Ethical Issues of Biotechnology in Agriculture and Agri-Business

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Abstract

Agriculture in India is the hub around which the wheel of Indian economy and society revolves. The growing population puts extra pressure on agriculture to sustain the food and nutritional requirements. The emergence of Biotechnology has given the hope to the agriculture scientists and policy makers for tackling the problem of food security in an efficient and effective manner. Any new or innovative technology also brings with itself the various ethical issues from the perspective of the society and economy. In recent times, hardly any technology has come which has created such a stir throughout the world from the ethical point of view. This technology has literally divided the world into two halves. One half staunchly favours the technology and the other half vehemently opposes it. The pertinent question that arises is that the problem lies with the technology itself or the problem lies with its use. This paper focuses on agriculture Biotechnology. The attempt is to find out the reasons for doubt over this technology and arguments that are given in favour and also the arguments given against the technology. Then the ethical issues related to Biotechnology and biotechnology business in agriculture is discussed and finally how Biotechnology can affect the farmers is discussed.

Introduction

Most of the management experts would agree that nothing is more lucrative for the business world than the idea whose time has come for implementation. The basic question arises that what is that paradigm whose time has come when it comes to Indian agriculture and agri-business companies involved in it. Is it Biotechnology? The moment this word 'Biotechnology' comes immediately one set of people say yes, definitely; and one set of people say no, never. This paper does not attempt to highlight biotechnology as a paradigm for solving all agricultural problems and neither this paper attempts to degrade the technology. In this paper a stance is taken from the Indian agriculture perspective that the problem does not lie with the technology rather it is the judicious use from the environment perspective and for the benefit of farmers, society, and the nation's economy that is required without hindering the social, cultural and traditional fabric. Moreover, in this paper relevant issues are discussed from the ethical perspective and the possible impact that this technology can have on farmers.

Biotechnology is a phenomenon that has been imported by India from the West. Indian agriculture which withstood all the challenges for ages and through the efforts of the farmers supported by the varied agro-climatic conditions faced little problem in feeding the people of the nation. But for last few years a scenario has been created by few experts and policy-makers that there is a huge challenge on the front of food and nutritional security of India and some urgent solution is required. Whether it is a reality or illusion it is difficult to answer by a common man but enough conducive environments has been created for the entry of controversial technologies like Biotechnology to enter in this nation via the big multi-national giants involved in producing products using biotechnology such as seeds which are the basic inputs of farmers. Is Biotechnology a feasible solution for Indian agriculture and is the real need of the nation or it is only the need of the big business organizations to expand their business and some parties with vested interests. The question is difficult to answer.

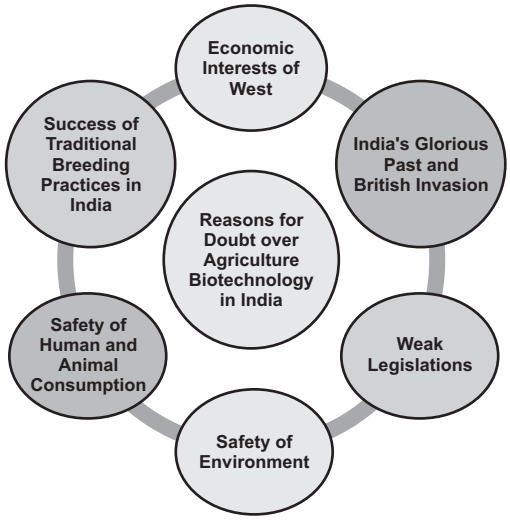
As western world is keenly interested in injecting Biotechnology in Indian agriculture it is worthwhile to take note of the fact that science and technology have contributed immensely in creating a culture of multinational companies spreading its wings across the world. Today in the backdrop of jargons like globalization and free economies business occupies a centre stage driving the policy makers to succumb to the mighty power of big MNC's who today exudes a huge economic and even social influence. When a country like India which has a history of more than 5000 years is exposed to a single minded motive of few individuals, organizations and nations who have the history of pursuing self-interests at the cost of culture, traditions, social structures, and indigenous power and strength protests are bound to come. Already this country has seen that how a small looking company called East India Company could enter this country and through bad intentions and backing of a powerful nation could make this country a slave in literary sense. Similar type of situation has been envisaged by many in India through the injection of Biotechnology in Indian agriculture as agriculture is the backbone of not only Indian economy but also the social and cultural fabric of the nation.

There are enough reasons to doubt this technology called Biotechnology when seen in relation to the Indian agriculture and it is prudent to discuss them first before coming to the ethical issues associated with this technology.

Reasons for Doubt

In India we find that presently a sense of suspicion surround the issue of Biotechnology and the chances of unified voice on the issue seems unlikely. There are enough polarized views amongst politicians, bureaucrats, scientists, NGO's, and other segments of society on this issue that some concrete clarity seems unlikely.

Given below are some of the reasons which raise doubt in the minds of many in India when it comes to agriculture Biotechnology:



Economic Interest of Western Countries

It's hard to deny the fact that western countries have been a major contributor in the development of field of science and technology in modern times. Modern history shows that science was responsible in the western world to bring at the fore-front the facts and objectivity providing real solutions to many myths and false arguments which were spread by the religious thinkers and leaders earlier. Science contradicted many observations made earlier and was able to prove many prophecies, revelations and predictions wrong which were given earlier. Reasoning prevailed over the blind acceptance. Science gave a new path and thinking process to the society. There was tremendous growth of new ideas through the development of science. Gradually, human life was 'secularized' and the role of religion was reduced to certain rituals.

