Adoption and Implementation of Intellectual Property Rights: Experiences of Selected Countries†

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(Received 6 September 2001)

The new global trade order, initiated at the Uruguay round of global trade negotiations culminated in the establishment of the World Trade Organization (WTO). One of the important prescriptions of the new trade rules in the form of Trade-Related Intellectual Property Rights (TRIPS) includes the compulsive modification of the existing Intellectual property protection legislation with regard to agriculture especially by the developing countries. The new set of rules prescribed by WTO under TRIPS were opined to open new dimensions in the type and extent of research exchange between the nations and also aim at redefining the role of public and private research organizations. One of the important reasons for extending intellectual property (IP) protection for plants and other living organisms, it is said, is to make agriculture a commercial venture and for attracting private investment into agricultural research. The popular rationale in support of intellectual property rights (IPR) for plants has often said to be one of stimulating effect. The present study reviews the economic impact of the adoption of IP protection mechanisms in USA and Latin American countries. Results indicated that availability of IP protection is in itself insufficient in determining the rate of innovation. More important factors like the scientific base of plant breeding, market forces and demand side factors appear to have greater influence in determining the rate of introduction of new varieties. Consolidation by the multinationals in seed industry and increased seed prices were among the other significant results. The need to commercialize new plant varieties has raised the strategic importance of public germplasm and reduced its availability for other users. On the other hand, access to public germplasm by the private seed industry improved due to more formal and transparent procedures. The PBRs like many other policy instruments were favourable towards resource rich farmers than the small and marginal groups.

†This work formed a part of the author's research experience as a Fulbright Visiting Scholar at Cornell University, Ithaca, USA.
Inclusion of new areas in trade regulation, viz. textiles, intellectual property rights (IPR) related to trade in agriculture (including plants, animals and microorganisms) and services made the Uruguay round of GATT, the longest and the most debated one. The international trade negotiations in this round opened several new avenues of research including agriculture and microorganisms and raised issues that are not only related to science and technology policies but often cut across the economic, ethical issues and international trade politics. Important among these are the issue of IP protection of the results of research, issues of technology import and food security leading to widening technology-lead productivity gap between the resource rich and resource poor countries.

Developing countries being the net importers of modern technology seldom opted for the adoption of IPR laws. As natural reserve of biological diversity, which is required for any crop improvement activity, developing countries have shared this reserve freely for global needs, without any compensation of any sort, leave alone, an acknowledgement. In contrast, the WTO and TRIPS provisions compel them to modify existing Intellectual Property protection legislation with regard to agriculture, including plants and animal resources. The new set of rules prescribed by WTO under TRIPS are likely to open new dimensions in the type and extent of research exchange between the nations and also aim at redefining the role of public and private research organizations. One of the important reasons for extending IP protection for plants and other living organisms is to make agriculture a commercial venture and for attracting private investment into agricultural research. Has this objective been fulfilled in the developed countries? Or in other developing countries which have already adopted some form of property protection mechanisms? Are questions that need answers? An attempt has been made in this paper to review the status of IP regimes for agriculture in other countries and elaborate on the experiences in the adoption and implementation of IP regimes to draw inferences for future use.

International Efforts in Exploiting /Conserving Global Biological Diversity

The interdependency of countries for genetic resources for crop productivity improvement or for disease resistance is well established. Countries like North America are completely dependent on species from other countries for their food and industrial crops. Instances of international collaborations rescuing crop variety loss or reinstating a crop in its primary habitat through the exchange of plant genetic resources are innumerable.

The adoption of international undertaking on plant genetic resources as a non-binding agreement by the FAO in 1983 (Rome Convention) marked the first step in the direction of conservation, exchange and utilization of global plant genetic resources. This system has two components:

(i) The international agreements and cooperation under FAO, and

(ii) International research systems working in close collaboration with one another.

Conservation of genetic resources in situ, ex situ, their access, distribution and use has been the important tasks of these global systems, popular as the Consultative Group on International Agricultural Research (CGIAR). National Agricultural Research Systems (NARS) across continents have benefited substantially from the free accessibility of biological diversity under the CGIAR institutions. Indian Rice research and wheat improvement under green revolu-
lution have gained substantially through these collaborative efforts. The gradual improvement in the yield potential of rice was possible only through crosses between distant parents (*indica* and *japonica*); exploitation of hybrid vigour from crosses arising from places of distant origin.

