prepared. Experience from China shows that it takes some time for the courts to develop requisite expertise in this area. In all countries studied, private and public plant breeders do not necessarily recognize that the major

responsibility for identifying violations and pursuing cases rests with them, implying additional investments of staff and resources. Multinational seed companes, on the other hand, are well aware of this and cite difficulties in enforcement, that is high transaction costs (or uncertainty associated with these costs) as one of the most decisive factors influencing their use of the PVP system.

Costs of enforcing rights are also affected by how the application and testing system is established. For example, some parts of the private sector have concerns about the security of deposited inbreds, particularly in China. International horticultural seed companies in particular, repeatedly pointed out that concerns about the security of DUS testing facilities were sufficient to prevent them from applying for PVP in certain markets and marketing their more valuable varieties.

Plant Breeding and Seed Companies

There has been significant private seed sector activity in many developing countries even before the establishment of national IP regimes for plant varieties. By far the most dynamic private seed sector in the sample (India) has grown and diversified without benefit of any PVP regime but in the context of quite liberal seed laws and in many cases through the use of hybrids as a way of appropriation (e.g. Pray and Ramaswami, 1990; Pray et al., 2001). Colombia's private seed sector is more than two decades old, but private seed enterprises in the other three countries are the outcome of fairly recent policy changes that move away from public monopolies on seed production.

Thus PVP is not a necessary condition for initial private seed sector development, but it may contribute to its growth and diversification. The only major example of private domestic plant breeding in Colombia is for rice, and the establishment of PVP almost certainly encouraged the further development of the industry, which is based on OPVs.

Foreign companies also market protected OPVs of soybean and cotton, but it is difficult to point to examples of the diversification of the private seed industry in Colombia due to PVP. It is even more difficult to identify any effects of PVP on the nascent private seed industry in Kenya, where the few products of private domestic breeding have yet to seek protection and the hybrid maize offered by MNCs may not have PVP. In Uganda, exclusive rights over public varieties given to local private companies have contributed to the emergence of local seed enterprises, and it is worth noting that this was done without any formal IP-legislation. Although the (foreign) horticultural industry pressed for the establishment of PVP in Colombia and Kenya, and the national regimes certainly provide added confidence and contribute to the perception of a better business environment for expansion, neighboring countries with similar ecologies but less developed PVP (e.g. Ecuador and Uganda) can still participate strongly in the industry. The course of private seed sector evolution in China will depend on a wide range of factors, and the role of IP is uncertain.

Seed companies tend to take advantage of PVP and patents when it helps protect them against competitors gaining access to their materials. Thus OPV rice varieties are regularly protected in Colombia (as are cotton and soybean). Hybrid maize is not protected in Colombia because the hybrids are relatively secure. Similarly, OPV barley has sought protection in Kenya, but private hybrid maize varieties have yet to apply for PVP. In addition, those OPV crops that seek protection are ones that are grown in commercial systems, where variety and seed quality are important and where seed cost is a relatively small proportion of costs of production. Where hybrids are used in diversified seed industries, such as India and China, hybrids do attract the majority of interest for PVP.

A broader scope of protection in PVP systems can also limit farmers' seed saving (such as intended by the 1991 Act of the UPOV Convention) in order to provide additional incentives for private seed provision, but there are no instances of this as yet in the case study

countries except for the flower industry where on-farm production of planting materials is fairly adequately regulated by the breeders. Two cases were identified where there is movement to limit seed saving. In Colombia there is a considerable amount of seed saving and informal commercial sale of farm-produced rice seed and the industry would like to control this; a new resolution limits seed saving to farms below a certain size. In Kenya, there are complaints that wheat farmers save and trade the majority of their seed, rather than buying commercial stocks, and Kenya proposes making its regulations compliant with UPOV 1991. These instances involve relatively large-scale commercial agriculture where the extra costs to farmers of obligatory seed purchase will probably be acceptable, but the changes in law and regulation may open the door to much wider control of seed use without any obvious mechanism for discretion. In both cases authorities admit that it would be difficult to enforce such requirements with smallholders (as well as being politically sensitive).

Public Sector Research Institutes

Whereas the intended effect of IPRs, in particular PVP, on private sector breeders, is relatively simply, the situation for public sector breeders is more complex. The use of IPRs by national agricultural research institutes (NARIs) may address three goals: revenue collection, recognition of achievement, and technology transfer. These goals may not always be compatible, and the development of adequate policies for the NARIs is a difficult task. The establishment of PVP regimes comes at a time when public agricultural research in developing countries is being asked to take much more responsibility for revenue generation.

