Intellectual Property Rights and Agricultural Technology

Interplay and Implications for India

With the Plant Varieties Protection and Farmers Rights' Bill being referred to a select parliamentary committee, the advent of an IPR regime in the agricultural sector is imminent. This paper attempts to sketch heuristically, the research domain and its portfolio in the agricultural sector. It is argued that inter alia, the legal and policy framework will determine the shape of things to come. Based on the nature of protection for different technologies, the role of probable stakeholders and their plausible impacts are examined.

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I
The Setting

Improvements in crop productivity are crucial to sustain food security. A significant body of research attributes increased agricultural productivity to past research and development (R and D) efforts. Increasingly, technology will drive future sources of growth in Indian agriculture. In order to push the frontiers of productivity, generation and harnessing of state of the art agricultural technology becomes important. These demand appropriate investments in agricultural R and D. Studies have indicated impressive rates of return to investment in agricultural research [Evenson, Pray and Rosegrant 1999]. Apart from investment in agricultural research, intellectual property rights (IPRs) have profound impact on technology development, and its transfer. Besides, trade related IPRs (TRIPs) impact trade relation between countries in myriad ways [Ravishankar 1996]. Inter alia, technology development, technology transfer, foreign direct investment (FDI), investment in R and D, trade flows and rent transfer are influenced by IPRs [Lee and Mansfield 1996]. Past patented innovations are likely to affect the types of innovations that are likely to be pursued in future. Social values and conflict between private national benefits and dissemination of technology are other issues that are influenced by the IPR regime [Moschini and Lapen 1997].

The history of IPRs dates back to the Paris convention for protection of Industrial Property (1883). References to IPRs were present in the General Agreement on Tariffs and Trade (GATT) from its origin in 1947. The TRIPS agreement under the Uruguay round of multilateral trade negotiations is the most comprehensive multilateral agreement on intellectual property. This agreement seeks to include non-discrimination and equal application of minimum standards of protection by all members in relation to every category of IPRs. The three main features of the agreement are (i) minimum standards of protection to be provided by each member; (ii) domestic procedures and remedies for the enforcement of IPRs; and (iii) dispute settlement between World Trade Organisation (WTO) members about the respect of the TRIPS obligations subject to the WTO's dispute settlement procedures. The areas of intellectual property that the TRIPS agreement covers are: copyright and related rights; trademarks including service marks; geographical indications including appellations of origin; industrial designs; patents including the protection of new varieties of plants; the layout-designs of integrated circuits and undisclosed knowledge including trade secrets and test data. The types of IPRs, instruments, subject matter, fields of application and related international agreements are provided in Annexure.

The onset of a new IPR regime will determine the future agricultural technology development paradigm. Three situations are likely to emerge, viz, IPRs driven technology development, IPRs necessitated technology development and technologies that influence IPR regime. In fact, the interplay between technology development and IPR regime will determine the contours of agricultural R and D in the new millennium. The dynamics of IPRs and technological innovations have multiple impact. These can be categorised as social, economic and ecological. Due to the peculiarities of Indian agriculture, the magnitude of this impact will be manifold. Increasingly, frontier technologies will play key role in stepping up agricultural productivity. Such technologies are capital intensive. An IPR regime is one way to justify the huge investments. Apart from technology demand and supply factors, nature of technology and government regulatory policies [Pray and Echeverria 1991 and Umali 1992], availability of protection is one of the major determinants of private research investments. Excluding Australia, the levels of private research investment is higher in countries with adequate protection to intellectual property (Table1).

At the outset, we have categorised different technologies and the types of IPRs that are applicable. Possible role of the public and private sector in the changed protection scenario is also dwelt upon. Further, the social, economic and ecological implications of the new technology pathway under protection regime are discussed. The interplay of IPRs and agricul-

Table 1: Private Research Investment (Per Cent) in Agriculture and Levels of IPR Protection

Country	Share of Private Sector (Per Cent)	Status of IPR Protection
United States	53	Yes/in Full
United Kingdom	63	Yes/in Full
Japan	51	Yes/in Full
Germany	58	Yes/in Full
Australia	10	Yes/in Full
Mexico[a]	28	Yes/in Part
Philippines[b]	32	Yes/in Part
Brazil[c]	8	Yes/in Part
India*	15	Yes/in Part

Note: 'In Full' implies the availability of protection in all sectors and 'In Part' means that certain sectors are excluded from protection.