While genetic diversity is essential for crop improvement, continued use of hybrids or improved varieties could lead to genetic uniformity and attendant problems. Genetic uniformity over the years has been the single most important reason for crop failures in the past. The great Bengal famine of 1943 in India, Tungro virus epidemic in rice in Philippines and Indonesia in the 70s, are examples of such calamities. Over exploitation of genetic resources for achieving higher crop productivity often leads to over dependence on some species and thereby the neglect of others leading to their extinction. The International organizations like the CGIAR through their Multilateral Material Transfer Agreements (MMTAs) have been instrumental in reverting crop losses in all such situations.

In sharp contrast to the free exchange of genetic material under international collaborative efforts, the practice of private ownership and application of intellectual property protection in the form of 'patents' or 'patent like' protection mechanism has been in vogue elsewhere over a long time. There have been other efforts as well, which focused on environmental concerns. The Convention on Biological Diversity (CBD) assigns sovereign rights to State over all its biological resources. By this, the convention provides for 'regulating access to genetic resources', and introduces 'benefit sharing clause' to the benefit of developing countries.

Pending approval of the newly modified Indian Patent Law 1999 and the Protection of Plant Varieties and Farmers' Rights Bill (PPV, 2000) are expected to provide the necessary protection for the natural resources and biological diversity of the country. There has been a clear shift in stand from one of total dismissal of the idea of 'protecting live forms' to identifying and providing 'patent like protection' over the years. The concerns with regard to the implementation and effectiveness of such legislation in providing the much needed security for the biological resources of the country and as a mechanism that is expected to boost investment into agricultural research is yet to be seen.

It is in this context that this presentation attempts a review of the experiences of the selected countries, which had adopted intellectual property protection procedures for protecting plant varieties.

**Experiences of other (Selected) Countries in the Adoption of Intellectual Property Protection Rights**

The argument often made is that since plant varieties are easily reproducible and largely inherit their characteristics, private breeders are not able to recoup their investments in breeding, thereby discouraging increased private sector investments into this sector. The popular rationale in support of IPR for plants has often been said to be one of stimulating effect. As a result of intellectual property protection, it is hoped that private activity in plant breeding will increase. This increased investment will be in the form of increased entry of new firms in plant breeding, larger volumes of real investment, and expansion of already existing private breeding programs. On the other hand, there are contradictions to this theory, which raise the issue of increased monopoly
market power and other new forms of barriers on trade.

Several countries have modified the legislative support for providing IP protection for plants and living organisms. The introduction of PVPA Act 1970 in USA is prominent among these, and serves as an example for comparison with present Indian dilemmas. The experiences of Latin American countries serve empirical evidence for future reference for India.

**Economic Impact of Adoption of IP Protection for Plants (Plant Breeders' Rights)**

The review of the economic impact of the adoption of IP protection mechanisms has been presented under the following heads:

1. Changing direction of private investment in plant breeding due to the adoption of plant breeders' rights (PBRs),
2. Capacity of PBRs in stimulating plants breeding, and
3. Evidences in the direction of increased monopoly power in the seed market.

**Changes in the Direction of Investment in Post-adoption Period**

The only research on the relationship between PBRs and private investment is the one conducted by Butler and Marison, in 1985 on the R&D outlays of 60 companies in US. This study evaluated the impact of PVPA on US agriculture after the adoption of PVPA in 1970. The evidence establishes the increase in private investment in the aggregate, but does not prove clearly the same as true with regard to the composition of this investment and the factors underlying the changes. In terms of total investment in research, older firms (i.e. existing prior to the 1970) showed greater R&D expenditure as a group, but the range of crops covered was few. The R&D/sales ratios of these companies indicated that the R&D expenditure of older firms, that were established prior to PVPA had investment ratio of US$1.4 million in 1980 with average sales of US$40 million. While those established later had R&D expenditure of US$0.4 million in 1980, with average sales of US$11 million. It could be inferred that those firms that entered the industry after PVPA inception, remained relatively small and occupied marginal share of the market. The main-breeding firms by and large were from the larger MNCs, primarily through the mergers and acquisitions that had increased during the post PVPA period in the US.