In Colombia, for example, there is little evidence so far of potential revenue generation from public breeding. In Kenya, the fact that most of the maize hybrids grown by farmers are products of public breeding would indicate the possibility of substantial revenues, but the domestic and foreign private plant breeding sector is expanding rapidly. In Uganda, public

plant breeding has not yet resulted in a widespread use of public varieties by farmers, and because it concentrated on OPVs until recently it has not contributed to the nascent seed industry. The private sector is still insignificant in terms of breeding. In India, although the vast majority of hybrid seed is now the product of private plant breeding, huge areas of wheat and rice are planted to public varieties, and even though only a fraction of that area is planted to purchased seed, the royalties could be significant. But it would appear that there are no plans at present to shift away from the practice of selling breeder seed to any legitimate seed producer. In China, the system is in a state of flux, as public breeding institutions for major crops are making the transition to take partial responsibility for revenue generation. As there are substantial quantities of public varieties of many important field crops grown with purchased seed (especially hybrid rice and maize), the revenue generating possibilities are substantial. But public funding and broader mandates are also important.

The expectations of NARI management for the amounts of revenue that can be generated are thus quite high. The degree to which a PVP system can help generate income for NARIs depends to a large extent on whether NARIs can keep control of plant breeding skills and resources for commercially important crops. The experience of India in the past two decades is instructive; as policy changes encouraged the emergence of private plant breeding, the expertise for commercial (largely hybrid) seed crops began to shift from the public to the private sector, even for supposedly 'marginal' crops like sorghum and pearl millet. As the private seed sector developed in India, NARI staff were hired away, and the private sector now offers an attractive alternative. In the smaller countries studied, the ability of the NARI to retain plant breeding personnel and resources in the face of an expanding private seed sector is even more in doubt. In Kenya, KARI's traditional partner, the Kenya Seed Company (KSC), is now a rival, with a separate breeding program, and other domestic companies are assembling their own breeding resources.

A fundamental problem with revenue generation from PVP is that the potential opportunities are generally concentrated in more commercial crops which could lead to questionable public research resource allocations. Should hybrid rice research earn much more than wheat research just because of differences in seed systems? Although it makes sense to assign research resources to crops and problems for which there is high farmer demand, commercial seed systems often provide imperfect signals of that demand. There are already indications that these signals from the seed system and associated PVP are making their marks on NARI priority setting. This can be seen with the case of hybrid rice in Hunan and Guangdong provinces, as well as with the longer running approach to vegetable breeding in China. NARO in Uganda is encouraged to concentrate on research where commercial contracts or PVP will provide revenue, and KARI's calculations for income are based on hybrid maize.

The emergence of PVP thus comes at a time when there are many uncertainties about the role of NARIs relative to the private sector in terms of mandate crops and the division of labor between upstream and downstream research. The dilemma is that in most countries the conventional private seed sector does not have the incentives to produce and market the full range of public sector varieties for which there may be farmer demand, such as beans, but the public sector has shown itself incapable of organizing an efficient alternative.

Conclusions

This research contributes to developing an understanding of what the effects of IPRs will be on the plant breeding and seed sector in developing countries and economies in transition. An improved understanding will help clarify some of the debates and controversial issues surrounding IPRs. The picture that is emerging is quite rich in complexity which is due to the array of factors that affect the decision-making of plant breeders and seed companies.

The immediate policy implications of the findings are that IPRs such as PVP can not be expected to initiate the development of a commercial seed sector. Many other factors, including for example efficient seed regulations, play an important role in early stages. Once these have been passed, PVP does appear to contribute to a more transparent and efficient sector, although the scope of protection need not necessarily too strong at this point. For countries deliberating on how to fulfill their TRIPS obligation or facing demands to implement broader IPRs for plant varieties in negotiations concerning bilateral trade and investment agreements with the U.S. or the E.U., the results suggest a measured approach. It may well be better to take advantage of the flexibilities in TRIPS which allow for instance for a staggered introduction and tightening of IPRs according to say particular crop sectors.

The results also highlight the importance of devoting more attention in the implementation of PVP systems to the minimalization of transaction costs associated with acquiring and enforcing rights. In this regard, further research could explore the tradeoffs in alternative fee schedules and scenarios for self-sufficient PVP offices. Opportunities to maximize the benefits from PVP by reducing transaction costs are currently being missed in the arrangements for DUS testing. In general, it is thus important to look not only at the scope of protection and the wording of the legislation.

Similarly, these results can also provide inspiration for a richer analytical and theoretical treatment of IPRs in which appropriability and the transaction costs are examined in a more specific manner. With respect to empirical research, we argue that there is an important role for more qualitative studies of this nature that seek to identify or predict changes in behavior based on detailed, semi-structured interviewing. In many developing countries, it will be some time before sufficient data is available for econometric analysis. In this study, we found that even a coding of responses to interview questions would have buried much of the rich information gathered. This is particularly apparent in the reaction of NARIs

to PVP and other IPRs, and it appears that this is an issue of pressing concern for policy makers (see also Byerlee and Fischer, 2002).

Finally, the increasing spread of biotechnology in agricultural plant breeding in developing countries implies that the IPR situation will become more complicated, and this is already being seen in some countries. The effective implementation of patent systems is lagging in many countries, but their introduction in the field of agricultural biotechnology is more complicated than is the case with PVP. In addition, patents and PVP will overlap, raising again questions about how the details of such implementation can minimize transaction costs. This should provide plenty of possibilities for further research in the future.

