Challenges of agro-biotechnologies, intellectual property rights and globalisation: role of academic institutions in achieving the millennium development goals

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Abstract: The present paper is an attempt to analyse the role of academic institutions in meeting the challenges posed by agro-biotechnologies, IPRs, globalisation and its implications for achieving the millennium development goals. The problems of implementing the MDGs are certainly intertwined and the entire nexus requires attention. However, serious doubts are being raised by many that these daunting goals would be achieved in the present international system, with an uneven 'globalisation' and conflicts generated by the TRIPS. Moreover, given the nature of agro-biotechnologies and the fact that commercial interests are found to be predominant, it is doubtful whether it will have any impact on food security, bio-safety or poverty reduction. The preceding context demands that the academic institutions pay greater attention to socio-economic & environmental objectives, IPR training & documenting traditional knowledge. This necessitates adoption of an active role in the development process rather than merely developing a node in a knowledge network.

Keywords: agro-biotechnology biodiversity; food security; GATS; globalisation; IPR; poverty; TRIPS.

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1 Introduction

The present paper is an attempt to develop a framework for the role of academic institutions and societies for achieving the Millennium Development Goals (MDGs). The UN’s MDGs are a set of eight quantified targets to eradicate extreme poverty, hunger, improve health and education and ensure environmental sustainability. The problems of implementing the MDGs are not only intertwined; serious doubts are being raised by many as to whether these daunting goals would be achieved in the present international system. The challenges posed by globalisation, trade-related aspects of intellectual property rights (TRIPS) and General Agreement on Trade in Services (GATS) are likely to have a significant influence on this process. As agriculture is the mainstay for most of the developing countries, it will be pertinent, therefore, to analyse the nature and socioeconomic impact of agro-biotechnologies in the context of the role of academic institutions.

Along with the rapid changes in the international system, the last two decades of the 20th century have witnessed the emergence of new technologies. The new economic environment of liberalised policies and increasing ‘Globalisation’ has shaped the character of S&T and its organisational structure. This phenomenon has not only offered many promises but has also raised a number of socioeconomic, ethical and political issues. Information technologies have not only revolutionised industrial production and trade but have also boosted international integration. Biotechnologies have opened new doors for treating genetically oriented diseases, increasing agricultural productivity, nutritive qualities of food crops and for utilising the vast bio-resources of the South. Moreover, increasing environmental degradation, population pressures, consumption levels against the backdrop of depleting resources, glaring socioeconomic disparities and a relative ineffectiveness of modern S&T to solve many problems have raised many questions.

2 Globalisation

Though the globalisation and liberalisation process assumes free flow of technology and capital, it has belied expectations, with varied regional and sectoral impact. There has been unprecedented inflow of FDI and technology from the developed to the developing countries with the introduction of liberalisation. However, only a few countries have been able to attract and benefit from it, sectoral variations notwithstanding. As far as FDI in biotechnology (Rao, 2002) in India is concerned, a meagre amount of a total of US$ 31 million for 26 cases during 1999–2002 was invested. Moreover, declining official development assistance especially in the field of S&T from bilateral as well as multilateral sources (Desai, 1997) in the last two decades or so to the developing world has heightened the importance of TNCs and FDI (Foreign Direct Investment). It is also observed that the national system of innovations is under increasing strain (Patel and Pavitt, 1998) not only in the developing countries but also in the developed OECD countries, due to liberalisation, competition, increasing range of technologies and uneven technological development.
3 Eradication of extreme poverty and hunger

