Economics of knowledge*

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THE breathtaking pace at which science is moving is not only shaping our present, but also is going to dominate our future. A nation's ability to convert knowledge into wealth and social good through the process of innovation is going to determine its future. I, therefore, want to focus on the exciting subject of economics of knowledge, which will dominate the coming century.

Knowledge societies

Tomorrow's societies will be knowledge societies. Tomorrow's markets will be knowledge markets. Tomorrow's wars will be fought not by the conventional weapons, guns, missiles and so on, but they will be fought in the knowledge markets with the new thermonuclear weapons called information and knowledge. The war on a patent right, which took place between Eastman Kodak and Polaroid, was settled for about one billion dollars recently. This is half of India's R&D budget! So these wars in the knowledge market will be quite expensive.

The power of knowledge in the knowledge society is there for all of us to see. The paradigm shifts are truly dramatic. For more than a century, the world's wealthiest human being has been associated with oil, starting with John Rockefeller in the last nineteenth century and ending with the Sultan of Brunei in the late twentieth century. But today, for the first time in history, the world's wealthiest person is a knowledge worker, Bill Gates!

I want to emphasize that to meet the twin objectives of growth with equity, knowledge cannot be the prerogative of a few; everyone in the society must have access to knowledge and become a knowledge worker. Nations which do not create knowledge societies will vanish into oblivion. But those that do create these knowledge societies will have the potential to lead the world. India has a chance to become a leader provided it sets this process of creating the knowledge society in place with speed and determination.

Knowledge workers

If the Indian society has to become a knowledge society, then it is important that every Indian becomes a know-

*Excerpts from the 16th Dr C. D. Deshmukh Memorial Lecture delivered on 14 January 1999 at the International Centre, New Delhi, India.

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ledge worker. We need to recognize the concept of a knowledge worker in the broadest possible sense. It is not scientists and technologists alone, who will be knowledge workers. Even a farmer can be a knowledge worker, provided he understands the soil that he is sowing his seeds in, he understands why and how of the micro-nutrient and pesticide addition that he makes, he lives in an information village, where he has the benefit of short- and medium-range weather forecasting to plan his farming activity and so on. If he does so, then he will be a continuous user of knowledge and he will be a knowledge worker.

Let me illustrate this concept further. I had the privilege of witnessing some truly novel models being tested by M. S. Swaminathan Research Foundation on creating new knowledge systems in the villages around Pondicherry last week. The knowledge system for sustainable food security in the Pondicherry villages has its goal in the empowerment of rural women, men and children with information relating to ecological agriculture, economic access and utilization. Such a knowledge system is being managed by local youth at the Village Knowledge Centre, from where the computer-aided information system is operated. Farmers, who are becoming knowledge workers, are also being trained to maintain a 'Soil Health Card' to monitor the impact of farming systems on the physical, chemical and microbiological components of soil fertility.

If a customer becomes a knowledge worker, he will change the market dynamics. We take great pride in the *white revolution* that took place in India, with India emerging as the largest milk producer in the world last year. But let us remember those early days when some producers began diluting the milk and customers could not determine its quality before buying it. It was empowering the customers with knowledge using simple kits to determine the buttermilk content, that put emphasis on quality, and led to the qualitative and quantitative growth of milk production.

Enlightened citizens empowered with knowledge will be able to see the crucial link amongst the 5Es, namely environment, ecology, economics, equity and ethics. They will not be then guided by misinformation fed by vested interest groups. But they will use their knowledge to decide on their own as to what is wrong and what is right. They will not stop projects that lead to economic development, but they will stop those that lead to destruction. India's economic development will crucially depend on the society's understanding of the new knowledge. After the green revolution, we need an evergreen revolution and a nutritional revolution. We will have the gigantic task of producing 350 million tonnes of food grains by the year 2040 to feed 1.5 billion Indians. We will have to produce more food from the same land; only new knowledge can do that. Modern biotechnology involving genetically engineered crops will be a crucial alternative. But lack of understanding in the society can stop the process of this new

knowledge from reaching the farm, the signs of which are already seen in India. Empowerment with knowledge at all levels is, therefore, crucial.