With regard to the distribution of private investment, some useful insights have been shown on the factors that actually stimulate private investment in plant breeding. In terms of magnitude and share of total investments in plant breeding, wheat and Soybean were the crops that attracted private investment. Their respective shares increased from 5% and 1% in 1965 to 10% in 1979. The question that needs to be assessed is, “Can this increased private investment be attributed to the presence of PBRs?”

The case of soybean brings forth the ‘mystification associated’ with the plea for IPR. Acreage under soybean in the US has increased rapidly between 1940-70, at approximately 10% per annum. The increased acreage is in reality, a reflection of the technical advancement that had taken place in the US agriculture during that time. The increased mechanization lead to what is known as ‘power farming’ agriculture in the US during this period. This lead to the increased substitution of animal and human labour by machines. At the same time, there was an increase in the use of chemical inputs.
like fertilizer to revitalize the soil nutrition. This structural transformation brought in changes in the cropping pattern. With the gradual elimination of the corn-oat crop-cycle, there was need for a new legume for nitrogen fixing in the soil. Since, soy aptly fitted into this role of nitrogen fixing crop, its popularity increased thereby increasing the acreage. Keeping these factors in view, the analysis of the role and impact of PBRs (in the case of the US) often suggests that the PVPA to be more marketing Act, rather than one that promoted research. "There is little evidence to support the contention that the PVPA has powerfully stimulated additional private investment in plant breeding research..."

As far as the increased popularity of soybean, the attention could be drawn to the additional demand side factors, such as the commercial value of the crop and its usefulness for other purposes, making it one of the most valuable crops by 1950s. Export markets for soymeal, use of soybean in a range of processed foods were some of these that added to the commercial importance of the crop. As far as seed companies were concerned, soybean had a crucial advantage compared to most other crops: the soybean germ is highly fragile and breaks down during the harvesting process thus rendering it impossible for farmers to save and reuse seeds. Consequently, private investments were quite secure. In this context, the stimulating role of PBRs remains questionable."

Capacity of PBRs in Stimulating Plant Breeding

The crux of a PBRs system focuses on the production of new plant varieties. In fact, though highly reductionist, the test of success of the system is substantially contingent on the resulting rate of introduction of new varieties. If private investment in plant breeding occurs, then by extension this should manifest itself in increased production of new varieties. This view is popular in the literature and used to validate the grant of protection. Several studies conducted since 1980 suggest that the availability of PBRs has increased the number of private sector breeders, as well as the number of private varieties released and planted. However, not only is society interested in the pace of innovation but also equally concerned about the direction of technical change - are the new varieties substantially better? Both, the rate of innovation and the nature of the innovations are important.

With regard to the evidence in terms of release of number of varieties, the question that needs to be asked is the causality or is the availability of PBRs the sole factor responsible for the number of varieties being released? Since, it is complicated and theoretically difficult to establish, the probable way is to study the trends in varietal release, 'before' and 'after' the enactment of PBRs. If the rate of introduction were higher in the subsequent period it is still necessary to establish the primacy of PBRs as the causal factor. Besides the various demand-side factors such as changing acreage, increasing crop profitability or there are crucial supply-side factors that could be attributed to the number of varieties released during a specified period. For example, technology advancement, such as a new breeding technique, technology such as the use of computer-based systems for information processing, monitoring of crosses have contributed to the increased production of new varieties. The relationship between the rate of innovations and IPRs is thus needs more comprehensive rationale than what is available in the literature.
The only available study that has examined this issue related to ornamentals and fruits in the UK. The results, as noted below, are clearly very mixed.

**Apples:** There is no statistical support for the claim that PBRs led to increased rate of introduction of new varieties. PBRs have had no perceptible impact on the trend rate of introduction of new varieties.

**Strawberries:** The availability of protection has had a positive impact on the rate of introduction of new varieties. However, the main beneficiaries of the availability of PBRs have been public breeders and foreign breeders, i.e. their respective shares of the PBRs increased.