Despite rapid technological advances, the issue of poverty alleviation still plagues S&T policies of most of the developing countries. Historically, there is evidence to suggest that technical advances have improved living standards and life expectancy. At the same time, there are examples of increasing inequality and bridging of inequality at the same time in different regions. In the last several decades, in some countries, the incidence of poverty (OECD, 2002) has fallen. The number of people living below the poverty line in the developing countries has generally declined during the last decade (1990–2001). However, in Sub-Saharan Africa which had the highest proportion of poor, there was an increase from 45% to 46%. The South-Asian region that had the second highest proportion of poor people (41%) has shown a decline to 31%. Some of the notable examples were even large countries like China and India. However, the absolute number of poor people in the world has continued to rise and inequalities between the richest and poorest countries have risen (World Bank, 2000). Of the world’s 6 billion people, about 800 million do not have enough to eat. Globally, nutrition has improved in recent decades, but malnutrition—including deficiencies in micronutrients—remains widespread. Hunger, combined with low intake of important micronutrients such as vitamin A, zinc, iron, and iodine, contributes to low birth weight, infections, and increased risk of death. In developing countries, close to 24% of all newborns have impaired growth due to poor nutrition. About 33% of all children under the age of five are stunted. Because of iron deficiencies, about 2 billion people worldwide suffer from anaemia, and nine out of ten of them live in developing countries. Improving nutrition will continue to be a challenge, and the current move toward accelerated globalisation can play either a positive or a negative role in reducing malnutrition and hunger. Policies that reduce the negative and enhance the positive effects of globalisation on nutrition and groups most at risk will be needed, at both the international and national levels.

Enabling developing countries to import food at adequate and stable prices still remains a daunting task. Three-fourths of the world’s poor live in rural areas and depend—directly and indirectly—on agriculture. In about 25% of developing countries more than two-thirds of total exports are agricultural commodities. Improved market access for these countries can increase agricultural exports, thereby increasing foreign exchange earnings and imports of food (and capital goods). Raising the level of income and employment among low-income rural families also increases the amount of food that poor people can afford and protects them from higher food prices in the event of shortages in domestic markets.

In the preceding context, could biotechnologies solve the problem of hunger and rural poverty? Some case studies (Fransma, 1991) suggest that a strategy of dovetailing biotechnologies with the economic priorities, resource endowment and S&T infrastructure of a country can bring about positive results and economic benefits but sometimes also economic disasters in terms of labour displacement, loss of revenues and export earnings or wastage of resources. Hence, it is crucial to understand the changing structure of agricultural research and technology and the features of the agro-biotech industry.
4 Rising significance of universities in the changing structure of agricultural research and technologies

Recently, significant changes have occurred in the structure of agricultural research and technology (Desai, 1997). In most developing countries agricultural research has been financed through the public sector which has accounted for almost 97% of the total agricultural research financing. Moreover in developing countries, especially in Africa, one or two commercial crops are encouraged at the cost of neglect of food crops. The national and international funding agencies have also contributed to strengthening a research system tilted in favour of the same.

With the emergence of biotechnology, the technological possibility of introducing new genetic traits in plants has become a reality. From the economic point of view, the focus of agricultural research has shifted from public sector to private sector or to the university system. Moreover, due to liberalisation policies, the national and international funding for agricultural research is also shrinking or stagnating. Thus, the share of private funding is likely to increase, resulting in greater influence of market forces guiding the direction of the same. The preceding tendencies and the new plant variety protection (PVP) system are expected to strengthen the existing situation.

5 Features of agro-biotechnology industry

It is pointed out by some scholars that the green revolution technologies with the productivity gains they have brought about have made a major impact on poverty reduction in the last five decades. However, the benefits of these technologies have levelled off. For example, the yield growth has slowed down (from an average of 2.9% per year for cereals in 1967–1982 to 1.8% in 1982–1994). This may be due to depressed crop prices, increased input demands and resultant increase in fertiliser and pesticide prices and increasing water scarcities. Will this reduced yield growth of the existing technologies meet the projected demand? Are the emerging technologies answers to these problems in the prevailing socioeconomic and international system? Will the emerging technologies increase the bio-safety risk to the poor or provide benefits such as increased productivity, reduced risks in terms of pests and drought – induced losses, improved storability, enhance health standards by nutritional improvement (with micronutrients like vitamin A, iron, zinc, etc.), and reduced exposures to agrochemicals and development of new edible vaccines?