Scientists and intellectuals like Newton, Einstein, Archimedes, Bernoulli, Darwin, Freud, and Bohr etc. shook the very foundations of religion and gave a new light to the thinking process of people. From the perspective of Agriculture, Mendel provided the foundation of plant breeding and it helped in establishing agriculture as a science.

With the bloom of science many scientific theories and principles were developed and many inventions and discoveries were made. Many subjects like Agriculture, physics, chemistry, economics, psychology, sociology, and anthropology got established. In the 20th century the

focus shifted to the development of practical applications of scientific theories and principles. The two world-wars which took place in the 20th century played a great role in the societal shift towards technology from science as many superior technologies in the various fields were developed for war purposes. Many technological innovations in the field of chemicals, aviation, electronics, automobiles, materials technology, mining, agriculture etc. took place. After the Second World War some sanity prevailed in the world society and peace was restored. The developed countries like America; European countries like Germany, Britain and France; and Asian countries like Japan who had participated fiercely in the second world war and had spent huge money on developing technologies now started thinking the economic way. The complete shift of the developed countries shifted to re-building themselves by converting the technologies developed during the war into commercial technologies. This resulted in huge emphasis on business activities which took the form of new warfare which can be called as economic warfare.

From the second half of 20th century the focus shifted to business driven by advanced technologies. This phenomenon is still continuing and today it would not be an exaggerated statement that the reins of technology development process in countries like America are in the hands of the corporate world. Milton Freidman (1970), noble prize winner economist had said that the only social responsibility of business is to increase its profits. It is known world over that business organizations in America and many other western nations have been the follower of this policy for long time. History shows that there economic interests have always dominated over any other issue. Economic interests are paramount for them.

Contrary to that, in India, agriculture has always been a social, cultural and sentimental issue rather than an economic issue.

In this backdrop, Biotechnology has been introduced to Indian agriculture by western countries through some multi-national giants and is now spreading its wings to almost all agriculture research organizations. After independence of India there are enough evidences that economic interests of west have already affected Indian agriculture in a silent way. Many believe that for them Indian rural areas are nothing more than the markets to be exploited. Technology has always been the passion of America and has been the prime force for development of business in America. The Corporate America which developed immensely from late 19th century onwards owes a lot to technology. Thomas Edison, Graham Bell, Morse, Goodyear, Eastman etc. are some of the many people who developed breakthrough technologies and helped the cause of American business.

This raises the doubt over Biotechnology as it has originated from the West and is now fast becoming a tool for business. Many critics think that Western nations are using this technology for economic dominance and controlling the food chain. Agriculture Science

which was involved in finding new facts few decades back has given way to many new technologies having practical implications. Biotechnology which can be considered as a relatively new technology has become the prime focus for some Western countries both from the research and the business perspective. Currently this technology has become the basis for business with plethora of companies now entering into the Biotechnology business. Huge investments are being made by organizations in Biotechnology and agriculture scientists and business organizations are involved in finding new ways of exploiting this technology for various purposes.

The "gene giants" are considered to be simply too large and powerful to trust (Clarke and Inouye, 2002; Guerrante, 2004 cited in Griesse, 2007). Can a multinational company that has invested billions and has a large share of the market be expected to act responsibly in evaluating the pros and cons of a new controversial technology? (Griesse, 2007).The purpose for which this technology is used has given rise to many debates and controversies. So it is the economic interest of the west that has caused so much of doubts in the minds of relevant stakeholders and more so the common man of India.

India's Glorious Past and British Invasion

Agriculture is considered as the backbone of India with majority of population depending on it directly or indirectly. Agriculture biodiversity of India is immense and historically India has hardly faced any problem in meeting the needs of the people. With majority of population dependent on it Agriculture is the heart and soul of Indian people and its contribution in sustaining the thousands of years of civilization of India is tremendous. The remarkable thing is that historically there always had been a balance that existed among different sectors of the economy namely agriculture, industry, trade and services. Going by the evidences, we understand that India maintained a top position in agricultural production, industrial output, international trade and different service sector activities. Paul S Kennedy notes that the India's share of world manufacturing output was 24.5 per cent even in 1750 (Kennedy, 1988 cited in Kanagasabapathi, 2010).

The noted economic historian Angus Maddisson (2003) has shown that India was contributing 32.9 per cent of the global GDP, the highest in the world, during the beginning of the Common Era, i.e.0 CE. We also come to know that India remained the largest contributor to the global economy for more than eighty per cent of the time during the previous two millennia, in spite of invasions and disturbances. India's contribution to global GDP was the highest by any nation even in 1700 with a share of 24.4 per cent (Angus Madisson, 2003 cited in Kanagasabapathi, 2010).

India was a golden bird before the invasion by Britishers but when Britishers left India in

1947 India was a poor country.

Kanagasabapathi (2010) writes:

"The all round prosperity and the superior achievements of India invited the attention of the foreign elements from the earlier times. As a result India's wealth was looted and parts of the nation occupied and ruled."

Further he says:

"But the entry of the Europeans changed the fundamentals of the country for they destroyed the very foundations of the social and economic systems. As a result the fine balance that existed among the different constituents of the society and between different sectors of the economy faltered. Unable to withstand the onslaught, the economy collapsed and the social and governing systems failed to function. Vast sections of the people became poor and they had to depend on very little for survival. Alien methods, that were unknown to the citizens all through their lives, were introduced from the above. Hence the native managerial and leadership systems broke down at different levels. Within a few decades of the British domination, India lost not just her prosperity and wealth; but also her leadership position and her management systems that guided the nations for centuries."

