



## **Significance of IPR on Fast Evolving Industrial & Environmental Biotechnology Arena and Conservation of Biodiversity**

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**Abstract:** The field of biotechnology has witnessed great horizons of scientific creativity. Research in biotechnology gives birth to new inventions, methods and tools, promising sustainable development of food, agriculture and healthcare. These new inventions can be protected through various legal regimes of intellectual property rights, such as patents, geographical indications and plant varieties protections. In developing and industrialized countries, the interface between International intellectual property law and indigenous environmental protection has been a topic of greater conflict and debate. Environmental biotechnology has assumed a great significance in the present global economy, and has enormous effects on the agricultural biotechnology and human rights in India. This article is an attempt to give a brief account of the various legislative measures on the management of natural resources, issues related to environmental biotechnology, benefits that industrial biotechnology provides geographical indications and Plant Variety Protection.

**Keywords:** IPR, Environmental Biotechnology, Industrial Biotechnology, Biodiversity, Patent, PVP, TRIPs

### **1. Introduction**

Biotechnology is the integration of natural sciences and engineering in order to achieve the application of organisms, cells, parts thereof and molecular analogues for products and services [1]. Biotechnology, which existed from ancient times, has envisioned newer horizons of development and applications. Biotechnology has pervaded into nearly all the major fields of human endeavour. Biotechnology has significant effect on medicine, food, agriculture, energy and protection of the environment. India is one of the emerging economies of the world. The Indian biotechnology sector is one of the promising and fastest growing sectors in India and will play a major role in shaping India's rapidly developing economy. India has numerous comparative advantages in terms of biodiversity, vast reservoir of scientific human recourse with reasonable cost, large number of research & development institutions, emerging pharmaceutical industry and rapid developing clinical capabilities. All these collectively suggest a strong biotech base with promising potential to emerge as a global key player. Indian biotechnology generated revenues of US\$ 4 Billion in 2011 and creating one million jobs by 2010 through products and services [2]. This growth has been accelerated by the robust performance by bio-pharmaceuticals, bio-services, agro-biotech, bio-industrial, and bio-informatics. Agriculture and Food Biotechnology, Industrial Biotechnology, Bio-

engineering and Nano-biotechnology, Preventive and Therapeutic Medical Biotechnology, Regenerative and Genomic Medicine, Pharmaco-genomics, Bio-informatics and IT Enabled Biotechnology, Clinical Biotechnology and Research Services. India has large domestic market and large export potential and low cost research base for international companies.

#### **1.1. Potential Application of Biotechnological Invention**

Biotechnology industry has grown from laboratories to a rapidly growing segment of Indian economy. The confluence of modern biotechnologies and the market niches that they occupy are consider as "the new bio-economy" [3]. The new industrial structures are likely to be driven by technological innovation. For a country like India, biotechnology can provide solutions to myriad challenges be it healthcare, food or fuel security. Biotechnology is a powerful enabler that can revolutionize agriculture, industrial processing and environmental sustainability. The structure of biotechnology industry basically composed of marketing firms, many big & many small companies, knowledge-intensive biotechnology firm, university research laboratories and foundations and also government agency that support biotechnological research. Hence, the solution that India can provide may be of both national and international significance. The two important wings of biotechnology that have

enormous effect on human life are environmental biotechnology and industrial biotechnology.

### 1.2. Environmental Biotechnology

Environmental biotechnology is a rapidly developing field, which continues to add value for sustaining life form in the environment, by identifying and exploiting the bio molecules and their utilities to provide clean technologies, in order to counter environmental problems. The field of Environmental Sciences has acquired new dimensions in the last fifty years due to the changing scenario of population explosion, agricultural activities for food production, rapid industrial development for commercial and household commodities and so on [4]. Population explosion and industrial development has led to environmental problems at the local, regional and global levels like global warming, acid rain and the destruction of the ozone layer. A set of revolutionary techniques of biotechnology can be applied to a wide variety of environmental issues including conservation, identification and characterization of rare or endangered species and taxa. It can provide sustainable methods of afforestation, reforestation, rapid monitoring of environmental pollution, eco-restoration of degraded sites (like mining spoil dumps), treatment of solid waste management, treatment or detoxification of effluents discharged by industries (oil refineries, dyeing and textile units, paper and pulp mills, tanneries, pesticide units etc.). A number of such technologies have already been generated and demonstrated in the country. However, the real challenge is the rate of diffusion adoption of technologies by the industry. In general, many corporate groups are not keen on adopting biotechnology. A number of technologies have been the subject of public policy aspirations. Therefore, industry should be involved at the planning stage of experiment; enforcement of environmental laws should be uniform at the ground level.