Some of the answers to these questions can be found by analysing the socioeconomic impact of the biotech industry that has, in the last two decades, expanded rapidly and widely. The estimated global area under transgenic crops (Clive, 2000) has increased from 1.7 million hectares in 1996 to 44.2 million hectares or 109.2 million acres in 2000, registering a 25 fold increase. The value of the global market for transgenic seeds has grown rapidly from $1 million in 1995 to an estimated $3,044 million. Only ten industrialised and five developing countries have contributed to this increase. The world demand for GM seeds is expected to increase at the rate of 12% per year to $3.8 billion in 2006, according to a study. Arable land planted with transgenic crops is expected to increase 7.2% per year to 184 million acres over the same period.
As far as the basic traits of these seeds are concerned, herbicide tolerance continued to be the most dominant trait occupying 75% of the global GM area in 2002, followed by insect resistance (17%) and stacked genes of herbicide tolerance and insect resistance, occupying 8%. The principal GM crops continued to be soybean, maize, cotton and canola. On a global basis, 51% of the 72 million hectares of soybean was GM, 20 per cent of the 34 million hectares of cotton, 9% of the 140 million hectares of maize and 12% of the 25 million hectares of canola. Thus it is doubtful whether it will have any impact on food security or enhancement of nutritive qualities, and therefore any impact on poverty reduction. Moreover, even the FDI in this sector in the developing countries is mainly attracted by the floriculture sector.

Global R&D expenditure in the private and public sectors is $4.4 billion with over 95% of the total being in the industrial countries, led by the USA. China is the leading investor in R&D on crop biotechnology in the developing countries, followed by India.

Global research into areas critical to developing countries remains woefully under-funded. For example, the annual operating budget of $400 million of the worldwide network of 16 tropical agricultural research centres under the Consultative Group on International Agricultural Research (CGIAR) is miniscule in comparison with combined research and development budgets of the world’s six largest agro-biotech companies, estimated at roughly $3 billion per year. The low budget of the CGIAR system as well as national agricultural research centres continues despite considerable evidence of the high social rates of return from R&D in tropical food production. Similarly, environmental constraints are notoriously under-researched across the developing world.

In addition, globalisation has accelerated the process of exposing the developing countries to the IPR preferences of the inventors of the technologically developed countries. The new IPR has particular implications for biotechnology (patenting activity in the biotechnology sector has registered a roughly ten-fold increase between 1985 and 2000). Protection of intellectual property rights encourages private sector investment in agro-biotechnology, but in developing countries the needs of smallholder farmers and environmental conservation are unlikely to attract private funds. It is also likely that the patenting of basic DNA sequencing could hamper rather than foster the downstream development of useful biotechnology products. The countries that lag behind in appropriating patents on DNA sequences will find themselves vulnerable. Access to genomic database and search software at reasonable costs are also crucial issues for the developing countries. Another important issue is the collaborative innovations and the sharing of the benefits of the same between the international biotech companies and the farmers in the developing countries. The conflict between breeders’ rights, farmers’ privileges and biotechnology patents and genomics database will have to be resolved amicably if access to the germplasm and bio-resources of the developing countries by the international biotech companies is to take place in an orderly and equitable manner vis-à-vis the developing countries.

It is also reported that the socioeconomic consequences are not positive in some cases. Some of the seed companies including the MNCs of some hybrid cottonseed farms in India, are employing female children as bonded labour (Venkateswarlu, 2002). Moreover, attempts are being made by some companies to release the new cotton hybrids using CMS (Cytoplasmic genetic Male Sterility) technology, which reduces the requirement of labour in the production of seeds by half. No food crops have been
introduced so far. The food crops with enhanced nutritive qualities and reduced expenditure on fertiliser and pesticides are expected to have some impact on poverty alleviation. However, as revealed by the efforts made so far, the major emphasis is either on pest resistance or abiotic stress. These efforts might reduce some financial losses. However, so far, due weightage has not been provided to enhancement of nutritive qualities in the GM crops.

