Intellectual property rights on biological resources: Benefiting from biodiversity and people's knowledge

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The Indian Patent Act is being amended, in part, because of our commitments under General Agreement on Trade and Tariff (GATT). Similar considerations have prompted us to formulate a Protected Plant Varieties Act. At the same time, a National Biological Diversity Act is also on the anvil in response to our commitments to the Convention on Biological Diversity (CBD). The CBD has advanced beyond the conventional intellectual property rights (IPR) regime to accept the sovereign rights of nations over their biodiversity resources, and the need thereof to share benefits of commercial applications of traditional knowledge of sustainable uses of biodiversity resources with local communities. It is important for India to benefit from these provisions and create a legislative framework that would be a model for other developing countries as well. Intellectual Property Rights (IPR) are now being extended to biological resources, beyond the conventional domain of mechanical and chemical innovations. On this new biological frontier, considerable pertinent knowledge and resources already exist in the public domain, and CBD has clearly accepted the need to respect and share its benefits with these public-domain resources. These considerations must be reflected in the Amended Patent Act. It is also vital that we ensure a proper harmonization of the provisions of the new Patent Act, Protected Plant Varieties Act, and the Biological Diversity Act. In this article we discuss measures for disclosure of country of origin, relevant public knowledge or agreements in the IPR applications under these acts.

KONRAD LORENZ, Nobel Laureate and one of the founders of the modern science of animal behaviour says that his philosophy of life has been to act creatively; neither to drift passively with the current, nor to break one's head against a brick wall[1]. We might, with profit, apply this philosophy to decide on how we should deal with the challenges being posed by the new compulsions of intellectual property rights (IPR) regimes. For, today, we seem to be engaged in pursuing the two courses rejected by Lorenz. Our political[2] and intellectual[3] leadership calls for rejecting most of the new provisions of the Trade Related Intellectual Property Rights accord (TRIPS) of the General Agreement on Trade and Tariff (GATT)[4]. Given the compulsions under which we operate, this is like breaking our heads against brick walls. So, in actuality, the Government meekly surrenders and we end up drifting with the current[5]. In fact, the few new provisions we make, such as the exclusion of innovations based on formulations in Indian medicinal systems, are more likely to harm rather than serve our interests. This is unfortunate, for the international Convention on Biological Diversity (CBD) has created space for us to creatively develop new approaches within the global framework that we are compelled to accept[6]. In this paper we have proposed various measures that should be adopted to take advantage of these possibilities, while developing the Indian framework for operationalizing a new IPR regime.

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Trade-related intellectual property rights

IPRs are meant to assure rewards to innovators, and are claimed to have been an important driving force behind the rapid industrial growth in the developed world[7]. They primarily evolved to protect mechanical and chemical innovations for which identification of novelty, the inventive step and the innovator is relatively straightforward. The current IPR regimes fail to provide any rewards to the public-domain foundations, on which the innovations may be based. This becomes a particularly important concern when the IPR regime is extended to the biological domain too. For, in this domain, activities outside the purview of formal science as well as publically funded research have generated extensive material and knowledge resources which could serve as the basis for further future protected innovations. Thus local cultivars of crops may provide genes with significant applications; as in the case of Pattambi varieties of rice that harboured a gene for

resistance to the brown leaf hopper whose outbreak was causing extensive damage in southeast Asia[8]. Furthermore, many high-yielding varieties of crops have also been developed through large public investments in agricultural research institutions. Other applications, such as the use of neem oil as an insecticide, or turmeric powder as an antiseptic, are part of public-domain knowledge which could be built upon through small steps such as the process for increasing the shelf-life of azadirachtin, the molecule responsible for pesticidal properties of neem oil[7]. Thus, today the IPR regimes, as enshrined in TRIPS, provide for no sharing of benefits with this public-domain foundation, resulting in claims that have been termed 'biopiracy'[9].

India, along with 129 other countries, is now a signatory to GATT – with TRIPS as one of its components –which has several provisions favouring developed countries over the developing ones[10]. TRIPS requires all member countries to provide for a strong 20-year-long patent protection to processes as well as to products based on both domestic and foreign innovations. Its Article 27 compels member countries to protect through patents innovations in all fields including food, health and other biotechnology-related fields. It also erodes the authority of the governments to demand compulsory licensing of essential goods, in the name of public interest, and to regulate their prices. Member countries may however exclude plants, animals, and essentially biological processes for reproduction from patenting. However, now it is mandatory to protect plant varieties through patents, or any other independent *sui generis* system, or combinations thereof that are effective. This requirement of efficacy would preclude farmers from saving, replanting, or selling for reproductive purposes their produce from the protected varieties. Within these limits, it is not mandatory for member nations to adopt the International Union for Protection of New Varieties (UPOV) system, which has no provisions to protect farmers' interests, or to reward them for development or maintenance of cultivars[9]. UPOV only provides for strong breeder's rights, suited to the developed countries, where functions of grain and seed production are divided between the farmer and breeder respectively[3]. Developing countries, like India, where more than half the seed supply is ensured by saving and exchanging of seeds[3], therefore require an innovative piece of legislation looking beyond UPOV.

Developing countries have been allotted a period of 10 years to reform their national IPR legislations to meet the aforesaid requirements. However, the developing countries must soon provide a mailbox facility to file applications for product patents, which will be scrutinized after 2005 AD. Till then, the developing countries must provide for Exclusive Marketing Rights (EMRs) to innovations, have obtained patent protection and marketing approval from any other GATT member nation. Developing counties, committed to these provisions, are finding it difficult to formulate legal and policy measures required to mitigate the serious implications of this requirement for the health and food sectors.

Product patents regime

It has been advocated that India must not allow patents on life forms and their derivatives[3]. No country has as yet adopted this stand, as it might conflict with the TRIPS provisions and invite multilateral sanctions. India was, in fact, taken to task by the World Trade Organization (WTO) for not providing the mailbox facility and EMRs[10]. In order to meet our obligations under TRIPS and to avoid possible sanctions, the Indian Parliament has amended the Indian Patent Act 1970, so as to grant EMRs in the field of agro-chemicals and pharmaceuticals[5]. EMRs would last for a period of 5 years, or till the patent application is approved or rejected after 2005 AD, whichever is shorter. When the amendments were tabled in Rajya Sabha during December 1998 session of the parliament, the pressure from opposition forced the government to agree to further modify them so as to exclude from the purview of EMRs any inventions based on formulations in Indian medicinal systems[11]. It is likely that such inventions may be excluded from product patents, even after the patent act gets amended further.

It is our contention that excluding the innovations based on the Indian system of medicine from the EMR regime may cause more harm than good: it would deprive Indian entrepreneurs and the Council for Scientific and Industrial Research (CSIR) of an opportunity of claiming IPRs; the developed countries may object to this restriction and continue to encourage IPR protection to such innovations domestically, putting Indian entrepreneurs at a disadvantage; and they may also refuse to share any benefits generated from such protected markets unless we too extend similar protection, as required by the 'national treatment' clause of the TRIPS.

In this context, there seems to be little reason to shy away from a system of product patents, with appropriate safeguards, so as to create space for approval of applications on the merit of each case. After all, the Indian government has amply demonstrated its commitment to TRIPS by drafting a Plant Variety Protection and Farmer's Rights (PVP) Act, ready for tabling in the parliament[11]. The earlier drafts of the PVP act proposed a 'Community gene fund' to recognize and reward farmers' contribution[12]. We are given to understand that the recent drafts have done away with such an arrangement in view of the proposed national biodiversity fund, under the draft Biological Diversity Act. Thus, the term farmers' rights, included in the title, appears to be cosmetic and, in reality, the act merely provides for strong plant breeders' rights (PBR) at the cost of the farmer.