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Table 1: Number of seed and plant breeding organizations interviewed by type and country

	China	Colombia	India	Kenya	Uganda
Private domestic seed companies	8	7	10	9	8
Multinational companies	5	5	7	5	3
Public sector seed and plant breeding organizations[a)]	10	2	8	4	5
Total	**23**	**14**	**25**	**18**	**16**

Notes

[a)] Includes national and provincial crop breeding institutes, other national agricultural research organizations active in plant biotechnology for crop development, universities and also international agricultural research centres active in the country (one in each country with exception of China where none were interviewed).

Table 2: PVP legislation in the case study countries

	China	Colombia	India	Kenya	Uganda
Legislation	Regulations of the People's Republic of China on the Protection of New Varieties of Plants (1999). Member of UPOV (1978) since 2000	Law 243 of 1995 establishes PBR. Resolution 2046 (2003) defines limitations on seed saving. Member of UPOV (1978) since 1996.	Protection of Plant Varieties and Farmers' Rights Act (2001) establishes PBR. India will apply to join UPOV.	Seed and Plant Varieties Act (Cap 326) amended in 1991 and 1994 to establish PBR. Kenya joined UPOV (1978) in 1999.	A draft Plant Variety Protection Act is being debated in Parliament in 2004. It defines PBR as well as farmer and community rights.
Scope of coverage	41 crops currently eligible. Certificates have been issued for 15 species to date; cotton not eligible for protection	All crops, eligible. In practice certificates issued for 7 agricultural crops and 15 horticultural crops.	No crops excluded, but exemption for varieties whose commercial exploitation would be a danger to public order, public health, etc.	No crops excluded; to date applications have been accepted for 31 agricultural crops and 23 horticultural crops	No crops excluded.
Length of protection	20 years for vines, fruits, and ornamentals; 15 years for all other crops	25 years of trees and horticultural crops; 20 years for field crops.	18 years for trees and vines; 15 years for other crops	18 years for trees and vines; 15 years for other crops	25 years for trees and vines; 20 years for annual crops
Farmer seed saving and exchange	Seed saving and exchange is permitted. (Local/informal seed sale regulated by seed law)	Farmers with more than 5 ha not allowed to save seed of protected varieties. No farmers' privilege for horticultural or tree crops, or transgenic varieties.	Seed saving, exchange and sale by farmers is permitted, but not sale of 'branded seed'.	Seed saving currently permitted, but moving towards UPOV 1991. (Local seed sale restricted by certification requirements)	Farmers have the right to use, exchange and sell farm-saved seed of protected varieties, but not 'on a commercial scale'.
Breeders' exemption	Protected varieties may be used for breeding. (No special rules for EDVs)	Protected varieties may be used for breeding	Protected varieties may be used for breeding. Protection of EDV depends on rights of original breeder	Protected varieties may be used for breeding, but moving towards UPOV 1991.	Protected varieties may be used for breeding
Protection of extant varieties	Protection offered for varieties that were in China up to 4 years before a species/genus	'Amnesty' for 1 year when PVP was introduced for officially released	Varieties already released and notified will be eligible for protection	Public varieties already released eligible for protection	Extant varieties not eligible for protection

	China	Colombia	India	Kenya	Uganda
	becomes eligible for protection (application to be made within 1 or 2 years (woody and agricultural species resp.)	varieties. Protection period based on remaining period, counting from year of release.	(from date of original notification)	(from date of filing), but decision contested	
Plant variety patents	Hybrids can fall under the scope of a patent for a 'breeding methodology'.	GMOs may be patented because not found in nature.	No patents of plant varieties	No patents of plant varieties	No patents of plant varieties

Table 2. Costs of PVP

Item	China	Colombia	Kenya	EU	US
Application	$217	$233	$200	$1,115	$432
Testing	$556	$1,396 ($155 if done abroad)	$600	$1,265 – $1,490 (depending on type of crop)	$3,220
Granting of rights	-	$39	$240	-	$682
Annual maintenance fee (by year)	(1-3): $181 (4-6): $236 (7-9): $306 (10-12): $398 (13-15): $517 (16-18): $672 (19-20): $ 874	(1): $78 (2): $155 (3):$ 233 (4-20): $311	(1-20): $200	(1-20): $540 (flat rate beginning 2006)	None
Cost of PVP and 10 years of protection	$3,340	$4,311	$3,040	$7,780 (lowest example)	$4,344
Cost of PVP and 15 years of protection	$5,687	$5,866	$4,040	$10,480	$4,344

Source: PVP offices in case study countries; website of the European Community Plant Variety Office (www.cpvo.eu.int) (fees converted at 1.24$/euro); website of Plant Variety Protection Office of USDA (www.ams.usda.gov/science/pvpo/PVPindex.htm).