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MODIFICATIONS IN INTELLECTUAL PROPERTY RIGHTS LAW AND EFFECTS ON AGRICULTURAL RESEARCH

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Modifications in Intellectual Property Rights Law and Effects on Agricultural Research[1]

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I. INTRODUCTION

During the 1980's, major changes were made in intellectual property law in the United States. Identifying those of particular relevance to agriculture, the fundamental extension of patent law was the Supreme Court's decision in *Chakrabarty* that, "anything under the sun which is made by man" is patentable subject matter.[2] The "anything" in that case was of course a living organism, a microorganism in that instance. Subsequent internal Patent and Trademark Office interpretations of *Chakrabarty* lead to the patentability of seeds[3] and animals[4]. Also notable but of a different order of magnitude was the 1980 amendment to the Plant Variety Protection Act[5], the US legislation establishing Plant Breeders' Rights. Among other changes, those amendments made it possible for the United States to join UPOV, the international Plant Breeders' Rights convention.[6] At this point it can be claimed that the US has the broadest range of allowable intellectual property protection for living organisms in the world. What do the 1990's hold in store?

This decade is, first, likely to be one of geographic expansion of protection worldwide. As of 1988, for which we have a good accounting, 52 countries expressly excluded patents for

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[1]This paper was presented by William Lesser at the Agricultural Research Institute's Conference on Dynamics and Performance of the U.S. Agricultural Research System. McLean, VA., Sept. 17-18, 1992.

[2]*Diamond vs. Chakrabarty* 447, US 303, 206 U.S.P.Q. 193 (1980)2

[3]*Ex parte Hibberd* 227 U.S.P.Q. 443 (P.T.O. Bd. Pat. App. & Int'f 1985)

[4]*Ex parte Allen* 2 U.S.P.Q. @d 1425 (P.T.O. Bd. Pat. App. & Int'f 1987)

[5]7 U.S.C. sec. 2321 et seq.

[6]In English, International Convention for the Protection of New Varieties of Plants.

plants and animals[7] while about a billion of the world's people live in countries lacking effective patent legislation. The United States, joined by other developed countries, has interpreted an absence or restriction of intellectual property rights (IPR) protection as a trade barrier under GATT - referred to as trade related aspects of intellectual property or TRIPs.[8] While the fate of TRIPs in any final GATT agreement is unclear, the US through the Trade Representatives Office has unilaterally pressed for enhanced IPR protection. That campaign is credited with success in Mexico, Indonesia, PRC and elsewhere; India may follow soon (Biotechnology and Development Monitor 1991). On what basis have these efforts been established, and what effects might they be expected to have for agricultural research in the US and worldwide? That is the first issue to be explored in this paper.

A second attribute of IPR in the 1990's might be called fine tuning of the laws. Minor changes might be made to adapt to unanticipated situations or to enhance worldwide harmonization. One recent example of this kind of change is the 1991 UPOV revision which introduced "dependency" into PBR. In brief, under this revision, if variety B is derived from A, and C from B, then both B and C are "essentially" derived from A and owing royalties to its owner. What affects will dependency have on plant breeding research in the US? In exploring that question the second issue developed here is the formulation of a recommendation as to whether the US should accede to the revised variant. For both of these issues, it will soon become apparent, there is much that we cannot answer specifically at this point. Thus the major outcome of the current effort is a further delineation of research needs.

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[7]World Intellectual Property Organization data summarized in Lesser 1991, Table 1. Regarding the exclusion of plants and animals from protection, it should be noted that the European Patent Convention in its Article 53 (b) contains such a prohibition although this has not prevented the issuance of such protection for plants so long as they are not in the form of a single plant variety. For developing countries the ban seems more broad based.

[8]For an overview of the issues see Primo Braga 1990.

II. GEOGRAPHIC EXPANSION

Projection of the impacts of enhanced IPR protection in developing countries on agricultural R&D is based first on what is known about the impacts of such protection on R&D funding. That exploration has two components, the theoretical and the empirical. Those are treated first. Subsequently it is essential for projecting private investments to understand the strategic decisions of firms, and US firms in particular, in regards to what is spent and where. That is treated in Section II.3. Finally in Section II.4 the projections are made and research needs are identified.