Challenge of biopiracy

The emerging IPR regimes, as enshrined in the TRIPS, primarily protect innovations developed within the system of formal sciences. As a consequence, the scientists and the entrepreneurs, especially from the developed world, are protected; while there is no provision for acknowledging and sharing benefits with the foundations of resources or knowledge in the public domain. For example, take the case of neem oil, a well-known pesticide in many parts of rural India, whose active principle, azadirachtin,

breaks down quickly. W.R. Grace & Co., a transnational corporation, invented a chemical treatment for stabilizing the azadirachtin, thereby increasing its shelf life and making it possible for it to be transported worldwide. This innovation was protected through a US patent (No. 5124349)[7]. Although the use of neem oil by the Indian farmers was mentioned in the patent application, there can be no provision for sharing the resultant huge commercial benefits from the sales of the insecticide with the Indian farmers under the present regime. Although the patent would not prevent the Indian farmers from using neem oil locally as a pesticide, as long as it was produced on the farm or purchased in crude form from neighbours or local market, any Indian entrepreneur would be prohibited from developing and marketing a similar commercial invention. The Indian entrepreneurs would therefore be compelled to pay royalty to the Grace Company and sell their product at the prices fixed by the company. Since neither the Indian farmers nor industry knew the process of stabilizing azadirachtin, it is therefore difficult to contest the claims of novelty and inventiveness of the patent.

In the case of Basmati rice, traditionally grown in India and Pakistan, a US Company, Rice Tec., has obtained a patent on similar rice grown in the US (Patent No. 5663484)[13]. The patent claims specify that the inventive steps lie in obtaining equivalent or superior quality of grain from crop grown in an entirely different country. Given the complexity of the case, Indians are still engaged for over a year in collecting evidence to contest it. In contrast, in one of the controversial cases, the US patent office granted a patent (No. 5401504), after initial reluctance, on use of turmeric in the powder form for wound healing, on the grounds that such usage was not known in the US[7]. However, CSIR could present published evidence in an appeal in the US court that such usage was known in India, and hence not novel. Consequently, the patent was revoked. This was an exceptionally easy case to argue. As exemplified by the neem and basmati cases, proofs of public-domain origin of knowledge or resources can be of little use in contesting and rejecting the patents. It is however possible to visualize using such evidences to claim a share of the subsequent commercial benefits, and channel these reward to promote public-domain knowledge and conservation of biodiversity resources, taking advantage of the opportunities created by the CBD.

Convention on Biological Diversity

CBD reflects, to a great measure, the worldwide concern to prevent unfair exploitation of the rich genetic wealth and traditional knowledge of the developing countries by the developed world[14]. Signed by 170 countries till date, including India, CBD came into force in 1993. The convention reaffirms sovereign rights of the member nations over their genetic resources. It requires all the nations to facilitate foreign access to their genetic resources; such access must be on the basis of prior-informed consent of the country of origin (article 15). The terms of agreement could include sharing of benefits, technology transfer, and preferential location of R&D units in the country of origin. It also requires member countries to obtain traditional knowledge of sustainable uses of biological resources with the approval of its holders, their involvement in its wider application and sharing with them the resulting benefits (article 8j). It requires nations to protect the traditional knowledge and customary practices relating to uses of biological resources (article 10c). Furthermore, it stipulates that IPR regimes should be supportive of and do not run counter to the CBD objectives of conservation, sustainable use and equitable sharing of benefits (article 16(5)). For example, countries providing genetic resources could seek technologies including those protected by IPRs, provided that adequate protection is ensured (article 16(3)).

Unfortunately, CBD does not provide any explicit rights, either to nations or people, regarding the vast store of genetic material or knowledge transferred abroad prior to 1993. Much of the public-domain repositories of germplasm and other pertinent information on it is today more readily available through repositories housed in the developed countries rather than in the developing countries of origin. For example, the most extensive and efficient source of information on traditional uses of Indian plants, like neem, is a database, NAPRALERT, housed at Chicago in the US[8]. This information is compiled through exhaustive search of literature, including Indian sources, often not available to most Indians. Moreover, Rice Tec. developed its Basmati lines from the strains obtained before the CBD[13] came into force. Hence, the question of prior-informed consent of India or Pakistan does not arise within the existing CBD framework. Despite such limitations, many of the provisions in CBD may be of great help in safeguarding the interests of the developing countries, provided that they enact supportive national legislation as well.

Proposed Indian Biological Diversity Act

To give effect to the provisions of the CBD, Indian government has drafted a biological diversity legislation[15] to be tabled in the parliament for enactment. It was widely circulated and discussed by the Ministry of Environment and Forests, including with the authors. The legislation contains the following important clauses relating to IPRs and benefit-sharing:

(i) People's knowledge shall be registered at local, state and national levels and protected with the help of a *sui generis* system of IPRs (article 14). This provision presumably refers to information yet undisclosed. Besides, institutions of self-governance – from village-level upwards – have been entrusted with the responsibility of chronicling biodiversity resources, people's knowledge, and conservation efforts (article 11); presumably to define the extent of public-domain resources.
(ii) Any person applying for IPRs in India or abroad, relating to biological resources occurring in and/or accessed from India, must obtain prior permission of and abide by the benefit-sharing conditions imposed by the national authority (article 17).
(iii) The national authority, if necessary shall oppose worldwide the IPRs granted in relation to biological resources or knowledge derived from India (article 8iv).
(iv) No foreign agency can access biological resources occurring in India and related knowledge without

the prior-informed consent of the national authority (article 15).
(v) In cases where a person or a group of persons exclusively contribute to the resource or knowledge, they shall directly share the royalty resulting from its subsequent commercialization. Otherwise, such share of benefits shall be deposited in a national biodiversity fund (article 16).
(vi) The national biodiversity fund would be primarily used to reward people for their conservation efforts and knowledge (article 21). Although the basis for making such awards is not specified in the act, the periodic documentation of resources, knowledge, and conservation practices by the village-level management councils, envisaged in article 11, may offer an accountable and transparent foundation.

These are indeed positive provisions. However, to operationalize these provisions, the proposed PVP Act and the amendments to Patent Act must play a supportive role. To enhance the complementarity among these three acts, we suggest below a series of measures.

Complementarity measures disclosing biological material and knowledge

Any benefit-sharing arrangements would critically depend on our ability to link the innovation to its biological origin and to prior knowledge of its uses. To do this effectively, it will be necessary that the patent, PVP act, and Biodiversity Acts enforce following disclosures and submissions in the specification section of the applications.

(i) *Biological source*: Specify the organism/s and products thereof used to produce the invention such as a drug, or the parental crop lines, or germplasm accessions used to breed a new variety.
(ii) *Country/ies of origin*: Specify the country/ies that harbour the biological source/s in natural or naturalized conditions. Several proposals suggest using some cutoff date in the history, such as 1500 AD, to determine prior natural geographical distribution of organisms[6].
(iii) *Accession details*: Specify country and agency (e.g. private farmer or village council, public sector or private sector gene bank, etc.) providing the organism or variety/ies used as source material/s.
(iv) *Material transfer agreement (MTA)*: Provide a certificate from the national authority of the country and, if necessary, the donor agency that provided the resource; specifying that access was granted on the basis of prior-informed consent and on mutually agreed terms. In case the country providing the resource does not require an MTA, then a sworn statement to that effect has to be provided.
(v) *Public-domain knowledge*: Provide relevant prior knowledge about uses of the biological materials; available through public sources such as patent documents, publications, other printed media, computerized databases and other electronic media, inscriptions and the village-level documents proposed under the draft Biological Diversity Legislation (article 11).
(vi) *Information transfer agreement (ITA)*: For knowledge not publicly available as above, mention the information transfer agreements with the private persons providing the undisclosed information. In fact, the proposed Biological Diversity Act mentions that the knowledge about biological resources occurring in India cannot be accessed by foreign agencies without the prior-informed consent of the national authority (article 15). Obviously, this provision seems to refer to transfer of undisclosed information. The law must additionally allow persons holding such information to become a party to the agreement. Such disclosures and proofs of prior-informed consent have been widely advocated in the IPR reforms suggested in recent literature[9,16,17].