Since its emergence, modern biotechnology has been associated with debates concerning benefits and risks. Concealed in the narrower debates on public policy and about the impacts of biotechnology on human health and the environment are wider concerns about socio-economic considerations, which can be translated into market dislocations [3]. But nowadays there is greater interest in the harmonization of regulatory practices among countries. The international instruments such as the Agreement on Trade-related Intellectual Property (TRIPs) under the World Trade Organization (WTO) reduce the prospects for technological spill-overs to developing countries. Moreover, globalization has intensified interactions among firms in the developed world and contributed to technological convergence

among firms in this region at the expense of linkages with firms in developing countries.

#### 1.2.1. Industrial Biotechnology

Industrial biotechnology has immense potentials and significant impact on human socio-economic development. Industrial biotechnology, also known as white biotechnology, uses biological systems for the production of useful chemical entities. White biotechnology is part of the contribution of applied science to a healthier environment and to sustainable development [5]. Industrial biotechnology is a broad and ever growing field that includes production of enzymes with a variety of industrial applications, bio-plastics, biofuels and other industrially important products. It also includes engineering of micro-organisms for the treatment of wastes and abatement of pollution, a process known as bioremediation. It cites progress in various areas such as industrial enzyme development, progress in bio-plastic and bio-fuels production, applications in the paper industry, bio-mining and environmental applications. These advances constitute a new front for society to interact with science but they will also point to future policy challenges for development and think-tank organizations [5]. Industrial biotechnology landscape is being transformed by advances in biotechnology-related fields like, genomics, genetic engineering, chemical engineering, bio-catalysis, fermentation technology, metabolic engineering and cell technology. Microorganisms, enzymes and enzyme variants are replacing different processes that depended heavily on chemicals, many of which are hazardous to environment. The application of industrial biotechnology offers significant ecological advantages. Agricultural crops are used as starting materials instead of using fossil resources such as crude oil and gas. This technology consequently has a beneficial effect on greenhouse gas emissions and at the same time supports the agricultural sector producing these raw materials. Industrial biotechnology has consistently showed significant performance benefits compared to conventional technologies [6].

Modern biotechnology has been associated with debates concerning benefits and risks. The potential of 'white' biotechnology is conducive to the tie-ups and linkages among government, industry and academe to work within a sustainable development framework [7]. The wider application of industrial biotechnology will heavily depend on the creation of suitable governance system for the new bio-economy. For developing countries to participate effectively in the new bio-economy, at least five key areas of the governance system will need to be adjusted: market access; international biotechnology alliances; intellectual

property protection; regulation; and risk management [3].

### 1.2.2. Biodiversity

Biodiversity refers to the range of variation or differences among some set of entities; biological diversity thus refers to variety within the living world. The term 'biodiversity' is indeed commonly used to describe the number, variety and variability of living organisms. This very broad usage, embracing many different parameters, is essentially a synonym of 'Life on Earth'[8]. It refers to the number, quantity of different species such as plants, animals, and other living things living within a particular physical and chemical environment.

There are lots of threats to biodiversity such as, unsustainable harvesting of natural resources like plants and animals, loss of ecosystems for agriculture and forest clearing, invasive non-native being introduced to ecosystems to which they are not adapted and where they have no or not enough, predators, to maintain an ecological balance. Threat also can be due to pollution and Climate change. Several international instruments and institutions deal with intellectual property rights and the conservation of biodiversity. In most cases the general parameters are laid out in the text of applicable treaties.

The Convention on Biological Diversity (CBD) is a legal regime for the genetic, species and ecosystem levels of biodiversity which deals with the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding [9]. The relationship between the objectives of the Convention on Biological Diversity (CBD) and intellectual property rights (IPRs) is the subject of continuing debate. The CBD's objectives are (1) to conserve biological diversity, (2) to promote the sustainable use of its components, and [3] to achieve fair and equitable sharing of the benefits arising out of the utilisation of genetic resources. These objectives find expression in the provisions of the CBD, many of which are affected, directly or indirectly, by IPRs [10].