Source: Pray and Umali-Deninger (1998) and Alston et al (1998); *Pal and Singh (1997).

tural technology in the Indian context is examined. How the contours of agricultural R and D and its portfolio will change in response to the dynamics of a new protection regime is sought to be addressed. Section I of the article provides the context of the topic. Section II elaborates the interplay between the IPR regime and technology development in the agriculture sector. Different impacts of the interplay are discussed at length in Section III. A preview on the proposed legislation concerning plant variety protection is provided in Section IV. The write up is summarised by identifying the parameters of debate in the final section.

II
IPRs and Agricultural Technologies: Interplay

Contrary to popular perception, the consequences of according protection are not simple and straightforward. Their manifestations are multitudinous and intricate. The manifestations interplay of IPRs and agricultural technology are: Technology development facilitated by IPRs (incentives for present efforts); technology development driven by IPRs (requirements of the IPR regime); and technologies that influence IPRs.

Technology development facilitated by IPRs (incentives for present efforts): The onset of protection will lead to the emergence of two distinct investment pathways in R and D. In the first scenario, current R and D efforts will receive a major boost and technology development processes will be accelerated without drastic changes in the research paradigm. Plant breeding efforts to produce hybrids is a case in point, which is likely to spread to newer crops. The second scenario relates to areas in which fresh private investment will be driven just because protection is guaranteed. A case in point is the HYV seeds – here private investment is bound to take-off especially in pulses. Besides, investment in technology development and transfer in inputs like feed, vaccines, and pesticides will witness increased activity. While the public sector will concentrate on basic research, the private sector will focus on applied aspects.

Technology development driven by IPRs (compulsion of IPRs regime): The degree and nature of protection inter alia, will influence investment behaviour. This can happen either in the public or in the private sector. The following example illustrates changes in investment decisions in the public sector. A new regime necessitates a mechanism for regulation, monitoring and dispute settlement. A class of technologies will emerge, therefore. Varietal identification is a pre-requisite for according protection as well to settle disputes.

A good example is the growing awareness and expanded investment in the DNA Finger printing technology. Currently, in the private sector a paltry 0.5 per cent of the net profits are ploughed back into R and D. This figure is likely to be much lower in agricultural R and D. The new IPR regime will influence investment decisions in two ways. First, private firms will be compelled to increase outlays for research, which may lead to innovations. Second, increased technology transfer through joint ventures (read equity participation) and/or mergers and acquisitions between domestic and foreign firms.

Technologies that influence IPRs: An extreme but realistic scenario is one where technologies are developed to overcome operational difficulties in seeking protection. New sets of technologies are in the pipeline that are strongly influencing and making the very framework of IPRs redundant. Technologies relating to varietal development will receive maximum boost among all the agricultural technologies once the protection regime is implemented. It is in fact improvement in crop varieties that contributes maximum to growth in productivity and other technologies revolve around this. Considering the enormous investment that goes into variety development, innovators are developing technologies that help overcome operational difficulties in seeking protection for their novel varieties with or without operational regime. Such technologies are collectively called as Genetic Use Restriction Technologies (GURTs) . A number of patents have already been issued for such technologies (Table 2).

Products of GURTs are crop varieties with traits whose expression is under the external chemical control. The traits may be germination, viability of seeds, flowering, nutritional and flavour qualities, resistance to diseases, pests and herbicides, sterility and fertility restoration (for hybrid production), etc. Seeds in possession of the farmers will be useless, if they do not buy the prescribed chemicals and use in the appropriate time, thus producing their seeds every year on their own but compelled to buy the chemical season after season. The underlying desire of a private innovator is not to force farmers to buy seeds every year, but to force farmers to pay for their seeds for subsequent use.

The GURTs, which may extend to livestock as well, just to facilitate, achieve this motto. GURTs do not try to prevent unauthorised use of seeds, but ensures profits from every user of the seeds, authorised or unauthorised. Foolproof biological protection that is embodied within the product renders the legal protection of the ownership completely redundant. Such is the gravity of this unexpected scenario that, the subject has been discussed already at various international forums, viz, FAO Commission on Genetic Resources for Food and Agriculture, Rome, CGIAR Beijing, UNCTAD; SSBTTA of CBD, Montreal and is slated to be a major issue during TRIPs review in WTO.

