POST NORMAL SCIENCE (PNS) PERSPECTIVE ON GENETICALLY MODIFIED (GM) FOOD CONTROVERSY: THE CASE OF BT BRINJAL IN INDIA

A Thesis submitted during 2015 to the University of Hyderabad in partial fulfilment of the award of a Ph.D degree in

Science Technology and Society Studies

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DECLARATION

I, hereby declare that this thesis entitled **"Post Normal Science (PNS) Perspective on Genetically Modified (GM) Food Controversy: The Case of Bt Brinjal in India",** submitted by me under the guidance and supervision of **Prof. E. Haribabu** is a bonafide research work which is also free from plagiarism. I also declare that it has not been submitted previously in part or in full to this university or any other university or institution for the award of any degree or diploma. I hereby agree that my thesis can be deposited in Shodganga/INFLIBNET.

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CERTIFICATE

This is to certify that the thesis entitled "**Post Normal Science (PNS) Perspective on Genetically Modified (GM) Food Controversy: The Case of Bt Brinjal in India**" submitted by Mr. Jacob Kalle bearing Regd.No.10SKPK01 in partial fulfilment of the requirements for the award of **Doctor of Philosophy** in **Science Technology and Society Studies** is a bonafide work carried out by him under my supervision and guidance.

The thesis has not been submitted previously in part or in full to this or any other University or Institution for the award of any degree or diploma.

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To

Late Shri. Naladi Susheelamma and Nasari

Late Shri.Govathoti Vararaju

Naladi Ramesh Babu

Naladi Jaya Prakash

They've taught me about hard work and discipline. I can only say a proper thanks to them through my future work.

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Jacob Kalle

ABBREVIATIONS

ABLE	:	Association of Biotech Enabled Enterprises
ABSP II	:	Agricultural Biotechnology Support Project II
APEDA	:	Agricultural and Processed Food products Export Development Authority
AYUSH	:	Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homoeopathy
BSE	:	Bovine Spongiform Encephalopathy
Bt:		Bacillus Thuringiensis
CBD	:	Convention on Biological Diversity
CEE	:	Centre for Environment Education
CPB	:	Cartagena Protocol on Biosafety
CSIR	:	Council for Scientific and Industrial Research
CSO	:	Civil Society Organization
DAC	:	Department of Agriculture and Cooperation
DARE	:	Department of Agricultural Research and Education
DBT	:	Department of Biotechnology
DCA	:	Department of Consumer Affairs
DG-ICMR:		Director-General of Indian Council of Medical Research
DLC	:	District Level Committees
DNA	:	Deoxyribonucleic Acid
DSIR	:	Department of Scientific and Industrial Research
EC	:	Expert Committee
EIA	:	Environmental Impact Assessment
EPC	:	Extended Peer Community
EU	:	European Union
FAO	:	Food and Agriculture Organisation
FAS	:	Foreign Agricultural Service
FASSI	:	Food Safety and Standards Authority of India
FSB	:	Fruit and Shoot Borer

FSSAI : Food Safety and Standards Authority of India

GAIN : Global Agriculture Information Network

GE : Genetic Engineering

GEAC : Genetic Engineering Appraisal Committee

GM : Genetically Modified

GMO : Genetically Modified Organisms

GOI : Government of India

GRAS : Generally Regarded As Safe

HYV : High yielding Variety

IAASTD : International Assessment of Agricultural Knowledge, Science and Technology for Development

IBSC : Institutional Biosafety Committee

ICAR : Indian Council for Agricultural Research

ICMR : Indian Council for Medical Research

IFOAM : International Federation of Organic Agriculture Movements.

IIHR : Indian Institute of Horticultural Research

IIVR : Indian Institute of Vegetable Research

IPCC : International Plant Protection Convention

IPR : Intellectual property rights

ISAAA : International Service for the Acquisition of Agri-biotech Applications

LMO : Living Modified Organism

MEC : Monitoring–cum Evaluation Committee

MH : Million Hectares

MoEF : Ministry of Environment and Forests

MoU : Memorandum of Understanding

MRTPC : Monopolies and Restrictive Trade Practices Commission

NBA : National Biodiversity Authority,

NBTB : National Biotechnology Board

NFC : National Farmers Commission

NGO : Non-governmental Organisation

NHB : National Horticulture Board

OECD : Organization for Economic Co-operation and Development

PNS : Post Normal Science

PPPs : Public Private Partnerships.

PPV&FRA: Protection of Plant Varieties and Farmers' Right Authority,

R & D : Research and Development

RCGM : Review Committee on Genetic Manipulation

RDAC : Recombinant DNA Advisory Committee

R-DNA : Recombinant Deoxyribonucleic Acid

SBCC : State Biosafety Coordination Committees;

SBCC : State Biotechnology Coordination Committee

SECs : Socio Economic Considerations

TEC : Technical Expert Committee

TERI : The Energy and Resources Institute

UNDP : United Nations Development Programme

USA : The United States of America

USAID : United States Agency for International Development

USDA : United States Department of Agriculture

WBC : White Blood cells

WHO : The World Health Organisation

WTO : World Trade Organisation

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CHAPTER I

INTRODUCTION

1.1. Introduction: Study Background

The discovery of the double helical structure of Deoxyribonucleic Acid (DNA) by James Watson and Francis Crick in 1953 has become an exemplar/paradigm that ushered in a cognitive revolution in biology. The discovery was the result of synthesis and integration of knowledge from various disciplines- physics, chemistry, biochemistry, crystallography and biology. It enabled scientists to understand life processes at the molecular level. The understanding at the molecular level also created the possibilities of developing strategies of intervention in the life processes at the molecular level. Another breakthrough achieved in the 1970s enabled scientists to transfer discrete genetic material from one organism to another and opened up the prospects of transferring genes, not only from one organism to another within a species, but also from one organism to another across species. The achievement ushered in recombinant DNA (r-DNA) technology or genetic engineering[1] (Haribabu 2004).

As genetic modification[2] enables the isolation and transfer of genes that regulate traits of interest from across species, it has some potential to provide solutions to some of the important

[1] The term 'genetically engineered' is often used in place of 'genetically modified'. I use 'genetically modified' because this is the terminology consistently used by many authorities internationally, including the Food and Agriculture Organization of the United Nations; the World Health Organization; Codex Alimentarius; European and Indian legislation; peer reviewed studies by industry and independent scientists; and the international media. It is also consistent with the Cartagena Protocol's term 'living modified organism (LMOs)'.

[2] The UN Convention on Biological Diversity (CBD) defines biotechnology as "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use". In this inclusive sense biotechnology can include anything from fermentation technologies to gene splicing. It includes traditional and local knowledge and the contributions to cropping practices, selection and breeding of plants and animals made by individuals and societies for millennia. It would also include the application of tissue culture and genomic techniques and marker assisted breeding or selection to augment natural breeding (TERI Policy brief 1 2010: 1).

questions related to crop improvement, such as biotic (Insects, weeds etc.,) stresses, abiotic (drought, salinity etc) stresses and overcoming yield barriers. Apart from this, scientists also foresee a second generation genetically modified food products that will bring a range of advantages, including health benefits for consumers, such as improved nutritional value, taste, longer shelf-life. But, the use of genetically modified organisms (GMOs) in agriculture has been controversial since the late 1990s. The year 1996 saw the first planting and harvesting of GM maize and soybeans, the two most widespread GM crops in the USA. Subsequently, the processed foods containing GMOs found their way onto US supermarket shelves.

In the Indian context, the genetically modified (Insect resistant) cotton, popularly known as Btcotton is the first and only non-food GM crop that was commercially released during the year 2002. Btbrinjal is the second genetically modified crop and the first food crop which has come so close to commercial release. Had the Ministry given the approval for release of Bt brinjal, it would have been the first genetically modified vegetable to be grown anywhere in the world.

Use of modern biotechnology to produce transgenic organisms elicits varying reactions across the world. For example in Europe genetic modification to provide medicines is not as controversial as the genetic modification of crops for human consumption'. Often the genetic modification of animals (especially reproductive cloning) is considered as less acceptable than modification of plants. Modification of the germ line in humans is usually considered as immoral

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Genetic modification involves transfer of gene(s) from an organism belonging to one species of a taxonomic group to the food crop that belongs to a species of another taxonomic group. The source of the genes may be a plant species, animal species or a bacterium. Therefore, in genetic engineering, genetic traits from any species like bacteria, virus, fungi, plants or animals can be introduced intoa desired plant species. Genetic engineering is able to precisely introduce specific desirable traits into a species, using the techniques of molecular cloning and transformation to directly alter the structure and characteristics of genes. Crops produced through this process are called 'transgenic' or 'genetically engineered/modified' crops. For example, the 'Bt' widely used in genetically modified crops is Bacillus thuringiensis, a common bacterium that producesinsecticidal proteins (TERI Policy brief 1, 2010 : 2).

(Gaskell *et al*1999). In the USA, genetically modified food crops have become a reality and genetically modified food is consumed. In the Indian context, biotechnology became very controversial when compared to nuclear technology. In India too, applications in medicine are less controversial than applications in agriculture. Within agriculture, when compared to non-food crops (Bt cotton), Bt Brinjal, being a food crop became more controversial when it was sought to be introduced. Thus, we see diverse images of biotechnology in almost all the countries in the world today.

The Bt brinjal in India was developed by Mahyco (A subsidiary of Monsanto). The production of brinjal faces a number of problems which cause yield losses and affect quality due to the insect pest the fruit and shoot borer (FSB). Thus, brinjal farmers incur income losses. For managing FSB pest, farmers depend on the application of chemical pesticides. Genetically modified technology has emerged as an alternative to chemicals in controlling insect-pests (Sant Kumar *et al* 2011:83).

Bt Brinjal is a transgenic brinjal created by inserting a gene (Cry1Ac) from the soil bacterium Bacillus thuringiensis into Brinjal. The insertion of the gene into the Brinjal cell in young cotyledons has been done through an Agro bacterium mediated vector, along with other genes like promoters, markers, etc. This is said to give the Brinjal plant resistance against Fruit and Shoot Borer. It is reported that upon ingestion of the Bt toxin by the insect, there would be disruption of digestive processes, ultimately resulting in the death of the insect. Bt-brinjal has the potential to solve crop failure due to FSB infestation (Varshney. 2010: 34).

On 14 October 2009, based on the risk assessment report of the Expert Committees-II, the government's Genetic Engineering Approval Committee (GEAC) cleared Bt brinjal for

commercial release, claiming that it would result in lower usage of pesticides, higher yields and contribute to India's food security. There is another view among the public according to which the genetic engineering technology that seeks to transform the organic world is fraught with risks and uncertainties for humans and environment. Therefore, consequent to the GEAC's decision, brinjal being a food crop, the public has expressed various concerns and apprehensions about the long term effects of GM food crops on human health and the environment. Responding to strong views raised both for and against the introduction of the Bt brinjal, the then Minister of State for Environment and Forests (MoEF) Mr.Jairam Ramesh called for public consultations. A series of consultations were held during January and February 2010 in seven cities across India, where various interest groups were invited to present their views. Interestingly, the Minister witnessed and sat through the entire consultation process in seven cities. Based on the outcome of this consultative exercise, the minister announced a moratorium on the commercial release of Bt brinjal on 9 February 2010 by invoking the *Precautionary Principle.*

What is very significant, in contrast to earlier practice was that the policy decision on Bt brinjal for the first time in the independent India was given as a 19 page Ministerial Note(Like a speaking order[3]) on any technology. *"It is incumbent upon us an accountable and transparent administration to respond to these concerns"* Minister said. (Ministerial Note, Para No.25 MOEF 2010:16). In this context, the primary thrust of the present thesis is an Ex-post facto analysis of the evidences that have gone into the Decision making on Bt Brinjal.

Secondly, though various strands of evidence including scientific evidence, views from the national and international experts, views from the State governments, etc.,, that have gone into

[3] Spaking order is a detailed written note stating rationale for the decision.It explain the reasoning behind the decision and to help build an institutional history.

the decision, the utmost importance was given to the outcome of the public consultations *"My objective is to arrive at a careful, considered decision in the public and national interest....decision will be made only after the consultations process is complete and all stakeholders are satisfied that they have been heard to their satisfaction"* Minister said (Ministerial Note, Para No.2, MOEF 2010:2). He also stated that *"I am also persuaded that the studies being demanded by responsible civil society groups before release of Bt brinjal should be conducted as a measure of our sensitivity to public opinion"* (Ministerial Note, Para No.25, MOEF 2010:16). Following the public consultation the moratorium was imposed on the commercial release of Bt brinjal for an indefinite length of time until the safety of the product was established by independent scientific research *"to the satisfaction of both the public and professionals in the field"* (Ministerial Note, Para No.26 MoEF 2010: Para No.17). Thus, the outcome of the public consultations formed the main basis for arriving at this policy decision.

In the Indian context, the national consultations on Bt. brinjal can be seen as first ever initiative to move towards recognition of the fact that controversies around modern biotechnology cannot be resolved purely based on scientific risk assessment. According to Alam (2011: 109), the emphasis on public opinion is represents the 'extended participation' model (Liberatore and Funtowicz 2003:146-50) of the interaction between science, expertise and politics and points out that *"Science is a crucial but not exclusive form of relevant knowledge, citizens are at the same time users, critics and producers of knowledge"*. Under the conditions of scientific uncertainty and conflicting values and interests among the social groups, the post Normal Science (PNS) as an alternative approach in policy relevant science advocates for the initiation of extended peer community.

Production of knowledge and its application is a socio-technical process involving facts, beliefs, meanings, interests and values. Drawing on the Post Normal Science (PNS) framework, the main thrust of the thesis is an ex-post-facto analysis of the Minister's moratorium decision on Bt brinjal in the Indian context.

1.2. Precautionary and participatory Approaches in Decision making: A Review

Using precautionary and participatory processes as a way to open up research and decision making has recently received a lot of attention. What might the reasons for this seemingly so strong and sudden rush towards a democratisation of science/society relations be? This interest could partly be a result of critical questioning of the authoritative role of science in decision making. There are three main reasons for the emergence of the precautionary principle and participatory approaches in decision making on novel technologies namely : 1) Technoscience : A Changed context of Knowledge Production 2) Science and Policy Relationship: Probabilistic Models, Organic world, Uncertainties, and 3) Dominant Risk Discourse reduces all public Concerns in terms of Risk. In the following section, I will discuss the above mentioned three reasons in detail.

1.2.1. Technoscience: A Changed context of Knowledge Production

Science is a precious resource to understand the natural world and transform that understanding into a resource for economic, social and cultural transformation. The belief that scientific knowledge is objective, true, invariant and infallible has been challenged by the new approaches in the post-Kuhnian sociology of scientific knowledge. The Post–Kuhnian approaches in the social studies of scientific knowledge questioned the received view of science and demonstrated that a) the earlier conception that science is a morally neutral and disinterested pursuit, autonomous from wider society and culture, is no longer tenable; b) all knowledge including

scientific knowledge is socially caused; c) the boundary between the internal and the external worlds is not rigid but porous, and d) there are intimate links between the context of discovery that is the process of production of knowledge and product of science (descriptions, explanations, models and theories).

On the other hand, scientific knowledge has been undergoing a cultural transformation from a disinterested and morally neutral enterprise to an enterprise that is intimately connected to values of profit and efficacy (industry) and political hegemony (military research) since the latter part of the 20th century. The IPRs regime of the WTO has made scientific knowledge that was hitherto a public resource into an intellectual property. Hitherto public support for science was based on the belief that the output of science would serve some public good and the governments across the world extended support to science.

For example, Latour (1983 in Haribabu 2004) showed that Louis Pasteur, by bringing the Anthrax-infected tissue of cattle in his laboratory, simultaneously brought the interests of farmers, government, veterinarians and the press, who were interested in finding a solution to the problem.Similarly, genetic engineering research is intimately connected to the interest structure and system of meaning of various actors – farmers, scientists, industry, state, regulatory bodies, consumers and civil society and its organizations. In other words, there is a continuous and dynamic interaction between the external world and the internal worlds of science. The term technoscience captures this interpretation. Therefore, the term 'technoscience' (Latour 1987) means that science always was and is ever more so driven by technological possibilities which open up and thus also shape new epistemic options (Keating and Cambrosio 2003).

This interpenetration can be distinctly seen in the case of the relationship between molecular biology and biotechnology. Commercial considerations are increasingly influencing basic research in molecular biology (Haribabu 2004). According to Gaskel *et al.,* (2001:117)*"The evident commercialization and industrialization of biotechnology, with the pursuit of private knowledge, patents and profits, hardly meets Merton's ethos of universalism, communism, disinterestedness and skepticism, or the public's expectations about the values, accountability and social responsibility of science. Biotechnology has become a technoscience, a commercial enterprise accountable to financial markets and to shareholders"*

Several scholars have highlighted this cultural transformation of science. Ziman, J. (1996) observes that 'public knowledge' is being transformed into 'intellectual property'. One of the significant features of the changing context of production of knowledge is that the research process is increasingly getting privatized. According to Ravetz (2004), the autonomy of science in academia and government has been steadily compromised by commercial interests. For example, the cooptation of scientific-rationality and the method of science in industry is manifest in what researchers refer to as the 'triple helix,' that is, the *"tight intertwining and mutual affinity of the government, commercial, and academic sectors . . ."* (Guston 2006:19). The transformation of university science to *University Inc, according to* Washburn (2006), has made the case for self-regulation in science more difficult. Scientists are no longer just experts; their personal fortunes could also influence their opinions. Nowotny *et al*. (2001) emphasise the emergence of transient innovation research (*Mode* 2) at the expense of the established university disciplines and their celebrated academic (Mertonian) ideals. In their view, the emergence of *Mode 2* research is a logical response to ongoing developments in the economy and technology and the inadequacy of university disciplines to deal with these problems. Krimsky (2004)

demonstrates the existence of a *funding effect* where Industry-sponsored studies are more likely to reach conclusions that are favourable to their sponsors than non-industry studies.

In this context, Jasanoff (2003) observes that when society becomes the laboratory in which new technoscience is tested, uncertainties proliferate. New technoscientific developments may have unanticipated consequences or be in conflict with fundamental societal values. In the present context in which science has become an intellectual property, what are the terms of contract between science and society and what is the governance model that can ensure participation of stakeholders with diverse interests and meanings in a country like India?

1.2.2. Science and Policy Relationship: Probabilistic Models, Organic world, Uncertainties

It is evident that major technological interventions always come with some risks. Evaluation of such risks is essential before taking any decisions on the introduction of such technologies (Purkayastha *et al* 2010:42).Hence, scientific risk assessment plays a vital role in decision-making processes related to emerging technologies. The important questions to be raised in this context are: Can Sound Science give us the tools for recognizing the possible health and environmental risks of GM crops? Why are they being recommended by scientists and approved as safe by regulators but found in some biosafety studies indications of harm? If adverse effects are indeed occurring, what is the likelihood that the existing risk assessment approaches would capture these effects if they were caused by a GM plants?

In the Indian context, the public debate surrounding the commercialisation of the Bt-brinjal has brought into focus the relationship between science and politics and the complex character of expertise in the public decision-making process (Alam 2011:106). Here, I will focus on a particular component of the science and policy relationship, namely the scientific assessments of

technological risks and particularly the treatment of scientific uncertainties in policy-relevant science[4].

Barbour (1980) defines risk as an uncertain potential harm to human life or health or to property or the environment. Stirling and Gee (2002) defined Risk as the 'magnitude of a possible hazard' multiplied by the 'probability that a hazard will occur'. Hence, the basic steps of risk assessments are to identify the possible hazards associated with a given technological invention and to calculate the magnitude and the probability associated with each hazard occurring. The exercise is commonly performed by scientists with expert knowledge in relevant fields.Here it is pertinent to make the distinction between the Risk and Hazard on the one hand and Risk and Uncertainty on the other.

Risk and Hazard: *Risk* analysts make a distinction between hazard and risk. A *hazard* is a situation with the potential for harm. A hazard is something that can cause harm, such as food-borne pathogens or chemicals. Hazard does not reflect any characterization of the likelihood that this harm will actually occur. To speak of risk requires an analysis of exposure as well as a hazard, where exposure is a characterization (usually quantitative) of the course of events that must occur for the harm to materialize. A risk is the chance that any given hazard will have adverse consequences, to health or the environment.

Risk and Uncertainty: According toWickson *et al.* (2010) *Risks* are less problematic and manageable, because knowledge of their nature and likelihood is well understood, such as routine pathogens. On the other hand, *Uncertainty*exists where knowledge of hazards may be well understood, but likelihoods are less well defined in the case of rare events or where human factors come into play.

[4]'Policy- relevant science' covers scientific activities that aim to provide information and advice for decision making.

The decision making on the emerging technologies in general is based on the predictive methods such as risk assessment, cost-benefit analysis, climate modelling etc. which are designed to facilitate management and control of risks and uncertainty. These methods, according to Jasanoff S (2003) achieve power through claims of objectivity and a disciplined approach to the analysis. Here, scientists play a central role in the introduction of novel technologies. They are the ones who develop technologies and often the ones who are called upon as experts to evaluate safety aspects. According to Funtowicz and Roger Stand (2009), the relationship between science and policy can be better explained through the 'modern model'. As per this model, science informs policy by producing objective, valid and reliable knowledge. To develop a policy was thus a matter of becoming informed by science and then, in a second step, to sort out diverse values and preferences. In other words**,** first, it assumes that the available scientific information is really objective, valid and reliable. Second, the modern model assumes not only that uncertainty can be eliminated or controlled, but also that the scientific information can be complete in the sense that it tells the policy maker everything that is necessary to know in order to decide for the common good. Thus, the practice of risk assessment is based on the assumption that occurrence of every hazard can be accurately predicted and its respective probabilities calculated using scientific methods. In this context Stirling and Gee (2002) argue that to express all uncertainties in quantitative terms and treat them as if they will be sufficiently reduced through more research is misleading. As argued by several scholars, numerous examples of unanticipated and undesirable impacts of technologies, which most often become evident only after a technology is introduced, have, however, questioned the ability of this approach to predict consequences and resulted in increasing attention about the existence of uncertainties in policy-relevant science (Funtowitcz and Ravetz 1993; Stirling and Gee 2002; Walker *et al.*, 2003; Felt and Wynne 2007). The

controversies such as the Bovine Spongiform Encephalopathy (BSE[5]) have highlighted the failure of traditional expert systems owing to their highly problematic entanglement with the policy world (Jasanoff 1997; Irwin 2001).

In this context, it is important to mention the strong words from one of the most central figures in the science system. In 2003, the editor of Science, Leshner (2003), wrote on the "Public Engagement with Science":

> *"Some people are not so happy about how central science and technology are in their lives. [...] One traditional response of the scientific community to what it views as a lack of appreciation or misinterpretations by the public has been to mount so-called public understanding or education campaigns designed to "enlighten" the populace, either about science in general or specific issues in particular. [...]*
>
> *But simply trying to educate the public about specific science-based issues is not working. Many science skeptics are already quite well educated, but they relate more to the risks of science and technology advances than to their benefits. Moreover, given the uncertainties in science, the best science-based strategy is not always as clear as we would like and as many in our community might claim. [...]*
>
> *The centrality of science to modern life bestows an obligation on the scientific community to develop different and closer links with the general population. That convergence will help evolve the compact between science and society so that it will better reflect society's current needs and values. We need to move beyond what too often has been seen as a paternalistic stance. We need to engage the public in a more open and honest bidirectional dialogue about science and technology and their products, including not only their benefits but also their limits, perils, and pitfalls. We need to respect the public's perspective and concerns, even when we do not fully share them, and we need to develop a partnership that can respond to them" (Leshner 2003:977).*

[5]A particularly noteworthy episode was the spread of bovine spongiform encephalopathy (BSE) or 'mad cow disease' in Europe, which was transmitted to human beings in the form of the Creutzfeldt–Jakob disease. In 1995, the first case of a new variant of Creutzfeldt–Jakob disease (vCJD), a disease in humans resembling BSE, was diagnosed in the UK, and in 1996, the UK government announced that there appeared to be a link between BSE and vCJD. The EU reacted by imposing a worldwide ban on UK cattle and beef exports. In this cases, regulators were perceived as having failed in their responsibilities, and concealing important information from the public. In the late 1990s, BSE appeared to be the leading cause for scepticism over GM food in Europe. As a result of BSE and other crises, many Europeans tend to mistrust not only industry, but also their regulators. Indeed, they trusted consumer and environmental organizations rather than governments, industry or academia.