So, India has seen in the past that how the outsiders can enter in India under a camouflage and destroy it for their self-interests without caring an iota for the welfare of Indian society. This past history of India has enough reasons to create doubts in the minds of people about the intentions of some western people and organizations when they speak of transformation of Indian agriculture through Biotechnology, a technique developed and commercialized by them and which is searching for new markets and we all know that where they will find a bigger market than a developing country like India.

Weak Legislations

Presently, with weak legislations in practice regarding Biotechnology as this field being relatively new to India many believe that big companies involved in Biotechnology may use Indian fields to test their Biotechnology products for the suitability without anybody in India knowing it. Companies like Monsanto and DuPont have already invested lot of money in R&D activities related to Biotechnology. There are enough groups which believe that they have the money power to influence the legislation process regarding Biotechnology in their favor as very few have sufficient knowledge regarding the bio-safety norms in the field of Biotechnology. Further, through intensive public relations these companies with the political support of countries like America can influence the policy makers of India who hardly have any knowledge of Biotechnology but could be impressed through some jugglery of facts and

figures.

Safety Issue

Introduction of Biotechnology in agriculture has raised many safety concerns regarding environment, human and animal consumption, and on society in general. There is a general belief that humans have no right to play with the creation of God by manipulating the genes as it could have dire consequences later on. When nature has given us such a huge biodiversity which should be utilized in a responsible manner for the benefit of the society why one should play with the natural creation by inducing manipulation at the genetic level. These questions have divided scientists over the direction of agricultural development

and sparked debate over the best way to feed the growing world population (Griesse, 2007). Finally, critics have argued that GM seeds are not just new and improved versions of conventional seeds, they represent a new form of technology that could have unknown consequences, thus the need for precaution and exhaustive studies (Clarke and Inouye, 2002; Greenpeace, 2004; Inouye, 2003; cited in Griesse, 2007).

Griesse (2007) writes:

"The emergence of these new technologies also requires us to reevaluate the theories on social responsibility. For instance, how should businesses proceed when laws or guidelines do not adequately address the issues or the new circumstances produced by these technologies... What procedures should governments, social movements, scientists, and businesses follow when developing and approving new technologies? Is there a difference in how developing countries might view and make use of these new technologies in comparison with Northern countries? What are the new issues that arise as these technologies develop?"

Indian Traditional System of Plant Breeding has been Successful

Post-independence, scientists in India have done a wonderful job by developing numerous varieties of various crops and that has helped the farmers in increasing their production. Since independence agriculture production has almost increased four times and that has maintained the food security in India. Traditional breeding methods have been adopted by Indian scientists and all the progress in development of varieties of various crops have come through research in the fields instead of laboratories. This farm field research has helped in better interaction between scientists and farmers. Recently only the cotton crop has gone in the fields of farmers where Biotechnology has been used. Resistance breeding using wild taxas has also been done by Indian scientists and this has resulted in development of varieties resistant to insects, pests, and viruses. The hardwork and persistence of agriculture

scientists has been commendable over a period of time. The results delivered by the scientists make many believe that is there any need of import of technology like Biotechnology when traditional breeding methods have been successful in the past.

Biotechnology: World And Indian Scenario

Biotechnology is any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use. (*Zaid et.al., 2003*)

Despite of the fact that there are so much controversies surrounding Biotechnology in agriculture the adoption rate is on the increase. Let us look at the world and Indian scenario related to agriculture Biotechnology.

It is the result of some positive initial results that the area of Genetically Modified (GM) Crops is on the increase worldwide. The global area of Biotech crops which was around 50 million acres in 1998 increased to around 325 million acres in 2008. There has been tremendous increase in the adoption rate of biotech crops around the world. It is not that only developed countries have adopted Biotechnology. There are many developing nations like India and China who are also adopting the GM Crops. The total world area on which GM Crops were grown in the year 2008 was 125 million hectares which was 9.4% more than the year 2007 which means that in 2008, 10.7 million hectares more land was used for GM Crops as compared to 2007 (Clive James, 2009). Even countries like Chile, Columbia, and Honduras have started growing GM Crops. Given below is the data of total land that was used in major countries for growing GM Crops.

Country	Area under GM Crops (in Million Hectares)	Area under GM Crops (in Acres)
USA	62.5	154.4
Argentina	21	51.9
Brazil	15.8	39.0
India	7.6	18.8
Canada	7.6	18.8
China	3.8	9.4
Paraguay	2.7	6.7
South Africa	1.8	4.4
Uruguay	0.7	1.7
Bolivia	0.6	1.5

Philipines	0.4	1.0
Australia	0.2	0.5
Mexico	0.1	0.2
Spain	0.1	0.2

Fig. The Status of GM Crops in 2008 *(Source: Clive James, 2009)*

In India when it comes to agriculture two challenges are considered: To feed a rapidly growing population and an increasingly scarce and threatened agricultural resource base. The foodgrain production needs to be doubled by 2050 to meet the projected food demand. Therefore, scientists and policy makers feel an urgent need not only for productivity enhancement in crop plants by infusing new genetic variability but also for improving nutritional quality. It is in this endeavour, plant biotechnology is widely considered to have the potential to help shift the balance towards a greater use of science and informed management, and also towards more efficient use of inputs and sustainable use of natural resources. Presently, Biotechnology is being used extensively by research scientists and private companies in India.

Scientists make a claim that recent advances in biotechnology has opened up new avenues for large scale multiplication of elite genotypes, protection against viral and fungal pathogens and pests, improvement for abiotic stress tolerance, better yields, better nutritional quality and post harvest management.