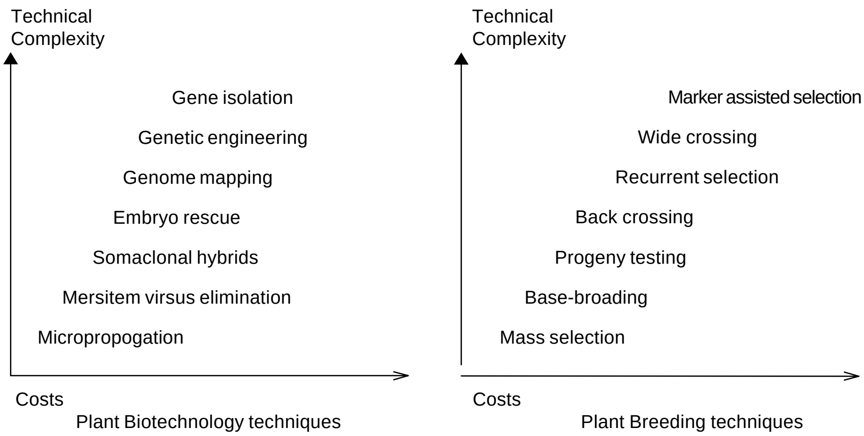
The interplay of protection regime and the R and D paradigm will improve the investment inflow. The dynamics of such interplay will necessitate considerable investment (Figure 1). A simple illustration is the use of molecular markers for introgression in breeding programmes that are prohibitively expensive. The cost of scoring molecular markers in the early 1990s was 100 to 1,000 times as expensive as measuring standard phenotypes in most crops [Lende 1996]. Genome mapping that determines the linkage between a specific molecular marker and a strongly heritable trait rep-

Table 2: Examples of Patents in GURTs

Current Patent Holder	Original Applicant	Patent Number	Date of Issue
Monsanto, US	Delta and Pine Land Co and The US represented by the Secretary of Agriculture	US 5723765	March 3, 1998
CPRO-DLO, Netherlands	Catholic University of Nijmegn, Netherlands	WO 9730166	August 21, 1997
Scottish Crop Research Institute, UK	Scottish Crop Research Institute, UK	WO 9841643	September 24, 1998
Max Planck Institute, Netherlands	SPENA, Italy	WO 9828430	July 2, 1998
John Innes Centre Innovations Ltd, UK	John Innes Centre Innovations Ltd, UK	WO 9828431	July 2, 1998
E I DuPont de Nemours and Co, Netherlands	E I DuPont de Nemours and Co, Netherlands	US 5608143	March 4, 1997
Astra/Zeneca, UK/Sweden	Zeneca Ltd, UK	US 5808034	September 15, 1998
Novartis Finance Co, US	Novartis Finance Co, US	US 5847258	December 8, 1998

Source: RAFI and IBM Patent Server.

Figure 1: Complexity and Costs of Plant Biotechnology and Breeding Techniques



Source: Adapted from FAO, 1998.

resents a major advance for plant breeding. Increasingly, such techniques will widely used for crop improvement and protection.

Another example is the introduction of transgenic crops that are engineered to express a *Bacillus thuringiensis* (Bt) toxin that confers resistance to insect predation. This promising discovery has potential not only to pre-empt the colossal potential loss due to insect-pest attack but can also appropriate significant positive externalities to the ecology. Obviously the extent of technology transfer and imports of such advanced (but vital) techniques would depend on the degree of protection and on the general programme of economic liberalisation.

Canvas of Interplay

In the past, R and D in agriculture has been predominantly in the public domain. But the advent of the IPR regime is bound to influence the technology paradigm via its influence on R and D and its determinants. Table 3 attempts to heuristically categorise agricultural technologies in the scenario of IPR protection. One or more types of IPRs govern agricultural technologies. Hence, their grouping according to nature of protection is relevant to understand and appreciate probable stakeholders and the plausible impact.

Here, agricultural technologies are grouped under different heads, viz, crop improvement, crop protection, Knowledge based, natural resources management, machinery based and technologies concerning livestock and fisheries.

Historically, crop improvement has been achieved through conventional breeding. The high-yielding varieties of rice and wheat (developed through conventional breeding) resulted in green revolution. Hybrids signalled the arrival of modern breeding Hybridisation and selection are two important components of conventional plant breeding, the products of which are often varieties with higher yields and resistance to biotic and abiotic stresses. Conventional breeding will continue to be the mainstay in crop improvement programmes. Agricultural biotechnology is a frontier area, which has the capability to further stretch the yield potential.[1] This can be achieved either through complementing crop breeding or by plant genetic engineering *per se*. Gene isolation and transformation are the basic techniques employed in various biotechnological plant improvement methods.[2] Conventional breeding and agricultural biotechnology are good examples of embodied technology.