**Rose:** The number of rose varieties released after the availability of protection has increased substantially suggesting a positive influence. However, statistical tests conclude that there has been a feedback effect between the number of grants made and the pace of innovation. The result casts serious doubts on the significance of PBRs in influencing the rate of introduction of new varieties.

**French bean:** PBRs have had minor influence on the rate of release of new varieties, though this appears marginal in comparison to the impact of other seed market regulations (e.g. National Lists*). The absence of a clear-cut positive impact of PBRs on the rate of introduction of new varieties across the spectrum of crop species substantially undermines claims for an enactment of PBRs in India. Any effort to suggest that PBRs have singularly caused the increase in the number of new varieties is questionable.

The above results indicate that availability of intellectual property protection is in itself insufficient in determining the rate of innovation. More important factors like the scientific base from which plant breeding emerges and demand side factors appear to have greater influence in determining the rate of introduction of new varieties.

Even placing the mixed result aside, it is necessary to consider wider social and economic issues concerning the rate of introduction of new varieties. The ever-increasing introduction of new varieties is not an end in itself. A mere count of the number of varieties introduced is an insufficient indicator of inventive activity or economic value. Given the scarce economic resources, it would be useful to examine the qualitative aspects of the new varieties. Economic value would be added if the new varieties were to push out the production frontier of the economy - enable a higher level of production. Here we are concerned with notions of inventiveness within the grant-giving process. Unfortunately, there is no test for inventiveness or utility in the system for grant of PBRs Commercial breeders predominantly work with improved material, varieties that are well adapted to local conditions. The pressure to consistently have a market presence with a portfolio of varieties restricts the range of breeding conducted by commercial enterprises. In the US and the UK, till very recently, substantive development of parental material was undertaken within the public sector. Internationally, research centres with the Consultative Group provided much of the foundational research and key breeding material. The private sector used these publicly developed

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*In UK, the committee on transactions in seed (1960), was commissioned to examine the appropriateness of PBRs in UK, and focused on the public good characterization of plants, which is popular as the National List.*
parental lines to produce new and distinct varieties. Obviously, given the widely shared parentage of the commercial varieties it would be difficult to establish an inventive step, either in terms of genetic makeup or in agronomic terms. Given the focus on distinctness, many of the protected varieties are genetically quite identical and in agronomic terms may not add anything to the economy. It is with this background that skepticism is expressed in terms of the use of the rate of introduction of new varieties as an indicator of inventive activity. The increase in the number of new varieties only reflects commercial strategies of product differentiation. Hence, the rate of the introduction of new varieties alone cannot be taken as an indicator for measuring the impact of PBRs.

It is therefore important to understand and evolve appropriate methods to evaluate the contribution of each sector in the development of new varieties. Equally important is the 'effective life' of a specified variety. It is often observed that a specific variety is long lasting than the others. The speed with which a variety loses its impact also needs to be quantified while assessing the impact of PBRs.

Limited econometric support exists to make the case that the rate of introduction of new varieties have increased after the enactment of PBRs and that this increase is solely a consequence of PBRs. Further, evidence from wheat in the UK suggests that age of the variety has an important contribution in assessing the net grants towards the increased inventive activity.