In a knowledge society, the knowledge workers will perform different tasks. Some of them will generate knowledge, some will acquire knowledge, some will absorb knowledge and some will communicate know-ledge. Generating knowledge will require an *ab initio* approach and will build on creativity. India traditionally has been good at this. Acquiring knowledge will involve both development of knowledge indigenously as well as acquiring it from elsewhere in the world, through licensing agreements, foreign investment and so on. Absorbing knowledge will involve ensuring universal basic education, creating opportunities for lifelong learning, supporting tertiary education in science and technology, etc. For building true knowledge societies, extending education to girls and other disadvantaged groups will be crucial. Education will be crucial for development, but education without openness to innovation and knowledge will not lead to economic development. The Soviet Union had near hundred per cent literacy but severe restriction on innovation in the market place led to an economic decline.

Communicating knowledge will involve, among other things, creative use of modern information and communication technology through competitive environment, but at the same time ensuring that the poor have an access. Revolution in information technology will galvanize the process of knowledge communication. The cost of transmitting a million bits of information over a kilometer has plummeted in the last twenty years from over twenty dollars to a few cents; and the curve is logarithmic. In 2020, half of the world's population will be connected by Internet; we will be then talking about 'netizens' and not 'citizens'! Access to information and knowledge will therefore assume a different dimension altogether.

Knowledge industries

Increasingly, the traditional factors of production – land, labour and capital – have become less important when compared with technology; the economists have termed this as the 'expansion of the production frontier'. The source of technology is in science, that is rooted in knowledge. It is easy to visualize that tomorrow's industries will be knowledge industries. The emphasis will not be on physical or tangible assets, but on intangible knowledge assets. The value of intellectual capital of an industry will determine its rank and competitiveness. In such industries, there will be a major shift from people, who handled information and did routine and unthinking work, to those who will use knowledge at every stage. For knowledge workers, information and knowledge will be both the raw material of their labour as well as its product.

The world's major growth industries – such as micro-electronics, biotechnology, designer-made materials, and telecommunications – are already brainpower industries. These knowledge industries stimulate other industries, in turn, to

become knowledge based. Consider the oil industry. The issue of 'bottom of the barrel' is driving the economics of these industries. New knowledge embedded in three-dimensional acoustical sounding, horizontal drilling, and deep offshore drilling is turning oil business into a knowledge industry.

One might wonder as to why the physical assets such as machinery in a factory, are becoming less important. Plant and machinery are tradable commodities today. Even capital was a scarce commodity until recently and was used as a competitive advantage. But with globalized markets the companies around the world have access to finances at inexpensive rates. So even capital is no longer a scarce commodity. It is the intangible assets which are knowledge based, and that are non-replicable, unique and proprietary, that are providing companies with a competitive edge.

The nature of intangible assets will vary from industry to industry, but they will include several commonalties such as research and development, patents, proprietary technologies, databases, brands and even relationships, people and so on. The dominance of intangible know-ledge assets will mean that we will have to make major changes in the management structures. Around the world, managements are built in the framework of stra-tegy, structure and systems. The top management is always the grand strategist and decides on the allocation of resources, and the lower management merely implements and administrates the strategy. With domination of intangible assets, one will have to create new models. The top management will create only an overarching purpose and an environment in which the people have the freedom to deliver. This means the emphasis will shift to defining the purpose of the organization, setting the right process and getting the right people and empowering them to deliver.

The industry will have also to think about things which it never cared for. For instance, among the intangible assets, customer loyalty which arises out of customer satisfaction and the commitment of employees will be the two very important intangible assets. The investors will not merely focus on tangible assets but start assessing the customer satisfaction index or an employee satisfaction index of a firm. Such intangible assets may become the heart of the annual reports of the companies. My own CSIR is a knowledge-based organization. When dealing with our industrial clients, we wish to undertake research as a business and do it in a business-like manner. Last year we set up the process of evaluating the customer satisfaction index and making it as one of the performance indicators that will determine every laboratory's budget. I expect this process to spread as rapidly as the quality movement in India spread during this decade.

Will the accounting norms for intangible-asset-dominated companies change? Can the intangible assets be valued and formally be a part of the balance sheet of firms? Will the stock markets be willing to recognize intangible assets as

something real, particularly when accounting norms do not do so? Will the lenders who lend today against current fixed assets be prepared to consider knowledge assets? One does believe that this paradigm shift will come in the near future and the balance sheets of knowledge-based companies will undergo a formal change. After all, Japan is already accepting intangible assets such as intellectual property as a security against loan and not insisting on fixed assets. A couple of years ago, CSIR laboratories were allowed to use knowledge as an equity in start-up companies, and not insist on payment of fees. Such and other formal recognitions will push companies into developing their intangible assets further leading to a better performance.