First and foremost, he is concerned with public trust in science, and whether citizens appreciate the role science and technology play in their lives. He goes on to argue that previous paternalistic strategies (Public Understanding of Science or deficit model) to build trust have failed, and hence a more open stance and dialogue is needed. A Second, relating to the inherent uncertainty of a science, Leshner (2003) states that the best political decision as well as the very best trajectory of a scientific or technological innovation may not be based on scientific expertise alone. Societal values and interests come into play in deciding which uncertain path to choose. Therefore, Leshner (2003) calls for transparency also concerning the downsides of science and for an open and bidirectional dialogue to build mutual respect and trust, and ultimately a partnership. Two broad rationales that have been identified by Leshner A for public engagement (or) dialogue with science are: to build public Trust in Science and secondly, to handle the uncertainty.

In view of above, it is important to acknowledge uncertainties in policy-relevant science and decision making which is at the core of the *Precautionary Principle*. Dealing with the uncertainties openly and explicitly will improve the quality of the information upon which decisions are based, which may lead to better risk management.

1.2.3. Dominant Risk Discourse reduces all public Concerns in terms of Risk

Technical analysis is vital for informed and accountable risk decisions, but the social science perspective suggests that trying to address risk controversies purely with more science that fails to account for the context dependent and culturally dependent nature of risk is likely to exacerbate conflict (Slovic and Gregory 1999). A technology cannot be studied as a force independent and outside society. The dominant risk discourse reduces all questions concerning governance of novel technologies to questions of risk is also problematic because it assumes that

what constitutes a risk can be scientifically and objectively defined (de Melo-Martin and Meghani 2008). Wynne (2008) argues that within policy arenas, complex, multifaceted issues surrounding technological and social innovations are often reduced to questions of risk and this serves to exclude wider cultural and political discussions.

According Barbour (1980:175), there are two important dimensions of risk: (a) judgment on the acceptable level of risk and; (b) the time element. Barbour argues that judgment on an acceptable level of risk is never purely scientific when the weighing of incommensurable costs and benefits involves trade-offs among diverse values. Hence, the culture of regulation varies across countries. The production of knowledge and its application is a socio-technical process involving a complex interplay of interests, values, beliefs and meanings and argues that technology has to be seen in relation to larger questions of justice and equity, rather than merely a technical fix (Haribabu 2004). A decision on the acceptable level of risk is always a negotiated outcome mediated by power relations among the actors and the institutions they represent. In this context, Haribabu (2004) observes that the differential in the evaluation of risk by different groups and the degree of affordability of risk are important sociological variables. What is acceptable risk by the yardstick of the industry may not be acceptable to farmers. Differential risk-bearing capacities also influence what level of risk is acceptable. For example: what is perceived as a risk by an Indian farmer holding two acres may not be seen as a risk by an Indian farmer holding 20 acres, who has the option of planning the genetically modified seed on a fraction of his /her land. Secondly, the time dimension refers to how long a particular technology is safe. What is the time frame over which it is safe and less risky to use a particular technology? How long will the Bt gene confer resistance against insects in cotton, given the fact that the insects co-evolve with the host plants?

Several scholars have highlighted the reductionist approach adopted by the dominant risk discourse. According to Slovic (1987), people are more likely to consider other impacts when dealing with these risks, such as ethical and moral or environmental factors or threats to future generations not usually accounted for by traditional statistical risk assessments. Helge Torgersen (2004:1) argues that many of the issues that determined the GM debate did not in fact originate from risk in a scientific understanding, but rather from a plethora of other arguments such as economic, political and religious considerations. Therefore, preventing unintended negative consequences is important and necessary to enable the implementation of any technology. However, only focusing on risk prevention is not enough to make a technology acceptable to a sceptical public. What is the broad based governance model which can accommodate the conflicting values and interests of different stakeholder while taking a decision on technological choice?

1.3. Precautionary and Participatory Approaches: The way forward

Using participatory processes as a way to open up research and decision making has recently received a lot of attention. This interest could partly be a result of critical questioning of the authoritative role of science in decision making and may be seen as an attempt to increase the legitimacy of and trust in decision-making processes.

The international protocols to which India is a signatory, emphasizes the use of the precautionary principle and also advocated the involvement of relevant stakeholders in the regulatory process when dealing with the safety of GM foods. Cartagena Protocol[6] (Cartagena Protocol on

[6]The Cartagena Protocol on Biosafety was negotiated over many years and implemented in 2003. The Cartagena Protocol is an international agreement ratified by 166 governments worldwide that seeks to protect biological diversity from the risks posed by GM technology. It embodies the Precautionary Principle in that it allows signatory states to take precautionary measures to protect themselves against threats of damage from GM crops and foods, even in case of a lack of scientific certainty (Convention on Biological Diversity 2000).

Biosafety 1992)and Codex Alimentarius[7] (Codex Alimentarius Commission 2003)principles share a precautionary approach to GM crops and foods. For example, Codex Alimentarius principles guide the assessment of the safety and nutritional aspects of genetically modified (GM) foods, while the Cartagena Protocol on Biosafety guides an assessment of genetically modified organisms (GMOs) on the environment. Both take a case-by-case empirical approach. Both refer to direct as well as indirect effects. The Codex includes an assessment of indirect effects of novel foods on human health and the environment (Codex Alimentarius Commission 2003); and the Cartagena Protocol recommends an inclusion of 'uncertain' effects with regards to the "conservation and sustainable use of biological diversity…taking also into account of risks to human health" (Cartagena Protocol on Biosafety 1992, Annex III).

The most widely cited formulation of the Precautionary Principle is from the Rio Declaration on Environment and Development or the 'Earth Summit' in 1992. Principle 15 of the Rio Declaration notes:

> *"In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost effective measures to prevent environmental degradation" (Rio Declaration on Environment and Development 1992).*

According to Sampson (2002: 60) the precautionary principle *"presumes that in situations where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation".*

The problem with new technologies is that it is not possible to know in advance the full risks. In this context, Purkayastha *et.al,* (2010:43) argues even though there is consensus that a

[7]Another international body, the UN's Codex Alimentarius, worked with scientific experts for seven years to develop international guidelines for the assessment of GM foods and crops, because of concerns about the risks they pose. These guidelines were adopted by the Codex Alimentarius Commission, of which over 160 nations are members, including major GM crop producers such as the United States.(Codex Alimentarius 2009)

precautionary approach is needed for introducing new technologies, the interpretation of this principle is quite different, depending on which side of the technological divide the parties are. For instance, Stirling (2006) points out that in the definition given in the Rio Declaration, different opinions prevail regarding how to understand terms such ‘threat’, ‘serious’, ‘irreversibility’, ‘degree of scientific certainty’ and ‘cost to whom’, depending on the situation and the interests of the actors involved.

Stirling (2009) argues that rather than treating precaution as a decision rule, it is more useful to talk about precautionary approaches, e.g., how precaution can inform wider processes of governance and decision making and promote social learning. This process-based view of precaution acknowledges to a larger extent the full scope of uncertainties. Perhaps the most important outcome of the discourses on precaution will be that research and decision-making processes to a larger extent are ‘opened up’ allowing for deliberative discussion on science and technology at an early stage of the developmental process.

1.4. Post Normal Science (PNS): A Conceptual Frame Work

The precautionary principle and precautionary-motivated risk assessment is important in the context of lack of scientific understanding and the complexity especially when scientists deal with the organic world. Post-normal science motivated by the precautionary principle has been advanced as a response to the above circumstances.

According to Ezrahi (1980) the traditional perspective on the ideal of science advice is based on two opposing views: the ‘utopian rationalist’ and the ‘pragmatic rationalist’. The ‘utopian rationalist’ or ‘technocratic’ ideal reflects the notion of science speaking ‘value-free’ truth to political power that gained institutional currency in the nineteenth century. Here, Proctor (1991)

argues that the notion of value-free science itself was based on the expectation that the impartiality and objectivity of scientists could help overcome political conflict. But, in the twentieth century, however, it became clear both that science cannot be value-free and that politics deals increasingly often with issues that are clouded with uncertainty, including value diversity. The presence of conflict among scientists, both epistemic and social, makes it hard to provide politicians with neutral advice. There is often considerable room for scientists and policy analysts to make choices in the assumptions of their analysis (Petersen *et.al.* 2011). On the other hand, 'pragmatic rationalist,' or 'democratic' ideal of science advice that accepts, within limits, the inevitability of political ingredients in science advice.

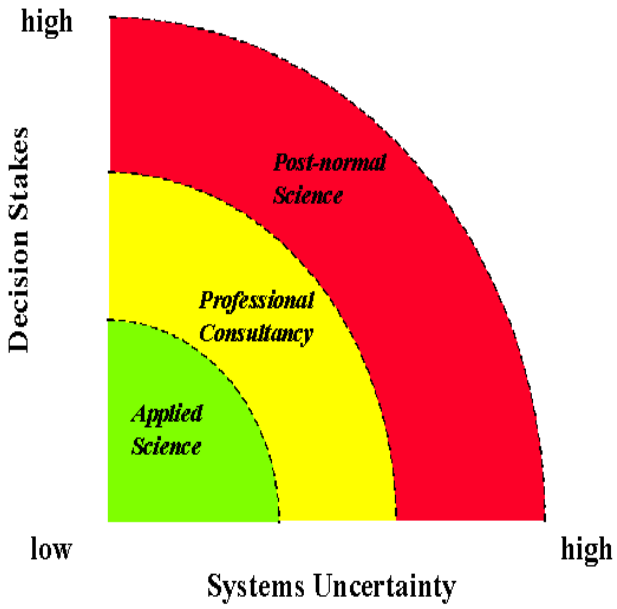
The presence of uncertainty and value controversy ask for science to contribute to political debate by representing different legitimate perspectives on policy problems. The approach is to recognize and identify the controversies, uncertainties, and ambiguities to open up discussion and stimulate the process of deliberative decision making. The post-normal science (PNS) paradigm can be understood as a strategy for the production of relevant knowledge, in line with the 'pragmatic rationalist' view on the science–policy interface.

According to Funtowicz and Ravetz (1990), Post Normal Science (PNS) is applied in the context of policy relevant science (also referred to as regulatory science-such as science done for purposes of risk assessment) which typically deals with post-normal situation where 'facts are uncertain, values in dispute, stakes high, and decisions urgent'

Funtowicz and Ravetz (1992) distinguish issue characteristics according to two dimensions: systems uncertainties (i.e., the complexities of the system under consideration, including technical, scientific, and managerial aspects and the ranges of possible outcomes) and decision stakes (Decision stakes are understood as the costs and benefits of various policy decisions for

all parties that are impacted by the issue at hand). This contextualising approach presented by representing the two dimensions as orthogonal axes on a diagram (see Figure No.1). They proposed to divide the world of policy-relevant science into three nested circles, each with its own system of quality control: (1) normal/applied science (borrowing the term from Thomas Kuhn), for ordinary scientific research; (2) consultancy science for the application of available knowledge to well-characterized problems; and (3) post-normal science**,** for the highly uncertain, highly contested knowledge needed for many health, safety, and environmental decisions.

Figure No.1: Dimensions of Post Normal Science Approach



Source : Funtowitcz and Ravetz (1992)

Post Normal Science (PNS) was introduced by Funtowitcz and Ravetz (1992) as a contrast to applied science and professional consultancy. Applied science is an adequate strategy when systems uncertainty and decision stakes are low. When systems uncertainty and decision stakes are medium, professional consultancy is necessary and may supplement applied science. Taken

together applied science and professional consultancy form what is commonly known as traditional science. Finally, the strategy of post normal science becomes critical when systems uncertainty and decision stakes are high. The necessity of using one of these three strategies for problem solving does not preclude the necessity of using the others. In fact, some complex problems may require the use of all three strategies (Marshall, Brent K. and J.Steven Picou 2008).

Applied scientists and professional consultants analyse problems as employees of formal organizations. According to Funtowics and Ravetz (1992:256), a key difference between the applied scientist and professional consultant is that *"the [applied] scientist's task is completed when he has solved a problem that in principle can function as a contribution to a body of knowledge, the professional's task involves the welfare of a client, and the science that is deployed for that is subsidiary to that goal"*.

According to Marshall and Goldstein (2006), the ideal of the objective scientist in traditional science is a myth, research may be value-laden, most research is politicized, and funded research projects are increasingly wedded to commercial interests. As the relationship between environmental problems and technological failure became increasingly apparent, the public's faith in science and trust of scientists has waned. Here, Funtowics and Ravetz (1992) argue that from the beginning in World War II and rapidly developing in the 1950s, applied science blurred the distinction between 'scientific validity' and 'engineering feasibility' which, in turn, resulted in the unleashing of unanticipated environmental risks.

In this context, Beck (1992), refers to a specific category of risks (modernization risks- the by-products of scientific and technological progress) that are global, imperceptible and fundamentally intractable in terms of spatio-temporal consequences, such as climate, genetic

engineering or radiation risks. The failures of technology such as nuclear disasters of Chernobyl and Fukushima, BSE (Bovine spongiform encephalopathy) controversy, which elevated risks to human health, exposed the fallibility and inadequacy of traditional science.

Funtowicz and Ravetz (1990) have analysed how the presence of irreducible uncertainty and complexity in environmental and technological policy issues necessitates the development of alternative problem-solving approaches and interfaces between science and policy, in which uncertainty is acknowledged and science is consciously democratized. Their ideas primarily concern replacing 'truth' as the standard for evaluating science, with a focus on 'quality assurance' based on increased participation in knowledge generation (Funtowicz 2006). The quality control function of the Extended Peer Community (EPC) does not necessarily operate according to conventional scientific criteria, which rely heavily on quantitative assessment (Healy 1999) and on falsifiability (O'Connor 1999). The knowledge production is to be organized in a way that increases the social robustness and guarantees scientific quality at the same time. When managing post normal problems decisions cannot be made based on the advice of experts alone, but require the involvement of an 'extended peer community' (EPC) consisting not merely of persons with some form of institutional accreditation, but rather of all those with a desire to participate in the resolution of the issue. This requires new interdisciplinary contacts and integration (internal extension of the peer community) on one hand, and new ''knowledge partnerships'' with policy makers, NGOs, industry, media, and the public (external extension of the peer community) on the other hand, to meet the challenges of quality control in the assessment of complex risks. In this way the PNS paradigm reflects on the transition from interfacing science and policy in normal 'getting the facts right' mode toward the post-normal 'working deliberatively within imperfections mode' (Funtowicz 2006). Here the proponents of

the PNS approach are not suggesting that scientists reclaim autonomy through post normal science, but rather through post normal science the biases of traditional science becomes transparent and problematized. PNS is seen as a space for presenting evidence and mutual learning, and carrying out what Ravetz (2006:278) terms *"negotiation in good faith"*—a *''long way from science and a longer way from politics''*. PNS hence becomes one way to help understand the limits of models and conventional science (Ravetz 2010).

The PNS approach implicitly assumes that EPC will result in better policy and more fair and sustainable outcomes. Yearley (2000) argues that the importance of power is crucial in understanding who participates in an extended peer community and how and the public appears to be much more interested in distribution, power, and fairness than quality assurance. On the other hand, Wesselink A and Rob Hoppe (2011) argues that there is no indication how exactlyPNS can be done, beyond a mention of 'dialogue' or 'stakeholder participation' and/or ''working at the science-policy interface.''. Similarly, van der Sluijs *et al*. (2005:481) raised the question that how in extended peer-review relationships between scientists and non-scientists can be managed in ways that favour production of good quality descriptions of complex problems.

Turnpenny, Lorenzoni, and Jones (2009:348-350) observe that if PNS is successful as a sensitizing concept, this is apparently not sufficient for knowing how to do PNS. To extend the PNS theory, they suggest a possible way forward by examining the politics of PNS more closely and from this derive how its conceptualization should be revised for it to become more effective at achieving its goals. Therefore, the post normal science paradigm has yet to articulate its theory of science and society fully in contemporary times and evolve a model of governance that is robust and addresses the specificities of different contexts. I use PNS as a sensitising concept to understand the Bt brinjal controversy in India.

1.5. Extent of Global spread of GM crops and Variations in Acceptability

A total of 170.3 million hectares of biotech crops was grown globally in 2012. Developing countries grew 52% of global GM crops in 2012 and industrial countries account for 48%. Of the 28 countries which planted the GM crops in 2012, 20 were developing countries and 8 were industrial countries. The five lead developing countries in GM crops are China and India in Asia, Brazil and Argentina in Latin America, and South Africa on the continent of Africa, collectively grew 78.2 million hectares (James 2012). While, five lead developing countries account for 46% of global, remaining 15 developing countries account for only 6% of the globe.

With regard to GM traits planted globally, HT crops account for 63%, and insect resistant crops account for 37% of global plantings in 2011 (James 2011). The country wise account of GM plantations, the US had the largest share of global GM crop plantings in 2011 (42%), followed by Brazil (21%), Argentina 15%, India 7%, Canada 6%, China 3% and others 6%. Some crop types have been converted entirely (or effectively entirely) to GM production in some countries.

Table No: 1 : Global Area of GM Crops in 2012: by Country (Million Hectares)

Rank	Country	Area (Million Hectares)	Biotech Crops
1	USA*	69.5	Maize,soybean,cotton,canola,sugerbeet,alfalfa, papaya,squash
2	Brazil*	36.6	Soybean,maize,cotton
3	Argentina*	23.9	Soybean,maize,cotton
4	Canada*	11.6	Canola,maize,soybean,sugerbeet
5	India*	10.8	Cotton
6	China*	4	Cotton,papaya,poplar,tomato,sweet pepper
7	Paraguay*	3.4	Soybean,maize,cotton
8	South Africa*	2.9	Maize,soybean,cotton
9	Pakistan*	2.8	Cotton
10	Uruguay*	1.4	Soybean,maize
11	Bolivia*	1	Soybean
12	Philippines*	0.8	Maize

13	Australia*	0.7	Cotton,canola
14	Burkina Faso*	0.3	Cotton
15	Myanmar*	0.3	Cotton
16	Mexico*	0.2	Cotton,soybean
17	Spain*	0.1	Maize
18	Chile*	<0.1	Maize,soybean,canola
19	Colombia	<0.1	Cotton
20	Honduras	<0.1	Maize
21	Sudan	<0.1	Cotton
22	Portugal	<0.1	Maize
23	Czech Republic	<0.1	Maize
24	Cuba	<0.1	Maize
25	Egypt	<0.1	Maize
26	Costa Rica	<0.1	Cotton,soybean
27	Romania	<0.1	Maize
28	Slovakia	<0.1	Maize
	Total	170.3	

*18 biotech mega-countries growing 50,000 hectares or more, of biotech crops
**Rounded off to the nearest hundred thousand

Source: Clive James, 2012

1.7. Regulation of GM crops: Two major Approaches

In general, the regulation of a new technology will be based on a risk assessment. A decision on how to regulate any new technology will be based on particular society's approach towards technology and nature. There are two predominant approaches to regulation of modern biotechnology in the world, one is the product based and other is process based approach.

According to TERI Policy brief 1 (2010:5) the differences in framing the modern biotechnology and its applications can best be illustrated with a comparison between the United States and European Union. In product-based regulation, which is the model of regulation employed in the United States[8], regulation is based on the safety, quality, and efficacy of the product with no

[8] The United States has not set up a separate body to regulate biotechnology, nor does it have a distinct set of laws that regulate genetically modified organisms (GMOs). Instead, GMOs are regulated by the same federal agencies that regulate conventional agricultural products, namely, the Food and Drug Administration, the Department of Agriculture, and the Environmental Protection Agency.

regard to the production process. In contrast, process-based regulation, the model of regulation employed in the European Union[9], is based on the process i.e. genetic manipulation by which the product is created. The European Parliament/Council of the European Union (2001) views genetic engineering as a stark departure from conventional technologies. It views GMOs as not occurring in nature, and therefore as fundamentally new and different. While traditional biotechnology is applied in appropriate environments adapted to the organisms it uses (e.g. a specific ecosystem), modern biotechnology (i.e. genetic engineering) is conducted in isolation and can cross species barriers and thus create new genetic makeup that could not be developed within nature, and which might therefore be hazardous for biodiversity.

Therefore, in the United States, regulatory emphasis is on the end product. GM food policy is based on the premise that GM products should be regulated like any other food, irrespective of their method of production. For the supporters of the Product based approach, agriculture with or without genetic engineering, means tampering with nature. For them genetic engineering is nothing more than an extension of traditional plant breeding, which is a form of genetic manipulation within one species. In this context, Haribabu (2012) observes that in

the United States crops based on transgenic seed and crops based on conventional hybrid seed are treated as '*substantially equivalent*[10]'. Regulators tend to think that mandatory labelling would send the wrong message regarding the safety of genetically modified food, thus creating

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[9] Scientific opinions about the safety of genetically modified organisms (GMOs) in the European Union (Austria, Belgium, Bulgaria,Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania,Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom) are given by the GMO Panel, which is part of the European Food Safety Authority (EFSA).

[10]The concept of *substantial equivalence* was introduced by the OECD with particular reference to foods produced by modern biotechnology. In this method, the overall chemical composition of the GE food is compared to an equivalent conventional food. The establishment of substantial equivalence in GM plants depends upon morphological features and agronomic data together with chemical analysis of critical nutrients (both macro- and micro-) and any critical toxicants and anti nutritional factors. If there is no significant difference between the two, the GE plant is considered to be safe.

confusion among consumers. The American people have been consuming genetically modified food. The regulatory regime in the United States expects the seed companies to carry out risk assessment voluntarily. On the other hand, in European policy, the *precautionary principle* (meaning that uncertainty about the safety of a product does not mean discharge from the obligation to act) is increasingly applied.

Patterson and Josling (2002) observes that the philosophy of the product model is preventive, harm is to be minimized where it has been scientifically demonstrated, while the philosophy of the process based approach is precautionary, that is, anticipating environmental harms that have the potential to occur but have not occurred to date.

Ramjoue (2008) observes that in the USA, the potential risks posed by GM foods are precisely defined in terms of their specific characteristics and immediate impacts on human health and the environment. The definition of risk used by US agencies is therefore relatively narrow, specific, direct and short-term[11]. The EU defines potential risks more broadly than the USA, and includes delayed effects on health and the environment, as well as social and ethical issues. In contrast with the USA, in the EU it is accepted that defining the level of acceptable risk is a normative decision, not only a scientific one (Christoforou 2004).In India the questions that are being raised regarding genetically modified food are similar to those raised in the European context. Based on the precautionary approach, the government of India is following a case by case approval of assessing the safety of a GM crops.

[11] US Food and Drug Administration. Statement of Policy: Foods Derived from New Plant Varieties.Federal Register 1992;57/104:22984-3004.

1.6. GM Crops in India: Bt Brinjal Debate

The potential of biotechnology to modernise agriculture caught the imagination of the Indian policy-makers to address challenges of enhanced food production, malnutrition, controlling the crop loss due to insect, pests and diseases and so on.

The GM debate entered the public sphere in the country on 26th March 2002, when the Genetic Engineering Approval Committee of India (GEAC) approved commercial planting of Bt Cotton. Bt cotton is the only GE crop approved for commercial cultivation in India. The areas under Bt cotton increased from 29307 hectares in 2002 to an estimated 6.2 m hectares by 2007.In 2012, India cultivated a record 10.8 million hectares of Bt cotton with an adoption rate of 93% (James 2012). India has emerged as the second largest producer and exporter of cotton in the world. To date, the Government of India (GOI) has approved six cotton events and more than 1100 hybrids for cultivation in different agro-climatic zones (GAIN Report IN 3083). Most of the approved Bt cotton hybrids are produced from two Monsanto events (Mon 531 and Mon 15985). Bt. Brinjal is a second crop in the series and only food crop that was ready for commercial release in India during 2009-10.

As revealed by an annual survey conducted by Bio Spectrum and Association of Biotech Enabled Enterprises (ABLE), *"India is ranked among the top 12 biotech destinations worldwide and third largest in the Asia-Pacific region. The biotechnology sector grew by 21.5 per cent in 2010-11, to cross the US$ 4 billion mark."*Indian Biotech Industry Revenue in IFY 2012/13 is $ 4.0 billion in which BioPharma account for the largest share with 64%, followed by BioServices 18%, BioAgri 14%, BioIndustrial 3% and Bioinformatics 1%. (ABLE Survey 2013). Therefore, biotechnology is one of the fastest growing sectors in India.