## 2. Introduction to Intellectual Property

Legal regime refers to 'property' as a bundle of rights protected by law due to ownership and possession. Intellectual Property (IP) is the property created by human intellect, resulting in inventions, literary and artistic works, symbols, names, images, and designs.

### *Basically IP is divided into two categories*

- a) Industrial Property, which includes inventions (patents), industrial designs, trademarks and geographic indications of source,
- b) Copyright, which includes literary and artistic works such as novels, poems and plays, films, musical works, artistic works such as drawings, paintings, photographs and sculptures, and architectural designs. There are rights related to copyright which provide protection to performers (actors, musicians, singers, dancers, or generally people who perform) and their performances; producers of sound recordings and their recordings (cassette recordings and compact discs); and broadcasting organizations, in their radio and television programs.

Intellectual property protection requires some level of novelty and originality. The threshold of novelty and originality differs from system to system. Intellectual Property is duration specific and territorial in nature. IP protection does not provide absolute and perpetual protection. However, in certain regimes of IP rights there are exception for the specific duration. IP protection includes the right to prevent others from taking advantage of the IP owner's ingenuity. Granting intellectual property rights (IPRs) to inventors balances interests of both public and private sectors in that the invention must be disclosed publicly, but inventors possess the limited right to exploit the invention for a pre-defined period of time. This assists in public good as it allows others to improve the invention and, after the termination of the monopoly rights, to develop competing products (as opposed to keeping the invention a trade secret).

### **2.1. Importance of Intellectual Property protection for Biotechnological Inventions**

Biotechnology industry is research intensive. New inventions in the field of biotechnology are generally the result of substantial research, inventive effort and heavy investment in knowledge and sophisticated laboratories. Granting intellectual property rights protection for new invention and products acts as an incentive for the people concerned to continue their work. Companies engaged in research only make investments if adequate legal protection is available for their research output. Flexible intellectual property rights law can play a pivotal role in favouring stable legal environments encourage public/private partnerships, investment and trade promotion needed for expansion of biotechnological innovations to other countries.

More than any other areas of technology, life science research requires intellectual property (IP) protection in

order to develop products. Without strong and effective patent protection, development (commercial development in particular) of new treatments, diagnostic tools, pharmaceuticals and other benefits of investment in science and technology will not be possible. The cost of development is a factor that dominates the field of biotechnology [11].

### **2.1.1. Importance of Intellectual Property Rights in Biotechnology**

IPR encourages an inventor to develop new technologies. It stimulates technical progress in the following ways:

- a. To encourage research and develop new technology.
- b. It stimulates technical progress in 4 ways,
  - i. It encourages research and innovation
  - ii. It induces the inventor to disclose his invention
  - iii. It offers a reward for the development of an invention which can be commercially exploited and it contributes to the creation of an environment that facilitates the successful industrial application of inventions and new technology, and the legal framework, which encourages investment, including from foreign countries;
  - iv. It provides an inducement to invest capital in the new lines of production.
- c. It creates a market for knowledge by providing a legal basis for technology sales and licensing.
- d. A world-wide exchange of technical information is possible only by the publication of such patent specification and by publishing the information or new inventions, it acts as a catalyst for the commercialization of inventions and their transfer to productive use;
- e. The value of patent system is demonstrated in almost all advanced countries with the number of patents granted.
- f. IP protection maintains a flow of inventions, one invention leading to another.
- g. Increasingly both qualitatively and quantitatively the production potential in the country by creating new processes and new methods in production of goods and services [12, 13, 14]. Biotechnology research leads to new inventions, new methods, improved trait levels, mutations and varieties of plants. These new inventions can be protected through different domains of intellectual property rights. The most commonly used types of protection in biotechnology are Patents Geographical indications Traditional knowledge Plant Variety Protection.

## **2.2. Patent**

A patent is an exclusive right provided to an inventor that excludes all others from making, using and/or selling an invention. Once issued, a patent gives the inventor the legal right to create a limited monopoly by excluding others from creating, producing, selling or importing the invention.