II.1. Theoretical Issues

The US patent law was passed, in words attributed to Thomas Jefferson, to "promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive rights to their respective writings and discoveries"[9]. This constitutes the economic justification for IPR in contradistinction to the more philosophical inalienable rights ("natural law") to personal creations, that "an idea belongs to its creator because the idea is a manifestation of the creator's personality or self" (Hughes 1988 P. 330). This paper considers only the more utilitarian economic incentives in line with the general interpretation of Article 1 to foster social goals (eg., Anderfelt 1971, p. 13).

The fundamental concept of IPR, as best expressed by Machlup (1958), is the provision of an incentive through the opportunity to recover research expenditures by allowing a **limited, temporary** monopoly to the creator. Such a monopoly protects the creator from direct copying while necessitating that any financial rewards come from the market. The market determines the value of inventions, not the patent office. To the degree that it is

[9]US Constitution, Article 1, sec. 8

estimated, only some 5-15 percent of patents are used (practiced) to any extent (Nogués 1989; Taylor and Silberston 1973). When referring to the monopoly rights, the adjective "limited" applies to the allowed scope of the patent or certificate of PBRs. "Scope" is a legal term referring to the extent ("closeness") of close copying which would be considered an infringement of the patent (Crespi 1988, Chapter 4).[10] Obviously meaningful protection must apply to more than exact copies[11], but the establishment of the appropriate scope is a complex matter determined in part by the patent examiner and, when necessary, by the courts.

"Temporary" refers to the duration of protection, typically about 20 years. Society extracts one other self-limitation from the applicant, the requirement that the invention be revealed, described so that anyone knowledgeable in the art can recreate (practice) it (35 U.S.C. Sec 112). This disclosure is typically satisfied by a written description but when that is not technically feasible, as is often the case with living organisms, a deposit of the protected material may be substituted[12] (see eg., Straus and Moufang 1990).

A more succinct way of saying all of this is that patents and other forms of IPR allow only negative rights; the right to exclude others from using your creation. IPR does not give anything, not even the right to use one's own patented invention. That invention may require regulatory approval for use, as with pharmaceuticals or the intentional environmental release

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[10]Technically, patent scope is determined by the claim in conjunction with the review of prior inventions, the novelty search.

[11]However I have argued elsewhere (Lesser 1986) that PBR as interpreted in the US do not prevent near copying, that they protect little more than the variety name. PBR scope in other countries is greater especially as in EC when combined with commercialization requirements. See Lesser 1987(a).

Patents can be informally classified into several groups, including process, product by process, new use and *per se.* The scope of protection varies across these types with *per se* allowing the greatest protection for the inventor because control is extended to new (unanticipated) uses of the invention.

[12]In the case of plant patents in the US, patents for asexually propagated materials, the disclosure requirement was changed from "full, clear and concise" to "description is as complete as is reasonably possible" so that deposits are not used (35 USC Secs. 112 and 162).

of many lifeforms, or its use may infringe on a previously-existing patent. Certainly the issuance of a patent is not some form of governmental sanctioning of the invention as some commentators seem to imply.[13]

Clearly there is an effort by the formulators of the IPR laws to strike a close balance between public benefit - the bringing forth of private research efforts, and public cost - the monopoly rights granted. What does economic theory have to say about that balance? In terms of the overall system, little beyond the descriptive. However the laws contain a myriad of specifics which are more conducive to economic analysis.

Economists have subdivided the invention process into three stages:

* invention,
* innovation, and
* diffusion (commercialization).

Studies have indicated that the basic creative process, the foundation for many significant inventions, is motivated more by the creative drive than by monetary incentives. Patents are more important in the long, tedious and expensive process of making the invention commercially acceptable (Jewkes, Sawers and Stillerman 1969).