Map No. 1 Map of India showing brinjal cultivation area

Source: National Horticulture Board

Note: Solid shading indicates a traditional brinjal growing area while light feathering indicates sparsely spread area under brinjal

1.7. Rationale for the Topic

At the dawn of the twenty-first century, questions concerning the relation of emerging science and society seem more pressing than ever. According to Neidhardt *et al* (2008) the public support for science from the external world of science is based on the assumption that science is a public good and advances in scientific knowledge contributes to productivity and the consequent wealth generation and public health and a decisive precondition for economic, technological, and even social and cultural development. This assumption and belief bring science in close contact with public policy and policy making. But, in the changed context of knowledge production where science is increasingly associated with commercial interests on the one hand, controversies such nuclear disasters of Chernobyl and Fukushima, BSE (Bovine

Spongiform encephalopathy) on the other have highlighted the failure of traditional expert systems owing to their highly problematic entanglement with the policy world (Jasanoff 1997). In this context, Böschen *et al.,* (2010) observe that potential source of citizen distrust of government and loss of institutional legitimacy may stem from the inability of traditional scientific strategies (which are based on probabilistic models) to address problems associated with complex, large-scale processes and disasters. Several studies have highlighted unpredictability and intrinsic uncertainty associated with GM crops as they deal with the organic world. In this context, what is an alternative approach to governance model which acknowledges openly the scientific uncertainties in decision making on technological choice?

Secondly, as argued by Carvalho (2005c) and Maeseele (2009), in the face of conflicting / contested knowledge claims, the ideological (i.e. value systems) and/or material (i.e. financial and economic) interests influence the social actors' acceptability of a particular scientific rationality claim. On the other hand, as argued by Purkayastha *et.al*. (2010:43) the introduction of new technology into society is not merely an abstract scientific question but also a policy problem embedded within social and political issues. Hence, debate on the genetic engineering crops grow beyond technical issues. Technologies cannot be treated as technical fixes to social problems. According to Jasanoff (1993), social acceptance of existing and emerging technologies results from a wide range of considerations. Apart from the risk and safety, there is a plethora of other aspects that shape public attitudes towards acceptance of a technology such as individual's general values, interests, culture and beliefs. According to Frewer *et al.* (2004) much of the controversy associated with the commercialization of genetically modified food has been the result of regulatory bodies failing to take account of the actual concerns of the publics', which has fuelled public distrust in the motives of regulators, science, and industry. It is important to

understand and analyse the conflicting interests and values of various stakeholders and incorporate them into decision making process. Therefore, this thesis is an attempt to understand and analyse the values and interests of different stakeholders on Bt-brinjal and also values underlying the regulation of GM crops.

Thirdly, Bt brinjal is the first in a series of GM food crops to be considered for commercial release in India. The decision making on Bt brinjal is particularly important as several private seed companies and public sector research institutions are working on the development of various genetically engineered (GE) food crops. Of the 91 applications for field trial before the Genetic Engineering Approval Committee (GEAC), 44 are GM food crops (GAIN Report IN 3083).In the beginning Bt brinjal controversy was framed in such way that it can be solved through the scientific risk assessment. Eventually, following the public outcry, the decision making process was extended to both internal (approaching other scientific experts in India and abroad) and external (public consultations with other stakeholders like farmers, consumers, NGOs, Industry etc.,) peer community. The current development and impending introduction of transgenic Bt-brinjal in India offers a timely opportunity to study the entire GM approach to Indian Agriculture.

The PNS framework foregrounds an alternative broad based approach under the above conditions. Post Normal Science deals with post- normal problems where ‘facts are uncertain, values in dispute, stakes high, and decisions urgent’ (Funtowicz and Ravetz 1990). The PNS approach works as the best risk management model under such conditions. Therefore, drawing on the PNS perspective, this thesis is an attempt to critically analyse the entire decision making process on Bt brinjal.

1.8. Research Questions

The present study, is guided by the Post Normal Science approach, raises the following research questions:

(a) Is science-based risk assessment an adequate approach to settle the public controversy such as Bt Brinjal?
(b) How does Bt technology for Brinjal crop improvement affect the interests and meanings of various stakeholders.

(c) Are utilitarian values are allowed primacy over human freedom/ human values? Do the farmer's economic benefits outweigh the concerns of other groups like consumers, environmental groups, society at large etc?

(d) What is the appropriate governance model that can facilitate socially inclusive decision making processes in the area of technological choices?

1.9. Objectives

The present study based on PNS perspective centres round the following objectives:

(a) To understand various strands of evidences that have gone into government's moratorium decision on commercial release of Bt. brinjal.
(b) To understand the concerns arising out of their interests and meanings articulated by farmers' and consumers' groups on Bt brinjal in Public consultations.
(c) To understand and analyse the publics' concerns on the existing regulatory and approval processes of GM crops in India

1.10. Argument of the Thesis

As discussed above, the scientific knowledge has been undergoing a cultural transformation from a disinterested and morally neutral enterprise to an enterprise that is intimately connected to values of profit and commercial interests (Ziman 1996). On the other hand, later part of 20th century, the world witnessed the controversies such as the nuclear disasters of Chernobyl and

Fukushima, BSE controversy etc. These controversies have highlighted the inadequacy of traditional expert systems owing to their highly problematic entanglement with the policy world. How does science deal with the anxieties of the publics' in this context? Against the above backdrop, there is a need to address the questions of risk and uncertainty, lack of consensus over values. The PNS model seems to foreground these issues. This thesis also argues that the PNS framework motivated by precautionary and participatory approaches appears to be appropriate model to deal with the questions of risk and uncertainties, lack of consensus over values and stakes of different stakeholders related to the use of GM technology in agriculture. Therefore, based on PNS perspective the thesis argues that given the uncertainties associated with knowledge and conflicting values, technological choices have to be made more democratically and transparently by not only taking into account the interests of various groups but also environmental considerations. The thesis argues that there should be a shift in the regulatory paradigm from a government-centred model one to that of a governance-centred one.

1.11. Methodology

As the present study is an Ex-post-facto analysis of the decision to impose moratorium on commercial release of Bt brinjal in India, the study is primarily based on secondary data sources. This kind of study is very timely and significant against backdrop of various GM food crops that are at various stages of the approval process in India.

The Genetic Engineering Appraisal Committee (GEAC) (earlier Approval Committee) is a statutory body under Rules 1989 of the Environment (Protection) Act, 1986 and which is authorised to grant approval for large-scale trials and environmental release of genetically modified organisms. The report of the Expert Committee (EC-II) submitted to the GEAC on October 8th, 2009 that formed the basis of the GEAC's decision of October 14th, 2009 for

commercial release of Bt-brinjal. But, on the issue of Bt-brinjal the GEAC in its 97th meeting held on October 14th, 2009 observed

> *" ....as this decision of the GEAC has very important policy implication at the national level, the GEAC decided its recommendation for environmental release may be put up to the Government for taking final view on the matter" (Ministerial Note, Para 1, MoEF 2010: 1)*

On 9th February 2010, the government of India announced the decision to impose moratorium on commercial release of Bt brinjal by invoking precautionary principle. There were mainly three kinds of evidence that have gone into the decision making process namely : a) Scientific Risk Assessment reports which includes views from the renowned scientists in the subject area from both India and abroad, b) views from the state governments, and c) the outcome of the public consultations on Bt brinjal. The report of the Expert Committee Report –II, the submissions from the scientists and state governments are available on the MoEF[12] website.

With regard to public consultation, Centre for Environment Education (CEE), an autonomous organization engaged in Environment and Sustainability Education, was entrusted with the task of organizing and facilitating these consultations. I had personally visited the CEE office and spent significant amount of time and reviewed all the records related to public consultation processes including access to the video and audio files. As per the registration records, a total of 5920 people registered under six interest groups in the consultation. The data with regard to the public consultations as culled out by the CEE from public consultation comprises of 631 transcribed propositions on various themes (CEE 2010). The CEE compiled the 631 Propositions under seven broad themes, namely Pest Management, Economy and Livelihoods, Human Health and Bio-safety, Consumer concerns, Biodiversity and Environment, Approval process and Regulatory process. However, the registrations at the consultations were done interest group

[12] www.MoEF.gov.in

wise. Therefore, for the purpose of analysis the concerns under seven themes were brought under 3 broad categories of stakeholders' namely 'farmers concerns', 'consumers concerns' and concerns of 'Society at large'. As mentioned earlier the Bt brinjal is primarily an agronomic trait which works against the Fruit and Shoot Borer pest, the ensuing benefits are derived by farmers in terms of saving expenditure on pesticides. And also growing GM crops has the environmental implications. Hence, for the purpose of the present study the concerns under the themes 'Pest Management', 'Economy and Livelihoods' and 'Biodiversity and Environment' have been included in the category of 'farmers group'. And, unlike the Bt cotton, the brinjal is a food crop, the first genetically modified vegetable crop anywhere in the world, taking cognizance of the concerns raised by the consumers is important as the majority of the brinjal produced is being consumed in India and only 0.04% of the total produce is being exported.

Therefore, the propositions compiled under the themes 'Human Health and Biosafety' and 'Consumer Concerns' have been taken under the category of 'consumer group'. The remaining two themes, namely, 'Approval process' and 'Regulatory process' have been taken under the 'Society at large' category. The propositions under 'Approval process' and 'Regulatory process' were combined together for the purpose of analysis.

For the purpose of the present study, the propositions were analysed by using coding method. In qualitative research, coding *is* analysis: the process of reviewing, transcribing, synthesizing, and dissecting field notes while maintaining the relationship between the parts is the essence of qualitative data analysis. Codes are "tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study" (Miles and Huberman 1994:56). In general, there are three methods for creating codes for qualitative data: the a priori approach, the inductive approach, and a third approach that lies partway between the first two approaches.

Inductive approach (Lofstedt 1996; Chong 2005) is used for this study. The unit of analysis was a sentence or multi-sentence chunk. The 631 transcribed propositions compiled in the CEE report were reviewed line by line. Thematic categories or codes were created for each concern or multi-sentence chunk until a 'saturation point' was reached, that is, until all the stakeholders' responses exhausted (Miles and Huberman 1994; Strauss and Corbin 1990).

Frequencies were developed for each theme as it appears number of times in the data. The frequency with which each theme appears in the data is denoted under the heading, 'Number of mentions'. To increase confidence in the internal validity (Kvale 1989) of one's findings, Miles and Huberman (1994) recommended asking a colleague (preferably from a different discipline) to look at the same data and come up with his/her own codes. Accordingly, a two member committee was constituted (one from biology and other from Anthropology background, who have prior fieldwork experience) to look systematically at the 631 concerns of National consultation so as to offer possible rival explanations for the data.

More specifically, the team members were asked to independently come up with themes that describe each sentence or multi-sentence chunk in the data set. The two sets of themes were compared and arrived at a common representative codes. A similar approach was used by Lofstedt (1996) in his study on public perception of nuclear plants in Scandinavia and also Chong (2005) in his study on public perceptions of farmers on Bt brinjal in India.

According to Trochim (2002) many qualitative studies are not even concerned with generalizing; they are just content to provide rich descriptions of the phenomenon under study. Thick descriptions are offered in this study through the extensive use of verbatim reporting of propositions to substantiate the analysis.

The other secondary sources of data includes communications received by the Minister from various scientists from both India and abroad, communication received from the various state governments on the Bt.brinjal, various reports on the MoEF website: Parliamentary Committee Report on GM Crops, Supreme Court Technical Expert Committee (TEC) final Report, books, journals, internet sources, and so on.

1.12. Structure of the Thesis

The thesis has been arranged in terms of seven chapters including introduction and conclusion. The first chapter introduced various facets of the thesis attempting to capture the Post Normal Science perspective, rationale for the topic, research questions, objectives of the study, argument of the thesis, methods of analysis, structure of the study, and so on. In the second chapter a brief account of trajectory from green revolution to gene revolution, lessons learnt from Bt cotton experience, and socio, cultural and religious and economic importance of Brinjal in India was presented. This chapter emphasises the need for the social embedded analyse of the technology before taking any decision. The third chapter is an appraisal and analysis of the various strands of evidences that have gone into the Minster's moratorium decision on commercial release of Bt brinjal.

There were three main evidences namely scientific evidence, views from the state governments, and outcome of the public consultations. Though various strands of evidence have gone into the decision making the outcome of the national consultations formed the main basis for the Minister's moratorium decision. These strands of evidence are analysed in the light of the Post Normal Science approach.

In the face of conflicting knowledge claims, risks and uncertainties, various social actors tend to frame the controversies, depending on their respective values and interests. To arrive at the heart of what is at stake, as argued by Maeseele (2011), these controversies on emerging technologies should be approached from an identification of the competing values and interests at work, instead of starting from an un-problematized 'scientific consensus'. On the other hand, food safety is not purely a scientific concept to be defined and controlled exclusively by food scientists or scientific risk assessment. Food choices are framed by cultural, social, and material circumstances (Draper and Green 2002). Therefore, when examining risks, it is important to judge what is considered as acceptable risk beyond the frequency and statistical probabilities of the impacts. The reductionist approach adopted by the dominant risk discourse reduces all questions concerning governance of emerging technologies to questions of risk. In this context, drawing on the data from the public consultations, a detailed analysis of the farmers' and consumers' concerns on Bt brinjal was presented in fourth and fifth chaptersrespectively.

In the context of attempts that seek to transform the organic world, which is deeply embedded in the interests and meaning structures of different social groups through application of science and technological interventions is fraught with uncertainties and risks for humans and environment. In this context, public have raised various questions on the lacunae in the existing regulatory and approval mechanism of GM crops. In this context, the sixth chapter presents an analysis of public concerns on the existing regulatory and approval mechanism of GM crops in India. This chapter argues for the shift in the regulatory paradigm from a government-centred model one to that of a governance-centred one in line with the Post Normal Science (PNS) approach which addresses the issues of scientific uncertainty and conflicting values and interests of different

interest groups by incorporating the contextual specificities. The summary of the findings of the study and concluding remarks are presented in the seventh chapter**.**

Chapter II

Green to Gene Revolution: Lessons from the Indian Context

2.1. Introduction

Technology cannot be separated from the social context where it is introduced. No technology in the world's history- from the discovery of file to the domestication of plants and animals, traditional biotechnology, the Industrial Revolution and the Green Revolution has ever happened in a social vacuum. Accordingly, the different spheres of society be they economic, political, social, cultural, ethical are all affected by the introduction and adoption of a technology, though different in the manner and pace (Conway 2003). Therefore, we cannot understand the technical performance of any technology by isolating it from its socioeconomic, cultural and environmental effects in a particular social context.

India has made rapid progress in agriculture and allied sectors after independence.With the vision of development guided by the notions of technical progress and modernisation through the application of scientific knowledge, India adopted the Green Revolution technologies during 1960's, in order to alleviate hunger and famine. The Green Revolution helped India to move from the net importer to achieve food security through domestic production. Taking cue from the success of the Green Revolution, in post 1990's, India embraced the biotechnology for the growth of the Indian agriculture. After the commercial introduction of Bt.cotton in 2002, the Bt.Brinjal is the second crop and only food crop that is ready for commercial release in India. Bt.brinjal is also the first ever GM vegetable crop in the world. With the potential benefits and intrinsic risks, the Bt brinjal controversy has elicited a very polarised debate between those for and those against the technology and finally the moratorium was imposed on the commercial

release of Bt.brinjal in India. Therefore, Instead of revealing GM crops as a technical fix to complex agronomic and socioeconomic problems, it is imperative to learn from the experiences of the Green Revolution and Bt cotton before going to extend the genetic engineering technology to food crops. Further, there are many other food/non-food crops that are in the pipeline at various stages of regulatory approval. Therefore, there is a need for a socially embedded analysis of GM crops in the context of the wider socio-technical system before any policy decision is made.

In view of above, this chapter aimed to give a detailed account on the lessons learnt from the experience of the Green revolution and Bt-cotton in the Indian context. Following, I will present a brief account of the impacts of Green Revolution and Bt-Cotton in the Indian Context.

2.2. Green Revolution

With the introduction of High yielding Varieties (HYVs) during 1970's, the Green revolution has helped India to overcome its food security problem. Though the Green revolution paradigm had contributed enormously to decreasing the hunger and malnutrition in global south, it has not shown to be a compatible and sustainable approach in the case of small and marginal resource poor farmers. In India majority of farmers are small and marginal farmers with less than 5 acres of land holding size. Several scholars have criticized the Green revolution paradigm on several grounds. Shiva (1991) argue that the Green Revolution has actually deepened the gap between rich and poor, made small holders lose their self-sufficiency, increased agrarian inequality and destroyed the eco-system. Similarly, Rosset *et al* (2000) argues that the rapid spread of Green Revolution agriculture contributed to the rapid rise in the use of pesticide as the HYVs were more susceptible to pest outbreak. Promising increases of yield were thus offset by rising costs

associated with increased use of chemical inputs. According to Pretty (2011) the high external input (chemical and fertilizer) intensive green revolution agriculture has contributed to the long term environmental costs, fossil fuel consumption, and greenhouse gas emissions.

According to Shah (2011:37) risks are not consequences, but are manufactured in the organisation of techno-scientific institutions such as the green revolution whose application not only create and perpetuate newer forms of risks but also produce and reproduce newer forms of injustice and inequality. Pests and consequently the newer forms of risks that pest-killing GMOs may entail are thus manufactured by the green revolution paradigm. This process is popularly known as "pesticide treadmill". The Policy makers are trying to justify the adoption of GM crops against the success of the green revolution paradigm. But, Modern biotechnology policy discourse largely ignored the contestations on the outcome of the green revolution (Shiva, V. 1989 in R. Murgai, M. Ali and D. Byerlee 2001)

2.3. GM Crops: Lessons from Bt cotton

India's population is expected to reach 1.5 billion by 2025, making food security most important social issue and food production will have to be increased considerably, to meet needs of a growing population. Food production will have to be doubled by 2025 to meet the needs of a growing population. Also, 27% of world's undernourished people live in India. But, the present growth of agricultural productivity, at the rate of about 2% per year, is much lower in comparison to the 3% growth required for food security. The food grain production in India has increased four times over the last five decades. Also, the yield of major food grain crops is reaching a plateau although its population continues to rise. The growth in agriculture sector

during the Eleventh Plan was of the order of 3.5 per cent. In the Tenth Plan it was 2.3 per cent. During the Ninth Plan it was 2.4 per cent. The Approach Paper to the Twelfth Plan pegs this growth around 4 per cent for the Twelfth Five Year Plan (2012-2017). Transgenic in food crops is being offered as the much needed solution for food security of the Country (Parliamentary Committee on GM crops).

The potential of biotechnology to modernise agriculture caught the imagination of the Indian policy-makers to address challenges of enhanced food production, malnutrition, controlling the crop loss due to insect, pests and diseases and so on. The Bt cotton was the first GM crop in India which was commercially released during the year 2002. We can draw many lessons from the almost thirteen years of experience which can go as policy input into policy making on future GM crops.

2.3.1. Wide Variability in Impacts

In 2006, Smale *et al.* (2006) carried out a detailed review of published literature on the impacts of GM crops in developing countries. One of the important lessons from the studies reviewed by Smale *et al* was that the performance of GM crops had varied widely, across farms and farmers, crop varieties, regions and seasons. Similarly, Qaim *et al.* (2006) argue that Bt cotton has had widely varying impacts across locations and seasons and, more particularly, that its performance depends heavily on factors like the background germplasm into which the Bt trait is insertedas well as other agronomic, socioeconomic and institutional factors. The wide variability in performance was confirmed in a similar analysis by Raney (2006: abstract), who noted that institutional factors such as national agricultural research capacity, environmental and food safety regulation, intellectual property rights and agricultural input markets matter at least as much as the technology itself in determining the level and distribution of economic benefits .

Grue`re *et al* (2008) also point to the importance of how Bt cotton "was introduced, sold, and used" rather than the technology itself. The broader farm-level contexts, that affect and are affected by the new technological regime in India are highly varied and poorly understood.

2.3.2. Regulatory Failure: Illegal Bt cotton

One of the important revelations of the regulatory failures in India was the spread of illegal/unapproved Bt cotton much before its official commercial release. Though Bt cotton was officially commercialised in India in March 2002, the unapproved Bt varieties are known to have been grown in the states of Gujarat and parts of Maharashtra, Madhya Pradesh, Andhra Pradesh and Karnataka for an uncertain period of several years prior to that date (Scoones 2005a). Navbharat-151 was one of the earliest brands of illegal Bt-cotton was being sold in India before it was approved for commercial cultivation which showcased the regulatory incapability in India. This highlighted the difficulty of monitoring the flow of transgenic materials in a developing country (Jayaraman 2001). According to Kuruganti (2006), the unbridled proliferation of illegal Bt cotton in the country has been proof of serious regulatory failure.

2.3.3. Proliferation of proprietary cotton hybrids: Farmers' Seed Sovereignty

Traditionally, local farming communities were close knit as seed exchange and farming knowledge were shared freely. Sangaralingam (2006) observes that the seed saving in case of Green Revolution hybrids is undesirable as the seed from the first generation of hybrid plants does not reliably produce true copies. Therefore, new seed must be purchased for each planting and this meant that farmers no longer preserving and storing seeds for the next planting season. This trend not only incurs extra costs for the farmers, but has an impact on social cohesiveness too. On the other hand, a significant change in the process of bt cotton development is the proliferation of proprietary cotton hybrids and followed by Bt-hybrids. As Murugkar,

Ramaswami, and Shelar (2007) note, *"In 1996 hybrid varieties accounted for about 55% of the total cotton area, but two-thirds of this was covered by public hybrids. By 2004, hybrids covered 6 million ha (two-thirds of the cotton area), of which 5 million ha were sown to proprietary hybrids."* Today more than 90% Indian commercial cotton is planted with Bt cotton hybrids. Therefore, farmers were increasingly relying on seeds purchased anew each season from a proliferating seed market.

2.3.4. The question of Compatibility: Small and marginal farmers

The area under Bt cotton has reached above 90% in many parts of the country. In India, The GEAC recommends for growing at least five border rows or 20% of the cotton area (whichever is the greater) as non-Bt to serve as a refuge for resistance management[13]. Bates *et al.,* (2005) and Tabashnik *et al*., (2003) argues that, though the practice of growing refugia is considered pivotal in the success of GM crops, due to unawareness on the concept of refuge, the farmers are not following this practice. The other reasons for not growing refuge are due to: small land holding, the intricacy of its implementation, ignorance of its necessity, and fear of reduced cotton seed production. The costs of implementing the refugee policy as measured by reduced yields are reported by Shelton *et al.* (2000). GM technology requires specific knowledge and awareness which typically inculcated through education and training, that leads to changes in practice.

2.3.5. Abiotic Stresses: Relevance of the technology

Cotton is cultivated in three distinct agro-ecological regions (north, central and south) of the country. The northern zone (Punjab, Haryana and parts of Rajasthan and UP) are almost totally the irrigated, while the percentage of the irrigated area is much lower in the central (MP, Maharashtra and Gujarat) and southern zones (Andhra Pradesh, Karnataka and Tamil Nadu).

[13]http://www.envfor.nic.in/divisions/csurv/geac/geac_home.html

Nearly 60% of the cotton area is grown in the central zone which records lowest rain fall. "Most of the cotton in India is grown in rain fed conditions, and about a third is grown under irrigation" (Bennett, Ismael, Kambhampati *et al* 2004:96). Therefore, technology alone may not work as seeds alone cannot do the performance. Unless we have a better productive soil, good water, good Sun shine pollination rate is more and unless is there, we cannot produce more food. This is a common science.

2.3.6. Reports on morbidity and mortality of Animals

There are few claims from different parts of the India about animals have either died or fallen sick after grazing on the Bt cotton crop residues in different parts of the country. On the other hand, there are also reports about the agricultural workers developing allergies after working in Bt Cotton fields in different states (Kuruganti 2006). But, there is no consensus on these arguments and it is yet to be investigated scientifically.

2.3.7. Reports of Farmer's Suicides

As Bt cotton is being highly capital intensive farming, there are several reports from different cotton growing states linking Bt cotton failures to farmers' committing suicides (Iyengar and Lalitha 2002). According to Gruère *et al*. (2008) Bt cotton could not be solely responsible for the seasonal increases in farmer suicides, but the high price of the technology, combined with the manner in which it was promoted to farmers and its failure to produce good yields undoubtedly contributed to some farmers' indebtedness and distress, as critics of the technological treadmill and neoliberal agricultural reforms have long argued. On the other hand, Gruère *et al.* (2008) and Qaim *et al.* (2006) argue that certain Bt cotton varieties really did perform poorly in particular areas of Andhra Pradesh and Maharashtra, especially during the first and third seasons after the

technology was commercialised, which coincided with spikes in the number of farmer suicides in those states.