Patents, plant breeders rights (PBRs), trade secrets and trademarks govern protection of processes and products of breeding and biotechnology. Patents are often issued to plant varieties, genetic engineering techniques, isolated DNA sequence, DNA constructs and newly transformed plants in the industrialised countries.[3] This scenario is unlikely to evolve in our situation. PBRs will be the predominant instruments through which protection will be awarded to propagating materials of plant varieties.[4] Trade secrets are accorded for plants for therapeutic purposes and for parental lines of hybrids. Trademarks go along with the other three forms of IPRs especially in the marketing of products like improved seeds and other inputs.

The introduction of IPR regime will not alter and/or shrink the predominant role of the public sector in crop improvement programmes. New players are unlikely to venture into basic breeding as this entails access to plant genetic resources (PGRs), huge investments (read infrastructure like farms and trained workforce) and long

Table 3: Categorisation Matrix – Interplay of Agricultural Technologies and IPRs

Technologies	Type of IPRs Applicable	Investors/Actors		Impact		
		Public	Private	Social	Economic	Ecological
A *Crop Improvement Technologies*						
Conventional breeding	Patents, PBRs, trademarks trade secrets	***	*	++ –	++	–
Agricultural Biotechnology	Patents, PBRs, trademarks, trade secrets	**	***	++ –	++	– –
Agro–chemicals	Patents, trademarks and industrial designs	***	*	++ –	++	– – –
Knowledge Based Technologies	Copyright and patenets	***	*	++	+	+
B *Crop Protection Technologies*						
Conventional breeding	Patents, PBRs, trademarks	***	*	+	++	++
Agricultural Biotechnology	Patents, PBRs, trademarks	*	***	+ –	++ –	+ –
Agro-chemicals	Patents and trademarks	*	***	– +	++ –	– – –
Knowledge based technologies	Copyright and patents	***		+	+	+
C *Natural Resource Conservation Technologies*						
Soil and water conservation technologies	Patents and copyrights	***	*	++	++	+++
Genetic resources conservation	Patents, geographic appellation	***	*	++	++	+++
D *Machinery-Based Technologies*						
Farm machinery and power	Industrial designs, patents, trademarks	*	***	– +	++	+ – –
Post-harvest Technologies	Industrial designs, patents, Trademarks	**	*	++	++	++
E *Technologies Concerning Livestock and Fisheries*						
	Patents, BRs, industrial designs, copyright, trademarks,	**	**	++ –	++	– –

Note: (1) Number of asterisks denote the magnitude of impact.
(2) Number of +s and –s represents the magnitude of positive and negative impacts.
(3) Read: crop improvement (that enhance yield) and crop protection (that prevent yield loss).

Source: Authors.

gestation periods (on returns to investment). Introduction of protection will stimulate private investments in activities relating to agricultural biotechnology. Returns to investment here are faster, higher and assured in relation to conventional breeding. Agricultural biotechnology in the private sector will be interested in and concentrate on crop protection technologies rather than crop improvement technologies. This is to be viewed in a relative sense, since the quantum of basic research, germplasm requirement and other associated costs for varieties with enhanced yields is far higher than that for disease-pest resistant varieties [Bent 1987]. Techno-economic feasibility is the criterion that determines such investment behaviour. The IPR regime will thus further strengthen the role of private sector in agricultural biotechnology research.

Crop improvement can also be achieved by the application of external inputs like fertilisers, insecticides, pesticides, weedicides and growth regulators. The world over, the agro-chemicals industry is a multimillion dollar industry. Current consumption of fertilisers (NPK) of 16 million tonnes is an eight-fold increase over the 1960s. Growth in the use of pesticides and insecticides has grown exponentially. Table 4 provides the current global expenditure on insecticides and crop losses caused by insect pests. This has significantly contributed to sustained growth in crop productivity. Increased use of growth regulators is witnessed in horticultural crops like grapes. Growth regulators played a major role in the initial hybrid-rice production experiments.

Patents, trademarks and industrial designs protect processes and products concerning agrochemicals. Patents are usually accorded to processes and products, trademarks to the products, and industrial designs for the manufacturing processes of agrochemicals like fertilisers. Concerning fertilisers, the public sector will continue to dominate the scenario after the introduction of IPR regime. This is so because of the regime's control over the raw materials, pricing and current market structure. The reverse holds true for insecticides and pesticides because of the nature of the products and market potential. The rate of innovation concerning bio-fertilisers and bio-pesticides will be faster in the private sector.