**Structural Changes in the Seed Industry in Post PVPA Period**

Between 1960 and 80, a total of 762 corporate take-overs have been reported in America and Europe. Between 1976-86, a total US$10 billion worldwide was spent in this acquisition drive - largely led by chemical companies like Sandoz, DeKalb-Pfizer, Shell, ICI, and Ciba Geigy, who accounted for almost a third of the corporate take-overs. In the US, 100 take-overs have been documented, out of which, only two occurred prior to the enactment of PVPA in 1970(B). These trends suggest that provision of IPR in plant varieties hastened the pace of mergers and acquisitions in the seed industry. It is widely felt that PBRs, much like any other IPR, aggravate market distribution since they are a barrier-to-entry. Being a right that debar other from a range of transactions involving the protected subject matter, PBRs impart a degree of monopoly power to the recipient. Empirical evidence suggests increased market distribution effect and seed prices. Reports indicated that more than 50% of the grants received for research purposes were being spent on the top four crop species. Even in the more profitable crops, which have attracted a larger share of breeding activity, e.g. soybean, wheat, cotton, peas and beans, the share of the top four companies is high - ranging between 38-67%. In some instances, the market is extremely concentrated with few firms gaining all the grants, e.g. tobacco where 3 firms hold 100% of the grants, cauliflower and onions where four firms hold over 90% of the grants, and barley, rice, tomato and corn where four-firm concentration ratios range between 71-84%. Based on this, it could be inferred that, the majority of Plant Variety Protection (PVP) certificates issued is for a few crops and is issued to a few plant-breeding organi-
The firms holding the major share of PVP certificates issued are seed firms with large plant breeding programmes that were established well before the passage of the PVPA. This conclusion establishes the relationship between crop specific profitability and the proportion of investment that goes into its breeding activity by a private investor. Secondly, the point worth noting is the impact of the size and the age of the breeding programmes on the share of grants secured. Evidence of the distribution of grants in wheat in the UK suggests a historical process of consolidation within the seed industry.

- The share of grants controlled by the top five increased from 68% in 1965-74 to 88% in 1975-85 and settled at 79% in 1986-95.
- Between 75-80% of the applicants received no grants.

The top five grant-holders formed a part of larger multinational seed companies like Unilever [and now Monsanto] and AstraZeneca, indicating a skewed distribution of grants. This was also reflected in the seed market share in UK. The wheat seed market share of UK was observed to be controlled by a single company - Plant Breeding International, Cambridge. Its market share increased from 20% in 1972 to cross 80% in 1980, after which it has maintained a share of approximately 65-70% through the 1990s. The other important stakeholders were AstraZeneca, Weibull, Limagrain, and Petkus. These companies represent a long track record into wheat breeding and also the significance of mergers and acquisitions into the formation of a company.

It was an interesting inference that indicated the firms, which were able to consolidate, were those which could charge a higher price. The IPR protection only enhanced their capacity to improve and consolidate their profits. Though other factors such as the existence of varieties in the market did influence, prices appeared to play a significant role in concentration of the seed markets. Empirical evidence in the US and UK, so far suggests an increase in the proportion of expenditure on seeds over the years. A major proportion of this increase was towards the increased prices of seeds, mainly the royalty payments.

Both the US and UK have experienced the withdrawal of the 'state' from 'near-market' activities - the breeding of new varieties and seed distribution. Simultaneously, the scope of PBRs has gradually widened to incorporate an even greater range of transactions involving the protected variety. Thus, the practice of on-farm seed saving and over-the-fence seed exchanges have been outlawed, as is the processing of saved seeds. It was the increased collaboration of chemical and seed companies that provided the firms to mark up their seed prices. Hence, it could be inferred that, though, PBRs were not solely responsible for higher seed prices, they provided certain important linkages towards the increased prices. These include the traditional marketing strategies such as product differentiation.

The Latin American Experience

In accordance with the GATT agreement, each one of the member countries are obliged to protect the genetic material and plant varieties either through patents or by any appropriate alternate system called the sui generis. Three Southern cone countries of Latin America, viz. Argentina, Chile and Uruguay adopted the Plant Breeders' Rights (PBRs) as a part of general laws regulating the seed industry, way back since early 1980s. Mexico and Colombia introduced the
intellectual property protection regimes during 1994 and 1995 respectively. The objective in all the five countries has been to foster the private plant breeding initiative and to increase access of improved varieties from abroad in case of fruits and ornamental crops.

The reasons for adoption of IPR or PBRs, impact of PBRs on research investments by private seed companies, changing structure of the relationship between the foreign seed companies and domestic ones, impact of such an adoption on the research direction of the public sector organizations has been reviewed. Irrespective of the differences in the relative size and importance of agriculture to their respective economies, the World Bank has identified all the five countries as developing countries. Agriculture and agro-industry, though declining, was found to be the most important economic sectors in these countries. Argentina and Uruguay are typically agro exporting countries, traditionally based on the export of commodities like wheat, maize, soybean, etc. However, all the five had diversified agriculture with declining dependence on agriculture. The other significant common feature between the five countries was the presence of dualistic agriculture, characterized by the co-existence of large number of traditional sector comprising small farms and peasants and fewer large farms with modern agriculture. Also typical to the dualistic agriculture, the entrepreneurial sector concentrated on export-oriented agriculture while the peasant agriculture still depends on sustenance farming.