2.3.8. Deskilling of farmers with GM crops

Referring to what happened to cotton farming in the mid-1990s, what Vakulabharanam (2005) terms a cycle of 'growth –induced distress' and 'distress-induced growth' saw farm-level changes affecting management skill and agricultural technologies. Fitzgerald (1993: 342) has pointed out, hybrids are innovations with real consequences for farm management: they *"effectively locked farmers out from an understanding of their own operations without the aid of experts. Where open-pollinates were transparent, hybrids were opaque"*.

According to Dong and Li, (2007) and Kranthi *et al*., (2005), one of the important causes of concern regarding deskilling was that Bt cotton brought a new category of accelerated technological change. Between 2002–06, all Bt cotton in India contained one genetic construct namely Cry1Ac gene. Later, with the introduction of new Bt genes there was a flood of new seeds containing both original Bt gene as well as new Bt genes constructs. Even with one construct, expression varies with the hybrid into which it has been bred, the age of the plant, and various environmental factors. By 2009 there were six gene constructs and more than 284 approved Bt hybrids available in the market (Foreign Agricultural Service 2009). The variability in the performance of these new constructs was not known in the scientific literature, let alone by farmers or vendors. What most farmers had heard was that there was now the option of 'double Bt.'. Chaturvedi *et al*. (2007) have observed that the role of Indian Council of Agricultural Research (ICAR) was minimal in the case of Bt hybrids, unlike in the case of other crop varieties wherein ICAR used to conduct region-wise agronomic trials and advise the farmers on the best

ones. This had left the farmers susceptible to any biased claims of the various companies involved, and more exposed to the vagaries of market forces.

2.4. Difference between Green and Gene Revolution

The technological trajectory from green to gene revolution is being shaped by the tension between the public and private domains because of the exigencies of globalization. Pinstrup-Anderson and Mare Cohen (1999 in Haribabu 2004) summarise the nature of problems that farmers are going to encounter with biotechnology when compare to Green Revolution. They point out three essential differences between green revolution and biotechnology, which have a bearing on the risk and benefits: One, the research efforts that led to green revolution was concentrated in public sector institutions. The intellectual property rights did not extend beyond the initial release. Once the farmers acquired the seed, they could reuse it without further payment, although the reused hybrid seed reduced the yield.

In contrast, modern agricultural biotechnology research is undertaken by the private sector firms, which protect IPRs through patents beyond the first release. Farmers cannot reuse the seed without the permission of the patent holder for the next season. A second related difference between the Green revolution and the Gene revolution involves the patenting of processes as well as products that indicates a shift towards the proprietary research process. The third difference is that while the Green revolution technology was focused on the specific problems of the developing countries, the Gene revolution focuses on research that is suitable for industrial countries. The transfer of genetic engineering technology from the industrial countries would ignore the socioeconomic and cultural specificities of the developing countries.

The Interest groups in the consultation have felt the need for in-depth study of Bt cotton experience before making any decision on Bt-brinjal. In this regard, a couple of statements made by the participant are as follows:

> *"With respect to socioeconomic studies, the first step would be to undertake an in depth analysis of the experiences with Bt cotton. Exhaustive socioeconomic studies are necessary to assess the impact of transgenic crops on traditional agricultural systems and indigenous crops." (Proposition No.207, MOEF, 2010: 34).*

2.5. Bt Brinjal: The First GM Food Crop in India

Brinjal (Eggplant) is the fourth most important and widely consumed vegetable in India after potato, onion and tomato. Due to its versatility in use in Indian food, brinjal is often described as the King of the vegetables. Brinjal is mostly grown in the states of West Bengal (23%) Orissa (20%), Gujarat (11%) Andhra Pradesh (11%), Bihar (8%) Maharashtra (5%), Chhatishgarh (4%), Madhya Pradesh (3%) Karnataka (2%), Haryana (2%) and others 12% (Indian Horticulture Database 2010-11).

2.5.1. Brinjal Area, Production and Growers

According to one estimate, about 1.4 million small and marginal farmers in India grow brinjal crop on 0.58 million hectares (Choudhary and Gaur 2009 in Sant kumar *et. al,* 2011:85). With regard to production, a significant progress has been made in the production of brinjal in India during the past two decades. Between 1991 and 2009, area under brinjal cultivation increased by 52.6 per cent (from 3.8 lakh ha to 5.8 lakh ha), production increased by 94 per cent (from 50.6 lakh tonnes to 98.1 lakh tonnes), and yield rose by 26.8 per cent (from 13.4 t/ha to 17.0 t/ha). The increase in brinjal production has largely been driven by the increase in its area, though yield-increase also contributed to it (Sant kumar *et. al,* 2011:85). About 9.5 million tonnes of

brinjal are produced in a year, nearly all of which is internally consumed. Only 0.04% of the brinjal produced is exported, mainly to the UK, France and Saudi Arabia. Export of brinjal at present is to the tune of Rs.1.71 crores only (APEDA 2009). India is the second largest producer after China with a 26% world production share. China and India are the world's largest eggplant producers, account for almost 85% of world production (Indian Horticulture Database 2010-11).

2.5.2. Cultural and religious significance of Brinjal

There are several names by which brinjal are known in India. Selected varieties /hybrids of brinjal in varying shapes, sizes, and colour are cultivated in different vegetable growing zones of the country to meet regional preferences.

A large proportion of the population of rural and urban India prepares brinjal in different recipes for local dishes. Many of these local varieties are used in the preparation of special brinjal dishes that are specialties of the region, for example a special preparation of *Malapur* goes well with Jola Roti (Jowar Bread). In addition, some varieties have significant cultural value. *Malapur* is an essential accompaniment at festivals, marriages, and other social functions in the Darwad region of Karnataka. There are some folk songs in local languages centred around brinjal in different states of India such as *Bihu folk* songs in Asom, *Konkani songs* in Maharashtra, *Jaina* in Karnataka and *Guthi vankya kooroyi baava* in Andhra Pradesh (ISAAA Brief No.38 2009).

Raghuram (2010) in his Karnataka state based study observes that some of the brinjal varieties have the religious significance in different part of India. For example Mattu Gulla in Karnataka is a special brinjal variety grown only in Mattu, a village between the Udyavar and Pangala rivers in the Udupi district of Karnataka. It is a small, green, round brinjal with a thorned hook. *Matti gulla* gives two crops a year and a part of the first crop is offered to the Udupi Krishna temple

2.5.3. Medicinal and Nutritional Properties in Brinjal

Brinjal has a low calorific value and rich in nutrition. It has very high water content and provides adequate calcium, phosphorous, potassium, fibre, folic acid, sodium and vitamins B and C. It is believed that brinjal possesses certain medicinal properties that enrich the haemoglobin in the human body and good in diet for Patients with liver complaints. In Ayurvedic medicine, it is used for curing diabetes, hypertension, and obesity. It is also used for processing in other dehydration industries (Chadha and Kalloo 1993; Bose *et al.*,2002; Kumar *et al.,* 1998).

2.5.4. Brinjal Diversity

The brinjal has its origin in India and is being cultivated for over 4000 years in the country (Sant Kumar *et al*, 2011:83). India is the centre of the world's biological diversity in brinjal with over 2500 varieties grown in the country (APEDA 2009).India has released 200 modern brinjal varieties, including 54 hybrids (IIHR 2007 2008). Four varieties of brinjal in Karnataka, regionally known as Hirangere,*Kudochi , Malapur, and Matti gulla* are being registered as *Geographical Indicator* status under the TRIPS Agreement (Raghuram 2010). These facts provide a substantive context for the assessment of gene flow risks with the Bt-brinjal.

2.6. Transfer of GM Technology: Socio-Cultural Context

Biotechnology in general, and modern biotechnology in particular, creates both costs and benefits, depending on how it is incorporated into societies and ecosystems and whether there is the will to fairly share benefits as well as costs. Neither costs, nor benefits are currently perceived to be equally shared, with the poor, tending to receive more of the costs than the benefits (IAASTD Report 2008). The vital role that economic and political contexts and institutional frameworks would inevitably play in shaping the outcomes of technological change

was often overlooked, in other words, delivering the pro-poor promise of biotechnology would require appropriate governance (Chataway 2005; Jasanoff 2005; Newell and Mackenzie 2004). Without troubling to analyse the complex, context-dependent ways in which new agricultural technologies might affect poor people, poverty was typically invoked merely as a moral platform on which a series of assertions about the value of GM technology could be made (Jansen and Gupta 2009).According to the Asian Development Bank (2002), biotechnology must meet four conditions if it is to contribute to food security in developing Asian countries:1) It must address problems faced by small farmers, 2) It must focus on the major crops, livestock and fish grown by small farmers, 3) The technology must be easy for small farmers to use, inexpensive and non-harmful to human health or the environment, and 4) Policy development in developing countries must provide the necessary support and infrastructure.

2.7. Summary

Unreflective adoption and rationalization[14] of a technology in a context different from its origin and development without the understanding of the social, cultural and political setting meant that the technology failed in many respects to yield the desired benefits. The claim that 'the technology is in the seed' cannot work as Bt technology requires specific knowledge and awareness to fill the skill gap. Therefore, there is a need for a socially embedded analysis of GM crops in the context of the wider socio-technical system. In this context, it is very unwise to move into an edible crop, that too a first-of-its-kind in the world without learning lessons from the Green Revolution and Bt Cotton experience. Therefore, the governments of developing countries have to balance the benefit that GMOs could have on their citizens with their ability to control the risks.

[14]In traditional sociology, rationalisation has been defined as a process that establishes a modern society by crystallising a particular technical code as technological rationality of that society (Max Weber, The Protestant Ethic and the Spirit of Capitalism, Trans. T. Parsons (New York: Scribners, 1958).

Chapter III

Bt.Brinjal Moratorium: An Appraisal of Decision Making Process and Analysis

3.1. Introduction

As discussed in the previous chapters, the proposed introduction of Bt Brinjal, the first genetically modified vegetable in India, has generated extensive debate across the country. On February 10, 2010, Mr. Jairam Ramesh, the then Minister for Environment and Forests, through a detailed nineteen page note (like a 'speaking order[15]') overruled the recommendations of the statutory Genetic Engineering Approval Committee (GEAC) for commercialisation of Bt brinjal and imposed a moratorium on the release . If we closely look at the decision making process on Bt brinjal, from the beginning the GEAC have framed the issue of Bt brinjal in such a manner that it could be solved only with scientific risk assessment. Later, while responding to the public outcry, Mr.Jairam Ramesh extended the evidence from scientific risk assessment to other sources and took into account evidences from different sources to arrive at the final decision.

The Minister has used mainly three types of evidences namely: First, scientific evidence in the form of Expert Committee- II report which formed the basis for the GEAC decision for approval of Bt brinjal. Here, in addition to the internal risk assessment, he also sought the views of national and International renowned experts in the subject area on the Expert Committee-II report. Secondly, views from the state governments and finally, organized nationwide public consultations in seven cities to seek the public opinion on Bt brinjal wherein different interest groups namely scientists, farmers, consumers, industry, and CSOs have participated. Thus, the

[15] The irony of the Speaking order is that it is a detailed written note on the evidences used or citing main reasons for arriving at a particular decision. The 'Speaking order' has twin purposes, firstly it is a written note to be placed before the public stating the rationale for arriving at a particular decision and secondly, it also useful to build the institutional history on the decision making.

Minister had used the breadth of evidences from different sources in a transparent and balanced manner. The participatory and precautionary approach adopted by the Minister reflects the so called 'Post Normal Science' approach.

Funtowicz and Ravetz (1991) argue that the guiding principle of normal science i.e., discovering the true facts must be modified to fit the post-normal principle to achieve the goal of quality. As a strategy, post normal science requires the formation of an 'extended peer community' in which a discourse occurs among all stakeholders affected by a problem. 'Extended peer community' becomes apparent when the contemporary problems are characterized by high degree of uncertainty, conflicting interests and values and urgency to take decision. Under such circumstances, scientific and technical discourse is no longer restricted to expert communities but needs to be inclusive of non specialist participant stakeholders (Funtowicz and Ravetz 1993). In such a participatory arena, science is but one of many sources of evidence, which together informs policy decisions. Here, the PNS approach emphasis two aspects, firstly to test the scientific knowledge for its validity and reliability and secondly, the same knowledge also be tested for its social robustness. Therefore, the knowledge production is to be organized in a way that guarantees scientific quality and increases the social robustness at the same time. Thus, PNS foregrounds an important risk management approach in policy decisions on emerging technologies. Therefore, the present chapter drawing on the Post Normal Science perspective is an attempt to critically analyse and appraise various strands of evidences that have gone into the Minister's moratorium decision on Bt brinjal.

3.2. Evidence Used in the moratorium decision

The approval of Bt brinjal for commercial release by the GEAC was challenged by civil society as well as by eminent scientists. The uncertainty associated with the present knowledge in this domain makes it difficult to craft a regulatory framework that covers all the facets of modern biotechnology. Responding to the national outcry, the minister announced nationwide public consultations and also sought the views of the experts from India and abroad. The minister also sought the views of the state governments on Bt brinjal. Thus, the Minister has used mainly three types of evidences. A detailed analysis of the above three evidence is presented below.

3.2.1. Scientific Evidence: No consensus on Safety of Bt brinjal

The public debate surrounding the commercialization of the genetically modified (GM) vegetable Bt brinjal in India has brought into focus the relationship between science and politics and the complex character of expertise in the public decision-making process (Alam 2011: 106). The decision making on the emerging technologies is mainly based on the risk assessment for analysing the possible harms of products for human health and environment. Stirling and Gee (2002) defined Risk as the 'magnitude of a possible hazard' multiplied by the 'probability that a hazard will occur'. Thus, the basic steps of risk assessments are to identify the possible hazards associated with a given technological invention and to calculate the magnitude and the probability associated with each hazard occurring. Importantly, the practice of risk assessment is based on the assumption that every hazard can be accurately predicted and its respective probabilities calculated using scientific methods.

On 14.10.2009, the Genetic Engineering Approval Committee (GEAC), based on the reports of the two expert committees Expert Committee-I and II constituted during 2006 and 2009 respectively, had recommended for the environmental release of Bt Brinjal. Thus, the decision of the GEAC on the safety of Bt Brinjal for environmental release was based on scientific facts/data. The GEAC's decision evoked sharp criticism from both general public as well as from scientific community. Responding to the public's skepticism and ambivalence, the minister had placed the Expert committee-II report in public domain and sought the views from the public and also from the renowned scientists from both India and abroad. The following is the analysis of the scientific evidence.

3.2.1.1. Conflict of Interest

Though the expert committee –II recommended for the release of the Bt brinjal, the decision was not unanimous. Three members of the 13 member Expert Committee-II on Bt brinjal are reported to have expressed their concerns and did not want the approval to be passed[16]. Further, several objections were raised against appointment of chairperson and three other members, who were known promoters of the GM crops or were associated with biotech companies. Deepak Pental, vice-chancellor of Delhi University who was the chairperson of the expert committee was working on GM mustard and his university was undertaking the same system of biosafety testing followed for Bt brinjal. Therefore, it is obvious that committee's recommendations would have a bearing on his own project. These commercial interests may have compromised the approval process (Seetharam 2010).

In addition to the above, the tests that have been conducted on Bt brinjal have been a major cause of difference of opinion among scientists. While some believe that the tests are abundantly

[16] Conservation and survey division, genetic engineering approval committee. Decision taken in the 97th meeting of the GEAC held on 14th October, 2009 [Internet]. Ministry of Environments and Forests. 2009 Oct 14 [cited 2009 Nov 27]. Available from: http://www.envfor.nic.in/divisions/csurv/geac/information.html

sufficient, others feel that they are absolutely inadequate. Expert Committee -I in 2006 had asked for several additional biosafety tests to be conducted. However, even though Expert Committee-II comprised one-third the members of the EC-I, the new expert committee chose to disregard the need for these tests while conducting its evaluation of Bt brinjal. The Supreme Court's nominee on the committee, P M Bhargava in his detailed critique of the report submitted by the EC-II, pointed out that eight essential tests had not been conducted by Mahyco (Ministerial Note, Para 14, MOEF 2010: 8-9). Thus, number of concerns has been raised about the integrity of the GEAC process. In this context, Purkayastha *et. al.*, (2010:48) point out that apart from the risk and safety, the critical issue in decision making on Bt brinjal is whether the regulatory protocols developed and used for testing them are sufficient and relevant to context for the purpose of evaluating their safety. Therefore, the conflict of interest with in the Expert Committee-I & II cast doubts on the ability of experts and veracity of scientific knowledge to provide complete answers to the policy questions.

3.2.1.2. Views from Domestic and International Experts

Responding to the request of the then Minister for MoEF Mr. Jairam Ramesh, renowned scientists from India, the U.S.A, France, Australia, UK, New Zealand and other countries have sent their views on the Expert Committee –II report, to the Minister. There are broadly three kinds of views among the scientists: A number of them supported commercialisation being of the view that India cannot afford to ignore this technology while many others opposed it and some others advocated caution and called for more data.

National and international experts have highlighted several flaws in the Expert Committee-II report and questioned the scope and adequacy of the report in evaluation of environmental and health risks. Some of the important concerns raised by the experts are: Gene flow to wild

relatives resulting threat to brinjal diversity, chronic toxicity, sustainability, labelling, lack of independent regulatory system, farmers dependence on companies, not following the international standards in biosafety (See Annex-I and also www.moef.nic.in). Out of the 18 scientists from abroad, who made submissions to MOEF, only eight supported Bt brinjal. In case of India, out of 26 submissions, 16 supported Bt brinjal and 10 opposed (Shah 2011:31).They were divided on the adequacy of tests conducted for the safety of the Bt brinjal.

Further, seventeen noted scientists from different countries in a joint letter addressed to the Prime Minister on February 8th, 2010 given scientific reasons against the release of Bt-brinjal(Ministerial Note, Para 17, MoEF 2010: 10). The line departments under government of India were also divided on the safety of the Bt brinjal. While the Indian Council of Agriculture Research (ICAR) and the Department of Biotechnology (DBT) have given their unqualified support to Bt-brinjal, Director-General of Indian Council of Medical Research (DG-ICMR) and Drug Controller to Government of India have expressed some reservations (Ministerial Note, Para 20, MoEF 2010:12). In this context it is worth mentioning that the review of the global studies listed on GM food indicates no evidence of health and environmental safety of GM food (Domingo, J. L. and J. G. Bordonaba 2011, Diels, J., *et al* 2011 ; Dona, A. and I. S. Arvanitoyannis 2009 ; Séralini, G. E., *et al* 2012 ; Séralini, G. E., *et al* 2013 ; Hilbeck, A. and J. E. U. Schmidt 2006 ; Marvier, M., *et al.* 2007 ; Zhao, J. H., *et al.* 2010, Hilbeck, A., *et al.*, 2011). Concerns raised by these studies have not been satisfactorily addressed and have not been followed up by targeted research that could confirm or refute the initial findings.

The lack of scientific consensus on the safety of GM foods and crops is underlined by the recent research calls of the European Union to investigate the long-term health impacts of GM food consumption in the light of uncertainties raised by animal feeding studies (EU Food Policy

2012). In this context, Helge Torgersen (2004:3) argues that we rely on science to define risk, what if scientists come to different conclusions? Which sciences should we ask and who are the experts on which to rely? Therefore, the case of Bt brinjal reveals the inability of scientific expertise to provide unambiguous and complete answers to policy questions (Alam 2011:111).

The currently dominating expert-led risk assessment approaches often fail in the face of 'real world' complex problems that are characterised by irreducible uncertainties. Here, Stirling (2007) argues that when scientists face a complex problem, they are unable to know in advance what will be the best way to address the problem, but nonetheless, they have to make a choice. As argued by Kimmelman (2004), these choices are often influenced by individual's assumptions about risk acceptability, social affiliation, and political and social worldviews.

While scientific methods of data gathering may be objective and reproducible, empirical data are still open to interpretation with alternative explanations possible. Under these conditions the evaluation of scientific evidence should not be restricted to scientists only, but should also involve impacted parties and the general public through 'extended peer review' (Funtowicz and Ravetz 1993). One of the important elements of the PNS is both internal and external extension of the peer community. The Internal extension requires new interdisciplinary committees rather than by individually selected specialists one the one hand, and new knowledge partnerships with policy makers, NGOs, industry, media and the general public (external extension of the peer community) on the other hand , to meet the challenges of quality control in the assessment of complex risks. This process will help in making underlying assumptions and priorities of the scientists more explicit, and it may contribute to the identification of a broader range of alternative solutions to a given problem.

According to Gillund and Myhr (2010), broadening the notion of expertise reflects the view that scientific evidence and analysis are essential but not sufficient to properly deal with complexity and uncertainty. Consequently, expert-led risk assessments should not have an authoritative and privileged role in the decision-making process. To expand the range of knowledge providers implies that one must gather knowledge, experience and viewpoints of all impacted parties and the general public (often facilitated through trans-disciplinary research and participatory processes), and to treat these as legitimate and valuable sources of knowledge for informing decisions. Here, the critical question for post normal science is not how do we reduce uncertainty, but rather how do we make better decisions in a world of irreducible uncertainties? (Marshall, Brent K. J.Steven Picou 2008)

In the Indian context, responding to the public outcry, the Minister chose a participatory approach where he made public the Expert committee report-II report which formed the basis for GEAC's decision for commercial release of Bt brinjal. Here, the Minister sought the views from other prominent experts from both India and abroad (Internal extension) on the expert committee report and on the other hand, he also sought the views from the Public through the public consultation wherein different interest groups have participated and also the views from the state governments (external extension). Following is the analysis of the views of the state governments and public consultations on Bt brinjal.

3.2.2. Views from the State Governments

As per the Constitution of India, Agriculture and Health are state subjects. Coming to the position obtaining in various States in regard to transgenic crops and field trials, several states have expressed their reservations about Bt. brinjal. While few states in fact have decided to prohibit environmental release of all GM seeds to keep the State totally GM free, some other states have also disallowed field trials in the State.

If we summarise the responses of the various state governments on Bt-brinjal: Andhra Pradesh, Chattishgarh, Karnataka, Bihar, West Bengal, Orissa, Uttarakhand, and Madhya Pradesh have expressed their reservations about Bt. brinjal. Kerala and Uttarakhand have in fact decided to prohibit environmental release of all GM seeds to keep the State totally GM free. Bihar, Kerala, Madhya Pradesh and Rajasthan have also disallowed field trials in the State. Himachal Pradesh will take a view on Bt. brinjal once all trials are completed and Government of India has taken a decision in the matter. It is note-worthy that more than 10 States cutting across political affiliations formally communicated to Mr. Remesh in 2009-2010 that they would not permit Bt brinjal to be released in their territories (Ministerial Note, Para 8, MoEF 2010:4-5) (See Annex-II and also www.moef.nic.in).

In view of the various concerns raised by the state government and the agriculture and health being the state subjects, the federal government should take the state governments into confidence while making any policy decision on emerging technologies which have potential to impacts human health and environment. In this direction the minister has set the precedence by consulting the state governments on Bt brinjal and the decision also upholds the importance of the Principle 10 of the Cartagena Protocol to which India is a signatory.

3.2.3. Public Consultations on Bt brinjal

The report of the Expert Committee (EC-II) submitted to the GEAC on October 8th, 2009 that formed the basis of the GEAC's decision of October 14th, 2009 for commercial release of Bt-brinjal. The EC-II report was made public by uploading on website[17] of the Ministry of Environment and Forests and comments were sought on this report sought by December 31, 2009. Responding to the strong views have been expressed on Bt-brinjal issue, both for and against, Mr.Jairam Ramesh, the then Minister for Environment and Forests (MoEF) announced the public consultations with the objective "*to arrive at a careful, considered decision in the public and national interest"* (Ministerial Note, Para 2, MoEF 2010:1)

The Minister upholds the importance of the outcome of the public consultations in his final decision when he said

> *"This decision will be made only after the consultations process is complete and all stakeholders are satisfied that they have been heard to their satisfaction."* (Ministerial Note , Para 2, MoEF 2010:2)

The Centre for Environment Education (CEE), an autonomous organization engaged in Environment and Sustainability Education, was entrusted with the task of organizing and facilitating these consultations.