Agronomic practices like sowing time, spacing time and frequency of inter-cultural operations, trap crops, crop rotation and indigenous technical knowledge (ITK) are examples of knowledge-based technologies. In order to claim ownership of IBTs, documentation is a *sine qua non*. Generally, copyrights govern such technologies. Additionally, patents can be obtained for different ITK provided they are documented. The advent of IPR regime is unlikely to alter the predominant role of the public sector in generation and transfer of IBTs. Traditionally, dissemination of such technologies has been the function of the state. The private sector may have little or no incentives to invest in these areas due to three reasons: First, knowledge transfer entails negligible profits. Second, effective dissemination of technology requires an efficient, huge and trained manpower. Third, the degree of appropriation is rather poor in such technologies. Therefore, such a system is unlikely to evolve in the private sector considering the sizeable presence of public extension system.

Technologies to conserve natural resources like soil and water can be vegetative, mechanical measures or by a combination of the two. Examples are zero tillage, contour bunding, terracing, farm ponds, live bunds, windbreaks and reforestation. Copyright and patents can protect such technologies. PGRs (landraces and wild relatives of crop plants) are another class of natural resources that are vital for sustenance of livelihoods. There are two methods of crop genetic resources conservation, i e, *in situ* and *ex situ*.

Various technologies concerning PGR conservation like cryo storage, tissue culture and DNA fingerprinting can be protected by patents. Conservation and documentation of PGRs facilitate obtaining geographic appellations in crops. Claims of national and or regional sovereignty relating PGRs are governed by geographic appellations. Effective conservation of soil and water resources requires collective adoption of the amelioration technologies/practices on a massive scale. This indivisibility in the use of such technologies pre-empts private investment in R and D with or without protection regime. Non-obviousness of technology adoption is another strong reason for the private sector to stay out of R and D in conservation technologies. Possible actors in the conservation of PGRs are fraught with possibilities. Even though the public sector will be the major investor in the R and D concerning conservation of PGRs, private investment (in the form of funding R and D) as joint stakeholders is a distinct possibility. This will however depend on the policy regime that will determine the degree of accessibility to crop germplasm.

Farm machinery and implements like tractors, power tillers and threshers will be governed by patents, industrial designs and trademarks. Post harvest technologies relating to storage, processing and various marketing functions will be protected by similar forms of IPRs. The size and magnitude of private investment will expand with the availability of protection. In fact, the product portfolio will witness significant improvements and diversification. As regards post harvest technologies the extent of public and private investment will vary according to the nature of functions. While the relative size of potential public investment will be higher in storage and treatment, private investment will be forthcoming in areas as processing and transportation.

Different technologies in the livestock and fisheries enterprises will receive protection by breeders rights, patents, trademarks, geographic appellations, copyright and industrial design, depending upon the nature of the technology, they will receive protection by either one or a combination of different IPRs listed above. The potential areas for private investment are likely to be feed supplements and health care processing technologies. Public sector will be the dominant player in research areas like breed improvement, conservation of animal and fisheries genetic resources and animal nutrition and health.

III
Implications of the Interplay

The dynamics of IPRs and technological innovations have multiple impact. These can be categorised as social, economic and ecological. Due to peculiarities of Indian agriculture, the magnitude of the impact

Table 4: Global Expenditure on Insecticides and Crop Losses due to Insect Pests, 1999

Worldwide Expenditure on Insecticides for Different Crops ($ million)		Worldwide Crop Losses Caused by Insect Pests ($ million)	
Crops	Expenditure	Crop	Damage
Fruits and vegetables	2465	Fruit	20000
Cotton	1870	Vegetables	25000
Maize	620	Maize	8000
Rice	1190	Rice	45000
Others	1965		

Source: Adapted from Krattiger et al.

will be manifold. The IPR regime not only influences research portfolio but also the contours of technology development. Primarily, the underlying motive of protection is to share profits with innovators. Therefore, the economic implications are not only predominant but also most obvious. The other two implications of access to newer technologies are on social and ecological dimensions. These three impacts are not mutually exclusive but often overlap.