Registering claims of knowledge

It is possible that some of the applications provide inadequate or misleading disclosures or agreements. For example, an entrepreneur may obtain information about medicinal usage of a plant from a villager without any prior agreement, and apply for IPRs on subsequent innovations. In such a case, when the patent claims are laid open for public scrutiny, any concerned agency or individual may submit evidence pertaining to the prior existence of this knowledge in the literature or databases, including in the village documents and the registration proposed under the Biological Diversity legislation[8]. In case such claims are sustained, the IPR applicant should not only share benefits with respect to the use of prior knowledge but also pay a penalty for the future to duly acknowledge it. For providing an effective opposition, it would be necessary for the people to register their knowledge fully or at least as claims. The proposed registration and documentation system under the Biological Diversity Act must permit full as well as partial disclosures. It is equally necessary to collate this information in the form of searchable computerized databases[8]. The Biological Diversity Act, Patent Act and PVP Act must require the respective authorities to conduct a thorough search of such databases to examine the claims of novelty made in IPR applications.

Instituting petty patents

The entrepreneurs may search the registered claims through computerized databases and approach suitable claimants to access the relevant information with appropriate approval of the government as per article 15 of the Biological Diversity Act. If such information constitutes addition to the publically available literature and databases, the claimants should be specially rewarded. Further, if such information triggers some commercial application, the reward may be proportionally higher. The rewards could take the shape of up-front payments received at the time of contract, or milestone payments received during various research stages and finally, a share in the royalty subsequent to marketing[14]. However, in any case the contractual arrangement is likely to enable the claimant to tap very limited benefits compared to the entrepreneur wielding more information and power. One must therefore explore the possibility of stronger protection to

such information.

Some of the folk knowledge or grassroots innovations or cultivars may indeed be worthy of special recognition other than mere claims protected through contracts. However, such innovations are difficult to protect under current IPR regimes which demand higher levels of inventiveness, investment and elaboration. Hence, to protect grassroots innovations, a system of petty patents should be initiated[9,16–18]. Such petty patents may be granted to individuals or group of persons. These should be relatively easy to apply for and quick to obtain, and the cost of their filing and maintenance low. The government may also consider subsidizing the costs of some of the more promising applications. The criteria for patenting may be retained but the degree of specification should be kept to its minimal. Thus to acquire a petty patent, it might suffice to demonstrate that a herbal mixture is clinically effective. This however is not the case today, for a patent cannot be granted on such knowledge. The petty patents too should be subjected to prior public scrutiny. The petty patents may thus provide correspondingly lesser degree of monopoly, and fetch lesser rewards than a patent[19]. To operationalize this system, the petty patent offices must be located at the level of each district or few neighbouring districts. Besides, these offices must have efficient computerized information network to undertake adequate and efficient scrutiny of the applications. The National Foundation for Innovations, proposed in the union budget 1999–2000, can take a lead in this direction[20].

Registering farmers' varieties

Besides modifying the patent system to protect special folk knowledge or innovations, it is necessary to explore the possibilities of tailoring Plant Breeders Rights regime to protect folk varieties. However, recognizing and protecting farmers' varieties is a very complex task. Usually folk varieties are genetically very diverse; manifesting considerable morphological and cultural variation from place to place, one generation to another. Hence, it is often difficult to distinguish one variety from another. Furthermore, their denominations could become confusing as a given variety may bear different vernacular names in different places; or else, a single base name may refer to two different varieties. The modern plant breeders develop varieties that have a very narrow genetic base so that these satisfy the criteria of distinctiveness (D), stability (S) and uniformity (U) prescribed for protection under the UPOV framework, also adopted by our draft PVP act[10]. However, the folk varieties are unlikely to satisfy these norms and are consequently deprived of protection[16]. Thus, instituting petty patents or a less rigorous plant breeder's rights system might serve to protect at least some of the folk varieties. Indeed, proposals have been put forth, both locally and globally, to modify the UPOV criteria and restrict them to distinctiveness alone[9]. Nevertheless, some questions pertaining to novelty and ownership of folk varieties raise further difficulties in protecting these folk varieties.

In general, most of the folk varieties are not novel. Nevertheless, these have not been registered under the Seed Act 1966 which primarily authorizes varieties developed by public sector breeding programmes, such as through the agricultural universities. The PVP Act precludes protection of varieties registered under the Seed Act. Hence, many folk varieties can be potentially considered eligible for protection, provided that suitable criteria are evolved under the PVP act or under the registration system proposed under the Biological Diversity Act (article 14). As many of the distinct folk varieties have a localized distribution, extending over a few talukas or districts, their custodianship may be entrusted to farmer communities or to appropriate institutions of self-governance. Identifying all the beneficiaries would of course be an immense challenge, requiring innovative mechanisms. In case a folk variety does not seem to be distinct in terms of either its identity or ownership, the cultivators could be rewarded from the National Biodiversity Fund as a general incentive for continued conservation; not specifically linked to the cultivar. Implementing any kind of benefit-sharing would necessitate a decentralized programme of documenting agrobiodiversity at the village-level itself. This could be organized along the lines of the village-level documentation proposed in the Biological Diversity Act (article 10). The local-level characterization of the folk varieties will have to be validated by agricultural university scientists, including through use of advanced techniques, such as DNA fingerprinting. This information must also be linked to the databases of accessions held by the National Bureau of Plant Genetic Resources (NBPGR). As a matter of fact, NBPGR has recently initiated a countrywide drive to collect germplasm of folk varieties[21]. This programme must include provisions to enable us to distinguish folk varieties, their geographical distribution, and the custodian farming communities.

Broader public scrutiny

Safeguarding the interests of nations or people who conserve biodiversity and associated knowledge, requires tailoring IPR regimes to strike a balance between the protection and public accountability. The evaluation of the IPR claims is becoming an increasingly complex affair demanding greater sophistication and specialization. The quantum of information available globally is also skyrocketing, posing difficulties in its compilation and screening. Patent authorities therefore find it difficult to adequately scrutinize new applications, especially the ones making claims of novelty. To step up the pace of granting patents, without sacrificing social justice, it would be desirable to make the patent scrutiny a more broad-based process. For example, specialists such as *Ayurvedic* and folk healers, private and public plant breeders, farmers, etc. must be effectively involved in evaluating the IPR applications[22]. Such openness would also serve democratic interests by eliciting participation of various stakeholders to create a 'win–win' kind of situation. Today, the only opportunity for such diverse sectoral interests to evaluate the IPR claims is when these are made public for inviting opposition. Instead, it may be more appropriate to institute a multidisciplinary appraisal of the IPR applications from the

outset itself.

Benefit-sharing tribunal

The purpose of these various suggestions is to suitably reform the IPR regime so that folk knowledge and resources too have a share in the commercial benefits; since, traditionally, the IPR legislation is only meant to protect the ability of an entrepreneur to monopolize the market and corner the benefits. Hence, IPR laws cannot on their own provide for sharing of the commercial benefits with the public-domain foundation of knowledge and resources underlying the innovation. That function is being entrusted to the national authority being constituted under the proposed Biological Diversity Legislation. It is therefore necessary for the patent office or the PVP authorities to evolve mechanisms to share their information with and provide appropriate advice to the national biodiversity authority to promote equitable sharing of accruing benefits. This collaboration is necessary to effectively discharge, at a minimum the following functions:

(i) To identify the nature and extent of public-domain knowledge collated through registration of claims on the one hand, and village-level documentation of knowledge and conservation efforts on the other. These activities are proposed under the Biological Diversity Legislation. It would be preferable to compile such information as networked computerized databases.
(ii) To adequately employ the material and information transfer agreements issued by the biodiversity authority.
(iii) To convey information relating to the grant of the IPRs to the biodiversity authority, so that it can levy appropriate benefit-sharing fees, and other conditions such as technology transfer, local R and D installation, etc.