During January and February 2010, a series of consultations took place in seven cities namely Ahmedabad, Bangalore, Bhubaneswar, Chandigarh, Kolkata, Hyderabad and Nagpur in which scientists, agriculture experts, farmers' organisations, consumer groups and NGOs were invited to present their views before the Minister. The basis of selection of cities in which these meetings were to be held reveals an emphasis on involving various stakeholders. Public meetings were thus held in Kolkata and Bhubaneshwar since West Bengal and Orissa account for 30% and

[17] . www.moef.gov.in

20% of India's brinjal production, respectively. Ahmedabad was selected because of the success of Bt cotton in Gujarat. Nagpur was chosen because it is the home of India's premier research institution in cotton and there have been controversies over Bt cotton in Vidarbha. Chandigarh was included because it is the capital of India's two most agriculturally advanced States while Bangalore and Hyderabad were chosen because they are the most important centres for biotech Research and Development. (Ministerial Note, Para 3, MoEF 2010: 2).

3.2.3.1. Consultation Process

The CEE office in Ahmadabad was the central secretariat for the public consultation process. With regard to publicity on the national consultations, newspaper advertisements appeared in English and the local language. Press conferences were also organised by the CEE. In addition to above, several news channels covered the discussions at each consultation. All of this provided considerable additional coverage to the consultations (CEE 2010).

Prior to the public consultations, a layperson's primer on Bt Brinjal was released by CEE in 11 major languages, namely, English, Hindi, Gujarati, Marathi, Kannada, Telegu, Oriya, Bengali, Punjabi, Tamil, and Malayalam. The primer aimed to provide an unbiased account of basic information on the importance of brinjal in India and also the prospects and concerns on Bt brinjal. In addition to above, the primer also refers to report of the Expert Committee (EC-II) on Bt Brinjal. The primer in English and local language was distributed to all who ever registered at each consultation. The primer helped the stakeholder participants to get an acquaintance with the current situation on Brinjal and steered the active participation (CEE 2010).

The Bt brinjal consultations were open to all members of the public. The participants were identified by interest groups that they represent and they were formed into six such groups, each group was distinguished by a colour-code. Accordingly the registration was done through six

counters at each consultation. Each registered participant was given a coloured sheet with a printed number. The colour of the sheet was indicative of the interest group and the unique number ensures that each participant was registered. This system of colour coding helped the Minister to identify the representatives of different interest groups when they make propositions on Bt brinjal. The organiser ensured that the registration was open even after the consultation began and to continue till end of consultation. The CEE staff ensured that the translation was available (CEE 2010).

Each consultation was started with a power point presentation on Bt brinjal in regional language and followed by the Minister's address to the crowd explaining the rational for arranging the consultations. The forum was subsequently opened up for discussions. CEE staff ensured that the translation was available from English to regional language and vice versa for all the propositions and comments during the consultations. Each consultation concluded with a brief address from the Minister. The proceedings of every consultation were compiled into regional reports. This included the entire on-site documentation, the raw video and audio footage, photographs and rapporteurs' report. Comments and studies sent via email, post or by hand to regional offices and to the central Secretariat have been compiled (CEE 2010).

3.2.3.2. Profile of the Interest Groups

The consultations offered a platform to a wide variety of stakeholders. As mentioned earlier the Registration of the participants has been taken in the following six interest groups categories (CEE, 2010).

1. Farmers/Farmer Organisations, 2. Consumer Forum/ NGOs /Environmentalists, 3. Scientists, Experts, 4. Students, Researchers, 5. Government Officials, Politicians/Elected bodies/members, and 6. Individuals, Citizen Groups, Business, Traders, Industries

Table No 3.1: National Consultations on Bt Brinjal: Location wise Participants Profile

S/No	Location	*Location wise Total Participants (As per Registration)	Farmers/ Farmers orgnizations	NGOs/Consumer Forum/Environmentalists	Scientists/ Experts	Students/ Researchers	Govt officials, Political/ Elected bodies/members	Individuals, citizen groups,business, Traders, Industries
			Number with %	Number with %	Number with %	Number with %	Number with %	Number with %
1	Kolkatha	478	62 (3%)	81 (17%)	148 (31%)	67 (14%)	86 (18%)	34 (7%)
2	Bubaneswar	623	274 (44%)	224(36%)	12 (2%)	69 (11%)	6 (6%)	38(6%)
3	Ahmedabad	1051	515 (49%)	189(18%)	53 (5%)	147 (14%)	10 (1%)	137(13)
4	Nagpur	1210	750 (62%)	145 (12%)	85(7%)	97 (8%)	36 (3%)	97 (8%)
5	Chandigarh	491	304(62%)	108 (22%)	30 (6%)	10 (2%)	0	39 (8%)
6	Hyderabad	719	432 (60%)	129 (18%)	79 (11%)	50 (7%)	7 (1%)	22 (3%)
7	Bangalore	1348	647 (48%)	189 (14%)	162 (12%)	40 (3%)	13 (1%)	297 (22%)
	Total	**5920**	**2984 (50%)**	**1065 (18%)**	**569 (10%)**	**480 (8%)**	**158 (3%)**	**664 (11%)**

Source: Compiled from the Centre for Environmental Education (CEE) National Consultation Report on Bt brinjal.

Note:* I have personally visited the CEE office at Ahmadabad and verified location wise registration details of the participants.

As the CEE office in Ahmadabad was the central secretariat for the public consultation process, I had personally visited the CEE office and spent significant amount of time and reviewed all the records related to public consultation processes including access to the video and audio files. As per the registration records, a total of 5920 people registered under six interest groups in the consultation. As per the Table No.3.1, the participant registered under '*Farmers /Farmers organizations*' group is very high, nearly 50% (2984) of the total participants, followed by the other groups '*NGOs*/Consumer Forum/Environmentalists', '*Individuals, citizen groups,*

business, Traders, Industries' and *'Scientists/Experts'* with 18%,11% and 10% of the total participants respectively. While the interest group 'Students*/Researchers'*accounts for the 8% (480) of the total participants, the ***'****Govt officials, Political/Elected bodies/members'* group accounts for the least percentage (3%) registration with 158 participants.

The data indicate that the conceptually identified six interest groups are by no means mutually exclusive. On the contrary, there are overlaps between these categories, that is to say, there are cases in which a scientist is an advocate for an NGO as well as cases in which a scientist works for the government or for industry. Even though they have fuzzy boundaries, the six categories represent distinct though not mutually exclusive groups that are useful for exploring the discourse on Bt brinjal in India.

3.2.3.3. Frames used by the Interest groups

There were 631 propositions expressed by the interest groups in the national consultations on Bt. brinjal. They have used six broad frames both in support of and against the Bt. Brinjal namely: (1) Biodiversity and Environment; (2) Pest Management; (3) Economy and Livelihoods; (4) Consumer Concerns; (5) Human Health and Bio-safety; and (6) Approval and Regulatory process. By using these six frames, 93 (15%) propositions were made in support of Bt brinjal, the remaining 538 (85%) were made against the commercial introduction of Bt. Brinjal in India (Table No.3).

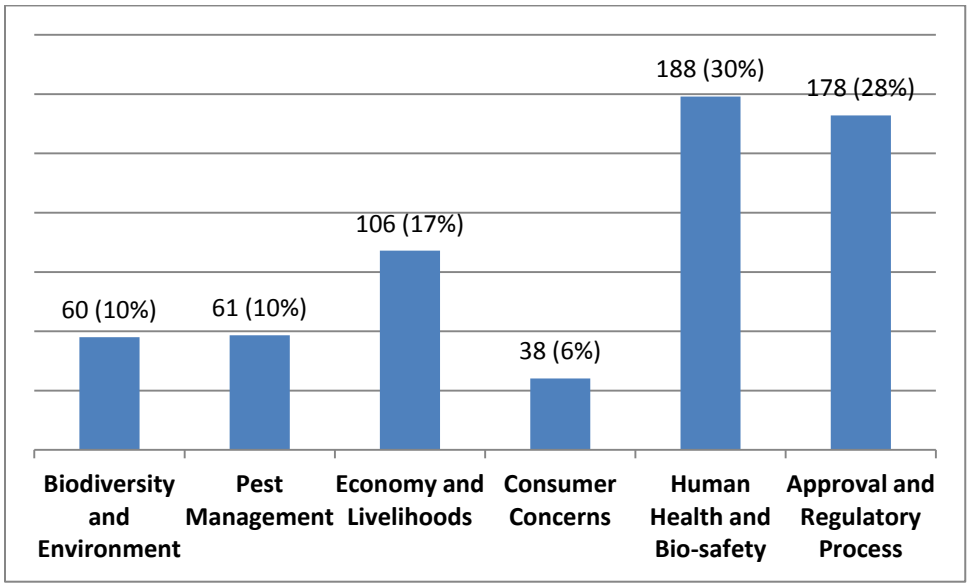
Table No. 3.2: Category wise number of 'For' and 'Against' concerns on Bt. brinjal

S/No	Category	Total	For	Against
1	Biodiversity and Environment	60 (10%)	5 (8%)	55 (92%)
2	Pest Management	61 (10%)	22 (36%)	39 (64%)

3	Economy and Livelihoods	106 (17%)	23 (22%)	83 (78%)
4	Consumer Concerns	38 (6%)	2 (5%)	36 (95%)
5	Human Health and Bio-safety	188 (30%)	34 (18%)	154 (82%)
6	Approval and Regulatory Process	178 (28%)	7 (4%)	171 (96%)
	Total	**631**	**93 (15%)**	**538 (85%)**

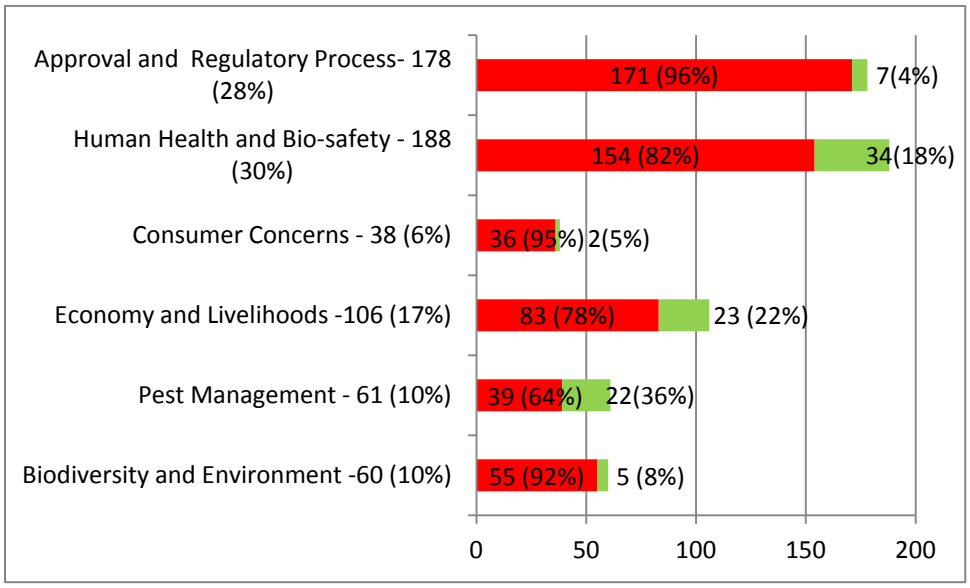
Source: Compiled from CEE's National Consultations report on Bt.brinjal

Diagram No.3.1: Theme wise Percentage wise concerns raised by the Stakeholders in the National Consultation on Bt. Brinjal



Source: Source: Compiled from CEE's National Consultation Report on Bt brinjal

Diagram No.3.2: Theme wise Percentage wise 'For' and 'Against' concerns raised by the Stakeholders in the National Consultation on Bt. Brinjal



Source: Compiled from CEE 's National Consultation Report on Bt brinjal

As shown in Table No 3.2, review of 631 propositions indicates that the Indian discourse concerning GM food crops revolves mostly around two frames, Human Health and Biosafety followed by governance (Approval and Regulatory process). Almost 58% of the total propositions are related to these two realms. While propositions concerning Biodiversity and Environment, Pest Management have equal share comprises of 10 percent each, the Consumer concerns are much lower which account for 6%. Propositions about Economy and Livelihoods make up the remaining 17 per cent. These numbers alone do not tell the whole story. However, they give some picture of what occupies the minds of the people who are evaluating modern agricultural technology.

The propositions presented by the interest groups in the Bt brinjal consultations have two essential parts, the premises and the conclusion. In the premises part, the interest groups used various 'frames' either in support of or in rejection to the GM crops. Many STS scholars have portrayed the interplay between science and society as a plurality of views (different values and interests) engaged in a kind of a framing battle (Wynne 1996; Irwin and Michael 2003; Jasanoff 2005; Irwin 2006; Stenekes *et al.*, 2006). Frames, according to Goffman (1974), "allow people to locate, perceive, and label social events". Frames are packages of social values and norms that shape people's evaluations of an issue, such as a new technology. The foundation/input for different 'frames' are the facts, interests, meanings, beliefs and values that the interests groups associate with GM crops. These aspects seem to influence the risk benefit perceptions of the interest groups and in turn, the risk benefit perception seem to have a direct bearing on the way the interest groups frame the issue either to support or oppose the GM crops. Therefore, different social groups tend to assimilate genetic engineering on the basis of their overall meanings, beliefs, interests and values vis-a-vis the differences in risk benefit perceptions. Irwin and Davis (1995) argue that frames effectively structure the way information is presented and, depending on the frame, judgments about the perceived risks versus benefits of a technology might be quite different.

As discussed above, the lack of scientific consensus as well as intrinsic uncertainty surrounding Bt brinjal limit the knowledge sources that regulatory agencies can draw on to effectively assess the health and environmental impacts. This creates an arena where the lack of conclusive evidence can serve differing interests. Maeseele (2009) argues that often conflicting and contested claims to knowledge are found to be selectively adopted by various social actors as a

material and discursive resource in pursuing broader social, economic or political agendas. The divergent groups may all present rational agendas given their contrasting risk-benefit perspectives, interests and values within the dynamic discourse of knowledge formation. For instance, industry can advocate the beneficial impacts of their novel products whereas other interest groups claim that application of the same products involves unacceptable risk to health or the environment. These 'risk conflicts' involve contestation between various social actors over competing *risk definitions*, which are based on the confluence of competing: (a) *scientific rationality claims*; (b) *values*; and (c) *interests*. (Maeseele 2010, 2011). In this context, Kaare M.Nielsen and Anne Ingeborg Myhr (2009) argues that in many cases, especially with new technology, the regulatory decision making is done in the absence of certainty and hence it is vulnerable to various types of subjective assumptions about the risks and benefits involved. Thus, the attempt for commercial introduction of Bt brinjal has generated a broad range of views among the stakeholders as to how GM crops should be regulated, if they are introduced.

To arrive at the heart of what is at stake, these controversies should be approached from an identification of the competing values and interests at work, instead of starting from an unproblematized scientific consensus. As a strategy, post normal science (PNS) requires the formation of an "extended peer community" in which a discourse occurs among all stakeholders affected by a problem. In such a participatory arena, science is but one of many sources of evidence, which together informs policy decisions (Funtowics and Ravetz 1992).

The propositions in consultation were not confined to Bt Brinjal but extended to the larger issue of genetically modified (GM) crops and to the process of approval of GM products. Therefore, the analysis of the values and interests of different stakeholder is essential and timely to provide the policy makers with valuable inputs with regard to GM food.

As discussed in the previous chapter, several studies in the case of Bt. cotton in Indian context showed mixed results on economic returns to farmers on account of yield gains and less pesticides applications. In additions to several apprehensions have also been raised on the negative effects for human health and environment. In case of Bt. brinjal, the commercial cultivation of this edible crop, apart from economic and environmental concerns, may have indirect effects on human health, culture and religion in the Indian context. Socioeconomic analyses of new technologies vary considerably in scope, ranging from narrow utilitarian analysis to ones considering a wider variety of human values and concerns.This analysis is particularly important as several GM food crops are in pipeline under various stages of approval process. According to one estimate, of the 91 applications for field trial before the GEAC, 44 are GM food crops. The detailed analysis of the public consultations data is presented in the subsequent three chapters: Chapter 4 on farmers' concerns, Chapter 5 on consumers' concerns and Chapter 6 on concerns related to regulatory/ approval process.

3.3. Summary

There were three main types of evidence that have gone into the Minister's moratorium decision on the commercial release of Bt brinjal namely scientific evidence, views from the state governments and outcome of the public consultations. The outcome of the National consultations formed the main basis for the Minister's decision. Using participatory and precautionary approaches in the decision making on Bt.brinjal in India could be a result of critical questioning of the authoritative role of science in decision making on emerging technologies and may be seen as an attempt to increase the transparency and trust in decision-making processes.

The GEAC, driven by the technocratic ideology, framed the Bt brinjal debate in such a way that it can be resolved only through the scientific risk assessment. But, the analysis of the scientific evidence clearly shows that there is no consensus within the scientific community on the health and environmental safety of the Bt brinjal. Prominent scientists have highlighted several flaws in the scope and adequacy of Expert Committee-II report. Further the instances of deep division, lack of transparency, conflict of interest among the Expert committee members cast doubts on the ability of experts and veracity of scientific knowledge to provide complete answers to the policy questions. Several concerns have been raised on the unpredictability of modern biotechnology, especially when dealing with the organic world.

In the face of unpredictability and complex problems, the scientists are unable to know in advance what will be the best way to address the problem, but, they make a choice. There has been increasing attention that these choices and different scientific interpretations of the problem may be the result of differences in disciplinary backgrounds, values and assumptions, or particular interests and priorities. Instead of striving for consensus, if the scientists make their underlying assumptions and priorities more explicit, it may contribute to the identification of a broader range of alternative solutions to a given problem. On the other hand, in the face of contested scientific knowledge claims and intrinsic uncertainty surrounding GM crops, the interest groups may all frame the debate according to their contrasting risk-benefit perspectives, interests and values within the dynamic discourse of knowledge formation. These framing battles tend to be based competing and sometimes conflicting values/meanings and interests. Hence, risk perceptions and perceptions on uncertainties vary. On the other hand, the analysis of the views of the State governments indicates more than ten states including the major brinjal growing states expressed their concerns on different grounds and have called for extreme caution on

commercial release of Bt brinjal. With regard to the Public consultation data, in addition to the risk and safety to human health and environment, various economic, social, cultural, and moral concerns came to be voiced.

Therefore, failing to adequately deal with uncertainties, conflicting values and interests undermines the quality of the knowledge and consequently the quality of the decisions in policy relevant science. In this context, PNS as an alternative approach advocates for new interdisciplinary contacts and integration (internal extension of the peer community) on one hand, and new knowledge partnerships with policy makers, NGOs, industry, media, and the public (external extension of the peer community) on the other hand, to meet the challenges of quality control in the assessment of complex risks (Funtowicz 2006).The detailed analysis on the various concerns expressed by the interest groups in the consultations is discussed in the chapters 4 (on farmers' concerns), Chapter 5(on consumers' concerns) and Chapter 6 (on concerns related to existing regulatory mechanism of GM food in India)

Chapter IV

Bt Brinjal: Farmers' Risk Benefit Perceptions

4.1. Introduction

Bt technology aims to control an agronomic trait, the Fruit and Shoot Borer (FSB) pest thereby reducing the frequency of pesticide applications, which in turn reduces the farmers' expenditure on pesticides and thus protects from the production losses on account of FSB damage. As per the registration details at the public consultations, the 'farmers and farmers organisations' group accounted for almost fifty percent of the total participants in the consultation. Further, out of the eight states where the public consultations were held, in six states, namely Gujarat (Ahmedabad) Maharashtra (Nagpur), Andhra Pradesh (Hyderabad), Karnataka (Bangalore) and Punjab and Haryana (Chandigarh) the farmers also have the experience of growing Bt.cotton. The remaining two states West Bengal (Kolkata) and Odisha (Bhubaneswar) account for around 50% of the country's brinjal production. Therefore, the farmers and farmers group have the representation from both Bt cotton growing states as well as major brinjal growing states. Any question that we raise about safety and potential risk in the Indian context will have to be from the perspective of the Indian cropping environment and resource-endowments of the highly differentiated peasantry in India. The GEAC based on the risk assessment reports of the Expert committee –I and II, cleared Bt brinjal for commercial release, claiming that it would result in lower usage of pesticides, higher yields and a solution to India's food security. But, the farmers have a broad notion of risk in the Indian context and expressed various concerns on the Bt brinjal in the consultations.

As discussed in the previous chapter, on the decisions related to policy relevant science, the PNS approach advocates for the extended peer community process in the context of intrinsic uncertainty, conflicting values and interests and decisions urgent. In the changed context of knowledge production and intrinsic uncertainty and unpredictability associated with genetic engineering technology, the scientific and technical discourse is no longer restricted to expert communities but needs to be inclusive of non-specialist participants through 'extended peer community'. An extended peer community includes stakeholders and general public those who desire to participate and openly discuss various dimensions of risks and their implications for all stakeholders. This process will also useful in assessing the conflicting interests and values of different interest groups and to arrive at consensus on the technological choice. In view of above, the primary aim of this chapter is to analyse the interests and values vis-à-vis the risk benefit perceptions of the farmers group in the public consultations on Bt brinjal.

4.2. Data and Findings

As discussed in the first chapter, for the purpose of analysis, the concerns under the themes 'Pest Management', 'Economy and Livelihoods' and 'Environment and Biodiversity' are included under the 'farmers' group'. Following, Table No 4 shows sub-theme wise number of for and against propositions under 'farmers' group'

Table No 4.1: Theme wise Propositions of the Farmers' on Bt-brinjal : For and Against the Introduction

	Theme	Total Propositions	For	Against
	Pest Management	61 (10%)	22 (36%)	39 (64%)
	Environment and Biodiversity	60 (10%)	5 (8%)	55 (92%)
	Economy and Livelihoods	106 (17%)	23 (22%)	83 (78%)
	Total	227	50 (22%)	177 (78%)

As per Table No.4.1 the Pest Management theme has a total of 61 concerns, while the Economy and Livelihoods, and Environment and Biodiversity theme have 106 and 60 concerns respectively. The three themes together have a total of 227 concerns which is 36% of the total concerns (631). While 39 (64%) propositions were made against the Bt-brinjal under the Pest Management theme, 22 (36%) were made in favour of Bt-brinjal. Similarly, under Economy and Livelihoods, 83 (78%) propositions were made against and 23 (22%) statements were made in favour of Bt-brinjal. In case of Environment and Biodiversity, 55 (92%) propositions were made against and 5 (8%) were made in favour of Bt brinjal. When the propositions under three themes combined together 78% (177) of the propositions were made against Bt-brinjal and remaining 50 (22%) propositions were made in favour of it. The main concerns expressed by various stakeholders in the consultations are coded in the following Table No 4.2.

Table No. 4.2: Farmers' Concerns on Bt-brinjal

	Frames	**Number of Mentions**
	Economic and Social Benefits	24
	Environmental Benefits	5
	Economic Risks- Small and marginal farmers	
	- Economic risks in the long run	8
	- Marketability of Bt brinjal	7
	Ownership over the technology	22
	Right to Choose and Availability of Non-Bt seeds	11
	Affordability of technology- Seed Price	7
	Monoculture and Soil contamination	6
	Is there any Demand for Bt-brinjal in India? And Who Decides?	21
	Need Plurality of Strategies to Pest Management	9
	Relevance of the GM Technology?	9
	The question of Compatibility and Sustainability	
	-Growing Refugia	11
	-Isolation Distance	6
	Potential gene flow to wild relatives and cultivated brinjal	14
	Impact on Brinjal Diversity	15
	Impact on Organic Farmers	6

	Unpredictability and Unknown Risks to Eco-system	10
	Health risks to Farmers and workers working in GM Crop fields	5
	Need long term Environmental Risk Assessment	6
	Food Security and agricultural growth with GM crops	14
	Others	11
	Total	**227**

The (Table No.4.2) study indicates that farmers' risk and benefits perceptions on Bt brinjal in the Indian context are driven by various economic, socio-cultural, rights based concern such as: Economic and social benefits, Environmental Benefits, Economic Risks, Ownership over the technology, Need of the technology, agriculture practices/compatibility (Refugia and Isolation distance), sustainability, Gene flow to wild relatives and cultivated brinjal, Impact on brinjal diversity /Centre of origin, impact on organic farmers, Food security, farmers' rights to seeds, Relevance, Safety, Need long term environmental risk assessment, Soil contamination with Monoculture, unpredictability and unknown risks to eco-system and other concerns.

4.2.1. Economic and Social Benefits of GM crops

The findings indicate that Indian farmers attach predominantly economic meanings to Bt brinjal. The farmers who have the experience of growing Btcotton or who have seen or heard about the performance of *Bt* cotton, the use of analogy in judgment making was universal. Over 90% of cotton farmers in India cultivate Bt-cotton. Many farmers have argued that Bt-cotton has been very profitable to them. The substantial increase in the cultivation of Bt. Cotton during the last decade or so has been showcased as the measure of success. The drop in usage of pesticide due to Bt. cotton cultivation is also being quoted as a plus point of the transgenic technology.Reduction in pesticides use has been viewed by Indian farmers' in terms of economic benefits rather than health benefits.