This right is of limited duration- for a period of 20 years from the date of filing the patent application. In exchange for the right of exclusion, the inventor must disclose all details describing the invention, so that when the 20-year patent right expires, the public may have the opportunity to develop and profit from the use of the invention.

### **Advantages of Patents to Inventor**

A patent can confer many advantages on its owner. Some of them are:

- Technological inventions provides incentives to monetary reward
- Exclusive right to use the patent
- Grant Licences
- Can prevent others from copying the monopoly granted in his favour
- By transferring Know-how also he can receive consideration
- Patents provide owner with “market exclusivity” that creates increased profits and profits motivate innovation
- Patents require disclosure of new innovations that fosters dissemination of knowledge and further innovation
- Patents discourage the keeping of trade secret
- Biotech businesses require large front-end investment at high risk □patents provide market exclusivity (i.e. profits) that provide a big pay-off when something works
- Patents create a currency of “intellectual property” that allows small inventors/start-ups to obtain investment money

### **2.2.1. Indian Patent system**

Indian Patents Act came into force on 20th April 1972. In India, a patent can be obtained only for an invention that is either a product or process and that should be new (or ‘novel’); involve an inventive step (or ‘not obvious’); and capable of industrial application (or have ‘utility’, or be ‘useful’). To be patentable an invention must have (i) technical advancement over existing knowledge, (ii) economic significance, (iii) or both which makes the invention not obvious to a person skilled in the art. If the subject matter of the invention is novel, non-obvious and the invention has industrial applicability, it can be patented in India [15]. According to Indian Patent Act, “inventive step” means a feature of an invention that involves technical advance as

compared to the existing knowledge or having economic significance or both and that makes the invention not obvious to a person skilled in the art [15].

### 2.3. Geographical indications

The agricultural products/ fruits are the result of the specific soil, climatic conditions and topography of the geographical area in which it is grown. Geographical indications are used to inform consumers about the geographical origin of a particular product. It suggests that their special quality and characteristics, which are the result of the product's particular geographical origin. Well-known examples include "Basmati" "Darjeeling Tea" and "Roquefort" cheese.

#### 2.3.1. Advantages of Geographical indications

Geographical indications are valuable to producers as they are source identifiers. Geographical indications, if not adequately protected, may be misused and misrepresented by dishonest commercial operators. False use of Geographical indications by dishonest parties is detrimental to consumers and illegitimate producers. India has enacted the Geographical indications of goods (Registration and protection) Act in 1999 to protect the geographical indications.

### 2.4. Plant Variety Protection (PVP)

Plant varieties are useful and precious biological resource. With the rapid development of biotechnology and genetic engineering, the value of the gene pool of a nation has assumed great value. In India, the Act for the protection of the plant varieties and farmers' right came into existence in 2001. In international level, The International Union for the protection of New Varieties of Plants (UPOV) governs the protection of new plant varieties. PVP allows the plant breeder to protect new plant varieties for a term of 20 years (25 for tree crops). It is considered a sui generis system, i.e., a system of rights designed to fit a particular context and need that is a unique alternative to standard patent protection. A plant or plant variety becomes eligible for protection if it satisfies the criteria of stability, novelty, non-obviousness, uniformity and being distinct.

#### 2.4.1. Advantages of Plant Variety Protection

The Act enables the establishment of new varieties of plants. Prior authorization of the farmer/breeder shall be required for the production or reproduction, conditioning for the purpose of propagation, offering for sale, selling or other marketing, exporting, importing, and stocking for any of the above purposes.

#### 2.4.2. Patents versus Plant Variety Protection

Patents are granted provided the invention is novel (new), is non-obvious to one skilled in the field and has a utility (use).

- Patents allow protection of plant genes, rather than just the plant, and allow control of the genetic material of a number of plants for multiple uses such as medicines, pest protection, herbicide resistance, oil production, etc.
- PVPs are less expensive than patents and simpler for both applicants and administrators; hence they tend to be favoured by developing countries.
- PVP allows two important exemptions that patents do not: (a) farmer-saved seed and (b) research use.
- Both patents and PVP are enforceable only in the countries for which protection is granted.