Economists have looked particularly at the duration of protection and the ramifications of the "winner take all" incentives established by patents and like laws. Considering duration the analysis has shown, not surprisingly, that a fixed term is not optimal. The ideal term depends on the demand elasticity and significance of the invention in cost reduction (review in Primo Braga 1990). As a practical matter this result is not very useful because we already know from patent renewal data, the escalating periodic fee to maintain a patent, that few patents are commercially viable for the full 17 plus years (Schankerman 1991). Thus the statutory

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[13]It should be noted that in European patent law the violation of public morals ('ordre public') is grounds for rejection of an application (European Patent Convention Article 53(a)). This article was used in part as justification for the initial rejection of the initial 'Onco mouse' application there (European Patent Office 1990).

life of patents is only rarely of practical importance so that, overall, the social cost of extended protection is small. Moreover, it is not administratively feasible to grant different durations of protection for different types of products.[14]

The race to be first is perhaps more conceptually interesting. At issue is the lack of reward to be second in the race. Does this cause more and wasteful investment in a race, or are firms conservative in not gambling to be first, holding down total investments? Alternatively, the ensuant competition may compel firms to work faster and take alternative approaches, enhancing the likelihood and speed of finding a useful result. There has been no general satisfactory resolution to this question because the analysis requires that strong assumptions be made about behavior and competition (Reinganum 1982; Harris and Vickers 1987; Loury 1979). But perhaps the matter is mooted by Dasgupta's (1986) observation that technological competition is a continuous process from which firms are absent at their peril. This is in contrast to the discrete decisions implicit in the issue of patent races.

Overall, in Primo Braga's (1990, p. 32) words, "Economic theory has raised more questions about welfare implications of intellectual property than it has answered. The theory of intellectual property protection is fragmented and provides no robust answer to the question of the appropriate or optimal level of protection under various sets of real-world circumstances." As limited and flawed as IPR clearly are, no one has yet identified a clear improvement (Jewkes, Sauers and Stillerman 1969; Benko 1987; Wright 1983).

II.2. Empirical Results

With the theory providing little guidance on the subject of the incentive effects of IPR,

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[14]However in a gross sense this is sometimes done because protection for very minor inventions known as petty patents or utility models are of short duration, typically five years. For regular (or utility) patents several countries have extendable durations based on a certain requirements (Lesser 1991).

the issue becomes an empirical matter. Here most of the evidence applies to Plant Breeders' Rights, the patent-like protection for traditionally bred open pollinated (US only) plants. The apparent reason for favoring PBR is its recentness, dating as it does only to 1970, whereas the US patent law was first adopted in 1790. The more recent legislation allows for "before and after" analysis not possible when the before was ten score years ago. Plant breeding for its part provides a concise sphere of activities with an easily identified product for evaluation. However, even if activities are temporally correlated, it does not necessarily demonstrate causality.

This is not to say that no estimates of the incentive effects of patents have been attempted. Schankerman (1991) used 1970 patent "cohorts" by major sector (pharmaceutical, chemical, mechanical and electrical) to estimate the private value of patents worldwide. He found the median value by sector to range from $1,600 to $3,100 in 1980 US dollars. There is an indication in these figures of the "winner takes all" component, for the top one percent of patents accounted for 15 to 25 percent of the median value (depending on sector). More pertinent to the incentive issue, Schankerman found that patents generate about a quarter of the private returns to inventive activity, not inconsequential, but not dominant either. These figures confirm statements of many executives that patent protection in general is not a critical factor in making R&D decisions (Reviews in Scherer 1980, p. 446; Nogués 1990, pp. 11-14).

The overall moderate significance of patents may, however, not be indicative of agriculture and especially the "new biotechnology" where for self-reproducible lifeforms legal protection is about the only protection there is. And nothing is as easily copied as non-hybrid seed where each plant has the means of replicating itself many times over. In contrast, for many other technologies portions of the know-how are kept as trade secrets so that the

invention in its most efficient form cannot be readily copied.[15] Thus, experiences under PBR are potentially very revealing of the potential incentive effect of IPR in agriculture.

Prior to examining the evidence it is helpful to understand better the differences between patents and PBR. Here the US law will be examined as the empirical evidence is from there. PBR has requirements of distinctiveness (clearly distinguishable), uniformity and stability (summarized as DUS) to parallel the novelty, utility and nonobviousness requirements for patents. With PBR distinctiveness is the key requirement, as it defines to a large extent the scope of protection. Uniformity and stability are technical requirements to assure that the variety has been bred for a sufficient number of generations to breed true to type. The distinctiveness requirement in the US is interpreted very narrowly so that virtually any difference, even if of no practical value at all, is sufficient to receive protection. This interpretation severely limits protection from close copying to the point that, in my interpretation, the US law really protects the variety name, not the germplasm itself (Lesser 1986).