6 Ensuring environmental sustainability

There are several perceived advantages of GM crops as claimed by many. These include: enhancement of productivity and nutritive qualities, reduction of financial losses with reduced demand for inputs and therefore considerable impact on poverty alleviation and environmental safety. However, some threats and risks are also involved with agro-biotech as the ultimate success of these technologies depends on the socioeconomic, political and regulatory environment as well as the ecological conditions of a region. There are problems of accessibility of GM seeds under the new IPR regime, as there are problems of pricing and the constraints of exports are involved. There is a risk of gene flow and bio-safety, ethical issues and a possibility of reduced demand for labour. There is also a perceived threat to bio-diversity.

Some experts take the view that possible implications of GM crops for the health of consumers have not yet been sufficiently examined even in the developed world. The precautionary approach is invoked in order to address the absence of reliable scientific data and on the basis of this; there are many who argue that, irrespective of possible benefits, a new technology should never be introduced unless there is a guarantee that no risk will arise. Since no one can guarantee an absolute absence of risk arising from the use of GM crops, it follows that there should be a delay in the use of the technology until complete assurances of absence of hazard are available.

Similar demands are made with regard to the impact of GM crops on the environment. Critics point to the risk of potentially irreversible effects on biodiversity, which can be understood as the variety of plants, animals and other organisms that exist in nature. Genetic material from GM crops could be transferred to other plants and organisms. This could lead to unpredictable transformations. It is therefore being argued that unless there is certainty about the absence of such risks, neither field trials nor commercial planting should take place.

With regard to the use of GM crops in developing countries, this concern is perceived to be of particular importance. Many regions are the centre of origin of modern crops, such as cotton or maize. These regions usually comprise a considerable variety of crops and wild relatives, which might be irreversibly altered by the transfer of genetic material from GM crops. Critics also assert that encouraging the adoption of GM crops by developing countries demonstrates a lack of sensitivity to their vulnerable position. Many such countries urgently need to address issues of food security and may be tempted to hastily adopt a technology that could pose severe risks. There are also concerns about how and by whom GM crops are developed and delivered. The substantial benefits, which accrued in developing countries from the Green Revolution, were largely the result of research undertaken in the public sector. But most research on GM crops is being undertaken by a relatively small number of private companies. Although there is significant work undertaken in the public sector, many of those who object to the use of
GM crops fear that research will be directed primarily towards commercial users in developed countries. Thus, it is possible that only large-scale industrial farmers will benefit, while the needs of small-scale, resource-poor farmers in developing countries will be neglected.

Doubts have also been expressed about the technical and financial capacity of some developing countries to develop and apply regulation to ensure the safe use of GM crops. Further, there is concern that a focus on GM-related applications may detract from efforts to explore other ways of enhancing agriculture, such as fostering more relevant national and international policies, improving systems of seed production and distribution, and promoting better development of markets and improved agricultural practices. It is also being argued that rapid growth of GM crops is more due to aggressive marketing by the influential seed companies than the initiatives of the developing countries or on the basis of their perceived socioeconomic and environmental advantages. According to a recent by ISAAA, farmers in developing countries are switching to GM crops at more than twice the rate of farmers in the industrialised world. Last year, the amount of land planted with GM crops in developing countries grew by 4.4 million hectares, or 28%. In comparison, the rate of growth in industrialised countries was 11%. The survey finds that seven million farmers in 18 countries – more than 85% of whom are resource-poor farmers in the developing world – now plant GM crops. Almost one-third of the world’s GM crops are now grown in developing countries, compared to one-quarter in 2002. But in other situations, the Nuffield Council accepts that the use of a GM crop may be less appropriate. For example, it says that GM herbicide resistant crops may lead to reduced demand for labour, which could hinder the reduction of poverty in developing countries.

7 Conflicts between TRIPS, agriculture, food security and bio-diversity

A feature that requires to be noted is that the majority of farmers in the developing countries are small farmers, and they depend on dry-land agriculture, and that the assignment of Intellectual Property Rights (IPRs) to living things is of relatively recent origin in these countries.