A multi-disciplinary tribunal to achieve harmony between the objectives of the Patent Act, PVP Act, and the Biological Diversity Act might best serve these interests. The national biodiversity authority is empowered to constitute any such committee to execute specific functions (article 8).

People's biodiversity registers

The village-level documentation of crop cultivars, locally used medicinal herbs, wild foods, and other biodiversity resources; and of their use, and conservation and management practices envisaged in the legal framework might take the form of people's biodiversity registers (PBR) for which we now have gained some practical experience[23]. These PBR, may also serve another important function, namely, that of promoting sustainable management of biodiversity resources. This would be greatly facilitated by suitable amendments in the Panchayat Raj Act so as to empower local communities to manage local biodiversity resources, to regulate harvests, and to charge appropriate collection fees along the lines of the provisions of the extension of the Panchayat Raj Act to Scheduled Areas Amendments of 1996 (ref. 24). Such collection charges are already a common practice in several other tropical countries[14]. Such empowerment of panchayats would strengthen the ongoing programmes of joint forest management; with PBR serving as an appropriate information base for planning and monitoring purposes[25].

Based on the documented efforts of conservation or contribution of knowledge, village councils may be rewarded[6] from the National Biodiversity Fund. These incentives could take various forms, such as allotment of a venture capital fund for conducting experiments to implement the innovations; like commercialization of local health practices, establishing of small-scale enterprises to commercialize the biodiversity resources – for example, setting up of a forest produce-processing unit, or to initiate biodiversity-friendly development measures like manufacturing of a smokeless stove[6]. A part of the fund could also be assigned to organize knowledge networks whereby local healers or traditional farmers across the villages can exchange and validate views, get felicitated or rewarded. Such taluka-level or district-level networks may also undertake promotion of such enterprises as cultivation of medicinal plants or establishing of their processing units. Such units are often non-viable at a small-scale, owing to limited resource catchments, high fluctuations in supply and demand, and limited expertise. Therefore, cooperative arrangements and sharing of information between these district-level and taluka-level networks can greatly facilitate infrastructural capacity building for managing biodiversity sustainably.

Translating IPRs into economic benefits requires suitable market opportunities and good information on them. But, in the present scenario, the medicinal plant collector or traditional farmer has no information on the premium markets of Europe, or even for that matter of Mumbai. The meagre income the villagers today earn from their biodiversity resources, only promotes unsustainable harvests of medicinal plants or replacement of landraces with high-yielding varieties, a practice which is accelerated due to subsidies for modern seeds, chemical fertilizers and pesticides. Therefore, for encouraging biodiversity-friendly practices, information on local and global markets must be collated and fed back to the villagers for making informed choices, and consequently assert themselves in having a say about procurement prices.

The people's biodiversity register programme would suit well the mandate of the National Bioresources Board (NBB), proposed to be constituted under the Department of Science and Technology, according to the union budget 1999–2000 (ref. 20). Since formal launching of this programme at the level of the government would take its own time; in the meantime, NGOs all over the country have on their own, initiated such moves. For example, the Indian Institute of Science coordinated a countrywide effort
with the support of World Wide Fund of Nature-India (WWF-I) during 1996–1998, which led to the compilation of PBRs 50-village clusters from 7 states, representing various socioeconomic and ecological zones[23]. Several other NGOs have also initiated preparation of such registers in their own areas, with their own flavour. Such NGOs represent a diverse spectrum including the Foundation for Revitalization of Local Health Traditions, Bangalore; Kalpavriksh, Pune; Navdhanya, Dehradun; M.S. Swaminathan Research Foundation, Chennai; Kerala Shastra Sahitya Parishad, Cochin; Vruksha Laksha Andolana, Sirsi;

Nagarika Seva Trust, Mangalore; and Deccan Development Society, Hyderabad.

International follow-up

Our national efforts on IPR need to be complemented by similar international efforts by promoting supportive international policies and legislative frameworks. The measures suggested here are not inconsistent with the TRIPS provisions and hence will not invite any penalties. On the other hand, these provisions would place India in a leading position amongst developing countries in fighting the inequities within GATT. Today, most of the other countries in the world are increasingly providing strong IPR protection in all fields of technology, as recommended by GATT. Even China, which is not a WTO member, provides for strong IPR protection[26]. It is therefore necessary that we accept the general IPR framework, but with due safeguards to protect and promote customary uses and traditional knowledge of biodiversity through equitable sharing of benefits. No major developing country has so far amended its IPR legislation towards this end, and India could lead the way. It may be noted in this context that the Kenyan Industrial Law, 1989, has provided for granting of petty patents on folk medicinal formulations[27]. However, it does not enforce acknowledgement and rewarding of public-domain knowledge, as these became important concerns after the CBD came into force in 1993.

India must therefore lobby with other developing countries, in fora such as G-77, for similar changes in IPR legislation worldwide which include the developed nations as well. Most importantly, these amendments must be incorporated into the TRIPS itself, when article 27 is reviewed during 1999 and the entire TRIPS comes up for review in 2000 (ref. 9). As a matter of fact, India had proposed amendments to TRIPS relating to disclosure of biological material and its country of origin during the WTO negotiations in 1996 (ref. 28). However, these suggestions were not backed by other countries and were eventually turned down. India must now renew its efforts in collaboration with other developing countries, with emphasis on rewarding public-domain knowledge. World Intellectual Property Organization (WIPO) of the United Nations has initiated round-table discussions to institute mechanisms to protect folk knowledge[29]. The database treaty, negotiated under the WIPO, raises new concerns and challenges. It provides discretionary rights to the creators of the databases[30]. In the context of databases of peoples' knowledge, such as trade secrets of Eucador[14] or People's Biodiversity Registers[6,23] of India, co-ownership of the people in the database is essential. Thus not just the accession fees, but also a share of the commercial benefits resulting from use and modifications of the databases must be channelized into the National Biodiversity Fund to reward the contributors.

While negotiating at the intellectual property fora, we must also continue to progress under the CBD framework, taking a clue from some of their recent developments. The International Undertaking on Plant Genetic Resources (IUPGR) of the Food and Agricultural Organization (FAO), United Nations, has lent credence to the concept of farmers' rights arising out of their past, present, and future contributions. This undertaking has accepted, in principle, the rights of the countries of origin over the *ex situ* germplasm preserved in the foreign repositories, housed by the Consultative Group on International Agricultural Research (CGIAR) institutions[31]. About 6,00,000 of these accessions are now proposed to be placed under the auspices of the FAO, which may make them available to the members of the undertaking, free of charge, on the basis of mutual exchange or mutually agreed terms[17]. It is quite likely that a protocol to CBD may soon be developed to operationalize these provisions. As the next step, we must demand that the Clearing House Mechanism (CHM) under the CBD undertakes the responsibility of furnishing information of IPR applications worldwide and of the relevant biological source, prior knowledge and their country/ies of origin[6]. This would help in arriving at international agreements on sharing the trans-boundary commercial benefits in an informed manner. Ultimately, it is intelligent response to enhance our capabilities and the available space that would pay slow but steady, assured dividends.

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The informatization of development*

Harlan Cleveland

The new millennium opens the door to fundamental changes to make civilization fairer to all peoples. Ten concurrent revolutions stem from the huge transformation in our global information environment. The widespread of information – abundant, transportable, leaky, shareable – bodes well for a fairer world, undermining the structures of hierarchy and discrimination that have privileged those 'in the know'. But the disadvantaged will need to work hard at learning how to use the powers inherent in this more accessible resource.