Finally, for a cash starved but intellectual-capital-rich country like India, emergence of knowledge industry is good news. But harnessing the full potential of knowledge industry requires an aggressive and visionary policy framework, creative planning, daring and risk taking. It needs to be recognized that the knowledge industries such as software development, pharmaceutical industry, biotechnology, engineering services, etc. operate in a highly competitive environment with great demand on the speed of response in dynamic market conditions. A high operational efficiency and functional flexibility is crucial for such industries. The Government policies, therefore, have to be conducive to provide these. For example, the knowledge-based companies that employ knowledge workers are in great demand and some of them may require global level compensation with schemes to create and share wealth. Employers' stock option plans need to be made available in such industries. India has yet to set up proper technology financing mechanisms, which are risk taking and which can cater to the knowledge industries. In particular, the venture capital financing is very poor in India and yet at the same time we recognize that Intel, Microsoft, Apple, etc. would not have seen the light of the day but for the venture capital financing. Appropriate regulatory frameworks need to be set up. The labour laws in India are obsolete when one considers the environment in which knowledge workers in knowledge industries thrive. For instance, Shops & Commercial Establishment Act, 1961 and Rules restricts working hours to 9 h on any day and 48 h in a week whereas in knowledge industries, flexible timings to meet the needs of the global customers are absolutely essential. It is important to recognize that knowledge work in knowledge-intensive industries cannot be governed by using the laws meant for physical labour. Several other changes in foreign exchange regulations, etc. will be needed to cater to the needs of export-intensive knowledge-based industries.

Options on knowledge generation and acquisition

Fredrico Mayor, the Director General of UNESCO recently said 'knowledge flows from north to south and wisdom flows from south to north'. I may make a small correction; 'knowledge' may flow from north to south but 'usable knowledge' does not flow that easily from north to south, since usable knowledge has the potential

to create wealth. No country, no corporation gives a competitive advantage to another, excepting at a price. India itself has realized this in the post-liberalization era.

In India, we always considered the ‘make’ or ‘buy’ options, which unfortunately got converted to ‘importing’ and ‘import substituting’ in the closed economy that we had. But if India has to create the best practice in economics of knowledge then it will have to carefully consider not just the two options of ‘making’ or ‘buying’, but also ‘buying to make better’, ‘making to buy better’ and ‘making it together’. Let me explain what I mean. ‘Making’ has been a preferred course of action, but one cannot make everything. Also if one has to reach a high rate of economic growth, then other alternatives have to be sought. ‘Buying’ the knowledge embedded in a technology or a machinery is possible, when the owner is willing to part with it. Even in the post-liberalized era, India has realized that when Mark III technologies are available with the owner, one has managed to discuss only Mark II and one has been lucky to get Mark I, since no one wants to give away a competitive advantage. Let us realize that India is not being looked at as a bottomless pit of demand but as a global competitor.

Smart countries like Japan opted for the third option of ‘buying to make better’ route. They acquired knowledge through licensing, absorbed it and developed superior products, which competed with the best in the world. India did not do that; we kept on buying and buying. We have also not followed the fourth option of ‘making to buy better’. Familiarity with a knowledge or a technology domain gives one an advantage in negotiations, strategic positioning and so on. It is only then one can negotiate for and get Mark III technologies from a position of strength.

For a resource-poor country like India, ‘making it together’ is the preferred option in the long run. This means creating knowledge networks between all knowledge centres in the academic world, national laboratories, etc. and our productive sector. Let me pursue this option in some depth.

Building knowledge networks

How do we build knowledge networks between the productive sector and R&D institutions and what are the hurdles? Publicly funded R&D institutions should be used as idea generators and providers of new concepts by the industry. Industry should not look at institutions as super markets where off-the-shelf technologies are sold. Indian industry should be prepared to assume the role of partners, who have the technical, financial and marketing strengths to take ideas to the market place. As regards the products emerging from R&D laboratories, these invariably come out as some sort of packages containing knowledge and information, whereas the business units will have to convert these into goods and services, which are saleable.

The Indian industry should willingly integrate national R&D resources into their business strategy. Improved communication and understanding, faith in mutual growth and development of healthy working relationships is necessary. The fact that new knowledge has to make an economic sense has not been realized by our institutions. On the other hand, the fact that competitive advantage in business will be reached by using cutting-edge knowledge has not been realized by our industry. There has to be a meeting ground between the long-term horizon of R&D institutions and the short-term horizon of business units. CSIR, as a large publicly funded R&D system, is trying to make a cultural shift in its operations, by looking at research as a business, defining a new product, defining a new process and doing it in a business-like manner. The transformation process has just begun, but CSIR hopes that it will become an effective hub in the Indian knowledge network and play a crucial role in driving forward the issue of getting economic gains from a vibrant Indian knowledge bank.