Therefore, economic benefits are so important for Indian farmers given the size of their land holdings and their sole source of livelihood. On the other hand, the social benefits associated with the economic benefits are improved living conditions of farmers, child education, health and housing. Following are few propositions that came up in the consultations arguing the economic and social benefits with Bt cotton.

> *"The use of Bt cotton has resulted in a decrease in the types and quantity of pesticides, thus financially benefiting farmers." (Proposition No. 61, CEE 2010: 23)*

> *"We have been able to economically benefit considerably from Bt cotton; my children now study in good schools." (Proposition No. 138, CEE 2010: 29)*

As analysis shows, even in case of Bt brinjal, the farmer's perceptions are primarily driven by future economic benefits. Bt-brinjal is primarily an agronomic trait which works against the particular pest namely the Fruit and Shoot Borer (FSB). Many brinjal farmers expect several benefits with Bt brinjal such as: reduce reduction in cost of insecticides (on account of lower use), cost of labour (due to less number of applications), health benefits to farmers, and also decreases the yield losses. The following are the few propositions that came up in the consultations with regards to benefits with Bt brinjal:

> *"Sixty percent of the plant protection cost is for controlling fruit and shoot borer." (Proposition No.74, CEE 2010: 24)*

> *"Bt Brinjal will reduce the pesticide usage in cultivation by 80%." (Proposition No.77, CEE 2010: 24)*

4.2.2. Economic Risks – Small and Marginal Farmers

Two issues have been highlighted under economic risks namely: long term economic risks and Marketability/Demand for Bt-brinjal.

4.2.2.1.Long Term Economic Risks

Incentives for farmers are the prime movers for technological change in most cases. These incentives or benefits may sometimes be high in the short term, but may have low returns in the long term (as in the case of chemical intensive approach to agriculture). Several concerns have been expressed with regard to long term negative effects of GM crops by drawing analysis from the Bt cotton experience. Following are the few statements made by interest groups in this regard. On the other hand, arguments were also made linking farmer's suicides with the economic losses from Bt cotton crop failure.

> *"Production of Bt cotton decreases over subsequent years. Hence it is not profitable for farmers in the long run." (Proposition No.147, CEE 2010: 29).*

> *"The productivity and production of Bt Brinjal and the earnings of farmers may increase in the short run, but positively not in the long run. On the other hand, the cost of cultivation will increase greatly after a few years." (Proposition No.213, CEE 2010: 34)*

4.2.2.2.Marketability of Bt brinjal

Unlike Bt cotton, Bt brinjal is a food crop. As the food is a cultural marker, several concerns have been raised on the marketability of Bt-brinjal in domestic market. About 9.5 million tonnes of brinjal is produced in a year in 0.58 million hectares, nearly all of which is internally consumed only 0.04% of it is exported (APEDA 2009). Consumers may not prefer eating Bt-brinjal on religious and cultural grounds.

> *"Many consumers might not prefer eating Bt Brinjal, hence the marginal farmers who cultivate Bt Brinjal might incur huge financial losses." (Proposition No.203, CEE 2010: 33)*
> .

Concerns have also been expressed about the possible negative effects of Bt brinjal on exports. The exports of other vegetables would also adversely get affected due to the inability to introduce co-existence measures in a country like India, where the majority of the farmers have

small and marginal land holdings.Without segregation and traceability measures in place, India could lose the EU market if the cultivation of GM food crops increases.

> *"Experience shows that several nations will not accept Bt foods." (Proposition No.178, MOEF, 2010: 31)*

> *"The introduction of Bt Brinjal would raise suspicion in the international community regarding other vegetables too (due to horizontal gene transfer within the family) and would adversely affect our exports." (Proposition No.194, CEE 2010: 32)*

Concerns have also been expressed on the possible reduction in brinjal price on account of enhanced production with Bt brinjal.

> *"High brinjal production will lower prices and farmers may not recover even the production cost. There are several instances of farmers dumping onions and suffering heavy losses." (Proposition No.164, CEE 2010: 30)*

4.2.3. Ownership over technology

The issue of IPRs has received extensive attention and is the subject of intense debate in the public consultations. Farmers' group have argued that the introduction of patented Bt brinjal will threaten farmers' seed sovereignty and put them at the mercy of seed companies from which they have to buy seeds every season. The following are the main concerns in this regard:

> *"Implicit monopoly of profit-oriented corporates is against public interest and may lead to dependence of our farmers on them, as they will have to acquire fresh seeds every year because GM seeds are not reusable." (Proposition No.42, CEE 2010: 68)*

> *"Traditional seeds make farmers self-reliant in terms of storage and re-use, Bt technology will make them dependent on market forces." (Proposition No.157, CEE 2010: 30)*

> *"Almost 80% of India's farmers still follow the traditional system of saving, sharing and exchanging/bartering seeds, and hence do not buy them. It is important to maintain sovereignty of these farmers and their traditional methods." (Proposition No.168, CEE 2010: 31)*

Many groups fear that monopoly over seeds will have dire long-term consequences for the self-reliance of entire communities that become dependent on these technologies for their livelihoods (Chong and Scheufele 2002). In this regard, following are the few concerns expressed by the interest groups in the consultation.

> *"In India 60 per cent of the population is dependent on agriculture and this population will be controlled by multinationals through the control of seed and agrochemicals production." (Proposition No.6, CEE 2010: 65)*

> *"Approval of Bt Brinjal is a move towards establishing complete control by the corporate multinational stranglehold over agricultural and food production in India." (Proposition No.470, CEE 2010: 52)*

Farmers' group have also argued the need for the public sector to play a greater role in developing GM crops and self-reliant.

> "*India should be self-reliant in developing new technologies, which will help avoid drain in profits, and technologies will be based upon locale-specific issues." (Proposition No.153, CEE 2010: 30)*

> *"A monopoly of multinational companies in seed production and sale of the seeds is not in the economic and political interest of India." (Proposition No.145, CEE 2010: 29)*

4.2.3.1. Affordability of Technology

With regard to seed price, the supporters of the technology have argued that the enhanced seed price is insignificant when compared with the ensuing benefits associated with Bt brinjal. The proponents also argued that the seed cost is only a fraction of the total investment.

> *"Cultivation of Bt Brinjal will reduce insecticide use against FSB by 70% and so the pesticide costs for the farmer will be significantly reduced. The cost of seed to the farmer is less than 3% of the cultivation costs of Bt Brinjal and hence the question of substantial increase in input costs does not arise." (Proposition No.131, CEE 2010: 28)*

On the other hand, the opponents argue that un-affordability of the package of seeds may lead to loss of livelihoods, which may result in the further widening of the gap between rich and poor farmers. The following are the few propositions that have been made with regard to seed price.

"The Bt seeds will be very expensive. Also, they can be used only once, which further raises the cost of cultivating Bt Brinjal." (Proposition No.196, CEE 2010: 32)

"In India, 85% are marginal farmers. They require small or low cost technology. Bt or GMO technology is not affordable for them." (Proposition No.197, CEE 2010: 33)

4.2.3.2. Right to choose and Availability of Non-Bt seeds

In the public consultations the participants have also used rights based arguments both in support of and against the commercialisation of Bt brinjal in India. In this regard, the groups have drawn their own experience with the Bt cotton while arguing their case. Some farmers' organisations like the Bharat Krishak Samaj and Shetkari Sanghatana and farmers' spokesperson like Bhupinder Singh Mann and Sharad Joshi have come out fully in support of GM crops and argued that introduction of GM crops would improve the incomes of farmers and hence farmer should be allowed to use modern technology (Ministerial Note, para 21, MoEF:13).

"If Bt Brinjal helps in getting higher profits, it should be allowed. (Proposition No.124, CEE 2010: 28)

"If Bt Brinjal is raising the crop output, income and profit then some farmers have no problem in cultivating it." (Proposition No.125, CEE 2010: 28)

On the other hand, several farmers and farmers' groups have argued for the right to choose the non-Bt hybrids and government's responsibility to ensure the availability of non-Bt hybrids in the market. The following are the concerns expressed in this regard:

"Who will protect the rights of a farmer if he wants to grow only non-GM Brinjal but cannot get guarantee of obtaining pure seed because in a few years all the varieties in cultivation may get contaminated with GM genes?" (Proposition No.521, CEE 2010: 57)

"Let farmers have the right to decide which brinjal varieties they want to grow. There should be no imposition from any agency." (Proposition No.523, CEE 2010: 57)

"No cotton seeds apart from Bt are now sold in Amaravati, Maharashtra; the local farmers there (as also in Andhra Pradesh) have no choice but to buy Bt." (Proposition No.169, CEE 2010: 31) .

4.2.4. Monoculture and Soil Contamination with GM crops

By drawing the analogy from the Bt cotton experience, the interest groups have raised several concerns about the potential impacts of GM crops on the soil. The GM technology by its very nature promotes monoculture and has serious implications for soil erosion. Following are the few concerns raised by the interest groups.

"Bt cotton may have used less pesticides than non-Bt cotton but it requires far more fertilizers, which has serious implications regarding soil pollution." (Proposition No.46, CEE 2010: 22)

"The introduction of Bt cotton has led to rapid depletion of nutrients and microorganisms from the soil. Minor pests are qualifying as major pests." (Proposition No.38, CEE 2010: 22)

4.2.5. Is there any need of Bt brinjal? Who decides?

Several questions have been raised by the farmers' groups on the need of the Bt brinjal in the Indian context, given the abundance of brinjal production, with the availability of FSB resistant brinjal varieties, and also availability of alternative strategies for pest management. Field reality indicates that market availability of brinjal is more than adequate, and in fact, any increase in yield could result in a drop in prices, thus affecting farmers adversely.

"Countless varieties of brinjals are cultivated all over the nation at varied agroclimatic zones. Will the GM crop match up to the naturally available climate resistance as in case of the indigenous brinjal varieties?" (Proposition No.39, CEE 2010: 22)

"FSB resistant natural Indian varieties already exist. Government should initiate research programmes for their improvement and propagation." (Proposition No.114, CEE 2010: 27)

"Brinjal is one of the highest produced and consumed vegetables in India, and there is no current shortage. There are various traditional holistic methods of protecting brinjals against pests that have been practised for hundreds of years." (Proposition No.95, CEE 2010: 25)

The questions have also been raised with regard to who decides on what is good for the entire nation? One of the participants argued this in the following way:

"*Scientific invention alone is not the basis for large scale application of a technology. It is for society to draw up their limits based on ethics and plain good sense and whatever they come up with by remaining within those limits, decide what is acceptable and what must be rejected." (Proposition No.85, CEE 2010: 72)*

"The introduction of Bt brinjal in India calls for a holistic rather than a reductionist approach, particularly because it is a favourite vegetable" (Proposition No.527, CEE 2010: 57)

4.2.6. Need for Plurality of Strategies for Pest Management

With regard to alternative strategies to pest management, the proponents of the technology have argued that the adoption of the GM crops is the only solution for the present problems in the Indian agriculture.

"Bt technique is scientific and good for environment as well. In the current situation it is not possible to follow organic farming or Integrated Pest Management (IPM) to increase the yields even though they are good practice." (Proposition No.72, CEE 2010: 24)

On the other hand, the opponents have argued that Bt technology is not the panacea or the silver bullet that can address all the problems of Indian Agriculture. Several propositions were made by the interests groups with regard to the need for a plurality of practices/approaches based on the local specific problems in different agro-climatic zones in India.

"If the Bt gene is to be used, its use must be selective - only where it will have a clear advantage over other approaches." (Proposition No.100, CEE 2010: 26).

"We are talking of genetic modifications for controlling the attack of FSB (fruit and shoot borer) only. The rest of the many insects are often more of a problem and may even make

the engineered crop more susceptible to sucking insects." (Proposition No.90, CEE 2010: 25).

"Fruit and shoot borer is a minor problem in brinjal cultivation in West Bengal. The major constraints in the state are serious infestations of bacterial wilt caused by Pseudomonas solanacearum and 'little leaf disease' caused by phytoplasma." (Proposition No.117, CEE 2010: 27).

The opponents of the technology have also argued that pest needs to be managed with the sustainable, cost effective, alternative approaches like NPM or Organic methods rather than killing the pest with Bt gene.

"Bt Brinjal is not needed when safer, affordable, sustainable and farmer-controlled alternatives exist for pest management. Integrated Pest Management (IPM) and Non-Pesticidal Management (NPM) work well for pest management in brinjal cultivation." (Proposition No.89, CEE 2010: 25)
"Pests / insects are major problems for our agriculture. We have been using various expensive pesticides for many years now but we have learned over a period of time that all pests should not be killed but managed or controlled. If farmers adopt such practices then there is no need to accept Bt Brinjal." (Proposition No.110, CEE 2010: 27).

4.2.7. Relevance of the GM Technology

Various concerns have been raised with regard to the relevance of GM crops with biotic traits when the Indian farmers are grappling with from a biotic stresses such as drought and salinity.

"Bt is stress-intolerant. Hence, farmers may suffer huge economic loss due to failures of crop in case of droughts or floods." (Proposition No.201, CEE 2010: 33)

"GM crops require irrigated land and are not suitable for dryland farming. Most farmers have gone bankrupt because of Bt cotton farming in Vidarbha of Maharashtra." (Proposition No.211, CEE 2010: 34)

4.2.8. The question of Compatibility and Sustainability

Several concerns have been raised on the question of the compatibility of GM crops in the Indian context.

4.2.8.1. Growing Refugia

Several questions have been raised about the suitability of growing refuge[18] in the Indian conditions owing to the land holding position as the majority of brinjal growers are small and marginal farmers. In India the GEAC has recommended refuge of non-Bt (5 border rows) with Bt-cotton per acre or an area of 20%. This strategy was not found popular with farmers since it was not suitable for Indian conditions. The following are the few concerns of the interest groups in the consultations:

> *"New as well as currently minor pest species (like mealy bugs) will replace fruit borer and fruit and shoot borer. This will create a need for a new technology." (Proposition No.83, CEE 2010: 24)*

> *"There are chances that the pests build resistance to the Bt toxin. Will this not make our agriculture, and thereby the farmers, more and more dependent?" (Proposition No.167, CEE 2010: 31)*

4.2.8.2. Isolation Distance

Lack of co-existence measures is one of the important problems in India as most farmers' plots are too small and too close together to apply isolation distances. Several studies have also highlighted the difficulty of maintaining the isolation distance in India. The practical difficulty in maintaining the isolation distance as expressed by one of the participants in the following way:

> *"To grow Bt crop safely, a minimum of 30 metres of isolation is required, but in India there is hardly any plot which can fulfil this condition. This can cause various health hazards, soil contamination and other imbalances in the environment." (Proposition No.501, CEE 2010:55).*

[18] By growing refuge, the large number of susceptible insects emerging from normal cotton will mate with few potentially Bt-resistance ones from Bt- cotton and reduce chances of progeny becoming resistant, because the insects emerging from normal cotton is susceptible. Therefore, these refuges provide Bt-free food for cotton pests, thus slowing the speed with which pests develop resistance to Bt.

"Small and marginal farmers have very small land holdings and cannot maintain isolation distance to check transgene out-pollination." (Proposition No.24, CEE 2010:20)

4.2.9. Potential gene flow and impact on Brinjal Diversity

The other important concern that has been raised with regard to the environment and biodiversity is the gene flow to wild relatives with transgenic crops. Horizontal gene transfer is defined as the non-sexual transfer of genetic information between organisms. Ordinarily gene transfer takes place vertically from parent to offspring. Many fear that extensive adoption of *Bt* brinjal might threaten the genetic diversity of wild and cultivated forms of brinjal. They have also argued that *Bt* brinjal should not be released in India, which is the centre of origin of brinjal.

"Indian farmers through their traditions have kept alive nearly 2500 varieties of brinjal for 4000 years. This natural diversity will get wiped out by the spread of GM Brinjal and no one will be able to reverse the process." (Proposition No.522, CEE 2010: 57)

"Brinjal is a crop with 2- 48% cross-pollination (refer All India Coordinated Vegetable Improvement Project of ICAR). Bt Brinjal will pollute our vegetable germplasm. Transgene cross-pollination is an irreversible risk" (Proposition No.7, CEE 2010: 19).

"Genetic contamination of Solanaceae family (potato, tomato, chilli) will have disastrous consequences to the nutritional security and livelihood security of consumers and farmers." (Proposition No.513, CEE 2010: 56)

"As per the Cartagena protocol, to which India is a signatory, transgenic versions of crops for which we are the country of origin should not be permitted." (Proposition No.31, CEE 2010: 67)

4.2.10. Impact on Organic farmers

Concerns have been raised about the possible risks to the organic growers on several fronts. Lack of co-existence measure would severely affect the prospects of the organic farmers. Producers of organic crops risk having their crops contaminated by nearby GM crops whose pollen can travel

long distances by wind or with the aid of insects. This situation is expected to be much more complicated in most developing countries where landholdings are much smaller and distances between farms are much shorter. Organic certification standards generally do not allow GMO contents, and agricultural products containing even small traces of GMOs do not merit the organic label. With the contamination of their organic crops, farmers would lose the organic certification status for those crops and the premium prices they command.

> *"Farming of GM crops is contaminating the soil. Thus, organic farmers are incurring financial losses because of denial of accreditation by certifying agencies." (Proposition No.152, CEE 2010: 30)*

> *"GM crops are strictly prohibited in organic farming anywhere in the world, as pointed out by the International Federation of Organic Agriculture Movements (IFOAM). Presence of GM in any crop immediately debars it from organic certification, with serious consequences for organic exports, a "sunrise sector of the global economy." (Proposition No.171, CEE 2010: 31)*

4.2.11. Unpredictability and Unknown Risks to Eco-system

Another important apprehension that was highlighted in the consultation was that inherent unpredictability/irreversibility with the GMOs. The following are the responses that alluded to fear of unknown risks by society at large:

> *"Bt Brinjal, once released, cannot ever be recalled, nor can the ecological chain reactions it unleashes be stopped." (Proposition No.99, CEE 2010: 26)*

> *"With over 50 more genetically modified (GM) crops reportedly in the pipeline in India, we must exercise utmost caution. Once released, the damage, if any, can never be undone." (Proposition No.55, CEE 2010: 23)*

4.2.12. Health risks to Farmers and workers working in GM Crop fields

Farmers' especially those who have experience with growing Bt cotton have expressed concerns related to developing skin allergies while working in Bt cotton fields. There was also a demand emphasising the need to conduct a detailed study on this aspect.

> *"Black spots are developing on the faces of people who go for picking Bt Cotton, and allergies among them are common. The Bt Brinjal might harm health." (Proposition No.389, CEE 2010: 46)*

4.2.13. Need Long term Environmental Risk Assessment

Inadequate risk assessment is another important concern highlighted by the participants against the Bt brinjal in the consultation. Various questions have been raised on the scope and adequacy of environmental risk assessment in view of potential long term environmental risks associated with GM crops.

> *"It can have long term implications on human health, farming methods, native varieties, adjoining non-Bt crop cultivations, environment, soil, ecology, biodiversity and the web of life." (Proposition No.28, CEE 2010: 21)*

> *"The science behind GM is very strong but the risk assessment is very meagre. The Government should ensure that a through risk assessment is conducted before giving the green signal." (Proposition No.66, CEE 2010: 70)*

4.2.14. Food Security and Agriculture growth with GM crops

The role of genetically modified (GM) crops for food security is another aspect of public controversy. The proponents of the GM crops argued that increased production will address the Food Security problem. The proponents of the technology portrayed GM technology as the only solution to feed the growing human population. Advocates for or against these technologies often are distinguished by their beliefs on whether it is genes or of the environment that is the right substrate to manipulate to improve agriculture.

"Organic farming will never feed the country or ensure food security. The only alternative when pesticides fail to improve yield, is GM crops." (Proposition No.141, CEE 2010: 29)

"Non-chemical IPM and organic farming need minimum pesticides, create no pollution, and offer more yield. Hence they, rather than GE technology, need to be promoted." (Proposition No.84, CEE 2010: 25)

With regard to food security, the opponents have argued that increasing access, better storage and distribution would help addressing food security than GM crops.

"GE is not an answer to food security; better storage, distribution, pricing and marketing strategies will eliminate the need for the risky GE technologies." (Proposition No.156, CEE 2010: 30)

Many have argued that Bt toxin is basically an insecticide and insecticides cannot increase yields, it only reduce losses against particular pest infestation. Therefore, GM crops cannot help in enhancing yield.

"It is widely accepted that GM crops do not necessarily yield more as they have no specific genes for high intrinsic yield; and in some cases they yield less than conventional crops." (Proposition No.14, CEE 2010: 66)

4.3. Discussion

The farmers' groups account for almost fifty percent of total participants in consultations and majority of them have experience of growing either Bt cotton or brinjal or both. Hence, this study offers a glimpse of the social meanings and interests Indian farmers attach to Bt brinjal cultivation.

The genetic engineering technology can generate conflict between the interests of the seed companies that produce genetically modified seed and the interests and values of the farmers. On the other hand, farmers are not a homogeneous group in terms of resource endowments. For example, the size of operational landholdings of more than 50% of the farmers is less than five acres (Haribabu 2004). In case of brinjal, about 1.4 million small and marginal farmers in India

grow this crop (Choudhary and Gaur, 2009 in Sant kumar et. al, 2011:85). Therefore, we can find varied interests among the farmers groups in relation to their landholding size and resource endowments.

Another source of conflict is the argument of the industry and scientific community according to which there is no change in the meaning of crops with genetic modification. For the biotechnology industry, life forms or parts of life, such as the seed (irrespective of whether the seed is a hybrid or genetically modified seed) constitute physical means of production whereas for farmers and other sections in the society life forms carry religious and aesthetic meanings (Haribabu 2004). Unlike the Bt cotton, Bt brinjal is a food crop and majority of the produce is being consumed in India. Therefore, these concerns need to be taken on board before taking any final decision on GM crops in India.

As discussed earlier, one of the key elements of the PNS apart from the scientific quality as defined by Funtowicz and Ravetz (1994) is to increase the social robustness of the knowledge production by assessing the conflicting interests and values of the different interest groups through extended peer community process. People hold different values and beliefs about the way societies sustain quality of life for their members. The first step, therefore, is to analyse people's value orientations and interests. In the post-normal domain, scientific and technical discourse is no longer restricted to expert communities but needs to be inclusive of non specialist participants and all of those with a desire to participate in the resolution of the issue. These extended peer communities will not necessarily be passive recipients of the materials provided by experts. They will also possess, or create, their own 'extended facts'. Following, I discuss the key interests and values that farmers' attach to GM crops in general and Bt brinjal in particular.

4.3.1. The Economic Benefits and Risks for Farmers

The findings indicate that GM crops have predominantly economic meanings for the Indian farmers. In case of Bt cotton, the primacy of economic benefit on account of reduction of number of sprays borne out by previous research in India (David and Sai (2002) ; Kshirsagar, Pandey and Bellon (2002), Asian Development Bank, 2002). In case of Bt brinjal, Chong (2005:628) study indicates that Indian farmers' perception of Bt brinjal is driven primarily by economic benefits. ABSP II Report (2003 in Chong 2005) study shows that approximately 25% of the pesticides applied on brinjal are targeted at the fruit and shoot borer. In this context, Yamaguchi and Harris (2004) argues that the primacy of economic benefits may have quite a lot to do with the uncertainty of the farmer's livelihood given their risk-bearing capacity and resource endowments. Given the vast difference in the socioeconomic contexts of developed and developing countries, economic benefits could have a potentially crucial influence on the way new technologies are perceived and accepted. Therefore, farmers in India frequently couched their interpretation of GM crops within the explication of economic problems that they face.

The pertinent questions to be asked in this context are; though farmers economic benefits are very much important, but, is farmers' or industry's short term economic benefits outweigh the long term risks to human health and environment? Or risks to future generations? Are the concerns of the farmer outweigh the concerns of the other stake holders especially the consumers, environmental groups etc?

Therefore, the cost-benefit analysis, which is generally concerned with economic benefits and costs, now has to reckon with social, environmental costs and other human values such as autonomy, freedom and so on. As emphasized by the PNS approach, the extended peer

community process is the right platform to deliberate upon and to arrive at as to how to prioritize the interests of different groups.