Generally, the use of improved seed or certified seed is a good indicator of the development stage of the seed industry. The existence of a well-established seed industry follows that the seed marketing gets deregulated and certification becomes less important. Only Argentina was in this stage of development. The rest of the Latin American countries still had peasants using land races while the entrepreneurial farmers used improved seed. The agricultural sectors were in the midst of profound changes with their economies opening up to the international markets and the redefinition of the role of state in the economy. The economic stabilization programs were implemented with objectives of increased privatization, unilateral reduction in tariff, enforcement of unilateral and bilateral free trade pacts signed creating free trade zones.

Seed Multiplication and Commercialization

State played a crucial role in the establishment and proliferation of seed industry in all the countries. The State intervention could be seen not only in plant breeding and direct seed production, but also in seed regulation and technology diffusion activities. The seed industry was consolidated by the existence of adequate regulatory framework and technical capabilities. Private seed industry followed the public sector initiatives. Domestic industry concentrated on self-pollinating varieties while the multinationals specialized in hybrids. The International Centre for Tropical Agriculture (CIAT) located in Colombia directly supported seed activities through training in aspects of PBR and technical assistance in seed production technology.

Introduction and Enforcement of Plant Breeders' Rights (PBRs)

None of the three Latin American countries that adopted PBRs had a public debate of the proposed changes in the legislation. This could be attributed to the military rule of the
countries at the time the decision to enforce PBRs was taken. However, even under the reinstated Civil Governance, the enforcement of PBRs was never a political issue. In Mexico, the private seed companies, fruit and ornamental plant growers were in support of the PBR legislation in order to get better varieties from foreign collaborators. The opposition was mainly from the public sector. The patent law was amended in August 1994 and does not provide for the protection of plant varieties any longer. Varieties will now have to be protected under PBRs. In sum, the main force behind the decision to strengthen PBR legislation comes from the fact that:

(i) Domestic seed companies wanted to protect their own plant varieties

(ii) Domestic seed companies and cultivators of fruit and ornamental plants that felt pressure from foreign breeders to improve the legal protection in order to get better access to foreign breeding lines and varieties. Subsidiaries of foreign companies wanted protection of their varieties and breeding lines in order to enter the Latin American seed markets, and

(iii) Public agricultural research centres, were in need of additional income to compensate budget cuts.

PBR Enforcement

Enforcement of PBR legislation, being a private right on property, is up to the individual right holder to enforce and exercise their rights. In Argentina, though the law was in force since 1981, it was in reality a dead letter. This was due to the lack of information, high inflation and lack of credit that forced the growers not to purchase fresh seed year after year. First ever effort to defend PBR was realized in 1990 by three Argentine wheat breeders, two private companies (Buck and Klein) and a private co-operative — 'Produsem', which has been created by the public sector research institute INTA. The Wheat companies jointly started to defend the plant breeders' rights by encouraging those dealers who were trading seed that was produced without authorization to change over to a system including the registration of seed transactions, licensing contracts and royalty payments. The wheat breeders' initiative was followed by the creation of an association of plant breeding organizations known as ARPOV in 1991.

ARPOV designed a successful administrative system to control the licensing of seed production. The licensing contract designed included:

- registration and protection of the variety,
- agreement between the breeder and the producer,
- licence to offer information upon request
- penalties for non-compliance with the seed law
- licence to maintain a seed book, and
- The licence to authorize ARPOV to realize audits at the licensee’s premises.

Seed bags that are traded through ARPOV carried a special stamp with a code number that refers to the names of the breeder, the licence, contract number and the variety. The control of protected varieties by breeders in Chile and Uruguay has been less effective as the titleholders were following individual policies and these did not succeed very often. Though, PBR are private rights, government plays an important role in enforcement of the law. Both in Chile and Ur-
guay, the ministry of agriculture was responsible for infringement detection. This mechanism of infringement detection in Argentina was found to be rather weak. A new institute known as the Institute of National de Semillas (INASE), a self financing body relying on the tariffs as the sole source of income, checks the compliance with the licence contracts and presence of ARPOV stamp.