SUPPOSE that none of us had ever heard of the Christian calendar and its culture-bound presumption that we are about to begin not just another year but a new century and a new millennium. Would we still have reason to think that we are living in a time of fundamental transformation? I think we would. Even without the Year 2000 looming on our desk calendars – and the coming perils of 'Y2K' shouting at us from the media – the twin signals of crisis and opportunity are everywhere to be seen.

What the millennium *does* provide is a burst of surplus energy for change, a new motive to innovate, a feeling of excitement, and a special incentive to take stock and map new directions for a longer term – the Global Century and beyond.

Take stock of what? Take stock of the situation as a whole – in American slang, the whole schmear. In a nutshell: We know now that the entire way of life in the modern world is not sustainable. It hardly matters whether by 'long term' we mean half a century or two centuries. Once we accept the prognosis, the crisis remains. Nothing short of fundamental transformation of our most powerful institutions – and underlying that, of modern thought and prejudice, will alter the ultimate catastrophe.

From means to meaning

Four years ago the late Willis Harman, an old friend of mine and a longtime co-conspirator in brooding about global affairs, helped launch a five-year inquiry called PeaceBuilding 21 and invited me to join in. It was, and is, a no-holds-barred effort to define, forecast, and perhaps welcome the fundamental cultural changes that seemed to be in prospect. In our shared way of thinking, two ideas were central:

One idea was that everything really is related to everything else, and therefore to whatever one is trying to think through, or get done, right now. To focus on universal connectedness requires one to combine material observation with spiritual experience – and, quite deliberately, to blur the distinction between the two.

Modern, 'Western' science has focused on what can be learned from systematic observation and experimentation, with an intellectual rigour that withholds the accolade of 'truth' from what cannot be proved by the Scientific Method. Yet there seem to be many human experiences, and not only in dreams, that cannot aspire to the credentials of scientific 'proof' but are obviously vivid, relevant, and useful in day-to-day living and planning-ahead, for individuals and their families, groups, and communities – and are therefore, in some larger sense, 'true'.

The other idea was a hunch about the macrotransition we are already in – 'a shift', Harman called it, 'in the locus of authority from external to internal', and a parallel 'shift in the perception of cause from external to internal'. We sensed 'a growing disenchantment with external authorities and increasing reliance on intuitive, inner wisdom and authority'. We resonated with the growing realization that 'we humans create our own reality', that we are 'co-creators' of the world we live in, and that 'ultimate cause is to be sought not in the physical, but in consciousness'.

Willis Harman was not challenging the Scientific Method as such; it had been an important part of his own professional upbringing. What he seemed to be saying in his latter-day writings was that scientific rationality simply did not, could not, go far enough to explain the way human beings are able to think, and therefore to act. This led him to raise interesting – to some, disturbing –questions, not so much about means as about meaning.

'The fundamental question as we look ahead', he wrote not long before he died, '. . . is basically a question of meaning. What is the central purpose of highly industrialized and technological societies where economic production is no longer a central purpose, in part because it does not lead to a viable global future?'

From means to meaning . . . from external to internal . . . from unsustainable to sustainable . . . . There are intriguing hints here about the macrotransition we are already in. For if we are to move from a century of fear to a century of hope, we will have to move

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beyond a focus on the instruments human beings use to a focus on the human beings that use them.

A look ahead

On this first day of the rest of our lives, it may be useful to raise our periscopes for a 360-degree look around. My sweep of the horizon shows ten worldwide revolutions already transforming our world. They are concurrent, but not parallel – rather, they are intermixed, interwoven, interactive.

First – The sudden increase in explosive power has clamped a lid on the scale of warfare – a first in human history. The invention of weapons too big to use converted much of our big-power military strategy into an expensive information game. But it also leaves smaller wars in scattered places as the archetypical conundrum of 'global security' in the 21st century.

Second – Biotechnology, including the deciphering of information in living genes, presents humankind with a vast range of new ethical and political puzzles. Human cloning, which currently captures the headlines, is only one of them. In all sorts of ways, we human beings are becoming increasingly responsible for our own evolution.

Third – Computers, serving as prosthetic extensions of our brainpower, are replacing much of the repetitious drudgery people have always had to endure. They bring in their train new puzzles about the future of 'work'. But the elimination of drudgery cannot be bad news for the generations to come.

Fourth – Linking fast computers with more reliable telecommunications enables us to model and simulate vast systems such as the global atmosphere, the human genome – and nuclear fallout from megaton explosions. This is sensitizing us to the consequences of what we people are doing to our natural environment – and might inadvertently do to ourselves.

Fifth – The widening spread of knowledge is creating a 'skill revolution' and a fundamental change in the technology of organization: pyramids and command-and-control are on their way out, *consultation* and consensus are increasingly 'in'.

These five transformations are driven quite directly by scientific discovery and technological innovation. The other five are facilitated, even intensified, by science and technology. But they are *driven* by universal aspirations of human spirit – by a widespread sense of entitlement to 'enough' (the fulfillment of basic human needs), and beyond that by equally basic human desires for a sense of achievement, justice, solidarity, and participation.

Sixth – A global fairness revolution is spreading as the spread of knowledge shows the disadvantaged in every society what they are missing – and provides them with new means of communication to express their rising resentments and help them 'overcome'.

Seventh – The idea of human rights for everyone has become the first truly universal idea-system in world history. It has most clearly come to mean, in the first instance, rights for members of groups – not only for traditional minorities and political prisoners, but also for women, children, and the aging, for immigrants, for refugees, and for all manner of people once considered 'untouchables'. But, nearly everywhere, the rights of *individuals* fall short of full recognition. And matching universal human rights with universal human responsibilities is mostly left to be worked out in the 21st century.

Eighth – Fierce loyalties to cultural identity with less-than-global communities – bonded by ethnicity, race, religion, ideology, and even occupation – are colliding everywhere *both* with the homogenizing cultures of globalization *and* with the human rights of individuals who happen not to belong to the in-group.

Ninth – An emerging ethic of ecology is producing a revolution in human self-control – based not on 'limits to growth' but on limits to thoughtlessness, unfairness, and conflict. The resulting international cooperation is producing, here and there, a 'growth of limits'.

Tenth – Openness, market incentives, and the practice of pluralism are currently on display in some of the unlikeliest places. Authoritarian and totalitarian systems are simply unable to compete with looser systems that 'go with the flow' in the global flood of knowledge.

These global tides and currents are all related to each other. Indeed, modern biologists and ecologists have joined a long list of spiritual prophets, inspired poets, and secular philosophers in insisting that everything is related to everything else, that human beings are all somehow connected to each other – and that, in consequence, each of us has to try and think hard about 'the situation as a whole'.

The striking thing about all ten of these global windshifts is the extent to which they all are rooted in or enhanced by the historically sudden spread of knowledge, that huge transformation under described by the pallid phrase 'the information revolution'.

The information environment

I learned in Hawaii, where I once lived in the shadow of a volcano, that long before it blows, seismologists can hear it rumble: the volcano is clearing its throat. In trying to detect the seismic rumbling of our human futures, we social non-scientists also learn to look for relevant clues. Among our clues are the tools we humans fashion ahead of the eruptions that follow – because our tools are typically invented *before* we can imagine what they will be used for.

Scientists who study animals suggest that it's not quite clear that humans are in all respects brighter than some animals – brainier than dolphins, say. But it's surely clear from our short history on this planet that humans are much better than dolphins, or chimpanzees or elephants, at making tools. We mounted an

agricultural revolution with 'the plow that broke the Plains'. We invented motors and brought forth an industrial revolution. And just the other day, we did it again.

In the great social event of the 1980s, we married computers to electronic communications and touched off another eruption of change that will affect everybody and everything – every political process, every business, every profession, every intellectual discipline, every 'settled' theory, every organized religion, every traditional culture – in the Global Century.

We cannot pretend to forecast just *what* will happen, or *when*. But we already know something more important: Why it will happen.