### 2.5. Traditional knowledge

The traditional knowledge refers to Traditional knowledge (TK) is knowledge, innovations, skills and practices that are developed, maintained and passed on from generation to generation within a community around the world. Traditional knowledge can be found in a wide variety of contexts, including: agricultural, scientific, technical, ecological and medicinal knowledge as well as biodiversity-related knowledge. Innovations based on TK may benefit from patent, trademark, and geographical indication protection, or be protected as a trade secret or confidential information. However, traditional knowledge as such - knowledge that has ancient roots and is often oral - is not protected by conventional intellectual property systems [16].

#### 2.5.1. Protection of Traditional knowledge Defensive protection and Documentation of Traditional Knowledge

Aim to prevent people outside the community from getting intellectual property rights over traditional knowledge. India has compiled a searchable database of traditional medicine Traditional Knowledge Digital Library [17], that can be used as evidence of prior art by patent examiners when assessing patent applications. Defensive strategies might also be used to protect sacred cultural manifestations like sacred symbols or words from being registered as trademarks. Documentation helps in preservation, dissemination, use and management of this knowledge rather than for the purpose of legal protection. There is also concern that documentation could lead to misappropriation.

Positive protection is the granting of rights that empower communities to promote their traditional knowledge, control its uses and benefit from its commercial exploitation. Some uses of traditional knowledge can be protected through the existing intellectual property system, and few countries have also developed specific legislation [17].

#### 2.5.2. Benefit Sharing

Benefit sharing is a contract between source countries and bio prospectors, with the intention that royalties are shared between them amicably. Benefit sharing is a technical term used in the context of access to and use of human and non-human genetic resources. Non-human genetic resources include plants, animals and microorganisms. The term describes an exchange between those who grant access to a particular resource and those who provide compensation or rewards for its use [18].

## 2.6. International treaties

World is increasingly getting flat and integrated. The developed countries have technologies and investment; while the lesser developed countries are the major markets for these products and biodiversity materials. This brought a commonality of interest over showing the conflict of interest and forcing the need for international agreements. India is a member of The Trade-Related Aspects of Intellectual Property Rights (TRIPS) and Convention on biological diversity (CBD).

### 2.6.1. TRIPs

The Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement was adopted by over 100 countries in 1994 and requires that “patents shall be available for any inventions, whether products or processes, in all fields of technology.” It allowed countries to exclude from protection “plants and animals other than microorganisms.” It does require that countries provide for protection of plant varieties either by patents or by an effective *sui generis* system (i.e., PVP) or both. In 1995 India became a signatory to TRIPS (Trade Related aspects Intellectual Property Rights) after it joined the WTO in 1995. TRIPS permit countries some flexibility in the precise form and the extent of protection. It promotes the fundamental idea of extending IPR to agricultural genetic resources.

### 2.6.2. Convention on Biological Diversity (CBD)

The Convention on Biological Diversity (CBD) entered into force on 29 December 1993. It has 3 main objectives: The conservation of biological diversity, the sustainable use of the components of biological diversity and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. Article I of CBD describes, the objectives of this Convention, to be pursued in accordance with its relevant provisions, are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding [19]. This

treaty is expected to provide developing countries to reap some measure of benefit from international use of their indigenous knowledge. Firms could bio prospect only with consent, and both the firm and the species-rich country would need to share any and all benefits [20].

## 2.7. Conserving biodiversity for sustainable development

Biodiversity is essential ecosystem and are crucial to human dignity and survival. The biodiversity-dependent ecosystem is provision of potable water, food and fibers; soil fertility; maintenance of the ‘genetic library of biodiversity’. The factors crucial for maintain a sustainable biodiversity are new innovations, pharmaceuticals and chemicals; climate regulation etc. Our traditional knowledge, innovations and peculiar practices developed from experience gained over centuries, adapted to the local culture and environment are all rooted in our natural environment. It is mostly information held in human memories and not written down. Biodiversity has measurable economic value and these knowledge systems do not act in isolation and include spiritual experiences, philosophies, politics, and technologies and strongly influenced by the indigenous traditions. The unsustainable use of our natural resources, combined with the needs of a growing global population, is seriously jeopardizing the health of our ecosystems, resulting in the loss of biodiversity. Today, approximately 17,000 species are in danger of extinction. As biodiversity declines, so too does the resilience of our ecosystems. Scientists estimate that 60% of the Earth’s ecosystems have reduced their capacity to deliver the vital ecosystem services on which we all depend. Loss of biodiversity also leads to loss of cultural diversity. The UNESCO Biodiversity Initiative was created to address, in a holistic and integrated manner, all aspects related to the conservation and sustainable and equitable use of biodiversity from the perspective of UNESCO’s mandate, programmes and activities. The contribution and value of UNESCO to the international biodiversity agenda is evident, particularly in addressing the underlying drivers of biodiversity loss, such as human demographics; consumption and income levels; the resource-intensiveness of industry; and how economies value – or do not value – biodiversity. Education, communication and policy are instrumental in addressing these underlying and proximate causes [21].