The social impact of new technologies is manifested in terms of its influence on equity. Other important issue pertains to 'scale effect'. These issues can be explained by the illustration of green revolution. This seed-fertiliser technology was predominantly applicable in the areas with assured irrigation. Further, these technologies were not scale neutral and contributed to the widening of the regional disparity. Viewed from a macro-perspective, the revolution was a great success that helped realise cherished goal of self-sufficiency in foodgrains. Considering the predominance of marginal and small holdings in Indian agriculture, the revolution has accentuated the degree of inequity. Therefore, the magnitude and nature of social implications vary according to the category of the technology (Table 3). Knowledge based technologies and technologies concerning conservation of natural resources have positive impact on the society. Because of their nature (public good), the net social welfare increases manifold. Certain technologies that require intensive input use (hybrids and HYVs) have a mixed impact on the society. The predominant positive impact (++ –) clouds the negative effects. Yield enhancement by conventional breeding is an ideal example. While the absolute income increases across the size of the holding, it is disproportional. By the same yardstick, if conventional breeding aims at preventing yield loss (pest and disease resistant varieties) it becomes cost-reducing and has no negative impact (+). There are technologies where the negative component impact is marked (–+). Current levels of technologies (and its costs) in farm machinery and power precludes their accessibility to small and marginal farmers. There is a distinct possibility that in the near future farm machinery is tailor-made to suit smallholdings.

Most technologies, excluding agricultural biotechnology and crop protection chemicals have a net positive impact on the economy. There are however, implicit benefits like the saving of potential losses due to pests and diseases. Newer techniques invariably shift production functions thereby improving incomes of the individuals and that of the nation. Research in the public domain will concentrate in cost-reducing technologies that are helpful to the weaker sections. Conservation of genetic resources have huge positive externalities (both intra and inter generational). Considering the market structure of crop varieties and crop protection chemicals and the nature of potential technologies the scope for market malpractice such as monopoly and cartelisation is real. Generally embodied technologies are likely to have relatively more apparent impacts than KBTs. Presence of the public sector is vital for the provision of disembodied technologies [Umali 1992, Jha and Pal 1999].

Increased use of agrochemical will accelerate environmental degradation (– – –). Though biotechnological means to develop the use of agrochemicals to some extent (+ –), they are feared for their contribution to gene pollution (– –). Development of such resistant varieties by conventional breeding has no negative impacts (++). Any technology encouraging the use of improved varieties is likely to contribute to narrowing of genetic base (–). Increasingly, the use of antibiotics, harmones, unconventional feeds and genetic engineering in livestock and fisheries has raised questions about health hazards and animal biodiversity (––). Destruction of soil structure and groundwater depletion are serious ecological risks associated with the excessive use of technologies associated with farm machinery and power. Technological advancements in the conservation of soil, water and genetic resources have profound positive impacts on the ecology (+++). IBTs including ITK will receive a fillip in the event of availability of protection. Being locally evolved and practice based, IBTs optimise resource use thereby imparting positive externalities to the environment.

IV Legal Framework

Eventually, the way this interaction will shape up and subsequently determine the contours of the research portfolio in the near future is contingent on the legal framework and its subsequent operationalisation. Different pieces of legislation concerning different IPRs are in place or are in the pipeline. Table 5 provides the status of different IPR related legislations.

Of all bills, the one concerning PBRs is most relevant for discussion in the context of the paper. Titled aptly as the Plant Varieties and Farmers' Rights Bill, the proposed bill has generated more heat than light. Some positive features of the bill have been highlighted in the Table 6. The proposed bill does not extend protection to micro-organisms, genes or DNA constructs. It also clearly excludes technologies that are perceived as being harmful or dangerous to humans, animals or plants. Protection is not available to those technologies that are controversial in nature like the 'terminator technology'. The bill has adequate clauses to protect the interests of the society in general and farmers and researchers in particular [Ravishankar and Archak 1999]. Establishment of the Plant Varieties and Farmers' Rights Protection Authority, registry and their offices and the National Gene Fund are institutional responses to the new IPR regime. The authority is conferred wide ranging regulatory powers to deal sternly with infringement, offences and the strict implementation of the modalities and procedures enlisted in the bill. Clearly, the legal framework in consonance with the general economic structure will play a crucial role in shaping the interplay and implications between IPRs and technology development in the agricultural sector.

V Parameters of the Debate

In the new millennium, the research paradigm will undergo significant transformation. The interplay and the implications between the IPR regime and agricultural technology will shape this process (Diagram).