As far into the future as we can see, information will be playing the lead role in world history that physical labour, stone, bronze, land, minerals, metals, and energy once played. That requires us, who are now destined to live in the 21st century, to revise all sorts of assumptions we have treated as solid but now turn out to be fragile and flawed. We have to burn into our consciousness how very different information is from all its predecessors as civilization's dominant resource – because information is *symbols*, not *things*. The essence of this difference is that information is more accessible than the world's dominant resource has ever been before.

Information is not necessarily depletive: it *expands as it is used*. It is readily *transportable*, at close to the speed of light. Information *leaks* so easily that it is much harder to hide and to hoard than tangible resources. The spread of knowledge *empowers the many*, simply by eroding the influence that once empowered the few who were, as we used to say, 'in the know'. Information *cannot be owned* (though its delivery service can); so the phrase 'intellectual property' is surely an oxymoron. And giving or selling information is not an exchange transaction, it is a *sharing* transaction.

These six simple, pregnant propositions, as they sink in around the world and down the generations, should help us sort out some of the big conundrums that puzzle us as we turn the corner to a new millennium. Let us see what they do to our thinking about 'development'.

Rising expectations, cascading revolutions

A doleful legacy of the 20th century is the still-growing gap between rich and poor – among countries and inside countries. As information – abundant, shareable, instantly accessible – now becomes the world's dominant resource, what does that do to the prospects for fairness?

Surely it means that people who get educated to handle information, who hone their analytical and intuitive powers, who learn how to achieve access to information and (even more important) how to select what they need from the information overload, will likely be better off and more fairly treated than those who do not.

In the industrial era, poverty was explained and justified by shortages of things: there just were not enough minerals, food, fiber, and manufactures to go around. Looked at this way, the resource shortages were merely aggravated by the propensity of the poor to have babies.

In the era just ahead of us, physical resources are elbowed from center stage by information, the resource that is hardest for the rich and powerful to hide and to hoard. Each of the babies, poor or not, is born with a brain. The collective capacity of all the brains in each society to convert information into knowledge and wisdom is the measure of that society's potential. Consider this measuring rod as you think about India's role – and China's, too – in the 21st century.

But there is a catch: Whether the informatization of the globe will actually mean a fairer shake for those who in earlier times have been the victims of discrimination depends mostly on what *they* do from now on.

Most of the fairness achieved in world history has not been the consequence of charity, good-heartedness, or *noblesse oblige* on the part of those who already possessed riches and power. Always in history, it seems, fairness has been granted, legislated, or seized when there was no alternative. And usually the reason there was no alternative was that the 'downs' were determined – or at least perceived by the 'ups' to be determined – to cast off their shackles and take the law into their own hands.

As information leaks around the world, very large numbers of people are learning about what goes on elsewhere – good things happening in places near and far that could happen to them if their leaders were wiser and more flexible, and bad things happening to other people which could fall out on them if they do not watch out.

During the revolutions of 1989–1991 that pulled the fraying rugs from under the Communist regimes of Eastern Europe, then swept into history the Soviet Union itself, the impatient crowds in the big public squares were moved not by distant visions of Utopia but by spreading information about neighbours, mostly in Western Europe, who were obviously getting more goods and services, more fairness in their distribution, and firmer guarantees of human rights than their own bosses and planners seemed able to deliver.

The good news was that information leaked – and that sharing has long been the natural mode of scientific and cultural communication. The changing information environment was bound to undermine the knowledge monopolies that totalitarian governments had converted into monopolies of power.

The future is an ethical category

Those cascading revolutions a decade ago were dramatic in their details and unpredicted in their timing. But they were no surprise to those who had noticed the way the eastward information flow – by television, radio, facsimile, telephone and most of all by the written word – bred people's intolerance of longtime leaders who simply could not liberalize their policies fast enough to escape the people's wrath.

Around the world outside of Europe, the intensified spread of information was also enhancing the people's political aspirations on every continent – not so much selling them on Western concepts of freedom and democracy as persuading them, by the

millions, that they deserved a say in policies that bore on their own lives and destinies.

Shortly before he died at the end of 1989, the Indonesian philosopher Soedjatmoko (perhaps the wisest wise man I have been privileged to count as a personal friend) spoke of the need for a political philosophy that reconciles freedom for the individual and fairness for the individual. Some human societies meld fairness with freedom better than others do. But none has yet met his prophetic standard. In dancing around this dilemma, he thought, we cannot expect much help from 'the older religions, ethical systems, and philosophies', because today's options, opened by the information revolution, did not exist when they were developed.

We will therefore have to learn, said Soedjatmoko, 'to enhance our capacity for moral reasoning, to deal with problems' for which 'we cannot find analogies in older, petrified systems of wisdom'. Unless we do that, we will be stuck with 'obsolete, fossilized social and political structures'. Then we would be destined 'to work hard for our own demise . . . in a world of very rapid change without fixed road signs'.

The learners in every society are starting to fashion their own road signs – some adapted from older systems of wisdom, some the result of new intellectual or spiritual inspiration. 'The future is an ethical category', Soedjatmoko was fond of saying, 'because we choose it ourselves'.

A global fairness revolution

The rich countries – and the rich people in every country – thus face a global fairness revolution, multiplying the demands on a world economic system that still knows how to include only a minority of humankind in its benefits.

Both among and within the 'nation-states' of the 20th century, the old French warning retains its relevance: *Entre le fort et le faible, c'est la liberté qui opprime et et la loi qui affranchit.* (In relations between the strong and the weak, it is freedom that oppresses and law that liberates.) But if law is too rigid and universal, as Aristotle had already figured out two and a half millennia ago, the urge for equality or fairness will arise to correct the law. A 'triple collision' (modernization versus tradition versus fairness) can be found in the recent and current history of dozens of countries, with local variations reflecting local cultures. Part of the stew of resentments seems always to be the complaint every child learns to make from infancy: 'it isn't *fair*'.

The key that unlocks 'growth with fairness', in the United States and India and elsewhere in the global information society, is widespread access to relevant education.

More than any one factor, it was that forward-looking early nineteenth-century decision to mandate free public education for every young US resident that enabled the American people to pull themselves out of 'underdevelopment'. Another wise educational policy, the Morrill Act of 1862, used federal land grants to set up university-based agricultural research stations and build a county-by-county extension service to deliver the resulting science directly to farmers. That made possible those 'amber waves of grain', celebrated in our loveliest national song, that are still today a centerpiece of the world food market.

Around the horizon of the developing world in Asia, Africa, and Latin America, the close connection between education and equitable development is now crystal clear: *The poor can get rich by brainwork*.

The Japanese amply demonstrated this theorem of wealth creation from the earliest dawn of the information era. Two of the most dramatic demonstrations in my lifetime have been India's Green Revolution in the 1970s – a public-sector initiative in which our host M. S. Swaminathan played so central a role – and the private-sector software surge in the 1990s that has made India a global player in the world's most phenomenal industry.

Also in our own time the hustling people of South Korea, empowered and emboldened by a national policy of universal education dating only from the 1950s, have become the newest members of the OECD, the 'rich countries' club. During the same half century, Taiwan, Singapore, and Israel have in their differing fashions demonstrated the close connections between brainwork and prosperity. Their economies have not only grown faster than those in other developing countries, but the benefits of that growth have been spread more fairly among their own people than in developing countries that are 'favoured' (as they are not) by endowments of oil or hard minerals or good soil or moderate climate.

Indeed, the growing importance of brainwork has to be good news for every country less endowed with geological riches and arable farmland than were the early arrivers of the industrial age. Around the developing world, the striking paradox is that the most successful countries are precisely those *not* blessed with wealth-creating natural resources.

Nor does this mean they had to swallow Western culture whole along with the industrial, agricultural, and information technologies they import, improve, then export. The Japanese, after more than a century of modernization, are still strikingly Japanese. The South Koreans, after half a century of intensive Western exposure, are still strikingly Korean. The Chinese of Singapore have managed to become 'modern' without becoming more than superficially 'Western'.