The value of biological diversity including, the ecological, genetic, social, economic, scientific, educational, cultural, recreational, aesthetic values and its critical role in maintaining ecosystems provides essential services, which are critical foundations for sustainable development and human well-being. The

severity of the global loss of biodiversity and the degradation of ecosystems and suggest that these undermine global development, affecting food security and nutrition of present and future generations. This highlights the importance of the conservation of biodiversity, enhancing habitat connectivity and building ecosystem resilience. Indigenous peoples and local communities are often the most directly dependent on biodiversity and ecosystems and thus are often the most immediately affected by their loss and degradation [22].

Convention on International Trade in Endangered Species of Wild Fauna and Flora that promotes the conservation and sustainable use of biodiversity, should contribute to tangible benefits for local people, and ensures that no species entering into international trade is threatened with extinction is important. Firm and strengthened action are required to be taken for illicit trafficking in wildlife. Effective international cooperation among relevant multilateral environmental agreements, inter government organizations and international organizations are utterly crucial for the sustainable development and conservation of biodiversity [23].

### 3. Discussion

The scope of patent system has been expanded to accommodate fast evolving arena of biotechnology. However, modern biotechnology poses greatest challenge for patent regime where a clear distinction between patentable inventions and un-patentable discoveries is difficult to identify. The core substance for biotechnological invention is living material which is the 'product of nature'. According to patent law of most countries, 'products of nature' are not patent eligible subject matter [23].

#### *Issues/concerns of developing countries in extending IP protection to agriculture and biodiversity are,*

- IPRs, particularly patents, restrict the flow of knowledge and information and therefore inhibit R and D by others.
- Developing countries often lack the expertise to draft appropriate legislation (PVP or patents) and begin administering such a system.
- Developing countries are concerned that new technology will be held solely in the private sector and will be inaccessible to them; this concern centres on multinational companies in particular.
- Developing countries may question the ethics of protecting, or "owning," living organisms.

Therefore, each country needs to weigh the benefits and costs of IPRs in agricultural biotechnology and frame its policies accordingly. The need for an integrated biotech

policy with concurrent attention to education, social mobilization and regulation is considered to be an essential pre-requisite for an orderly progress of the biotech sector. Synergy between technology and public policy is essential for us to achieve an effective mobilization of the tools of new biology for adding both years to life and life to years [24].

### 4. Conclusion

IPRs are critical for growth of the biotechnology industry and conservation of biodiversity, and lack of intellectual property protection in a country can limit access to the results of biotechnology and bio-conservation originating elsewhere, blocking inward investment. It is imperative that our research and academia should move biotechnology from research to commercialization, foster India's industrial development, inform people about the science, applications, benefits. India needs to leverage resources through partnership and build regional innovation systems. The strategy will help develop local talent for a globally competitive workforce. The development strategy is based on a strong innovation promotion framework in which industry, academia, civil society organizations and regulatory authorities will communicate in a seamless continuum. The perspective for Indian biotechnology would be global while also concentrating on local issues. Harnessing biotechnology IPRs for the conservation of biodiversity and benefit of the poor will require considerable attention in many areas including: allocation of additional public resources to agricultural research; appropriateness of, and access to, biotechnology by resource-poor farmers; improvement in the seed distribution and extension systems; capacity-building of the public sector in biotech R&D; public education; policies and regulatory frameworks on biosafety, food safety, and stronger public-private sector links for both international and local collaborative undertakings. Appropriate investments, intergovernmental Science-Policy Platforms, incentives & policies that support the conservation and sustainable use of biological diversity and restoration of degraded ecosystems are important. So adequate regulatory measures, public debate, human resource development and training, public-private sector collaboration, intellectual property management, and support from international development organizations are required for effective IPR policy formulation and regulation.

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