PBR has another clause limiting the scope of protection. This is the "farmer exemption" (7 USC Sec. 2544) which permits farmers the right to retain seed for replanting and to sell limited quantities as a secondary activity.[16] Farmers then become direct competitors to the seed companies, limiting the value of protection. I personally believe this is not such a major factor, as farmers will buy new seed anyway every third year or so because of genetic drift and

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[15]Many countries do not require that the patent application disclosure constitute the "best use" of the invention, only that it is a workable example. This allows the inventor to protect the most valuable form or use of the invention. US Patent Office practice, however, mandates that the best use be disclosed.

[16]The revised UPOV statutes make the farmers' privilege a matter for national law, see Section III following. Presently only the US allows the sale of seed which has proven to be a difficult activity for the seed companies to detect and control. There have been calls for its repeal (American Society of Agronomy 1989).

improvements in the intervening years. Moreover, companies can price a three year input higher than a single year input (Lesser 1986). Nonetheless, in an empirical study Knudson and Hansen (1991) found that farmers could increase yields and profits by using purchased rather than "bin run" seed. However because farmers do use bin run seed for about a third of their needs, the farmers privilege does reduce the value of PBR.

Against this backdrop of limited protection, how has the private sector responded? Overall, quite substantially, as measured from several perspectives. Butler and Marion (1985, Chap. 3) conducted a survey of major private seed companies' investments in non hybrid breeding before and after the passage of PBR in the US and found for the 14 largest firms a quadrupling in constant dollars of R&D expenditures from 1960-80. Over the same period there was a marked shift from corn breeding, which as a hybrid cannot be recreated through saved seed, to open pollinated varieties, especially soybeans. Numerous smaller firms established open pollinated breeding programs and employed breeders over the same period. Most of the major investments were made prior to the 1970 passage of the PVPA, so it must be inferred that this was done in anticipation of passage. That is, causality cannot be proven.

The findings are summarized as follows (Butler and Marion 1985, p. 30):

> The sharp increases in R&D expenditures that occurred during 1967-70 were largely concentrated on research facilities and non-personnel costs. This was followed during 1970-75 by a significant increase in the number of plant breeders per firm. Since 1975, plant breeding R&D activity has experienced more modest increases.

It should be emphasized that the effort has been uneven across crops with soybeans receiving the greatest attention, followed by wheat, while most crops are unaffected. Perrin, Hunnings and Ihnen (1983) have shown that the level of private investment across crops can be explained by such factors as the yield increase potential and the multiplication rate, as well as the value of the crop. Prior to the passage of the PVPA essentially all non-hybrid breeding was done by the public sector. Subsequently it is important to note that there was no obvious

reduction in the public effort in this activity, although budgetary limitations are clearly having impacts across the spectrum of public sector activities.

Brim (1987) and Foster and Perrin (1991) have provided further data on increases in breeding programs and breeder numbers following the passage of the PVPA. Private programs have increased from one to 34 over the period 1960-88 while Ph.D.'s employed by private firms grew from six in 1970 to seventy in 1988.

Several studies have attempted to draw inferences from the large increases in numbers of certificates of plant variety protection which have been granted. However as Stallman and Schmid (1987) point out, the mere existence of certificates connotes little, because many will represent modest and practically insignificant differences. The breeding of so-called cosmetic differences has been an issue since 1980. Perrin, Hunnings and Ihnen (1983) have given some insights into this issue by showing that private varieties are somewhat more productive than public varieties, although the statistical evidence is limited. It can also be noted that for some crops, including soybeans, private varieties now dominate acres planted. If it can be assumed that farmers are good appraisers of varietal differences, which seems likely in a competitive sector with measurable product attributes, than this too suggests that private varieties are productive.

Overall the evidence supports the theoretical projection that the incentives provided by IPR do indeed stimulate private R&D investments. There remains much that is not known, including the level of incentive required, differences across sectors, and interaction with other protection mechanisms including secrecy. Yet when secrecy is not possible, as with self-reproducible organisms, there is a clear private response to IPR. The net social return to this protection is a far more difficult question to answer, but that is not the focus of this paper.