By contrast, in the countries whose people have been kept in ignorance (by colonial policies, or their own leaders' mismanagement, or first one and then the other), it hardly seems to matter what riches lie in the space they occupy. Most of their citizens become peasants of the information society – along with the drop-outs in the post-industrial world. The physical riches get siphoned off to benefit the educated folk huddling in the affluent sections of their central cities, and to enrich the information-wise foreigners who 'come to do good and do well'.

No excuses

To chart the potentials of the global information revolution is not to fulfill them. The predictable trends in information technology will make it possible to organize as a commons most of the world's most useful information, serving it up to those on every

continent who take the trouble and make the effort to convert it into usable knowledge and practical wisdom.

That is not to say that this will happen. But it helps me leave you with two solid predictions about the coming millennium. First: Those who now think 'it isn't fair' will have plenty of opportunity to get access to almost any information now being withheld from them to their disadvantage. But second: They will have to prepare their brains for the task, and they will have to want to work hard at it. In the information society as in its predecessors, there is no free lunch.

In the rapidly changing information environment of the coming century and beyond, there will be much less excuse than in the past for depriving whole populations of the benefits of development that *could* benefit the many, not just the few.

There will also be less excuse than in any previous time for the leaders of the disadvantaged to blame their condition on the world's barons and bosses, when the accessible information to create their own knowledge and wisdom is already floating out there in cyberspace.

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How to get a research grant

N. R. Kalla

Career as a research scientist requires intellect, imagination, skill and great deal of persistence. Research is, of course, a costly endeavour, no less valuable to society than any other business or trade. Scientists have long had to generate money for their research. Perhaps there could be some examples where the personal wealth has allowed for free expression and pursuit of their ideas, but these could be exceptions rather than the rule. Thus if you wish to develop a career as an independent scientist you must also be able to successfully compete for these funds that would allow you to fulfill your objectives. These come primarily in the form of grants, either from private foundations or from government funding agencies. Grants are available from international agencies also. Winning a grant means that you, your department and your institute are benefited.

It is widely acknowledged that many a budding scientists find the task of writing a research grant proposal more difficult then executing the project once the funding has been obtained. It is quite surprising that those bright ideas just do not seem to come off the end of the pen, or the keyboard in a well-organized and systematic way. The same hardworking young investigators write confidently research papers for the journals which have high impact factors.

In India, the main government agency responsible for funding in science is Department of Science and Technology (DST),

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Government of India and the unit of the DST at the state level. In addition, there are other agencies giving grants in specified areas, e.g. in agriculture by the Indian Council of Agriculture Research, in health by the Indian Council of Medical Research/Ministry of Health, etc.. While application forms and processes may be different for these agencies, the concepts are all similar in that you must compete for funds before peer review panels. Regardless of the source of funding, the successful grant application is characterized by: (1) clearly stated and novel hypothesis, (2) the presentation of a strong rationale in support of this hypothesis, (3) compelling data providing evidence for the feasibility of the study, (4) development of a logical, well-conceived experimental plan that will unequivocally test the hypothesis, and (5) a realistic budget to complete the project in a specified time frame.

There are two kinds of grant applications: by an individual scientist and by an organization. The grant applications by individuals are more in number. Prasad, a former officer of World Health Organization rightly said. 'Out of all the countries perhaps it is easiest to get a grant support in India'. As a matter of fact, plenty of money is available but there are not sufficient grant applications. Grant support is an important component of scientific manpower training. In USA hardly 10 to 15% of the scientists end up in getting a grant support. Although the National Institute of Health (NIH), the largest research funding agency in USA in bio-medical sciences, approves many grant applications on scientific merit but it does not provide funds in many cases due to lack of money.

University Grants Commission (UGC) provides grant support for college lecturers, university teachers and retired teachers up to the age of 70 years with a honorarium of Rs 6000/month. In addition bulk money is provided by the UGC to the universities for grant support to young teachers. To get more teachers into research, UGC provides small amounts of money to young teachers in the form of minor projects.

In India the organizations do not have a system to maintain the list of funding agencies and/or availability of funds under different programmes. It is difficult to find a directory giving information about the availability of research grants under different programmes. I once asked Gumman, Assistant Registrar, (Academics) of my University to provide me a list of agencies providing grant support. To my great disappointment, he not only showed his total ignorance about what I was asking but said emphatically that there is no section in the University which keeps this information. I must admit, he was right. I presume this is true, by and large, for most of the universities. I made an abortive attempt to get this information from the Dean's office who in turn asked me to contact Dean, Science Faculty. His reply was 'it does not fall in my preview. You have to find out yourself'.

Although there are no rules to get a research grant, a granting agency develops a set of criteria to be used by the reviewers as they evaluate the merit of the grant. With minor modifications, the same principle applies across all levels of grant review. One should be aware of these criteria, since the way in which one addresses them will be a part of the assessment of merit of the grant. During the course of the review, the following questions are to be asked as part of the evaluation.

Significance: (i) Does the study address an important problem? (ii) How will the study advance scientific knowledge? and (iii) Will the expected outcome further improve the field?

Table 1. Agencies providing grant support in science and technology

Agency	Contact address
Department of Atomic Energy (DAE)	The Scientific Secretary (BRNS), Department of Atomic Energy, Director's Office, Ist Floor, Central Complex, BARC, Trombay, Bombay 400 085
Department of Biotechnology (DBT)	Director (R&D), Department of Biotechnology, CGO Complex, Lodhi Road, Block No. 2, Floor 7, Room No. 12, New Delhi 110 003
Department of Chemicals and Petroleum	The Secretary, Ministry of Chemicals & Petroleum, Sastri Bhavan, New Delhi 110 001
Department of Coal (DOC)	Director (Research, Development & Technology), Central Mine Planning & Design Institute, Gondwana Place, Kanke Road, Ranchi 834 008
Department of Education (DOEd)	Deputy Education Adviser (T), Division TD. VI, Department of Education, Ministry of Human Resource and Development, Shastri Bhavan, New Delhi 110 001
Department of Electronics (DOE)	The Member Secretary, Technology Development Council, Department of Electronics, 'A' Block, CGO Complex, Lodi Road, New Delhi 110 003
National Radar Council (NRC)	The Member Secretary, National Radar Council, Department of Electronics, Lok Nayak Bhavan, New Delhi 110 003
Electronics Materials Development Council (EMDC)	The Member Secretary, Electronics Materials Development Council, Department of Electronics, Lok Nayak Bhavan, New Delhi 110 003
National Microelectronics Council (NMC)	The Member Secretary, National Microelectronics Council, Department of Electronics, 1, Eastern Avenue, Maharani Bagh, New Delhi 110 065
Department of Environment (DOEN)	The Secretary, Department of Environment, Paryavaran Bhavan, Block No. 2, CGO Complex, Lodi Road,

Table 1. (*Contd*)