Biotechnology is seen as a major initiative which is being used for multiplication, crop protection, improvement, efficient production and post harvest management. The use of molecular markers based on electrophoretic and PCR technique for fingerprinting germplasm is being utilized for conserving and fingerprinting their native relatives and cultivars. In fruit technology protoplast-mediated genetic manipulation offers exciting possibilities in crop improvement because any two protoplasts, irrespective of their phylogenetic relation can be fixed. Plants have been regenerated from the protoplasts of several fruits. Agrobacterium-mediated transformation techniques as well as biolistics methods have come in handy for transferring gene of interest to many crops. Tissue culture technique has helped in production of large scale planting material (Singh and Mishra, 2003).

When it comes to business there are many companies in India which are involved in using Biotechnology for business purpose. Given below is the list of major players involved in Biotechnology along with their products. The list includes pharmaceutical companies also.

COMPANY	PRODUCTS
Avesthagen Technologies	Plant genomics, GM Rice, Contract Research
Bharat Biotech	Hep B Vaccine, GCSF, Interferon, Streptokinase
Biocon India	Enzymes, Lepuridine, Gamma Inferferon, GCSF, Streptokinase, Human Insulin, Monoclonal antibodies. Clinigene International Human genomics, Bioinformatics : Contract Clinical Research
Dr Reddy's (DRL)	GCSF, Interferon
Genotypic Technologies	Array based HTS contract research
MAHYCO	GM seeds : Bt Cotton
Panacea Biotech	Hep B Vaccine, Interferon, GCSF
Pro-Agro Seeds	GM Crops, Bt cotton
Photonics & Biomolecules	Laser based diagnostics
Jain Irrigations	Tissue Culture Plants
Strand Genomics	Bioinformatics based contract research services
Synegene International	Disease Targets, r-DNA proteins, animal cell & tissue culture Contract Research
Syngenta	GM seeds
Wockhardt	Hep B Vaccine, EPO, GCSF, Human Insulin
X-Cyton	Recombinant diagnostics for AIDS, Hep C etc.

Fig. Major Biotech Companies of India and their Products

The major areas in which Biotech companies in India are investing are given below:

Major Areas of investment
Vaccines
Diagnostics
Bioactive therapeutic proteins
Seeds (Hybrids, GM)
Biopesticides
Biofertilizers
Amino acid production
Production of specialty biochemicals and plastics

Fig. Major Areas of Investment in Biotechnology

When it comes to research in Biotechnology we find that in India almost every Agricultural University has a Department of Biotechnology at present and there are many Central Government sponsored Biotechnological Institutes and schemes. We can say that Biotechnology has been taken very seriously in India by the Government, Reasearch Scientists and Business Organizations. Bt. Cotton and Bt. Brinjal are two commercial products which came from the business world in India recently and have created lot of storm. *Bacillus thuringiensis* (Abbreviation: Bt) is a bacterium that produces a toxin against certain insects, particularly *Coloeptera* and *Lepidoptera*; a major means of insecticide for organic farming (Zaid *et al*., 2003). Scientists believe that some of the toxin genes are important for transgenic approaches to crop protection. Moratarium has been imposed on Bt. Brinjal but when it comes to Bt. Cotton it has shown tremendous response from the farmers. The increase from 50,000 hectares in 2002, (when Bt cotton was first commercialized) to 8.4 million hectares in 2009 represents an unprecedented 168-fold increase in eight years. The deployment of Bt cotton over the last eight years has resulted in India becoming the number one exporter of cotton globally as well as the second largest cotton producer in the world. Equally important, India is now poised to benefit from the continued productivity gains that biotech cotton hybrids and varieties offer for the short, medium and long term future. In summary, Bt cotton has literally revolutionized cotton production in India. In the short span of seven years, 2002 to 2008, Bt cotton has generated economic benefits for farmers valued at US$5.1 billion, halved insecticide requirements, contributed to the doubling of yield and transformed India from a cotton importer to a major exporter (Chaudhary and Gaur, 2010).

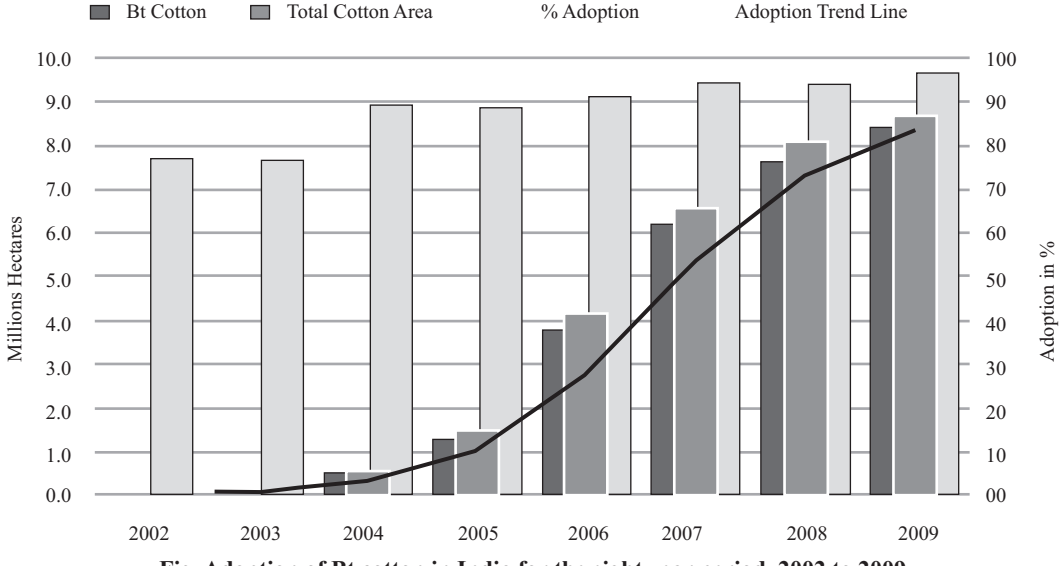


Fig. Adoption of Bt cotton in India for the eight year period, 2002 to 2009

(Source: Chaudhary and Gaur, 2010)