The TRIPS Agreement has been extended to the agricultural sector (except plants, animals and biological processes) including micro-organisms. Under this agreement, developing countries may choose an ‘effective sui generis’ PVP system or accession to the UPOV Treaty (Union International pour la Protection des Obtention Vegetables). This has raised a number of issues for the developing countries in the context of technological and organisational change. With the adoption of the TRIPS Agreement, developing countries have been obliged to adopt protection of plant varieties by patents or by other means, without any serious consideration being given as to whether such protection would be beneficial, both to producers and consumers, or its possible impact on food security or whether it is a suitable mechanism for promoting technologies required, and if so, whether these technologies would be accessible to poor farmers. It is being argued that the treaties that evolved in the western countries with food surplus and agricultural research that is overwhelmingly privately financed, may simply promote commercial crops. Another contentious issue is whether the provisions of the TRIPS Agreement will succeed in protecting bio-diversity as mentioned in the Convention on Biodiversity (CBD) or the plant genetic resources as mentioned in the FAO Treaty. While the CBD asserts national sovereignty over genetic resources, there is nothing in TRIPS to
provide support to these CBD objectives. The TRIPS is silent about the equitable 'benefit sharing', and 'prior informed consent' that are emphasised in the CBD.

Patents or Plant Breeder’s Rights (PBRs) normally impose restrictions on farmers’ ability to sell grown seed (and in some cases to reuse it) and thus enhance the market for the breeder’s seed. Even in the developed countries, reuse of seeds remains quite common although for many crops annual purchase is now the rule. In developing countries the majority of farmers reuse, exchange or sell informally, and annual purchase of new seed is relatively rare in most countries. In respect of IP, the CBD states that access and transfer (of genetic resources) should be consistent with the ‘adequate and effective protection of intellectual property rights’. Governments should put in place policies to ensure that, particularly for developing countries, access to genetic resources takes place on mutually agreed terms. It notes that patents and other IPRs may have an influence on implementation of the Convention, and governments should cooperate (subject to national and international law) in order to ensure that such rights are supportive of and do not run counter to the CBD’s objectives. It is also being pointed out that since patenting based on the use of genetic resources is allowed under TRIPS, (subject to meeting patentability criteria), this does not support the objectives of the CBD because the criteria for patentability do not include prior informed consent or mutually agreed terms for benefit sharing. Foreign companies may obtain private rights derived from national resources.

In the developing countries there are large differences in plant breeding capabilities, the proportion of farmers who use modern varieties and the value of the plant genetic resources available. Thus, the impact of IPP will be different for different regions (Butler, 2002). Moreover, many of the National Agricultural Research Systems (NARS) in the developing countries indicated very low capability for intellectual property management. In view of the growing importance of intellectual property (IP) for accessing proprietary technology in biotechnology and benefit sharing in plant genetic resources, a heightened awareness in IP matters among the NARS is imperative.

7.1 Bio-diversity and conflicts in the international treaties

The requirement for uniformity (and stability) in UPOV type systems excludes local varieties developed by farmers who are more heterogeneous genetically, and less stable. But it is these characteristics that make them more adaptable and suited to the agro-ecological environments in which the majority of poor farmers live. It would be open in principle for developing countries to devise systems that would offer protection for varieties that meet criteria suited to the circumstances and crops on which poor farmers depend. However, in reality, such criteria may be difficult to devise and costly to operate. In such a situation, governments may not find such a system useful for their farming systems.

While proponents argue that by stimulating the production of new varieties, PVP actually increases bio-diversity, others claim that the requirement for uniformity, and the certification of essentially similar varieties of crops, will add to uniformity of crops and loss of bio-diversity. Of course this concern is wider than PVP. Seed legislation in many countries imposes strict uniformity requirements, sometimes stricter than PVP legislation. Moreover similar concerns have arisen in respect of greater uniformity arising from the success of the Green Revolution varieties, leading to greater susceptibility to disease and loss of on-field bio-diversity. As plant breeding becomes an increasingly private sector
activity, new varieties are likely to displace traditional varieties on a large scale. Then, a crucial issue that will arise is of how genetic resources are to be conserved and maintained for possible future use, whether in fields (in situ) or in ‘gene banks’ (ex situ).