An important measure of the effectiveness of PBR system is the reduction in the seed produced and traded without authorization of the breeder. Seed dealers including grain elevators and cooperatives purchase grain from farmers and sell this grain as seed to other farmers. In Argentina, between 1989 and 1994, the number of unregistered seed dealers reduced to 40%. The enforcement of PBR in Argentina has increased the share of seed supply under the control of breeders to nearly 55%. These figures are in comparison with those in USA for wheat and soybean seed.

Indian Experience Prior to Enforcement of Intellectual Property Rights

The legislation on the plant variety protection has now been approved by the parliament, it is yet to be enforced in India. A review of the existing pattern of research investment and research linkages in India revealed the predominance of public sector organizations till mid 80s and there after a changing structure and contribution of private sector research institutions. The Indian Council of Agricultural Research (ICAR) is the primary authority for co-ordinating research in India, the average research expenditure by public, state and private sector research organizations stood at around Rs.2360 million by 1987. But in the post liberalization period between 1990 and 1995, the research expenditures tripled due to the initiation of several new institutions and expansion by the existing institutions. The major thrust has been into agricultural biotechnology with the establishment of Department of Biotechnology with an initial investment of over US $30 million. Over 400 private seed companies have been in operation dealing mainly in the production of biotechnology related products.

A review of private sector seed companies and their performance by Selvaraj et al, 1998, indicated that 90% of the hybrids developed in various crops originated from the private sector institutions. Irrespective of size of the investment by the company, their research programmes were for the development of hybrids. Cereals followed by vegetables were their option for developing hybrids. Seed industry was well aware of biotech research options and were concentrating on crops like tomato, maize and cotton in the order of preference and tissue culture based micropropagation, somaclonal variation, DNA markers for genetic traits and transgenic crops were their research priorities. Although, private sector dominance is on the increase in India, even prior to IPR, it is envisaged that the public vs private sector inter dependence would increase in the post IPR adoption period.

Concluding Observations

a. Assessing the precise impact of PBR protection on private investment into seed industry is a difficult task. The trends indicated that, besides PBRs, there are other important macro-economic factors such as the market size, and demand, which have significant impact on the investment pattern. However, it has been observed in Argentina and Chile, that the PBR legislation has enabled domestic wheat and soybean companies to increase their
sales and royalty incomes. It could also be inferred that the PBR legislation had strengthened the plant breeding programmes of the public sector institutions in these countries.

b For the multinational seed companies involved in hybrid production, the enforcement of PBRs complements the biological protection against unauthorized multiplication. The PBRs may effect the relationship between the domestic companies and foreign seed companies if the protection for parental lines is increased and the number of hybrids increased.

c PBRs have both positive and negative effects on the access to germplasm at public institutes. The need to commercialize new plant varieties has raised the strategic importance of public germplasm and reduced its availability for other users. On the other hand, access to public germplasm by the private seed industry improved due to more formal and transparent procedures.

d PBRs provide a better opportunity for the growers and plant breeders to collaborate with foreign breeders. On the other hand, foreign breeders may restrict the supply if their material leads to enhanced exports from these countries.

e No direct negative effects of PBR legislation on seed diffusion were observed in the three Latin American Countries. The seed saving by the farmers was not effected by the PBR laws, due to the exemption included in the legislation for farmers' use.

f The PBRs have favourable impact on the domestic plant breeding industry. If the same trend could be observed elsewhere is yet to be seen, as it depends on the number of breeders who are active and their access to plant breeding material. The seed dealers were the main losers in the process of implementation of PBRs.

g The main limitation of PBRs was that it has been designed to support those farmers who have better resources. PBRs may not be suitable instrument for those farmers who operate on marginal areas and low resource base.

Acknowledgement

Author acknowledges the facilities, opportunity and guidance provided by Prof. William Lesser at the Department of Agricultural Resource and Management Economics (ARME), Cornell University, USA, during her fellowship period. Author wishes to thank the anonymous referees and other friends for their valuable suggestions for the improvement of the paper.

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