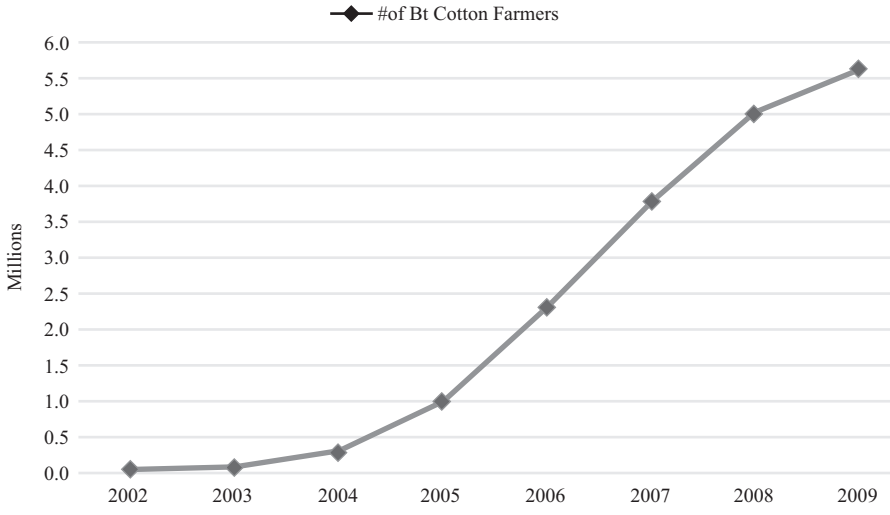


Fig. Number of small farmers adopting Bt cotton hybrids in India, 2002 to 2009
(Source: Chaudhary and Gaur, 2010)

The above figures are the testimony of the influence that Biotechnology can have on farmers and agriculture at large. But it is not that everything is rosy regarding Biotechnology. There are large number of ethical issues that need to be addressed before Biotechnology can be accepted in more holistic manner.

Ethical Issues In Biotechnology

On surface there does not seem any ethical issue related to use of Biotechnology in agriculture as it can be viewed as simply a technology that can be used efficiently and effectively for improving the productivity of the crops, helping in providing food and nutritional security, ensuring enhancement of the income of farmers, and improving the processes. But some critics object to the whole ideology of "genetic engineering". They say that do we have the right to "play God" (Rifkin, 1984). Some other critics focus on policy-oriented ethical questions.

The first and foremost ethical issue is the benefit this technology should deliver to the society. Then the other issues such as sustainability, approach, and accountability also come under the ethical umbrella. Further, Burkhardt (1988) had identified three areas of concern from the ethical perspective. They are the (i) impact on human health and environment, (ii) socio-economic consequences, and (iii) nature and extent of professional and scientific responsibility.

Some of the major areas of ethical concern could be summed up as:

- Benefit to the Society
- Sustainability
- Approach and Accountability
- Impact on human health and the environment
- The Socio-economic consequences
- The nature and extent of professional and scientific responsibility

Benefit to the Society

Any business is successful when it gets the legitimacy from the society. In India there are many stakeholders who get directly or indirectly affected by agriculture. Farmers, input dealers, consumers, non-farming rural communities, Government, banking and financial institutions are some of the stakeholders. Business organizations involved in agriculture biotechnology would have to ensure the positive impact on all the relevant stakeholders instead of catering to the interest of selected parties with negative impacts on others. Biotechnology in agriculture should result in contributing to the factors given below for acceptability:

- Total factor productivity – input and output
- Food Security
- Nutritional Security
- Production function
- Employment function
- Economic surplus

Ethics demand that instead of single minded focus on the profits, business organizations would have to ensure the overall positive impact on not only the relevant stakeholders but also on the overall agriculture system and chain of India for Biotechnology to be established as an integral part of Indian agriculture.

Sustainability

Sustainability of application of biotechnology in agriculture is a critical issue from the ethical perspective. It would be difficult for business organizations to establish the sustainability of biotechnology if this technology will not be used in a judicious manner in alignment with the real needs of the farmers. There are so many areas where biotechnology can be very helpful for Indian agriculture but these areas may not be financially lucrative for business organizations. For sustainability a holistic and inclusive utilization of this technology would have to be made instead of focusing on lucrative areas or those areas which are more beneficial for the business organizations instead of the society. One of the examples that can be cited here is that of selection of crops. Many would agree that India

hardly need any Biotechnology intervention in seeds of crops like brinjal where there is no demand supply gap and through traditional breeding majority of the problems related to insects and pests could be handled. Further, it could easily be found that there was no real demand from the farmer side for such type of intervention. So, sustainability means that real problems that are hampering the Indian agriculture should be taken care of by biotechnology instead of poking the nose in non-required areas and this is a serious ethical issue to be looked into.

Approach and Accountability

It's a well known fact that technology can be used or abused. Einstein and many other scientists would not have ever believed that the theories developed by them could be utilized for the devastation of human species as has been done. So, approach adopted towards biotechnology is an ethical issue as it could be dangerous if used improperly. We all know that biotechnology can show lot of wonders in laboratory tests but to take it to the farmer's field without realizing the ill-effects in totality could lead to dangerous results. The whole ecological system is interconnected and one intervention affects many in this system. So, prudence in approach is necessary instead of jumping to conclusions and commercializing the lab results for short-term gains without going into the details of long-term impacts. Moreover, there should be a complete accountability system in practice. For example, who would be responsible if claims prove to be false or some ill-effects appears in long term.