4.3.2. Ownership over Technology and Its Implications

Another important aspect that the farmers' grapple with was ownership over technology. Ownership over technology is one of the important sources of conflict of interest between biotechnology industry and farmers. As discussed in the previous section, the IPRs have several implications on Indian agriculture such as: Farmers seed sovereignty, Accessibility (seed price), Right to choose, plurality of knowledge systems, and so on.

In the late 20th century, with the changed context of knowledge production, the trend began to prioritize the means and sources of knowledge production through intellectual property rights (IPRs) regime. For example, the first Green Revolution was an entirely public sector-driven. Improved varieties in rice and wheat were developed in publicly funded institutions and were disseminated through them. But over the past few years, the locus of R & D in agri-biotech has shifted to the private sector and it is this that has caused much of the concern (Ramesh 2014).

According to Lal (2009) the emphasis on genetics or seed-based tools is an unavoidable outcome of innovation in the top-down model. As there is more profit to be made with the interventions in the agriculture input trade than the outputs based interventions. Hence, the agriculture business companies aggressively commoditized the input trade. Presently available commercially cultivated GM crops across the globe are with agronomic traits are either pest resistant or herbicide tolerant crops. According to Purkayastha *et. al*, (2010:47) the process patents that owned by the Monsanto makes it possible to create monopoly over Bt crops seeds. This is the reason why that Monsanto promotes hybrid seeds to ensure that farmers buy from the seed companies every season.

The farming communities had the customary right to save the seed for the next season and also exchange seeds. For the farmers the seed is both a material resource and a cultural resource that symbolizes food security. The genetically modified seed, which is a proprietary product protected by the patent law, will undermine the customary material and cultural right. Therefore, the skewed intellectual property rights in favour of the multinational companies (MNCs) will have serious effects on the farmer's seed sovereignty. Here, the important question is: It may be legal, but is it moral to prevent small farmers from reusing the saved seeds? (Haribabu 2004). Expertise which was once located in the farmer's field was more focused in laboratories, many of which belonged to private firms. Can private science work for public benefit?

In this context, Shiva (1995) observes that new plant biotechnologies will follow the path of the earlier high-yielding varieties (HYVs) of the green revolution in pushing farmers on to a technological treadmill. With regard to the access of the GM seeds to the small and marginal farmers, state governments had to fight with the Monsanto to bring down the exorbitant seed price. In January 2006, Andhra Pradesh state government filed a complaint with the Monopolies and Restrictive Trade Practices Commission (MRTPC) contending that the technology fees were too high. Similarly, other state governments have followed the suit to bring down the Bt cotton seed prices (GAIN Report IN3083). In this context, Purkayastha *et al* (2010:45) argues thatif the technology remains hostage to transnational agribusiness, the cost of seeds would remain high.

The GM crops are primarily designed for the industrial agriculture. Therefore, concerns have been expressed about the ability of small farmers to participate in GM crop cultivation, which involves issues like large capital, new skills, affordability, etc. Keeping the above aspects in

view, Swaminathan (1987) argues that research efforts should be directed towards development of technologies that are not only scale-neutral but also resource-neutral.

With the IPRs the private agribusiness tends to monopolize the markets with the only Bt Hybrids. The Bt cotton experience in India shows that the corporate forces with the aim to aggressively expand their business have monopolized market with Bt cotton hybrids. For instance, more than 90% of the commercially grown cotton in India is planted with Bt cotton seeds. Going by the Bt cotton experience, the approval of Bt Brinjal cultivation in the country will potentially violate the rights of those farmers who want to be GM-Free. The corporate monopoly of GM seeds will have larger implications of the farmers' right to choose non Bt hybrids (Ministerial Note, Para 13 MoEF 2010:7).

Thus, Farmer's groups have invoked rights based questions for both in support and opposing the Bt brinjal in India. The pertinent questions that need to be asked in the context are: Is it possible for the farmers' to exercise their own rights? Who decides and control the farmer's choice? Is it moral to take away the rights/freedom of the farmers to remain Bt-free?

> *"Bt cotton seeds have dominated markets due to manipulative systems, and farmers as consumers are forced to purchase it due to difficulties in purchasing non-Bt varieties." (Proposition No.149, CEE 2010: 30)*

Purkayastha *et.al* (2010:45) argues that corporate control of agriculture is likely to promote the process of monoculture that tends to thin down biodiversity on the ground. Thus, it is not an issue intrinsic to GM technology, but to the imperatives of the marketplace, with the ownership over the technology. In this context, the Minister stressed the strategic importance of farmers and the public retaining control over the seed industry. He stressed that during the moratorium period, the government will give "serious thought to the strategic importance of the seed industry

and how we retain public and farmer control over it even as we encourage private investment in agricultural biotechnology" (Ministerial Note, Para 28, MoEF 2010:17).

4.3.3. Plurality and Relevance

The context-dependent nature of food production and culturally mediated food preferences pose challenges to the view that it is possible to develop one technology for all contexts (Haribabu, 2004). For instance, Bt cotton is grown in three agro-climatic zones and nearly 60% of cotton is grown under the rain fed conditions in the central zone. The performance of Bt cotton varieties depends critically on the local suitability of the background germplasm and is also heavily dependent on favourable rainfall or reliable irrigation. Cotton yields in rain fed agriculture remain low, even with Bt.

Because the Bt trait protects cotton plants against just one type of pest, Bt cotton is just as vulnerable as non-Bt cotton to outbreaks of so-called secondary pests, as well as other threats such as drought. Keeping in mind, the wide variability in the results of Bt cotton, one technology is not the solution for all the agro-climatic zones. The pest and other problems are specific to the different agro-climatic zones. Swaminathan (2002) suggests that a combination of genetic engineering and organic farming may be seriously examined.

The Minster Mr. Jairam Ramesh, in his note has referred to the NPM (non-pesticide management) method that is being practiced in Andhra Pradesh State to eliminate chemical pesticides use completely. He also felt the need to evaluate the Andhra Experiment from the point of view of replicability on a larger scale. In Andhra Pradesh around 6 lakh farmers are fully practicing Non-pesticide management (NPM) in about 20 lakh acres. *"The advantage of NPM is that it eliminates chemical pesticides use completely, whereas Bt-technology only reduces the pesticide spray, albeit substantially"* said the Minister (Ministerial Note, Para 9, MoEF 2010:5).

Plurality approaches are important as Brinjal is grown in eight different agro climatic zones in India. Selected varieties/hybrids of varying shapes and sizes of brinjal are cultivated in different vegetable growing zones of the country to meet local preferences. Therefore, there is an imperative for thorough needs assessment of the ecological and socioeconomic situation into which the technology is introduced.

The National Commission on Farmers (2007[19]) pointed out that priority must be given in genetic modification to the incorporation of genes that can help impart resistance to drought, salinity and other stresses. Such prioritisation of the technology is possible only if public research institutions take the lead in developing suitable GM crops. The coexistence of a multiplicity of knowledge systems requires recognition of cognitive justice (Visvanathan 2009), and in order to understand the plurality of knowledge systems, cognitive empathy may be useful as a methodological heuristic (Haribabu 2000). Therefore, the reductionist focus on a single technological intervention or strategy is incapable of grasping the complexity, diversity and riskiness of smallholder agriculture as a socio-technical system.

4.3.4. Compatibility, Sustainability and Brinjal Diversity

With regard to sustainability and compatibility, non-implementation of co-existence measures and failing to grow refugia will have larger implications for sustainability of the technology, livelihoods of non-Bt and organic growers, biodiversity and marketability.

Several questions have been raised in the consultations on the feasibility of growing refugia and maintaining isolation distance in India given the majority of the Indian farmers have small and marginal land holdings. In this context, Jayaraman (2002) argues that How is it possible for

[19] http://agricoop.nic.in/imagedefault/policy/NCF3.pdf Retrieved on 13 April, 2013.

Indian farmers grow and able to set aside land for refuges (20% of the area), where majority of them have less than 5 acres of land? Similarly, under Indian agriculture conditions, how will the government ensure that the minimum prescribed isolation distance of 300 metres between Bt Brinjal and other old native varieties?

Scientific studies show that eliminating or decreasing the size of Bt free refuges increases the probability of increase in pest resistance. It has been reported that the extent of natural crossing is 0 to 48% in brinjal depending upon insect activity (Agrawal R. L, 1980). Purkayastha *et.al* (2010:46) raises an important question that how likely is it that the recent, relatively rapid emergence of Bt-resistant pink bollworm in India is related to the failure of these strategies?

The Minister also stressed the importance of preserving the Brinjal diversity. The national Bureau of Plant Genetic Resources of the ICAR reveals that there are 3951 collections in the Bureau and the number of diversity rich district in India are 134. The Bureau also points out that the diversity-rich regions are likely to be affected by the introduction of Bt-brinjal due to gene flow. “The loss of diversity argument cannot be glossed over, especially when seed in light of the experience we have had in cotton where Bt cotton seed has overtaken non-Bt seeds” said the Minister (Ministerial Note, Para 12, MoEF 2010:7). In this context, Kuruganti (2006) argues that India is the centre of origin for brinjal and any gene transfer/ contamination from transgenic plants could prove to be disastrous for the crop itself. Further, Alam (2011:107) argues that corporate influence on agriculture and the aggressive marketing of high-yielding varieties of seeds may encourage monoculture that tends to thin down biodiversity on the ground.

The inability to implement the co-existence measures will also severely affect the economic prospects of the organic farmers due to the contamination of their fields from neighbouring GM

crops. The important questions in this regard are: What is the fate of the non-Bt and organic growers, if their crop gets contaminated with Bt gene, who takes liability for the damages? There is no liability law in this country. How will small and marginal farmers fight legal battles against big and powerful seed companies?

On the other hand, marketability of the Bt brinjal has implication for the farmer's economic benefits. The inability to implement traceability, segregation and co-existence measures will also have impact on the marketability of Bt brinjal in the domestic market and also effects exports of the other vegetables. The consumer groups' in the consultation have expressed various apprehensions on the Bt brinjal (Consumer concerns are dealt with in Chapter-5). Another important question that arises here is: Are the farmers' economic benefits outweigh the concerns or values of the other stake holders especially the consumers?

4.3.5. Is there any need for Bt brinjal? and who decides?

Several arguments came up in the consultation on the need of Bt brinjal when there are numerous traditional FSB pest resistant brinjal varieties available in India. In terms of production, the public argued that brinjal has never been a shortfall. In this context, Shanmugam (2011:147) argues that there are several varieties of brinjal in India which are found to be resistant to the Brinjal borer. Similarly, Kesavan and Malarvannan (2010) point out that *"With such a biodiversity providing useful genes, it is imprudent to develop Bt transgenic brinjal that inevitably would break down within a few years"*.

With regard to who decides on the technological choice, it may be also argued that scientific invention alone is not the basis for application of a technology; it is for society to draw up their limits. The publics' have demanded for thorough needs assessment and upstream public

engagement prior to approval of such crops. The Brinjal cannot be looked at in isolation as this debate is about the entire GM approach to Indian agriculture. Therefore, there need be a holistic and broad based approach with democratic principles.

4.3.6. Unpredictability of the Technology

Several responses in the consultations alluded to unknown and irreversible risks with GM technology especially when dealing with organic world. There are also concerns over the lack of withdrawal strategies in case of any unpredictable adverse effects occur in the future with GMOs. At present there is no labelling and post market surveillance mechanism in place in India. Once GM is released there may be no turning back. Is it right giving priority of agronomic performance (yield) of a crop over the the environmental impacts it carries? The publics' demanded for long term environmental risk assessment.

4.3.7. Is Food Security Possible with GM crops?

There was a big debate in the consultations on the possible role of the GM crops in addressing the food security problem in India. The proponents have argued that GM technology in food crops offers the much needed solution for food security of the country. On this question, first of all, Bt toxin is an insecticide, and insecticides cannot increase yields, only protects yield losses against particular infestation/pest. The advantage of the protection of the yield will come only if there is an infestation. If in a particular year there is no infestation, the farmer who has used Bt seed will not get any advantage because there are no harmful effects.

The Secretary, Department of Agriculture and Cooperation confessed before the Parliamentary committee and stated that a saving of 10% in post-harvest crop losses would mean 23 million tonnes of extra food grains. In this context the Committee opined that the problem today is that

there is a huge disparity in availability of food in spite of sufficient production and more than double the amount of buffer norms food stocks with the Government. A large majority does not have access to food due to extreme poverty while colossal amounts of food grains, fruits and vegetables are being lost during post-harvest storage. (Committee on Agriculture 2012, Para 7.71: 276)

The Parliamentary committee also questioned the rationale for commercialization of Bt. cotton in India which is not a food crop. According to Haribabu (2004), the important question is to evaluate whether genetic engineering is the only alternative to increase productivity and remove hunger? The increase in productivity may not necessarily remove hunger as the question of hunger is related to distributive justice and accessibility to food. Food surpluses and hunger can co-exist as one finds in India. While arguing that genetic engineering is not the answer to hunger, Sharma (2003:38) concludes in his pamphlet on GM crops by writing "*Like the Green Revolution, which bypassed the small and marginal farmers, the misplaced gene revolution will bypass the hungry"*.

The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD 2008) report based on 4 years of investigation by more than 400 scientists from over 60 nations (a unique collaboration of the World Bank, FAO, UNDP, UNEP, WHO and representatives of governments, civil society, private sector and scientific institutions) indicate that GM crops are highly controversial and will not play a substantial role in addressing the challenges of climate change, loss of biodiversity, hunger and poverty. Instead, small-scale farmers and agro-ecological methods are the way forward; with indigenous and local knowledge playing as important a role as formal science. India is also a signatory to this report.

Therefore, Haribabu (2004) argues that genetic engineering technology is supply-driven rather than demand-driven. Because the corporate sector, especially the multinational enterprises has developed Bt cotton inserting Cry1 AC gene, and now they are trying to market it aggressively with the Bt brinjal and other food and non-food crops in India.

4.4. Summary

One of the key elements of the Post Normal Science (PNS) approach apart from scientific quality is to increase the social robustness of the knowledge production by assessing the conflicting interests and values of the different interest groups through extended peer community process by involving non specialist participants and all of those with a desire to participate in the resolution of the issue. The farmers' group account for around fifty percent of the total participants in the consultation. The analysis of the farmers' groups concerns on Bt brinjal clearly shows that there are conflicting interests and values within the farmers group as well as in relation to other stakeholders such as Industry, consumers, environmental groups etc.,. They have raised several questions on various aspects namely: economic benefits and risks, ownership over technology, accessibility, right to choose non-Bt seeds, rights of the organic farmers, plurality of knowledge systems, relevance, compatibility, sustainability, unpredictability with the technology, brinjal diversity, food security, health and environmental risks, decision making on technological choice etc.,

Therefore, the controversies around genetic modification of food suggest that innovations have to be socially acceptable in terms of safety, equity, sustainability, and the cultural considerations (Haribabu 2004). As discussed above, in the light of various concerns, farmers' group have demanded for an upstream public engagement not only in the phase where technological choices are debated but also in the innovation process as co-participants to incorporate their perspectives.

Here, the issue is not only limited to whether to accept or reject Bt brinjal, but that the entire GM approach to agriculture must be justified. It should not be accepted just because Bt gene is available for licensing. A thorough Needs Assessment must constitute the first step. Is Bt brinjal is really needed? Which problem in agriculture does the transgenic crop attempt to address? Are there alternative approaches? Has the breeding based on exploring the variability in the primary gene pool of brinjal been exhausted? What are the apprehensions on Bt Binjal? And how to go ahead with Bt food crops? The PNS approach which is based on democratic norms and transparency as guiding principle in the decision making on technological choice can be seen as an alternative approach toward this end.

Chapter V

Consumers' Risk Benefit Perceptions on Bt.brinjal

5.1. Introduction

The genetic engineering technology can generate conflict of interests between the interests of the promoters of the technology i.e seed companies and the interests of consumers and society at large. A number of studies have shown that acceptance of GM foods varies among consumers in different socio-cultural contexts (Colson *et al.,* 2008; Dannenberg *et al.,* 2009). As discussed in the previous chapter, the genetic engineering technology also generates conflict of interests between the consumers and farmers. For the biotechnology industry, life forms or parts of life, such as the seed (irrespective of whether the seed is a hybrid or genetically modified seed), constitute the physical means of production, whereas for other sections in the society life forms carry religious and aesthetic meanings (Haribabu 2004). Food is a cultural marker .It is a common feature of all cultures to attach meanings to what is consumed as food. In India, about 9.5 million tonnes of brinjal is produced in a year in 0.58 million hectares, nearly all of which is internally consumed (APEDA 2009).

Food choices are framed by cultural, social, and material circumstances (Draper and Green, 2002). Apart from the risk and safety, several concerns have been raised by the consumer groups in the public consultations on Bt brinjal in India. In this context, Frewer *et al.,* (2004) argues that understanding societal responses to emerging technologies and their applications is key to developing commercialisation strategies associated with specific products, as well as optimizing strategic development of science and technology in the future. Once public concerns and interests (and the values on which they are based) are understood they can be more effectively introduced into risk assessment and risk management practices.

The challenge in the present context is the decision making on the technologies in the face of risk, uncertainty and conflicting interests and values. A new type of methodology is necessary to face different types of uncertainty and the coexistence of a variety of legitimate perspectives. In this context as mentioned earlier, Post Normal Science (PNS) is an alternative contextualising approach useful to analyse the conflicting interests and values of the different interest groups through the 'extended peer community' process which upholds the values of democratic norms and transparency in decision making on the technological choice. Against this backdrop, this chapter primarily aims to understand and critically analyse the various concerns expressed by the consumer groups in the consultations.

5.2. Findings

As discussed in the methodology part in the first chapter, for the purpose of analysis, the concerns under the themes 'Consumer concerns' and 'Human Health and Bio-safety' are clubbed under the consumers' group. Following, Table No.5.1 shows sub theme wise number of pro and against concerns under 'consumer group'

Table No.5.1 Theme wise propositions of the consumers' on Bt-brinjal: For and Against the Introduction

Theme	Total Propositions	For	Against
Consumer Concerns	38 (6%)	2 (5%)	36 (95%)
Human Health and Bio-safety	188 (30%)	34 (18%)	154 (82%)
Total	226	36 (16%)	190 (84%)

As shown in Table No.5.1, the theme 'consumer concerns' has 38 propositions, while the 'Human Health and Bio-safety' has 188 propositions under it. These two themes combined together have a total of 226 concerns which account for 36% of the total propositions (631).

With regard to 'consumer concerns', while 36 (95%) statements were made against the Bt.brinjal, only 2 (5%) were made in favour of Bt-brinjal. Similarly, 154 (82%) statements were made against and 34 (18%) statements were made in favour of Bt-brinjal under the theme Human Health and Bio-safety. When the statements under these two themes combined together, 190 (84%) statements were made against and remaining 36 (16%) statements were made in favour of Bt-brinjal. The main concerns related to consumer group are coded in the following Table No.5.2

Table No.5.2: Consumers' Concerns on Bt-brinjal

	Frames	No. of Mentions
	Consumer Benefits	7
	Food Safety and Risks	
	-Need Long Term allergencity and Chronic Toxicity Studies	61
	-Concerns on the use of antibiotic resistant markers	35
	-Impact on Traditional Medicine	16
	-Need Human Trails and studies on Cooked Bt brinjal	24
	-Concerns on Animal Morbidity and Mortality	10
	-Unknown/Unpredictable Health Risks	18
	Cultural Concerns	7
	Religious Concerns	5
	Rights Based Concerns	
	-Need Labelling to Uphold Consumer Choice	19
	-Availability of Traditional/non-bt brinjal in the market	12
	Is Labelling Possible in India?/ No Labelling Mechanism in Place in India	9
	Need Public Education on Labelling	3

Source: Compiled from the CEE's National Consultations report on Bt brinjal

The (Table No.5.2) study indicates that the risk and Benefit perceptions of the consumers are driven by various factors such as : consumer benefits, Health safety and Risks, Allergencity and Chronic Toxicity , use of antibiotic resistant markers, Impact on Traditional Medicine, lack of Human Trials/ studies on cooked Bt-brinjal, Concerns on Animal Morbidity and

Mortality. The consumer concerns also driven by rights based arguments such as: Cultural concerns, Religious concerns, Labelling and Informed Choice, Availability of Traditional Varieties, Public awareness on Labelling. In the following paragraphs, a detailed discussion on the above themes is presented.

5.2.1 Consumer Benefits

The first generation GMOs that are presently available are primarily the agronomic traits i.e. either insect/pest resistance or herbicide resistance. Bt binjal is primarily an agronomic traits aimed to control the Fruit and Shoot Borer (FSB) pest thereby reduces the number of pesticide applications, which in turn reduces the farmers expenditure on pesticides. Second generation GMOs featuring nutritious benefits, better flavour or a longer shelf life might benefit consumers. The supporters' of the technology argue that the consumers may get indirect benefits through decreased brinjal price in the market on account of increased production with Bt brinal. Availability of the quality brinjal without chemical residue in the market is another indirect benefit cited by the promoters of the technology. Several questions have been raised on negative correlation between increased production and price.

> *"The health problems that occur in India are an outcome of the very high pesticide residue on food." (Proposition No.299, CEE 2010: 39)*

> *Bt cotton has increased production but cotton prices have not come down. On the other hand the costs are increasing. If a similar fate meets Bt brinjal, consumers will not benefit from it. (Proposition No.232, CEE 2010:35)*

5.2.2. Food Safety and Risks

Five issues have been highlighted under Health Risks with Bt brinjal namely: Long Term allergencity and Chronic Toxicity Studies; Concerns on the use of antibiotic resistant markers;

Need for Human Trials; and studies on cooked Bt brinjal; Concerns on Animal Morbidity and Mortality; and Impact on Traditional Medicine.

5.2.2.1 Need Long Term allergencity and Chronic Toxicity Studies

The theme allergencity and chronic toxicity was one of the contentious issues in the consultations with regard to GM food safety. The following are the main concerns that have been raised by the consumers' group in the consultations.

The advocates of the biotechnology claim that rigorous biosafety tests have been done by Mahyco as required by the Indian regulatory system.

> "*Rigorous biosafety tests have been done as required by the Indian regulatory system. This includes acute toxicity tests in laboratory rats, sub-chronic oral toxicity studies, allergenicity studies on rats and rabbits and feeding studies in fish, chicken, goats, and milking cows." (Proposition No.266, CEE 2010: 37).*

The proponents have also argued that Cry 1AC protein expressed in Bt brinjal is well tested and proven safe for human beings by various studies all over the world and there is a strong precedence for safety of the gene itself.

> *"Cry1Ac protein, expressed in Bt Brinjal, has been proven safe by various studies all across the world." (Proposition No.277, CEE 2010: 38)*

> *"In USA people are eating GM crops for the past 13 years and no adverse effects have been observed." (Proposition No.268, CEE 2010: 37)*

> *"Bt Brinjal is not the first GM crop entering the food chain. Bt Cotton-seed oil and cotton-seed cake are used in significant volumes and are already in the food chain since 2002." (Proposition No.275, CEE 2010: 38)*

In some of the propositions the consumer groups have also drawn the analogy between the biotechnology applications in medicines to argue the safety of the biotechnology applications.

> *"A large number of recombinant DNA, medical products developed by using genetic engineering, such as vaccines, insulin, etc are being used to alleviate human suffering and provide medical relief to patients in the millions worldwide. Many products developed as a*

result of genetic engineering are being used in the area of human health in India (Proposition No.287 CEE 2010: 39).”

Consumer groups’ have raised concerns on the safety of the Bt-brinjal in terms of potential long term allergencity and chronic toxicity and demanded for long-term allergencity and toxicity studies on Bt brinjal.

“Long-term studies on allergencity and toxicity have not been carried out prior to getting the approval for commercialisation of Bt Brinjal.” (Proposition No.301, CEE 2010: 40)

“Brinjal itself has an inherent property of allergenicity which may be enhanced further in the Bt variety.” (Proposition No.438, CEE 2010: 50)

The opponents have also argued for the need of conducting multi-generational and reproductive studies to assess the adverse health effects/ consequences which cannot be determined with the short-term studies. With regard to long term chronic toxicity, none of the protocols have evolved procedures to estimate inter-generational hazards.

“Mahyco research lacks coverage of reproductive studies of animals, which is a crucial parameter in biosafety studies.” (Proposition No.409, CEE 2010: 48)

“No intergenerational studies have been carried out by the promoters of Bt Brinjal or anyone else, and the genetic safety aspect has not been addressed at all.” (Proposition No.426, CEE 2010: 49)

Some of the interests groups have also referred the European Union Countries stand on the GM cropsto oppose the introduction of Bt brinjal in India.