I have spoken about Indian knowledge networks, but I see equally exciting possibilities for global knowledge networks for economic gains, where India could assume a dominant position. The chain of concept to commercialization necessarily crosses transnational boundaries today. Thus, many major multinational corporations in USA and Europe, whose R&D budgets are larger than even India's R&D budget, are becoming partners of India's R&D laboratories. CSIR's partners today include giants such as Mobil, General Electric, Du Pont, Boeing and so on. For India, rather than remaining a perennial seeker of knowledge from the West, opportunities are opening up for doing even reverse transfer of knowledge.

What is driving this process? Many companies across the world today consider it to be rather unwise to attempt for self-sufficiency in technology development, particularly in an era, where the R&D costs are increasing rapidly. The concept that technology could be acquired rather than reinvented is gaining momentum. As a part of the global innovation strategy, several companies world over are scouting for new ideas and patents. These companies believe that the surest way of becoming technically strong is through knowledge networking with premier organizations across the world. In an era of global connectivity through modern information technology, the concept of virtual laboratory is gaining ground. These global networks are allowing the real-time management and operation of laboratories in any part of the world. Thus, companies are seeking to gain a competitive advantage by using the global knowledge resource and working with a global time clock.

Basic skills are gaining importance and the new paradigm is skill-based competition. The high technology companies are asking as to what skills, capabilities and technologies they should build up, rather than asking a stereotype question, as to which markets they should enter, and with which products. I see an enormous opportunity for India to become a global knowledge platform in the coming century, by partnering these companies in areas where

we can cooperate, leveraging strategically those Indian niches, where we have a competitive advantage.

Role of intellectual property rights in economics of knowledge

I made a reference earlier to the expensive wars in the knowledge market that the Indian industry will have to face, as it integrates its economy with the global economy. Intellectual Property Rights (IPR) will be crucial in fighting these wars! Indeed in the world of knowledge-based competition, IPR will emerge as a key strategic tool. India is way behind the rest of the world and the continuing illiteracy in IPR will hurt us badly. Incorporating strong systems on generation of IPR, its capture, documentation, valuation, protection and exploitation will need a massive thrust.

The issue of patents in particular, has created a national interest and debate of great dimension.
I thought it might be useful to focus on this specific area. A weak physical infrastructure, inadequate intellectual infrastructure, poor public awareness and delays in implementing government policies is hurting India today. We are behind the rest of the world in patents, both quantitatively and qualitatively. Why is this so? The basic criterion for the grant of a patent is that the innovation must have elements of *novelty, non-obviousness and utility*. How much of the research that we do today meets even some of these basic criteria? Many of the Indian R&D institutions and industrial firms have so far focussed on imitative research or reverse engineering. How do we change our mindsets so that we move on to doing truly innovative research or doing forward engineering? This is the first big challenge.

Skills in filing, reading and exploiting patents will be most crucial in the years to come; but our ability to read or write patents is very poor. Neither can we properly protect our inventions nor can we understand the implications of the patents granted to our competitors. Many of the patents written by our professionals could be easily circumvented. Manpower planning for IPR protection needs priority. IPR must be made a compulsory subject matter in the law courses in the universities in India. Our graduates coming out of engineering and technology streams have no idea about IPR, and yet it is these young people, who will have to fight these emerging wars in the knowledge markets. A number of patent training institutes will have to be set up. China has already set up 5000 patent training institutes! Judicious management of patent information will require well-structured functioning of information creating centres, information documenters and retrievers, information users, IPR specialists and information technology experts.

Need for rethinking IPR

There are several areas of conflict and debate in the existing patenting system. One issue is that of public vs private knowledge. Some types of knowledge – for example educational technologies, life saving technologies, must be available to all, not just to the rich. We need to develop principles by which we determine as to when the knowledge will be publicly available and when it will be kept private. Agencies should be set up to buy knowledge for the public good, including application of those principles used in land-acquisition proceedings – but this requires a clear legal and policy framework.

The present patent system is made applicable to all types of industries, types of inventors and types of knowledge. This cannot work. The electronics industry, where product life cycles are small, wants speed and short-term protection. Whereas pharmaceutical industry, where profits are earned, after a long time of rigorous evaluation of safety, toxicity, etc. wants long-term protection. We must realize that one size does not fit all and revisit the patenting system based on the issues of cost, speed of issuance, dispute settlement and so on based on the type of industry, inventor, knowledge, etc.