II.3. Strategic Behavior

If the above is convincing in indicating the private incentive effects of IPR at least for certain agricultural products, then the ancillary questions for the US agricultural sector are: 1) does greater protection further encourage private research by expanding the geographic markets? and 2) where geographically are those monies spent? That is, what are the strategic decisions made by firms in determining where and how research funds are to be used? Clearly it is significant for the US and for our university system that the work be done domestically.

This, regrettably, is an area about which we know little. Firms must balance multiple factors, including:

* The availability of trained researchers,
* The product life cycle (Bozeman and Link 1983), and
* Local adaptation requirements (Evenson 1988).

For agriculture several of these factors create divergent forces. Typically agricultural inputs, especially seeds, require very local adaptation, necessitating that the work be done broadly. On the other hand the life cycle for most self-reproducible agricultural inputs is brief, suggesting that firms will attempt to license them widely. In the words of a textbook explanation (Cundiff and Hilger 1984, p. 290):

> if the life cycle of a technology is expected to be short, it is probably best to use quick methods such as licensing to introduce the product, process or technology to the widest possible world market at the earliest possible time.

Since patents are an assist to licensing this suggests that a geographical extension of protection will enhance domestic R&D.

Some overseas markets are facilitated by IPR. Speaking for Canada as an importer, most likely from the US, Young (1989) described the situation with plant varieties as follows:

> Some private varieties should be available for use in Canada even though they may be created elsewhere as part of the larger plant breeding program, and a consequence of no breeders' rights legislation is a restriction on the availability of such private varieties.

The same situation applied to Argentina which has purchased varieties from the US following the

passage of its own PBR legislation (Gutiérrez 1991). Hence geographically expanded protection can be expected to enhance the total market, but probably not greatly for many agricultural products due to local adaptation requirements.

The subsequent issue is where geographically that research will be conducted. Overall the location of R&D is likely to change in future years as the number of well trained researchers (many in US universities) provide less expensive options to working in the US. These choices will not be available for complex products where facilities in developing countries are inadequate, but that applies to a limited number of technologies. Indeed, IPR may make a shift in research activity more possible as research operations depend heavily on maintaining secrecy, "trade secrets" to use the formal term. Or there may be a more direct link, as with the apparent agreement between Canada and the major pharmaceutical companies to expend research funds there in exchange for the allowance of patents for those products (Spurgeon 1992). Assuming no major increase in overall funding, this means expenditures elsewhere, including in the US, will be reduced.

II.4. Conclusions and Research Needs

The available evidence, as limited as it is, suggests that IPR do what the theory predicts, they foster private R&D. The incentive effect, to the degree it can be inferred, appears not to be great overall. Living self reproducible organisms, for which there is little protection beyond the legal, are an exception; protection is critical to private firm involvement. Because agricultural research includes a large portion of such products, the importance of IPR is consequently greater than the average. And we have fairly strong evidence that appropriate protection increases private domestic R&D.

The US presently has, by world standards, broad and strong protection so that little will change domestically to enhance incentives and investments. The attention is now on the

enhancement of IPR protection elsewhere, notably in developing countries, which often have weak or nonexistent protection. When particular products are identified for exclusion, they fall heavily in the realm of agriculture, such as a ban on "plant or animal varieties". Pharmaceuticals too are frequently excluded. Some advances have been made recently in response to pressure from the US in expanding protection in such countries as Mexico, China and Indonesia.

The indications are that these legislative changes will lead to some, but not major, increases in agricultural research in the US. Many agricultural applications require local adaptation restricting the direct market. What added research is done may be increasingly concentrated in the target markets, especially in developing countries where costs are lower. The enhancement of IPR can hasten that movement, but the key factor is the training of foreign researchers in major universities, especially in the US.

To understand more fully the balance of these factors and their implications on US agricultural research, more needs to be known about the incentive effects of IPR. However those issues are related principally to the social optimization of IPR, certainly an important issue but not the focus here. Where our knowledge is really lacking is in understanding where research moneys are spent and the affect of IPR on those decisions. The US through the Trade Representatives Office has moved ahead vigorously on strengthening IPR in developing countries. This may help multinational firms overall, but its affect on research within the US while not well understood, is likely to be limited.