Impact on Human Health and Environment

On this aspect, critics say that going against the nature may produce unpredictable happenings and the technology which seems safe in short term may produce negative impacts in the long run on human health. No one can predict what will happen if we allow bioengineered organisms and Genetically Modified crops into the system. To play with genes which are the basic structures provided by the nature can be disastrous. The strongest ethical basis for criticizing Biotechnology comes from ecocentric principles:

“Because the complex web of ecological relationships embodies or displays a certain completeness and integrity, destroying or risking some part of this web is inherently unethical.” (Kimbress and Rifkin, 1987)

In most cases, the health/environmental critique attempts to highlight the uncertainties associated with environmental risk assessment:

“We simply can't be sure how engineered micro-organisms will affect present or future humans or the environment, even though, as some scientists suggest, there are good models and analogies that can be used for assessing the nature and consequences of products of the

new biotechnologies." (Teich et al., 1985)

The Socio-economic Consequences

When it comes to socio-economic consequences of Biotechnology three ethical arguments emerge:

1. The structural issue
2. The fairness issue
3. The corporate benefit issue

India has a well established agricultural structure. There are farmers who produce the crops; there are intermediaries and then the final consumers. Then Government has the Public Distribution System in which selected crops are purchased from the farmers directly by the Government at MSP which is fixed by the Government itself. There are Agricultural Universities, State Agricultural Departments, KVK'S, and other Government agencies who are involved in farmer oriented activities such as developing improved varieties of crops, production technologies, crop protection technologies, training, and other extension activities. In last few years there has been a substantial increase of Agribusiness activities in India. Many business organizations are now involved in the business of seeds, insecticides, pesticides, biofertilizers, and biopeesticides. Many multinational companies have increased their investments in agribusiness activities in India. Earlier farmers were mostly dependent on Government agencies for farm inputs. But now scenario has changed. Dramatic increase of business organizations in agriculture has shifted the dependency of farmers for farm inputs on these private players. Multinational companies are coming with the technologies, processes, and investments in India and suddenly agriculture which for so many decades after independence was never looked upon as a business activity has suddenly become a commercial activity for many with competition and profits involved. The major companies like Monsanto, Nunhems, and Syngenta, are expanding their activities and one of the tools which is being perceived by these Multinationals which can give them competitive advantage is Biotechnology.

As Biotechnology is relatively a new field for India, Biotechnology research is still at an infant stage in India. But companies like Monsanto have been in this field for a longer period of time. Moreover, they have already developed technologies and products which have commercial viability. They have even patented the technologies. Now these companies want the returns on their investments and India being a huge market these companies are going all out for extracting maximum from the Indian markets. The structural ethical issue that emerges here is that how to ensure that the imported technology based on Biotechnology is good or bad for Indian agriculture, human health, farmers, and

environment. When the technology is new to India and it involves genetically engineered microorganism and gene manipulation which many view as against the nature then what mechanism has to be adopted to know the feasibility of technology. Do we have only this alternative for better agriculture or other better methods are also available? Shall the Government shifts its focus from traditional breeding methods to Biotechnology based crop improvements? What should be the funding patterns of Government regarding Biotechnology and the existing research systems? What regulatory mechanisms have to be set-up? What precautionary measures are required from biosafety perspective? How to assess the outcomes of Biotechnology? What about the unpredictability that biotechnology brings with itself? Is this technology more in favour of companies or farmers? There are so many ethical issues that emerge from the structural point of view.

The fairness issue involved in Biotechnology relates to justice this technology will do to all those who are involved directly or indirectly with agriculture sector. The farmers, final consumers, agribusiness companies, intermediaries, research organizations, labours, Government etc. are some of the major stakeholders who are linked to the agriculture. The utilitarian argument prevails here that if it can do greatest good to greatest number of people then it is acceptable. But if it affects positively to few and negatively to many then it raises the question mark over the technology. Biotechnology may affect big farmers in a positive way and may affect negatively to small farmers. A situation may arise that small farmers may be forced to leave farming. More commercialization of agriculture through technologies like Biotechnology may create a favourable situation for only large-scale farming. Then what will happen to small farmers. So, fairness issue is a large ethical issue from socio-economic perspective.

The corporate benefit issue is a prominent one when it comes to India. The reason being that for first time it was Monsanto who commercially introduced Bt. technology in India. This technology did not come from India's agriculture research system. The argument which many critics give against Bt. technology in India is that private companies are more interested in their profits and are least bothered about the environmental safety, human health, and farmer problems. Some critics say that as India does not have appropriate structure and knowledge-base to assess the short term and long-term impact of Biotechnology these companies make use of such shortcomings. Critics say that private companies highlight those aspects which are in their favour and hide those facts about their Biotechnology products which can go against them. So unless and until the proper mechanism is set-up such products or technologies should not be allowed to become commercial.

The Nature and Extent of Professional and Scientific Responsibility

There are huge numbers of agriculture scientists who are working in public funded organizations. They have the responsibility of improving the socio-economic status of farmers by developing better agriculture technologies and products. Today there are many such scientists who are involved in projects which are funded by private companies who are involved in the business of agriculture biotechnology.

According to Burkhardt (1988):

"The ethical issue that arises here is that should a scientist, particularly working in a publicly funded university or other research organization, pursue or receive private or corporate funding while retaining his or her "public role". Should scientists and research administrators in publicly funded organizations pursue biotechnology R&D at the expense of other kinds of research such as traditional breeding? This may tend to contradict the "mission" of the governmentally-instituted research effort-to serve agriculture. Is it legitimate for corporate decision-makers to seek to control the public sector research agenda?"