The industrial property systems were set up centuries ago for inanimate objects, and that too in formal systems of innovations. A great challenge is now emerging to look at the systems that will deal with animate objects (such as plants and animals) and with informal systems innovation (such as those by grass root innovators like farmers, artisans, tribes, fishermen and so on). The standard intellectual property system will certainly not suit such innovators and their innovations. We need innovation in the intellectual property system itself. Shorter duration patents for smaller innovations, including specific improvements in traditional knowledge need to be conceived. They will involve a simple registration-cum-petty patent system where the inventive threshold would be lower but even a small improvement in material, process, product or use could be protected at much lesser costs and for shorter durations. This will give a boost to the creative capabilities of the otherwise deprived innovators. We, in India, will have to develop our own models for this.

New IPR regime and Indian knowledge industry

The knowledge-based industries in India, such as the IT industry, pharmaceutical industry, etc. will have to face new challenges in the new IPR regime. The IT industry has maintained an impressive growth rate and we have the dream of becoming an IT super-power, raising our software exports from $2 billion to $50 billion in the next 10 years. If this has to happen, we will have to reduce the content of body shopping and move on to innovative IT products, which will need IP protection. The Indian IT industry has not so far cared for this, but it will have to pay attention to this aspect.

The same is the case with our pharma industry. From an importer of even the formulations in early 50s, our pharma industry has become a net exporter. We

need to recognize that it will start feeling the heat of the global competition soon. The global pharmaceutical industry is a knowledge industry and the emerging Indian pharma industry will have to be no exception. It has survived so far without developing new molecules. Indeed, only fourteen new molecules have been developed so far in the last forty years, out of which eleven have been from the CSIR system. But with the advent of the new patent regime, the strategies will have to change. I do strongly believe that the Indian industry can once again rise to the occasion just as it did in the 70s under the provisions of the Indian Patents Act 1970. Indian pharma industry, apart from pursuing novel synthetic routes to known molecules must pursue *basic research* for patent-worthy inventions comprising new molecules. It will have to forge partnerships with national laboratories in a 'Team India' spirit to surge ahead. As a new strategy, the pharma industry could pursue the development of new molecules up to the point of pre-clinical stage and then forge strategic alliances for co-development or license these to national and international partners. Some of the enlightened pharma players in the Indian industry are already beginning to reap the benefits of this strategy.

Before we protect IP, we must generate IP which is worth protecting. Our institutions, national laboratories and industrial R&D laboratories will have to gear up for this. Nurturing a strong innovation base through a balanced system of recognition and rewards is the need of the hour. We will have to invest liberally to enhance the skills and knowledge base of scientists, through structured in-house and external professional training programmes, some even abroad, on understanding, interpreting and analysing the techno-legal and business information contained in IP documents, and in drafting of IP documents. For this we need to avail the services of high-class national and foreign consultants and attorneys. We need to encourage the publication of R&D results in scientific papers only after careful consideration of the consequences on IP rights. It is hard to estimate the loss of Indian intellectual property due to the inadvertent publication of usable knowledge in the last few decades. Monitoring national and international patents and other IP through access to on-line databases, to ensure effective protection and to ward off infringements and threats to India's IP portfolio will be crucial. Analysing and assessing techno-legal and business information and market intelligence to identify strategic alliances and to exploit potential uncovered niche areas of opportunities itself will give rise to new knowledge-based business.

I believe that we will have to mobilize public opinion and influence government decisions and policies on diverse IP issues. This should be done, not through emotional cries, but on the basis of analytical and scientific studies taken up in-house or commissioned nationally and internationally. We must spearhead a movement towards formulating a national IP policy.

Economics of traditional knowledge

The issue of economics based on traditional knowledge and biodiversity is far more complex. India, with approximately 8% of the world's biodiversity and as one of the greatest storehouses of traditional knowledge, has the potential of becoming a major player in the global trade in herbs-based formulations, medicines and products. An estimate by the EXIM Bank puts the international market of medicinal plants-related trade at US $60 billion per year growing at about 7% annually. India has only 2.5% share of this market.

Knowledge-rich companies and researchers from the developed world have been attracted to the wealth the poorer countries have in their biodiversity and the traditional knowledge systems. Some argue that the access to such biodiversity and community knowledge by the industrially developed nations is necessary for the larger welfare of mankind as this advances knowledge and leads to new products which contribute to the well being of global consumers. However, this is not the point. The point is that this access to the resources of the poor does not benefit the poor in any way, while their natural resource and intellectual property continues to be appropriated and exploited.