III. FINE TUNING

The statement was made above that IPR in the United States is relatively broad and strong by world standards and that a major target of US and other developed country policy in the subject area is the enhancement of IPR protection in developing countries. At the same time it

was concluded that it has not been possible to determine whether current protection is optimal. None of this, however, prevents ongoing efforts to modify protection in specific aspects. The aspect under consideration here is a recently proposed modification of UPOV, the international convention for PBR. This convention, the International Convention for the Protection of New Varieties of Plants, goes into effect when signatory nations adopt similar legislation into national law. In the US the applicable law is the Plant Variety Protection Act of 1970. The US joined UPOV in 1980 following some minor harmonizing amendments.

When UPOV was first drafted in 1961 it appeared to function as a "separate but equal" statute for plants which paralleled patent protection for mechanical, chemical and electrical inventions. This apparent specialization of protection, or as it is commonly known, double protection, is evident in Article 2(1) which reads,

> "Each member State of the Union may recognize the right of the breeder provided for in this Convention by the grant either of a special title of protection or a patent. Nevertheless, a member ... may provide only one of them ..."

It should be noted that the US qualified under Article 37 of the 1978 text thus allowing it to offer two forms of protection, patents and PBR. But that is a detail; the significant point is that the Convention was first passed in an era when plants and plant-based research were clearly distinguishable from other forms of research.

That era passed quickly with the advent of biotechnology and subsequently the terminology "plant and animal varieties and essentially biological processes for the production of plants and animals" (EPC Article 53 (b)) have caused great definitional problems (see Bent, Schwaab, Conlin and Jeffery 1987, Chapter 4; Commission of the European Community 1988). At the same time the existence of the farmers' and research privileges in PBR has meant that protection is not as strong as for patents. Using an existing protected variety as the basis for developing a new one, as is permitted by the research exemption, means that near direct copying is possible. This is true in my estimation even outside of the US where the inventive step

requirement is greater (Lesser 1987a). The proposed 1991 amendments to UPOV seem to me to be an effort to restore the attempted equivalence between PBR and patents.

The amendments, which do not become law until they are ratified in a member country, apply to four major areas (UPOV 1991):

* dropping of the ban on double protection (Article 2),
* making the farmers privilege optional under national law (Article 15),
* mandatory extension of protection to all genera and species within three years (Article 3), and
* institution of the concept of "dependency" (Article 14(2)).

This paper considers only the ramifications of dependency as the most far-reaching charge. The limiting of the subject should not be taken as an indication that the other major amendments are insignificant or not important topics of research in their own rights.

Under the 1991 version, dependency mandates that permission will be required for commercializing protected varieties "which are essentially derived from the protected variety where the protected variety is not itself an essentially derived variety." A variety shall be considered to be essentially derived from another variety ("the initial variety") when (1) it is predominately derived from the initial variety, or from a variety that is itself predominately derived from the initial variety, particularly through methods which have the effect of conserving the essential characteristics ..." The text goes on to identify natural selection, induced mutation, variant selection or transformation by genetic engineering, as examples of methods of conserving the essential characteristics.

To my reading, this means that if variety A is recognized as the initial variety, then breeders of varieties B derived directly from A, and C from A via B, both require permission from A's owner to commercialize their developments. Typically such permission is granted for the payment of a fee, the royalty, although this need not be the case; A's owner may wish to retain direct control. Certainly as a result of this new article it can be anticipated that there will be major definitional squabbles over such terms as "essentially derived" and "essential

characteristics". While the clarification of these definitions will be important in individual applications, the overall intent is clear, at least to my mind. It appears that PBRs are being strengthened in another attempt to equilibrate them with patent protection. Biotechnicians can do their thing at the genetic level; breeders will have their protection through PBR even if engineered genes are incorporated into varieties. In most instances, traditionally bred plants lack the nonobviousness (inventive step) needed for patent protection.

This new article creates powerful new incentives for the way plant breeders operate. What can be surmised about the effects of these incentives on plant breeding and on the public? Two distinct cases can be considered which will be referred to as commercial breeding and background breeding.[17]

III.1. Effects on Commercial Breeding

Commercial breeding is defined as the minor year-to-year improvements which are intended for immediate commercial use. That is, resistance may be added for a new strain of a virus in an ongoing process as the viruses themselves mutate. The annual changes are typically small (considering the number of attributes of the variety) but nonetheless important, especially cumulatively. To these annual changes are attributed about half of the long run one to two percent annual yield increases for the major crops. That growth rate, when compounded, leads to doubling every 20 or so years. From the perspective of the breeder the improvement is continuous, with no individual making a notable single contribution. Indeed at my university, Cornell University, which has a major plant breeding program, it has been the policy for revenues from PBR to go to supporting the research program rather than to an individual. It is felt that the last breeder made only a limited contribution to the entirety of the variety and is

[17]I would like to acknowledge W. R. Coffman's role into bringing the key distinction between these two cases to my attention.

undeserving of the returns for all of it (Lesser 1987b).