Agency	Contact address
	New Delhi 110 003
Department of Non-conventional Energy Sources (DNES)	The Secretary, Department of Non-conventional Energy Sources, Block No. 14, CGO Complex, Lodi Road, New Delhi 110 003
Department of Health and Family Welfare	
(i) Voluntary Organization for Health & Family Welfare	The Under-Secretary (VOP), Ministry of Health & Family Welfare, Nirman Bhavan, New Delhi 110 011
(ii) Family Welfare	Dr Vikram Behal, Assistant Commissioner, Department of Family Welfare, Nirman Bhavan, New Delhi 110 011
Department of Ocean Development (DOD)	The Secretary, Department of Ocean Development, Mahasagar Bhavan, CGO Complex, Lodi Road, New Delhi 110 003
Department of Science and Technology (DST)	
(i) Science and Engineering Research Council Scheme (SERC)	The Head, SERC Secretariat, Department of Science and Technology, Technology Bhavan, New Mehrauli Road, New Delhi 110 016
(ii) Intensification of Research in High Priority Areas (IRHPA)	The Adviser, STP, Department of Science and Technology, Technology Bhavan, New Mehrauli Road, New Delhi 110 016
(iii) R&D Programmes under Engineering Science	The Adviser, ET Division, Department of Science and Technology, Technology Bhavan, New Mehrauli Road, New Delhi 110 016
(iv) Science and Society Related Programmes	The Head, Science and Society Division, Department of Science and Technology, Technology Bhavan, New Mehrauli Road, New Delhi 110 016
(v) Science and Technology Application for Rural Development (STARD)	
(vi) Science and Technology for Weaker Sections (STAWS)	
(vii) Scheme for Young Scientific Professionals	
(viii) Science and Technology for Women	
(ix) Utilisation of Scientific Expertise of Retired Scientists (USERS)	
(x) Special Component Plan	
(xi) Science and Technology Communication and Popularisation Programme	The Director (NCSTC), Department of Science and Technology, Technology Bhavan, New Mehrauli Road, New Delhi 110 016
(xii) Natural Resources Data Management System (NRDMS)	The Director (NRDMS), Department of Science and Technology, Technology Bhavan, New Mehrauli Road, New Delhi 110 016
(xiii) Instrument Development Programme (IDP)	The Adviser, Instrument Development Division, Department of Science and Technology, Technology Bhavan, New Mehrauli Road, New Delhi 110 016
(xiv) R&D Medium Range Weather Forecasting (NCMRWF) and Crop-Weather Relationships	Project Coordinator (NCMRWF), Department of Science and Technology, Technology Bhavan, New Mehrauli Road, New Delhi 110 016
(xv) Opportunities for Young Scientists	The Head, SERC Secretariat, Department of Science and Technology, Technology Bhavan, New Mehrauli Road, New Delhi 110 016
(xvi) Science & Technology indicator and Manpower Studies	The Joint Adviser, National Science and Technology Management Information System (NSTMIS), Department of Science and Technology, Technology Bhavan, New Mehrauli Road, New Delhi 110 016
(xvii) Consumer Protection through Science and Technology	The Joint Adviser, Technology Systems Division, Department of Science and Technology, Technology Bhavan, New Mehrauli Road, New Delhi 110 016
India Meteorological Department (IMD)	The Director General of Meteorology, India Meteorological Department (IMD), Mausam Bhavan, New Delhi 110 003

Table 1 contd. . .

Agency	Contact address
Department of Scientific & Industrial Research	
(i) National Information System for Science & Technology (NISSAT)	The Joint Adviser, National Information System for Science and Technology, Department of Scientific & Industrial Research, Technology Bhavan, New Mehrauli Road, New Delhi 110 016
(ii) Technology Absorption and Adaptation Scheme (TAAS)	The Joint Adviser (TAAS), Department of Scientific & Industrial Research, Technology Bhavan, New Mehrauli Road, New Delhi 110 016
(iii) Details of other schemes	The Adviser, Department of Scientific & Industrial Research, Technology Bhavan, New Mehrauli Road, New Delhi 110 016
Department of Space (DOS)	The Scientific Secretary, ISRO Headquarters, F-Block, Cauvery Bhavan, District Office Road, Bangalore 560 009
Ministry of Welfare (MOW)	The Director (NI), Ministry of Welfare, Shastri Bhavan, New Delhi 110 001
Ministry of Urban Development (URBD)	The Adviser (PHEE), Ministry of Urban Development, Nirman Bhavan, New Delhi 110 001
Central Board of Irrigation and Power	
(i) Research Scheme Applied to River Valley Projects (RSRVP)	The Member Secretary, Central Board of Irrigation and Power, Malcha Marg, Chanakyapuri, New Delhi 110 021
(ii) Research Scheme on Flood Control (RSFC)	
(iii) Research Scheme on Plasticulture Development (RSPD)	
(iv) Research Scheme on Power (RSOP)	
Council for Advancement of People's Action and Rural Technology (CAPART)	The Director General, Council for Advancement of People's Action and Rural Technology, Guru Nanak Foundation Building, New Mehrauli Road, New Delhi 110 067
Council of Scientific and Industrial Research (CSIR), (a) Research Scheme, (b) Research Fellowship and Associateship, (c) Emeritus Scientistship, (d) Person/Institute based Centre of Excellence., (e) Otter Science and Technology Promotion Programmes	Scientist-in-Charge, Extramural Research Division, Council of Scientific and Industrial Research, CSIR Complex, NPL Campus, Pusa, New Delhi 110 012
Defence Research and Development Organization (DRDO)	The Director of Training & Sponsored Research, Defence R & D Organisation, Ministry of Defence, 'B' Wing, Sena Bhavan, New Delhi 110 011
(i) General Science Scheme Life Sciences Research Board	
(ii) Research and Training (Electronics) Scheme of DRDO	
Aeronautics Research and Development Board (ARDB)	The Secretary, Aeronautics R&D Board, Directorate of Aeronautics (R&D), Ministry of Defence, 'B' Wing, Room No. 328, Sena Bhavan, New Delhi 110 011
Indian Council of Agricultural Research (ICAR)	Officer on Special Duty (PI & M), Indian Council of Agricultural Research, Krishi Bhavan, Dr Rajendra Prasad Road, New Delhi 110 001
Indian Council of Medical Research (ICMR)	The Director General, Indian Council of Medical Research, Ansari Nagar, New Delhi 110 029
Oil India Limited (OIL)	The General Manager, (Research & Development), Oil India Limited, Duliajan 786 602
Oil and Natural Gas Commission (ONGC)	The Director – IEOT, Oil & National Gas Commission (ONGC), Post Box 123, Dist. Raigad, Panvel 410 221
Steel Authority of India	Steel Authority of India Ltd, Research and Development Centre for Iron & Steel, Inspat Bhavan, Lodi Road, New Delhi 110 003
University Grants Commission (UGC)	University Grants Commission, Selection and Award Bureau, South Campus, Delhi University, New Delhi 110 021

Approach: (i) Are the conceptual framework, design, methods and analyses adequately developed, well integrated and appropriate to the aims of the project? and (ii) Does the applicant acknowledge potential problem areas and consider an alternate approach?

Innovation: (i) Does the project employ novel concepts or

Elaborated...

Table 1. (*Contd*)

methods? (ii) Are the aims original and innovative? and (iii) Does the project challenge existing paradigms or develop new methodologies/technologies?

Investigator: (i) Is the investigator appropriately trained and well suited to carry out this work? and (ii) Is the work proposed appropriate to the experience level of the investigators?

Environment: (i) Does the scientific environment in which the work will be done, contribute to the probability of the success? (ii) Do the proposed experiments take advantage of unique features of the scientific environment or employ useful collaborative arrangements? and (iii) Is there evidence of institutional support?

Do not hesitate to take the help of professional grant writers to apply for a grant. If you cannot hire a person to do so, encourage people in your organization who can keep an eye on what programme money is available. Availability of the right information at the right time is important. One has to burn the midnight oil in writing a grant proposal. The key to winning grants is read the rules carefully; what the term means and how to use them. A friend of mine doing research at Indian Institute of Science, Bangalore submitted a grant proposal for support in biomedical research. It took more than two years to settle a minor administrative point. After the dispute was settled and when the application came for scientific evaluation, the proposal was turned down because the project had lost its importance. Try to find out what the granting agency wants and not what you have. There is no harm in modifying your plans according to their requirements. If you are asking for a big developmental grant, do not hesitate to take the help of the elected members of your area/organization whenever necessary.

Table 1 gives a list of agencies providing grant support in S&T. For more details about the granting agencies in India, please write to the author at the following address: Secretary, Northern Indian Science Association, P.B. 1204, Sector 14, Chandigarh 160 014, India.

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