There are considerable dangers to food security if the technologies are overpriced to the exclusion of small farmers, or there is no alternative source of new technologies, particularly from the public sector. Further, the increase in concentration, and the conflicting patent claims when both the public and private sectors have patented plant technologies, may have an inhibiting effect on research. In the private sector, the response has been alliances or acquisitions, but a problem for the public sector is how to access the technologies they need to undertake research without infringing IP rights and, if they develop new technologies, the terms on which they may be made available.

It is the failure of the breeders’ rights to address the problems of poor farmers that has led to the movement for farmers’ rights. In 1989 the FAO agreed to recognise these concerns by incorporating Farmers’ Rights ‘arising from the past, present and future contributions of farmers in conserving, improving, and making available plant genetic resources, particularly those in the centres of origin/diversity’. Finally in 2001, the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) took shape. The ITPGRFA recognises the contribution of farmers in conserving, improving and making available genetic resources, and that this contribution is the basis of Farmers’ Rights. It does not limit in any form whatsoever, rights that farmers may enjoy under national law to save, use, exchange and sell farm-saved seed. It also sets out the right to participate in decision making about, and to derive fair and equitable benefits from, the use of these resources. An essential feature of this treaty is that it will implement a ‘Multilateral System’ as opposed to the existing CBD ‘Bilateral System’ of access, to a list of some of the most important food and fodder crops essential for food security and interdependence, for those countries that ratify the Treaty. It will ensure that benefits from the commercial use of the genetic resources of these crops are returned to farmers in developing countries, the original source of most of the resources. Will the ‘Material Transfer Agreement’ (MTA) that has to be developed be equitable and protect crop genetic resources from privatisation? In the recent past there were examples of privatisation of germplasm deposited at the CGIAR gene bank. However, the attempt of an MNC called Syngenta was foiled. Not just National Collections but also CGIAR gene-banks could come under increasing pressure from MNCs to exchange the genetic resources in gene banks under public and CGIAR control. Gene bank managers have no right or permission to sell these genetic resources. The genetic resources are given to them by farmers to scientists and other collectors in the good faith that they will be held in trust for the benefit of humankind and that they will not be turned into private property.

Most of the evidence relating to the impact of patent or plant variety protection on research is from developed countries, and even that is quite sparse. Before IP protection was introduced, private sector breeding initiatives focused on hybrid varieties, particularly of maize in the USA, because inherent in these varieties is an element of ‘technological protection’. In the USA a study from the 1980s suggested that there was no evidence that total R&D activity had increased as a result of the introduction of PVP, although it appeared to have had some impact on soy beans and wheat. The latter crops also accounted for the majority of PVP certificates issued. There was also evidence that PVP was used as a marketing strategy for product differentiation and that it had
contributed to the large number of mergers that took place in the seed industry. But the evidence is inconclusive, in particular because of the difficulty in isolating the effect of protection from other ongoing changes. Even now, research spending on hybrid crops as a share of sales continues to exceed that on non-hybrid crops, which are the principal object of PVP. A recent study found that PVP on wheat in the USA had not contributed to increased investment in private sector wheat breeding, but may have done so in the public sector. Nor had it contributed to an increase in yields. But the share of wheat acreage sown, to private varieties, had increased markedly, reinforcing the suggestion that the main impact of PVP was as a marketing tool. A major study conducted in middle income developing countries, found little evidence of an increased range of plant material available to farmers or increased innovation as a result of PVP protection. Access to foreign genetic material had improved, but its use was sometimes subject to export restrictions. For many developing countries, agricultural commodities are the main source of foreign exchange earnings. Generally speaking, commercial farmers and the seed industry were perceived as the principal beneficiaries. Poor farmers had not benefited directly from protection, but could potentially be adversely affected by restrictions on seed saving and exchange in the future.

In contrast, TRIPS only requires that there should be some form of IP protection for plant varieties, and does not define in any way the exceptions that may be provided to the rights of owners of protected varieties.

7.2 Modernising traditional knowledge

Many of the developing countries have realised the inadequacy of the existing IPP system to protect traditional knowledge. They were also successful in convincing the TRIPS Council that it should engage in further work on protecting TK. This was also highlighted in the Doha WTO Ministerial Declaration. A final consensus is yet to emerge on this issue as the Article 27.3 (b) is still under review.