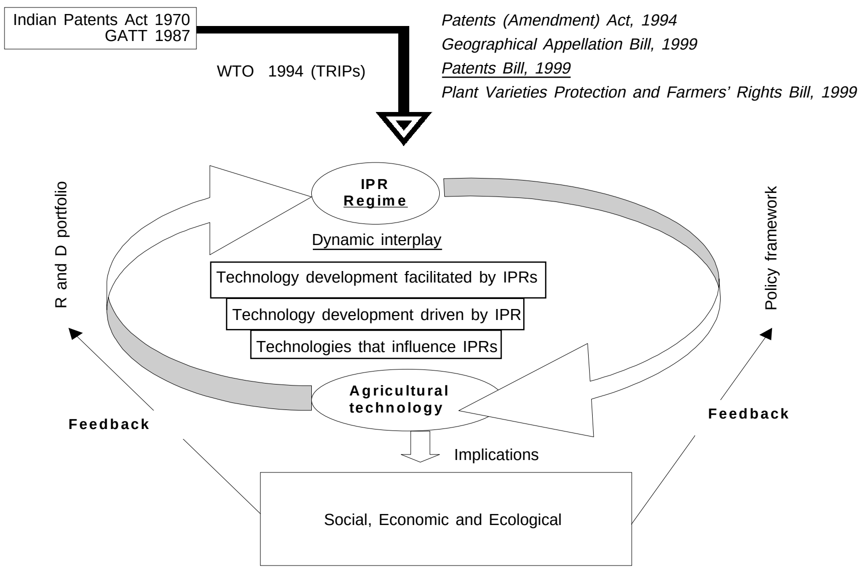
The interplay of IPRs, technology development and transfer will determine the research contours and portfolio. This interplay is a dynamic process with one to one, one to many and many to one interaction. There is no deterministic 'cause and effect' relationship in this process. Availability of protection inter alia is a crucial determinant of technology development and transfer. The magnitude of investment, kind of technology, pace of

Table 5: Current Status of Different IPR Bills in Country

Type of IPR	Status	
	Approved	Pending
Copyright	Yes	
Trademarks	Yes	
Geographical indications	Yes	
Industrial designs	Yes	
Patents		Yes
Integrated circuits	Yes	
Trade secrets	Yes	
Plant breeders rights		Yes

Note: The Patents and PBRs Bill have been referred to a select Parliamentary Committee. PBRs are not a different type of IPR but in a sense milder version of Patents.

Diagram



Source: Authors.

technology development and transfer and possible actors will be influenced by the nature of the IPR regime. In order to visualise the likely scenario in the agricultural R and D, gaining more insights into the IPRs and related aspects is inevitable. Different kinds of IPRs will govern various technologies (categorisation matrix). PBRs, trademarks and copyrights will be the predominant IPRs applicable in the agricultural sector.

The public sector will retain its position of prominence in basic research, IBTs and technologies relating to natural resources management. Applied research and embodied technology will receive the increased attention of the private sector. Core competencies of and synergies between the two sectors are of vital importance. The dependence of the private sector on the public research system will continue. A recent study in the US indicates that 73 per cent of private patents were based on knowledge generated by public funded institutions like universities and government laboratories [Thurrow 1997]. Frontier areas like agricultural biotechnology will witness greater action. The interplay of IPR regime and the process of technology development and transfer will have manifold impact on the farmers, researchers and organisations involved in agribusiness. The economic impact will be most obvious and explicit. Considering the peculiarities of our agrarian economy, social and ecological implications are important. Often, these implications transgress and overlap their respective domains. The extent to which negative impact can be minimised will depend on the degree of imagination that will go into the making of the modified IPR regime. Given the already existing and potential instruments for policy making, the aforesaid task is not insurmountable.

Three distinct research pathways are likely to emerge as a consequence of the introduction of a new protection regime. IPR driven technologies and technologies that influence the IPR regime in turn will form the dominant components of the technology paradigm. Some subtle issues merit attention. The debate relating to indigenous vs imported technology must be conducted in an environment devoid of emotions and passions. Concentration on those research areas in which we possess comparative advantage will yield better results and optimise scarce resources. Policymaking will hold the key in addressing many such related issues. No technology is good or bad in itself. Only its application will make it desirable or otherwise. The size and magnitude of investment (public and private) in agricultural R and D is abysmal despite attractive rates of return. Our farmers are denied the access to new and better technologies.