He further says:

"Many of these problems may be preventable or resolvable by a clear specification of relationship between public and private concerns over proprietary rights, sharing research results, and so forth. Some of them may require a more direct specification of the overall relationship between public and private research efforts. Some of these issues may simply require that scientists, administrators, and funding agents be honest with themselves and the public about the nature and consequences of specific research as well as the whole research agenda….If some biotechnology R&D does carry health or environmental risks, this would seem to be scientists and administrators main ethical responsibility."

The crux here is that scientists who are involved in developing knowledge through biotechnology are aware of their roles and responsibilities or not. Are they willing to accept the responsibility for involving themselves in R&D that can produce things that can result in a situation later on that may not be in their control and can do more harm than the benefit produced in short term? Are the scientists involved in Biotechnology satisfying their scientist ego by playing and manipulating the genes and adding to their publications and forgetting the larger societal issue for which the Biotechnology should be used?

Very often; a section of scientists involved in Biotechnology, policy makers, and agribiotech firms talk in general terms like "Biotechnology is the future of agriculture" or " Food and nutritional problem can only be solved through Biotechnology" neglecting the inequities in the distribution of benefits and burdens of agriculture and agriculture research. Or, they fail

to take seriously health, environmental, and socio-economic risks so often raised by critics. Monsanto is one of the example who suffered by not listening to the critics.

Firestein (2006) writes:

"In the 1990's, the firm developed a biotechnology so powerful that it seemed to bring the chance for meaningful reduction in world hunger. Monsanto's genetic manipulation enabled farmers to grow grains in a wider range of environments, and it could make crops immune to herbicides, thus permitting an application dosage and schedule that would free fields of weeds. The company, seeing itself in a historically advantageous position, adopted a hyper-aggressive marketing strategy. It decided to license the technology within the seeds as intellectual property rather than sell the seeds to farmers outright. Farmers were thereby prevented from collecting seed from current crops for future planting seasons, reversing traditional farming practices. Monsanto's management seemed deaf to the rising clamour of opposition. Activists warned that the genetic modification might be harmful to humans or the environment, and that they might jump to other plants with unforeseeable consequences. The debate both frightened and enraged the public, and as a result the European Union imposed a five-year moratorium on all genetically modified seed. The company soon lost its independence in a "merger". In a concessionary statement to the activist group Greenpeace, Monsanto Chairman Robert Shapiro said: "Because we thought it was our job to persuade, too often we forget to listen." "

Therefore, if biotechnology has the ability to serve the broader public good through servicing agriculture, it is the responsibility of those who direct and fund such research to understand, address, discuss and clarify these benefits and risks, and not simply sidestep the critic's point of view. This will also involve honesty with the public regarding the real "promises" of Biotechnology as opposed to "hype" and "gloss" (Burkhardt, 1988).

It is not that any scientist who talks in favour of Biotechnology is lying or the environmentalist who criticizes Biotechnology is speaking the truth or the other way round. The responsibility related to Biotechnology does not solely lie with the scientists or with the business organizations or with the critics. Citizens and consumers have equal responsibility. Neither the agriculture scientists, business organizations, nor the critics have the sole possession of truth. It is our responsibility to demand that they justify their efforts in explicitly ethical terms (Burkhardt, 1988). The only ethic which a common man demands from Biotechnology is that it should benefit agriculture and should serve broader social interests in present and future human health, environmental safety, fairness, and the food and nutritional security.

Implications of Biotechnology on Farmers

India, the largest democracy in the world, is highly dependent on agriculture. The performance of the agriculture sector continues to influence the growth of the economy – it is a major factor in driving India's national economy. In recent years, there has been a decline in the share of agriculture in the national economy from almost a quarter to 17.8% of its Gross Domestic Product (GDP). In contrast, there has been a very small decline in the workforce engaged in agriculture which still provides a means of survival to 52% of the population – more than half of India's population (Economic Survey, 2009). India is a nation of small resource-poor farmers, most of whom do not make enough income to cover their meager basic needs and expenditures. The latest National Sample Survey conducted in 2003, reported that 60.4% of rural households were engaged in farming indicating that there were 89.4 million farmer households in India (National Sample Survey, India, 2003). According to Clive James (2007), 'Sixty percent of the farming households own less than 1 hectare of land, and only 5% own more than 4 hectares. Only 5 million farming households (5% of 90 million) have an income that is greater than their expenditures. The average income of farm households in India (based on 40 Rupees per US dollar) was US$50 per month and the average consumption expenditures was US$70. Thus, of the 90 million farmer households in India, approximately 85 million, which represent about 95% of all farmers, are small and resource-poor farmers who do not make enough money from the land to make ends meet.' Biotechnology offers hope for farmers.

If we look back at the history of agriculture we find that farmers themselves have played a great role in in improving the crop plants alongwith the specialized agriculture that emerged. It is a testimony to the skills of the farmers that modern crop plants, in many cases, bear little resemblance to the original plants from which they evolved. Maize, for instance, is a classic example of crop domestication. Many generations of farmers have 'tailored' major crop plants such as maize through a lengthy domestication process. Farmers retained plants that had 'value', that is, met their locally determined needs such as food, feed, fibre, fuel or shelter. The main selection criteria that were used (and still being used by many farming communities) included yield and yield stability, risk avoidance, low dependence on external inputs, and a range of quality factors associated with nutrition, storage, taste preferences and cooking characteristics (Jefferson *et al*., 1999). It could be said that first breeders were farmers. Then in 19th century plant breeding evolved and agriculture started developing as a science.