Many researchers who have obtained knowledge about biodiversity and its uses from local innovators, communities and institutions do not even acknowledge their contributions, let alone sharing of the benefits resulting from such knowledge. One recalls here the case of a new antibiotic. This was launched in the USA based on the discovery of peptides in frog skin by a researcher who had found three tribes in Africa and America, which knew about the wound healing capabilities of the frog skin and were using it for that purpose. However, no benefit was given to the tribes.

Local communities or individuals do not have the knowledge or the means to safeguard their property in a system which has its origin in very different cultural values and attitudes. The communities have a storehouse of knowledge about their flora and fauna – their habits, their habitats, their seasonal behaviour and the like –and it is only logical and in consonance with natural justice that they are given a greater say as a matter of right in all matters regarding the study, extraction and commercialization of biodiversity. A policy that does not obstruct the advancement of knowledge, and provides for valid and sustainable uses and intellectual property protection with just benefit sharing is what we need. When we come up for reviewing Trade Related Aspects of Intellectual Property Rights (TRIPS Agreement), we need to push for TRIPS plus, meaning TRIPS plus equity and ethics.

It needs to be emphasized that the issues of the economics of community knowledge are truly complex. While it is true that many indigenous cultures appear to develop and transmit knowledge from generation to generation within a system, individuals in local or indigenous communities can distinguish themselves as informal creators or inventors, separate from the community. Furthermore, some indigenous or traditional societies are reported to recognize

various types of IPR over knowledge, which may be held by individuals, families, lineages or communities. Discussion of IPR and traditional knowledge should draw more on the diversity and creativity of indigenous approaches to IPR issues. In addition, there are power divisions as well as knowledge divisions among people in many communities, and sharing of benefits with a community as a whole is no guarantee that the people who are really conserving traditional knowledge and associated biodiversity will gain the rewards they deserve for their efforts.

To encourage communities, it is necessary to scout, support, spawn and scale up the green grassroot innovation to generate employment and use natural resources sustainably through linking of innovation, enterprise and investment. This requires building up adequate linkages with modern science and technology and market research institutions. In short, one needs new models of development, employment generation and conservation of natural resources. In this connection, one looks with hope at organizations like Gujarat Grassroots Innovation Augmentation Network (GIAN). GIAN has attempted to set up venture capital fund for small innovation providing for its linkage with R&D and scaling it up into viable enterprise. The recent effort by DSIR and DST to set up a Technopreneurs Promotion Programme is also noteworthy, since it provides the much needed financial support for the first time for such endeavours.

There is also a deep philosophical divide on the issue of IPR that we have to deal with. The existing IPR systems are oriented around the concept of private ownership and individual invention. They are at odds with indigenous cultures, which emphasize collective creation and ownership of knowledge. There is a concern that IPR systems encourage the appropriation of traditional knowledge for commercial use without the fair sharing of benefits, or that they violate indigenous cultural percepts by encouraging the commodification of such knowledge.

While recognizing the market-based nature of IPR, other non-market-based rights could be useful in developing models for a right to protect traditional knowledge, innovations and practices. Geographical indications and trademarks, or *sui generis* analogies, could be alternative tools for indigenous and local communities seeking to gain economic benefits from their traditional knowledge. To date, debate on IPR and biodiversity has focused on patents and plant breeders' rights. The potential value of geographical indications and trademarks needs to be examined too. They protect and reward traditions while allowing evolution. They emphasize the relationships between human cultures and their local land and environment. They are not freely transferable from one owner to another. They can be maintained as long as the collective tradition is maintained.

Whether one likes it or not, it is a hard fact that a mere focus on morally defined rights will not be successful, because it is too difficult to build arguments to bridge

the wide gap between general human rights and indigenous peoples' rights in the changing value systems in the modern world. It is generally difficult to attribute an objective economic value to the knowledge of local and indigenous communities, and associated resources, for a number of reasons. One could be the absence of a market for genetic resources, and the complexity of inputs into creation of new crop varieties. It will be more pragmatic to focus on the costs of conservation to indigenous and local communities as a guide to designing economic incentives that will help them gain adequate rewards. Different interest groups, such as industries, intellectual property experts, and indigenous and local peoples' organizations need to cooperate in order to define mechanisms for more effective sharing of benefits with the providers of traditional knowledge and genetic resources.