Dependency will change these incentives by providing a major incentive to be first, to develop the initial variety. To the developer of that initial variety go a disproportionate amount of the returns, for to him/her go some share of the value of all dependent varieties. Breeders of the dependent varieties (B and C in our example) for their part are no better off, and possibly worse off, than presently. While their variety is marketable, they must pay a royalty to the owner of the initial variety and when it becomes outmoded[18], as when B is improved upon by variety C, they will receive no royalties, as is the case presently. Incentives, then, are shifted heavily to the developer of the initial variety and away from successive breeders.

In cases in which the initial breeder added nothing more than the successive ones, this system is inequitable, for one breeder earns more as a result of when sequentially the award was granted rather than the market value of the contribution itself. But IPR is about economic incentives, not equity. The incentive structure is changed in major ways. What effects might that have?

Clearly there will be a rush to be first, so that the initial investment can be expected to increase. Subsequently the none-too-great PBR incentives will decline so that a decline in derivative (from the initial variety) breeding can also be anticipated. This is clearly counter to the intent of IPR. At the same time, private firms will have the incentive to develop alternative initial varieties by returning to an unprotected variety as a base. That is, if variety A was developed from "CU1", the breeder of variety B has a direct economic incentive to return to CU1 rather than use A as the base variety. This will mean to B's breeder no payments to A's owner and the possibility of receiving royalties in the future. It will also mean a reduction in cumulative breeding practices which have been so beneficial for agriculture. To my mind this

[18]Commercial varieties of major crops have a market life of about seven to nine years and declining (Studebaker 1982).

aspect of the response to the dependency clause is contrary to public and private interests.

III.2. Effects on Background Breeding

Background breeding refers to the longer term process of introducing important new traits discovered in the wild into commercial varieties. The introduction of dwarfing genes, now nearly ubiquitous, into wheat and rice is a well known example of this important practice. Presently there is interest in making corn a perennial using a distant relative recently discovered in Mexico. If commercial breeding takes a few years, background breeding requires 15 or more with no promise of eventual success.

Current PBR legislation provides essentially no economic incentive for background breeding. The first dwarfed wheat variety, for example, could be improved in some other minor, unrelated way (eg., rust resistance) and protected in its own right. The background breeder would collect royalties for a few years at best while competitors were developing their improvements. For this reason, background breeding is done principally at public expense, although with declines in public funding the amount may be ebbing. Dependency would change that.

The background breeder would (should) qualify for initial variety protection and receive royalties for an extended period. The financial incentive would be far greater for this important activity, and the amount should increase. This, I believe, is what was intended for enhancing incentives when the dependency concept was adopted.

III.3. Conclusions and Research Needs

The new dependency clause in the revised UPOV statute fundamentally impacts breeding incentives in two ways. For minor year-to-year changes in commercial varieties it shifts the benefits to the first protected, while reducing the incentives for subsequent enhancements. This is inequitable in terms of basing rewards on order of application, not on market value.

Moreover, it creates the incentive for breeders to abandon the long term practice of cumulative improvements in favor of the development of parallel lines, each based on a firm's own initial variety.

On the other hand, dependency establishes incentives for longer term "background" breeding which are totally lacking under current PBR. The lengthy process of introducing important new traits from the wild into commercial varieties is imperiled by the lack of private firm incentives and the declining budgets for the public sector. Dependency would do much to correct that.