The traditional methods used by farmers and breeders for crop improvement has two major aspects: one is that traditional methods are time taking and secondly the methods have no major negative effects from the perspective of environment or human health. Biotechnology on the other hand has the potential to use the genetic diversity of the nature to produce the desired traits in crops at a much faster rate but the question of biosafety poses a challenge. In a sense, at present, we can say that the positives of traditional methods are negatives for

Biotechnology and negatives of traditional methods are the positives of Biotechnology.

Through Biotechnology many applications have been developed which are being used by researchers and business organizations for specific purposes. In brief, some of these applications are :

- ***Tissue Culture***: Tissue culture is the *in vitro* culture of cells, tissues or organs in a nutrient medium under sterile conditions.

- ***DNA Fingerprinting***: DNA fingerprinting means the derivation of unique patterns of DNA fragments obtained using a number of marker techniques. It helps in the description of the genotype of an individual from the pattern of DNA fragments.

- ***Transgenesis***: Transgenesis is the introduction of a gene or genes into animal or plant cells, which leads to the transmission of the input gene (transgene) to successive generations. And transgenic is an individual in which a transgene has been integrated into its genome. In transgenic eukaryotes, the transgene must be transmitted through meiosis to allow its inheritance by the offspring.

- ***Biocontrol***: Biocontrol is a process of controlling pest through biological means. In this process living organisms are deliberately introduced to restrain the growth and development of other organisms, such as the introduction of predatory insects to control an insect pest.

- ***Molecular Genetics***: Molecular genetics is the study of the expression, regulation and inheritance of genes at the level of DNA and its transcription products.

- ***Diagnostics***: Diagnostics is a test or assay used to determine the presence of a specific substance, organism or nucleic acid sequence alteration, etc.

- ***Genomics***: Genomics is the research strategy that uses molecular characterization and cloning of whole genomes to understand the structure, function and evolution of genes and to answer fundamental biological questions.

The above technologies are being used by researchers and business organizations for enhancements in agriculture and especially for increasing the productivity and income of the farmers. The relevant point here is that if all those who are involved in developing agriculture through Biotechnology are able to develop mechanisms and processes which could answer all the ethical issues discussed in the paper then the Biotechnology can prove a real boon to the farmers. Then some of the potential benefits for farmers that could emerge through Biotechnology are:

- Germplasm for biotic stress resistance could be developed. It has been estimated that, in India, biotic stresses caused by insects, nematodes, fungal, bacterial and viral pathogens, and weeds, collectively result on an average approximately 45% yield losses annually (Rai and Prasanna, 2000).
- Resistance to insect pests in crop varieties could be developed. Insect pest incidence is one of the major factors limiting crop productivity in tropical countries like India. It would also save the expenditure spent on insecticides and pesticides.
- Development of disease resistance in crops could be achieved. Viral diseases do a lot of damage to crops.
- Abiotic stress tolerance in crops against drought, salinity and extreme temperatures could be developed. Classical plant breeding methods have not achieved much success in this regard.
- Herbicide tolerance could be developed. Weeds do lot of damage to the yields of variety of crops.
- Post harvest losses could be reduced. Biotechnology has opened up new avenues for reducing post-harvest losses and for improving the quality of horticultural crops. Estimates of post-harvest losses vary widely, ranging from 10-40% or more, and are difficult to measure accurately (Kendall and Pimentel, 1994).
- Development of Value-added food products through quality improvement of crop plants is another important area in which biotechnology can significantly contribute. Malnutrition is a major problem in rural areas of India. Conventional breeding methods with tedious and time-consuming selection steps, although effective, have had limited success in improving protein quantity and quality. Genetic engineering offers to provide ways to bring in directional changes in a precise manner in both quantity and quality of proteins.
- Micropropagation can help in achieving multiplication of plants throughout the year. It is already bringing good results in many horticulture crops such as banana, papaya, and potato.
- Water conservation through drought tolerant crops could be achieved.
- Reduction in soil degradation through Biotechnology is another future possibility.
- Reduction in Nitrogen fertilizer use through development of nitrogen - efficient crops can be achieved through Biotechnology.
- Biofertilizers could help in pursuing organic farming.

There are so many possibilities through Biotechnology that can really affect the farmers in a very positive manner. There are so many benefits that can be derived for the farmers through Biotechnology and above mentioned benefits are simply a brief summary. Biotechnology has the potential to improve the socio-economic condition of the farmers. Some of the positive signs have already surfaced through some of the Biotechnological products and

technologies which have been used by the farmers and they have been positively affected. The only pertinent issue is that:

- Can we capture the potential benefits of agricultural biotechnology in a fair and equitable way for today's and future generations?
- Can we balance the interests of human society and the environment using biotechnology?
- Can biotechnology contribute to sustainable agricultural systems?

Conclusion

Biotechnology, undoubtedly, has the power to create impressive opportunities to effectively tap the genetic potential and bring in genetic variability, across the reproductive barriers, that can be exploited by Agricultural scientists for the benefit of the farmers, food and nutritional security, and serving the agriculture. Efforts are, however, needed to ensure that Biotechnology serve the cause of the society on a sustainable basis. We must pay adequate attention to various issues associated with the development and commercialization of Biotechnology in view of the possible environmental, economic, social, legal and ethical implications. Everyone should realize the fact that it is too premature to predict that all the good will come through Biotechnology or all the wrongs will come through technology. There never was and there never will be any technology that will be bad. It is only upto we human beings that whether we use the technology or abuse the technology. Once again it will be the human factor which will decide the future of Biotechnology instead of the technology itself.

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