The CBD also set out principles governing access to genetic resources and the knowledge associated with them, and the sharing of benefits arising from such access. This involves the relationship between the IP system and the access and benefit sharing principles of the CBD in the context of both knowledge, traditional or otherwise, and genetic resources.

8 Role of academic institutions in achieving the MDGs

The academic institutions in the developing countries are already under great strain. Many of them are under-invested in and under-staffed. Some of the countries in Sub-Saharan Africa and South Asia are not able to contribute even 5% of their GNP towards education. Another perceived threat is that of the GATS, which implies a commitment to liberalise services on an ongoing basis through periodic negotiations. There is apprehension about the potential consequences of opening up services, especially public services, to foreign competition, in terms of the impact on the availability, quality, and costs of such services and on the realisation of domestic policy objectives. It is also feared that there could be a ‘corporate takeover’ of their services by foreign multinationals and forced privatisation of their service sector.
The education services sector, like the health services sector, has received very few commitments in the past Rounds of International Trade Negotiations, mainly due to concerns about the impact of liberalisation on quality, availability, and costs in this sector and the equity implications. Many critics point out that the present asymmetry and bias in market access commitments towards capital mobility as opposed to labour mobility (mode 3 as opposed to mode 4) works in the interests of developed rather than developing countries. In their view, it reflects a basic imbalance in negotiating position and lobbying power between the two sides.

In the preceding situation, the academic institutions can play a more effective role in achieving the MDGs if the following is ensured.

- Strengthening their infrastructural needs through national and international support including the UN, and improving the national policy environment.
- Reforming systems of higher education to make them relevant to development challenges. Creating entrepreneurial universities and technical institutes that focus on business incubation and community development.
- Paying greater attention to knowledge diffusion rather than merely knowledge generation.
- Adoption of an interdisciplinary approach or an approach that integrates social sciences, natural sciences and technology.
- Ensuring that scientific results and technological information reaches its desired targets effectively and evolving or strengthening a parallel ‘virtual infrastructure’, linking universities, corporations and policy-making bodies.
- As far as agro-biotechnologies are concerned, more training programmes will be required in the field of biotechnology policy, ethics, bio-safety laws, benefit sharing laws on biological resources and intellectual property matters.
- Agro-biotech research will require orienting more towards food crops and its nutritive qualities rather than commercial crops for export purpose.
- A new and imaginative public-private collaboration can make the gene revolution beneficial to developing countries. This is crucial for the well-being of today’s hungry people and future generations.

9 Concluding observations

In the preceding context, it seems difficult that any uniform framework for the entire world could be evolved. Given the socio-economic and S&T disparities that exist between and within the developing and the developed countries, the developing world require to evolve framework to achieve the MDGs to suit their conditions.

Agro-biotechnologies hold out the promise of many benefits for agriculture and agro-industry, thereby uplifting the rural poor. However, at the same time, they also pose many threats and risks. Biotechnology can contribute to future food security if it benefits sustainable small-farm agriculture in developing countries. Protection of intellectual property rights encourages private sector investment in agro-biotechnology, but in
Challenges of agro-biotechnologies, intellectual property rights
devoting countries the needs of small-holder farmers and environmental conservation are unlikely to attract private funds. The ultimate success would also depend on conscious attempts by governments to evolve suitable policies and regulatory mechanism in order to derive the full benefits and avoid the risks. An effort to impose a stronger IPR system has raised many controversies surrounding the TRIPS agreement. There are many areas where the objectives of the national, bilateral, regional and international agencies are found to be in conflict or have a conflicting interpretation. In the final analysis, it seems that concerted efforts will be required on the part of the international community to link up agro-biotechnologies and IPRs with development objectives.

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Notes
1Percent of people living below $1.08 per day at 1993 PPP.
2The ratio of per capita income between the richest and the poorest countries increased six-fold between 1870 and 1985. Between 1970 and 1995, the average per capita GDP of the middle third has dropped from 12.5% to 11.4% of the richest and that of the poorest third from 3.1% to 1.9%.