How should these two divergent incentives be balanced? First it should be noted that they ought not to have arisen. The level of contribution between what here is called commercial breeding and background breeding is clearly great. Regrettably the revised UPOV does not recognize this to allow dependency for background-bred varieties but not for commercially-bred ones. This kind of distinction is routinely made in patent grants under the nonobviousness (inventive step) requirement; precedent establishes the minimum contribution required for a patent. This standard varies by area so that the requirement for say pipe fittings, a narrow, long exploited area, would be less than demanded for a new plant, a relatively new area of endeavor. PBR scope could be defined, or at least identified, within the Convention as an additional requirement for receiving dependency rights. Admittedly, defining scope is difficult but it can be established over time by the examiners.

A second factor to consider is the implications of dependency for genetic diversity. Presently many major food crops are based on a limited number of initial lines. This means great similarity in their genetic makeup so that susceptibility to disease is potentially widespread (see National Academy of Sciences 1972). The dependency system, to the extent it interrupts the current successive selection of the best varieties for subsequent breeding, will help to broaden the genetic base of our crops. Certainly encouragement of background breeding

will bring new genes into the commercial plant population. However, it should be noted that much of the concern over genetic vulnerability is based on the near ubiquity of single dwarfing genes in such major crops as wheat and rice. Additional background breeding could help in that respect, and should be considered in any debate over genetic uniformity. However, it is clear that much uniformity is driven by market forces which will be largely unchanged by the revised UPOV system.

Without a scope requirement for dependency, should the United States adopt the new version or continue unchanged? Dependency does increase incentives for the breeders of initial varieties and I expect can be used by the private sector to increase overall incentives leading to more investment. Certainly the current protection granted by PBR, especially in the US, is limited and could, according to the extent we are able to measure these matters, be enhanced to public and private benefit. I, however, see great public cost in dependency, largely the incentives to diverge from cumulative breeding practices, and would recommend based on this article alone against its adoption at this time. A more complete evaluation considering the other changes, which on first analysis appear beneficial, could change this recommendation. Further attention is needed to enhance PBR incentives. We need in particular to know more about how private firms would respond to dependency provisions and particularly to the incentives required to invest in background breeding. It is possible that the practice is simply too long and uncertain to attract much private capital. If so, the decision to reject dependency is more evident.

IV. CONCLUSIONS

Following a turbulent decade in the enhancement of IPR in the United States, the system is now focused on more modest changes. This paper considers two, the geographic expansion of protection, especially to developing countries, and the modified PBR convention.

The US and its developed country allies have succeeded, through trade access pressure and other means, in expanding IPR protection in several key countries. Others are sure to follow. While these changes are likely to help certain sectors, particularly pharmaceuticals and publishing, the benefit to US agricultural research is not clear. Within agriculture, living organisms require local adaptation so that much of any additional investment would be done outside the country. Other products like pesticides are relatively difficult to copy so that IPRs are not as critical. Indeed, improved IPRs may increase the opportunity to conduct agricultural research outside the US as secrecy is fundamental in research and IPRs are fundamental to secrecy. In general agricultural research may be shifting to developing countries as lower cost options now that well trained researchers are in place in numerous countries. Overall, enhanced IPR may be beneficial overall and beneficial to multinational agricultural firms in particular, but possibly at the expense of research within the US. This consideration should not cause us to oppose enhancements in protection but rather to plan better for their indirect consequences.

The revision to UPOV to incorporate dependency is a narrower issue to consider but nonetheless one on which a decision must be made to retain the current statute or adopt the revised one. Dependency, the stipulation that the breeder of an "essentially derived" variety seek permission for commercialization from the owner of the "initial variety", sets up divergent incentives. On the one hand it provides a monetary incentive for long term "background" breeding, the introduction of significant new traits. This is much needed as it is completely lacking from current protection. On the other hand, dependency creates the incentive within year-to-year "commercial" breeding to breed the initial variety and not to proceed with the long term practice of small cumulative enhancements within a variety. That would be a fundamental change and on that basis alone suggests the need for extreme caution in adopting this version. However reducing the incentive for improving only the best varieties

will indirectly increase the genetic diversity of our major crops. With diversity already very limited, many observers consider our food base to be imperilled should a disease arise for which a ubiquitous gene construct has low resistance. Quantifications of either the effects of dependency on diversity or the specific risks of uniformity have, however, proven difficult so that policy makers must make a decision based on limited information. The new UPOV version contains other largely beneficial changes which need to be evaluated as well before a final decision is made. But should this version not be adopted, other approaches to strengthening PBR protection are called for and should be considered.

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