A realistic speculation of plausible scenarios attempted is however, subject to and dependent on the policy framework. While, the patents (amendment) and Plant Varieties and Farmers' Rights Bill have been referred to a select committee of the parliament; the geographic appellation bill has been approved. Adequate clauses to safeguard the interests of the society in general and farmers' and researchers in particular have been included in the Plant Varieties and Farmers' Rights Bill. Another highlight of the bill is the provision of 'compulsory licensing' and the clause relating to the 'protection of the security of India'. The plant varieties and farmers' rights protection authority is the institutional response to the new regime. Constitution of a national gene fund to address issues of benefit sharing and the conservation and sustainable use of genetic resources is another feature.

Food security, in terms of availability and accessibility continues to be a national priority. Rapid technological advance holds promise to break productivity barriers.

Table 6: Plant Variety and Farmers' Rights Bill, 1999: Some Positive Features

	Feature	Likely Intent
1	Broad based definition of 'Breeder'	To include discoveries
2	Wide scope of 'Common Knowledge'	To accept even non-documented evidence as proof
3	Exclusion of varieties containing gene or gene sequence involving any technology which is injurious to the life or health of humans, animals or plants	To pre-empt dubious and potentially harmful technologies without adequate empirical evidence based on research or trails
4	Requirement of passport data of the parent lines for registration	To record and or document in order to pre-empt potential disputes relating to proprietary and ownership
5	Duration of protection limited to fifteen years	To bring protected plant varieties into public domain as early as possible
6	Farmers' Rights	To allow for the reuse of seeds
7	Researcher's Rights	To promote hassle free research and or experimentation by not seeking prior permission
8	Reciprocity and special provisions for convention countries	To avoid duplication and streamline procedures
9	Compulsory Licence	To curb tendencies of monopoly, cartelisation and other related market malpractices. To ensure adequate availability of the propagating material
10	Rights of the communities	To recognise and reward contribution of local communities in the evolution of varieties.
11	National Gene Fund	To address issues of benefit sharing and the conservation and sustainable use of Plant Genetic Resources

Annexure: Intellectual Property Rights: Instruments, Subject Matter, Fields of Application and Related International Agreements

Types of Intellectual Property Rights	Types of Instruments	Subject Matter	Main Fields of Application	Major International Agreements
Industrial property	Patents	New, non-obvious, indigenous applicable inventions	Manufacturing	Paris Convention Patent Cooperation Treaty Budapest Treaty Strausbourg Agreement
	Utility models	Functional designs		
	Industrial designs	Ornamental designs		Hague Agreement Nice Agreement
	Trademarks	Signs or symbols to identify goods and services		
	Geographical indications			Lisbon Agreement
Literary and Artistic Property	Copyrights and Neighbouring Rights	Original Works of Authorship	Printing Entertainment (audio, video, motion pictures) software broadcasting	Berne Convention Rome Convention Geneva Convention Brussels Convention
Sui-Generis Protection	Breeders; rights	New, stable Homogenous, Distinguishable Varieties	Agriculture and food industry	Union for Protection of Plant Varieties (UPOV)
	Integrated circuits	Original layout designs	Microelectronic industry	Washington Treaty
Trade Secrets		Secret Business Knowledge	All industries	

Source: Adapted from WIPO (1994).

Against such a backdrop the dynamics of the interplay between the protection regime and agricultural technology needs thorough understanding. IPRs is one of the important determinants of technology development, transfer and dissemination. Institutional arrangements to keep pace with the developments to the new regime are necessary. Appreciation and understanding the intricacies in its manifold dimensions is the first in a series of steps to equip us in addressing the process of change. EPW

Notes

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1 In the popular media these technologies are dubbed as 'Terminator and/or Traitor' technologies.

2 By yield we mean biological, economic and nutritional yields.

3 Development of transgenic crops, manipulation of plant's reproduction system, marker aided breeding.

4 Some examples of patents issued in the US are Kiwi fruit plant, Inbred and Hybrid maize lines, Potato cultivar, Squash cultivar, Trptophan overproducer mutants, Mushroom mutant strains, process producing odourless soyabean, process for microplant propogation and Tetraploid maize and method to produce.

5 In India, the overwhelming view is to restrict protection at the plant variety level. Micro-organisms, Genetic engineering techniques and DNA sequences and constructs are likely to be omitted from the protection regime.

6 An emerging trend is one of clubbing of inputs. Along with the improved seeds, often one is tempted/forced to buy chemicals (that will enhance or prevent yield loss) from the same firm.

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