“The EU countries have banned GMOs because of serious concerns relating to potential adverse effects on human health.” (Proposition No.419, CEE 2010: 49)

5.2.2.2. Concerns on the Use of Antibiotic Resistant Markers

The use of antibiotic resistance marker genes (Kanamycin and neomycin resistance) in developing Bt brinjal is a matter of concern for many interest groups in the public consultation.

Kanamycin is a second line anti TB drug and India has over 10 million people affected by TB and drug resistance is a growing public health concern. The following are the main concerns:

> *"Bt Brinjal contains two antibiotic resistance genes, one for kanamycin resistance and another for neomycin resistance. Horizontal gene transfer to human gut bacteria is a proven fact and hence poses the threat of antibiotics resistance among human beings who consume Bt Brinjal." (Proposition No.323, CEE 2010: 41).*

> *"In a country where 10 million people suffer from TB and the number is rising, and where the resistance of the disease to antibiotics is on the rise, it is unwise to release or even experiment with a food crop in which antibiotic-resistance markers are being used." (Proposition No.429, CEE 2010: 49)*

5.2.2.3. Need Human Trails and studies on Cooked Bt brinjal

The interest groups have expressed apprehensions on the level of precaution that need to be taken on the Bt brinjal and demanded for human trails as conducted in the case of medicines.

> *"The same level of precautions which are taken for pharmaceuticals need to be taken for GM foods and Bt Brinjal. Human trial should be conducted, as in medicines." (Proposition No.500, CEE 2010: 55)*

> *"There are several unanswered questions. Bt protein degrades in human system. How much is degraded? Even if 2 per cent is left out it will accumulate over time, with possible side effects." (Proposition No.375, CEE 2010: 45)*

Several apprehensions have been raised on when or under what conditions the Bt protein get diluted in the human body. It has been said that cooked brinjal is safe, but the temperature at which the toxin will be neutralised is not given. But, there are several cooking methods that are being followed in different parts of India. The following are the main apprehensions in this regard:

> *"The Bt gene might trigger metabolic processes that have been lying dormant. It has been said that cooked brinjal is safe but the temperature at which the toxin will be neutralised is not given. The traditional cooked dishes include half-cooked brinjal in fries and pickles." (Proposition No.379, CEE 2010: 45)*

> *"When brinjals get left behind in the market, we feed them to stray cows. What will happen to them if they are fed rotten Bt Brinjal?" (Proposition No.373, CEE 2010:44).*

5.2.2.4. Concerns on Animal Morbidity and Mortality

Consumers' group have expressed several apprehensions on the reports about the Animal morbidity and mortality after grazing on Cotton residue in the Bt cotton fields. Feeding tests have so far been done only on cotton seed in the case of Bt cotton and fruit in the case of Bt brinjal, forgetting that in reality, farmers graze their animals on foliar material in an open grazing situation

> *"Consumption of Bt cotton fodder has resulted in mortality of cattle." (Proposition No.302, CEE 2010:40)*

5.2.2.5. Impact on Traditional Medicine

Brinjal provides food, some essential nutrients and has important medicinal values. The raw plant is also widely used in traditional medicine such as Ayurveda and Siddha traditions of Indian medicine .Concerns have been raised about the potential impacts of Bt brinjal on Indian system of medicine. The following are the main arguments in this regard:

> *"Brinjal and many other crops with specific properties are used in traditional Ayurvedic, Siddha medicines; GM crops will be harmful if used in Ayurvedic treatment or availability of non-GM varieties may be difficult for Ayurvedic practitioners." (Proposition No.307, CEE 2010:40)*

> *"No assessment has been made on the potential impacts (toxicity or ineffectiveness) of Bt Brinjal on Indian systems of medicine, given that brinjal and related plants are used in ayurveda, siddha, and so on." (Proposition No.329, CEE 2010:41)*

5.2.2.6. Unknown/Unpredictable Health Risks

Several apprehensions have been expressed with regard to the unpredictability, unknown and irreversible health hazards with the GM food crops.

> *"GM crops have the potential to cause unexpected allergies, and increased immune response to other food articles." (Proposition No.325, CEE 2010:41)*

"One gene is not meant for one function. Any foreign gene can produce some novel protein which may lead to cancer or some unknown diseases." (Proposition No.321, CEE 2010:41)

"The presence of marker genes which are antibiotic resistant in Bt Brinjal is a matter of grave concern. Bt Brinjal has two antibiotic resistance genes and they may express in human bodies in unexpected ways." (Proposition No.314, CEE 2010:40)

5.2.3. Cultural Concerns

As discussed earlier, there are more than 2500 brinjal varieties in India in different colours (light green to dark-purple in colour), sizes (Long, medium and short sized), and shapes (round, pear, and finger to egg shape). The brinjal is grown in eight agro-climatic zones with different local names.

As food is a cultural marker, culturally mediated preferences regarding taste and texture of cooked food play an important role in the acceptance of the GM foods. Several cultural concerns have been expressed by the consumer groups in the consultations.

"We have a native variety of brinjal called 'Kantawala brinjal' in Saurashtra (Gujarat), famous for its taste and life-promoting qualities. Such local species will be threatened by the introduction of Bt Brinjal." (Proposition No.37, CEE 2010:21)

"Mattu Gulla is a special brinjal endemic to Udupi in Karnataka. Its skin is thin, seeds are not bitter and, after cooking, the pieces retain their firmness and has a special taste."(Proposition No.59, CEE 2010:23)

"Many districts (Kandhamal in Orissa in particular) cultivate brinjals that are known throughout the state for their excellent taste and nutritive value - no artificially engineered brinjal can match up to its vigour." (Proposition No.234, CEE 2010:35)

5.2.4. Religious Concerns

Concerns have been raised against the commercial release of Bt bribjal on religious or aesthetic grounds.

"GM seeds contain genes of animals and insects and this is totally unacceptable in the context of the Indian ethos." (Proposition No.236, CEE 2010:35)

"We the Jains will consider all GM foods as non-vegetarian because of the presence of bacterial gene, and we demand strict labelling of such food items." (Proposition No.260, CEE 2010:37)

5.2.5. Moral/ Rights Based Concerns

Consumer groups have raised rights based questions, objections to the commercial release of Bt brinjal.

5.2.5.1. Right to choose Traditional/non-bt brinjal varieties in the market

Several concerns have been raised by the consumer groups with regard to the availability of traditional brinjal varieties in the market after the introduction of the Bt brinjal. They have also drawn analogy from the Bt cotton experience and expressed apprehensions that the market would be infiltrated/monopolized with the only Bt brinjal hybrids.

"Bt Brinjal will dominate the market and reduce availability of traditional varieties to consumers." (Proposition No.230, CEE 2010:35)

"If Bt Brinjal infiltrates the market, significant sections of people, conscious of its hazards, may be forced to stop eating brinjals altogether. They would thus be deprived of a cheap and excellent source of vitamins, minerals and amide proteins." (Proposition No.237, CEE 2010:35)

5.2.5.2. Need labelling to uphold Consumer Choice

Every citizen has a fundamental right to safe food. It is the duty of the government to protect this right. Several questions have been raised against the government's move to promote the GM food crops without proper labelling mechanism in place and infringe into the individual's fundamental right to choose.

"With food safety standards, procedures and enforcement machinery in a nascent stage, Bt introduction is a violation of consumer rights. The government cannot take steps that endanger public health." (Proposition No.390, CEE 2010:46)

"If Bt Brinjal is approved, consumer choice will be violated forever, as they will have no way of knowing whether the brinjal they are consuming is GM or not. This will be a violation of the right to know, right to safe food and right to informed choice with regard to food." (Proposition No.235, CEE 2010:35)

"Consumer's right to choice for non-Bt Brinjal has to be asserted by proper labelling of the product, which is not properly regulated in India." (Proposition No.244, CEE 2010:35)

5.2.5.3. Is Labelling Possible in India?

The difficulty of labelling GM food has also been flagged as a concern. Many participants in consultation expressed apprehension about the practical possibility to implement a labelling regime for a vegetable crop in a country like India as vegetables are sold by small scale vendors at weekly markets, street corner shops and on mobile carts.How will the vegetables on the vendor's cart or the corner shop be labelled?

How will GM food be labelled in a country where vegetables are sold not only in supermarkets? And how feasible is it to maintain the segregation from the field to the market? (Proposition No.30, CEE 2010:67)

5.2.5.4. Need Public Education on Labelling

No doubt, labelling provides a choice to the consumer. But,no process of labelling will make any sense unless the consumer understands the technology and the risks associated with it. Several people in the consultation also pleaded on the need for educating the public on the GM crops.

"This must be preceded by a public education exercise so that the label is not merely a coloured sign on the package but offers the opportunity for informed choice to the consumer. For labelling to make sense, it will have to be preceded by a system for segregation, traceability and Identity Preservation of GM crops." (Proposition No.58, CEE 2010:69)

5.3. Discussion

The Genetic engineering technology has potential to provide solutions to some problems in agriculture but also has the potential for unpredictable risks for human health and environment. Every technology comes with some risks, but the risk or safety is one of the many factors that influence the social acceptance of the technology. Apart from the risk or safety, the other factors like economic, socio-culture, religious, and moral considerations will have powerful influence in defining the way technologies are introduced and disseminated in any given society.

Apart from the above, in the light of conflicting knowledge claims (unknown or unforeseeable risks) with GM crops, the social actors' respective value systems and interests influence which scientific rationality claims are considered acceptable and significant to them. In this context of conflicting scientific knowledge claims on the one hand and diversified values and interests on the other , the PNS approach as an alternative strategy ask for recognition of uncertainties and competing values and interests to open up discussion and stimulate the process of deliberate decision making process through 'extended peer community'. The analysis clearly shows that the consumers' attitude towards Bt brinjal is deeply embedded in more general attitudes held by the them such as attitude towards nature and attitude towards technology.

5.3.1. Consumer Benefits and Emergence of "Alert Consumer'

With regard to consumer benefits, Sant kumar *et. al,* (2011:86) argues that about 66 percent of the overall indirect potential gains would accrue to consumers on account of access to a better quality produce free from pest and chemicals, increased access with higher volume of its production, lower rate due to a reduction in output price due to more production, and nutritional benefits with increased vegetable consumption.

The analysis shows that there are conflicting views among the consumer groups. Consumers make choices involving trade-offs between price advantage and their perceptions regarding GM food safety for humans, animals, and the environment and also freedom to exercise their preference in terms of cultural, religious, moral concerns. They also evaluate the way each product is being produced and the norms and values involved from an ethical angle (i.e., fair trade, child and animal rights)

While price matters for most consumers, various studies indicate that there is no positive correlation between enhanced production and price. In this context, Noussair, Robin, and Ruffieux (2004:103) while making distinction between citizen and consumer argues that "Surveys place respondents in the role of citizens, who make judgements from society's point of view, rather than consumers, who make actual purchase decisions".

But, as pointed out by Korthals (2000), the neat distinction between the roles of consumer and citizen is becoming more strained with the increasing prominence of ethical shopping on food markets where in consumers' express ethical and political preferences in the market itself and not solely on the political forum. In this context, Mortelmans and Watson (1995:244) introduce the alert consumer on the internal market which signifies these developments. However, there is a need to carry out a detailed empirical study in the Indian context to study the actual purchasing behaviour of the consumer when faced with real choices of GM food in real markets.

5.3.2. Food Safety: 'Substantial Equivalence' or 'Precautionary principle'

With regard to food safety and biosafety, the industry/ promoters of GM crops always insist on the principle of '*Substantial Equivalence*[20]' and thus Generally Regarded As Safe (GRAS)

[20]The establishment of substantial equivalence in GM plants depends upon morphological features and agronomic data together with chemical analysis of critical nutrients (both macro and micro) and any critical toxicants and anti-nutritional factors. If there is no significant difference between the two, the GE plant is considered to be safe.

concept for GM foods. Based on the principle of *Substantial Equivalence*, the overall chemical composition of the GM food is compared to an equivalent conventional food. The Mahyco seed company has also tested its Bt brinjal based on Substantial Equivalence.

Several questions have been raised on the scientific justification for substantial equivalence as it avoids a full safety assessment. The protocols of the various studies with respect to toxicity and allergic potential have been questioned by participants on scientific grounds.

In case of Bt brinjal long-term studies on allergencity and toxicity have not been carried out. Commonly, only 90-day feeding trials are conducted and conclusions of long-term risk are based on these short-term tests, despite their critical deficiencies in revealing sub-chronic and chronic effects (Seralini 2009; Spiroux de Vendomois 2010).

Another important objection for commercial release of Bt Brinjal is that the reports about the Animal morbidity and mortality after grazing on Cotton residue in the Bt cotton fields. In this regard, the study findings of the Indian Council of Agriculture Research (ICAR) 'Report on Animal Feeding on Bio-safety Studies with Biotechnologically Transformed Bt. Cotton Crop Seed Meal' conducted in 2008 shows that there was an increase in liver weight, testicle weight, testicle fat and RBC in the blood and decrease in WBC in the blood in the lambs fed with Bt. cotton seed. Noting these findings, the parliamentary Committee on GM crops have recommended a professional evaluation of these developments, their possible causes and consequences by an expert committee (Committee on Agriculture 2012, Para No. 2.90 and 2.91 Pp.79-80).

The potential complications as a result of using two antibiotic-resistance genes (Kanamycin and Streptomycin) in developing Bt brinajl is another contentious issue in the consultations.

In this context, Seetharam (2010: 10) argues that drug resistance is a growing public health concern in India. Kanamycin is a second line anti TB drug and there are about over 10 million people affected with TB in India. The safety assessments done so far cannot exclude the possibility that humans may develop resistance to antibiotics, allergies or biochemical abnormalities due to the toxin. Therefore, the potential public health risk of emergence of antibiotic resistance has to be addressed in systematic way.

Given the various methods of cooking across the different parts of India, there was a demand for the human trails as in the case of medicines/drugs. Here, Seetharam (2010: 10) argues that except a test that demonstrates that the toxin is undetectable within one minute of cooking, there are no other tests that demonstrate the safety of Bt brinjal for human consumption. The cooking methods of India didn't have any standard operating procedures. It varies depending on the culture and the available types. Indian culinary with brinjal largely varies because of its diversified uses.

For example, in south India very commonly they cook brinjal with tamarind juice and fired with Seasame oil. But, the study carried out and submitted to GEAC was cooking with groundnut oil only. In this context, Alam (2011:107) point out that brinjal is often consumed only lightly cooked or raw in India and this increases the risk posed by poisons in the plant. It must be noted that Bt tomatoes and Bt cabbage (currently under development) would often be eaten raw

On the other hand, there are no provisions for monitoring the long term impact of GE foods on the human health. In this context, Byravan (2010:14) points out that in case of Bt brinjal, the basis of the decision making and most of the research was done on acute toxicity, not on chronic toxicity. Chronic toxicity is what impacts human health over long time.

Proponents of the GM crops drew the analogy between the genetic engineering applications in medicines to argue the safety of GM food. Yet others claim that if long-term health effects have not been seen in the United States (US), where GM food have been consumed unlabelled for over a decade, there would not be any adverse impacts. Similarly, proponents have extended same argument to the consumption of Bt cotton seed oil in India since 2002 in support of Bt brinjal. In this context, Byravan S (2010:14) argues that as GM foods are not labelled in North America, it is scientifically impossible to trace, let alone study, patterns of consumption and their impacts.

Therefore, claims that GM foods have safe for human health based on the experience of North American populations have no scientific basis. We have no idea what to look for and where to look for it. Similarly, at present, there is no labelling system in place for GM food in India. Several questions have been raised in this context: In case of any adverse health impacts are reported from eating Bt.brinjal, who would be liable to pay compensation? How would the liability be fixed and what would be the quantum? In the absence of any kind of preparedness or safeguards, what would be the liability of the government for approving such food crops?

The principle of 'Substantial equivalence' also contradicts the claim to novelty and invention through patents. The industry in order to avoid the risk assessment and issues of liability, put forward the argument tht GM food is substantially equivalent to non GM food. But, for the purpose of getting patents or intellectual property rights, they use the novelty argument for GM food.

In the light of above, the scientific justification for substantial equivalence has been questioned as it avoids a full safety assessment. In this context, Millstone *et al.,* (1999) argue that:

> *"Substantial equivalence is a pseudo-scientific concept because it is a commercial and political judgment masquerading as if it were scientific. It is, moreover, inherently anti-*

scientific because it was created primarily to provide an excuse for not requiring biochemical or toxicological tests."

The international protocols Codex Alimentarius principles and Cartagena Protocol in which India is a signatory, emphasizes the use of the *precautionary principle*. According to the Codex Guideline (Para 13), though the principle of 'substantial equivalence' plays an important role in safety assessment of the new product, it does not imply the absolute safety of the new product. The Codex includes an assessment of indirect effects of novel foods on human health and the environment (Codex Alimentarius Commission 2003); and the Cartagena Protocol recommends an inclusion of 'uncertain' effects (Cartagena Protocol on Biosafety 1992, Annex III).

The concept of substantial equivalence is considered by many participants to be an inadequate measure of bio-safety. Therefore, the consumer groups in the public consultations have demanded for long term biochemical or toxicological tests, inter-generational, reproductive studies and human trails as conducted in the case of medicines to assess the adverse health effects.

5.3.3. Impact of Traditional Medicine

Concerns were raised about the potential impacts of Bt brinjal on Indian system of medicine. The raw plant of the brinjal is widely used in traditional Indian medicine such as Ayurveda and Siddha traditions of Indian medicine. Dried raw brinjal is widely used in preparation of Dasamoola chooranam in Siddha and Dasamoola asava in Ayurveda. Further, Ayurveda practitioners point out that 14 varieties of brinjal, each differing in its medicinal properties, are used in medicinal preparations. There are several concerns that transgenic changes to the plant will alter the currently coded characteristics of these varieties (CEE 2010: 16). Such concerns also lead to questions regarding the threat to biodiversity posed by Bt brinjal (Alam 2011:107).

A network of around 100 doctors across the country have sent a representation to the then Minister for Environment and Forests (MoEF) wherein they have raised several concerns on the impact of Bt brinjal on the Indian system of medicine. According to them, brinjal is being used as a medicinal ingredient, both raw and cooked form, for the treatment of respiratory diseases in ayurveda, siddha, homeopathy and unani. As the entire brinjal plant is used in such preparations, they fear that Bt-brinjal will destroy these medicinal properties due to loss to synergy, differences in the alkaloids and changes in other active principles. In the opinion of this network of doctors, these factors have not been considered by EC-II (Ministerial Note, Para 20, MoEF 2010:13).

The Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH) is of the view that the chemical profile and bioactivity of genetically modified medicinal plants should be compared with the conventionally produced/cultivated medicinal plants to know the alteration in the medicinal values of these plants. Further, the Ministry of Environment and Forests refused to co-opt the representative of the Department of AYUSH on GEAC right away while approving Bt. brinjal for commercial release and also when several other crops having medicinal propriety are already being assessed/ approved by RCGM/GEAC (Committee on Agriculture 2012, Para: 6.149,6.150, 8.59, and 8.61; Pp:228-229 and 331-332)

5.3.4. Cultural and Religious Concerns

For consumers eating is not only to satisfy a physiological need, it is also a socio-cultural expression, which interacts with many other factors. As food is a cultural marker, the questions related to cultural specifications such as: what is permissible, what is prescribed, what is prohibited and so on plays an important role on the peoples' risk benefit perceptions in a particular socio-cultural context. According to Haribabu (2004), the interests of the consumer on

GM food crops in the Indian context, revolves around the health and safety of food, culturally mediated aesthetic considerations such as the size of the grain, shape of the grain, and colour of the grain, taste, and the meanings they attach to food and the wider environment. For example, a special preparation of *Malapur* brinjal varietyis an essential accompaniment at festivals, marriages, and other social functions in the Darwad region of Karnataka.

As part of a culture, comprising interrelated meanings, social groups in all civilizations attach a divine meaning to life. If life has some divine meaning, interfering in life processes through genetic engineering amounts to interfering in divine creation. Many people believe that the tinkering with nature will upset the natural order of things, unleashing unknown consequences. For example, *Matti gulla* is important in certain religious ceremonies in Karnataka. Every year a part of the first crop is offered to the Udupi Krishna temple (Raghuram 2010). In India the Sanskrit saying, *Annam parabrahma swaroopam* (food personifies the Creator) signifies a religious meaning of food (Haribabu 2004).

In Muslim societies, whether GMOs can be considered halal[21] or haram (not permissible) sets the tone of the debate on their acceptability (Safian and Hanani 2005). For example, in Malaysia, there is a *fatwa* (religious decree) that states that GM foods with DNA from pigs are *haram* (not permissible) for Muslims to eat (MABIC 2004).

With regard to Catholic Church, during 2004, the Pontifical Council for Justice and Peace released the Compendium of the Social Doctrine of the Church, which is an "overview of the fundamental framework of the doctrinal corpus of Catholic social teaching." Biotechnology is mentioned as having powerful social, economic, and political impact but that it should be used with prudence, objectivity, and responsibly (Vatican 2004). According to Scottish Anglican

[21]permissible from the shariah perspective (halal) and of good quality (tayyib)

church GM foods are morally disgusting, as they view moving genes across species that could never breed normally is ‘not natural’ and likened to ‘playing God’ (Paarlberg 2000; Shepherd, Manaras, and Sparks 2000). As one critic puts it, “when you start playing around with genes, you’re playing God” (Jukes 1988: 249).

When examining risk issues, according to Kaiser (2005), it may be important to know more than the frequency and probabilities of the impacts, is may also be necessary to judge what is considered an acceptable risk. Therefore, it is very important to carry out a detailed empirical study with different social groups including religious leaders to ascertain the social meanings of food and conflicting values and meanings in the Indian context. In this context, the extended peer community may be a useful exercise towards this end.

5.3.5. Rights Based Concerns: Consumer choice and Labelling

Labelling is a mechanism for communication of information to enable consumers to undertake an informed choice (Gath and Alvensleven 1998). According to international agreements such as the Cartagena Protocol on Bio-safety, labelling of GM foods is voluntary. Globally different countries follow voluntary or mandatory labelling system for products derived from GM crops.

There are two broad philosophical approaches to labelling; one viewpoint holds that individual autonomy and consent are the key ethical norms, while the utilitarian ethical theory stresses an ethic of rational optimization. Using Utilitarian approach, people argue that the complex labelling system would create confusion and lead consumers to make less rational choice than they would if no label were present. McHughen (2000) observes two main arguments against the labelling.The first is that labelling will incur production and distribution costs, which will eventually be borne by consumers. The second is that the labelling of GM foods may simply lead to misleading rather than truthful and accurate information.

On the other hand, the underlying issue from the perspective of autonomy and consumer consent is that people should not be placed in a position where they are unable to act on the basis of their basic values, preferences and worldviews. Marris *et al*. (2001) provided four arguments in favour of labelling. The first is information provision so that consumers can exercise their preferences. A second reason is so that claims (that the product is genetically modified or "GM-free"- to use such terms as *GM-free* or *non-GM*), when made, can be standardized. The third reason for labelling is to restore consumer confidence. Finally, the argument has been made that labelling will provide insights into the long term impacts of these foods. According to Moon and Balasubramanian (2004), the choices are consistent with their preferences. Beyond the health and nutrition, the labels will allow the concerned consumers to purchase products that conform to social values such as animal welfare ("Against Animal Testing" label) and fair labour practices (products with the 'Fair Trade' label, carpets claimed to be produced 'without child labour') or have been a tool for encouraging environmental stewardship (Mitchell 2000).

The important questions that have been raised by the consumer groups in the national consultations are: right to choose non Bt brinjal varieties in the market; Is Labelling possible in India?

The multinational seed companies always operate with the neo-liberal principles to homogenize and monopolize the markets with their products. For instance, more than 90% of the commercially grown cotton in India is planted with Bt cotton seeds. In this context, Purkayastha *et. al* (2010:45) argues that the problem is not with the GM technology *per se*, but with the ownership over the technology. Here, the important question is: Is it moral to take away the rights/freedom of the consumers to choose non- Bt or traditional brinjal varieties in the market?

The following two propositions clearly illustrate the concerns of the consumer groups in this regard.

> *"If Bt Brinjal infiltrates the market, significant sections of people, conscious of its hazards, may be forced to stop eating brinjals altogether. They would thus be deprived of a cheap and excellent source of vitamins, minerals and amide proteins." (Proposition No.237, CEE 2010:35).*
>
> *"While biotech industry insists on the Principle of Substantial Equivalence and thus Generally Regarded As Safe (GRAS) concept for GM foods a consumer cannot avoid Bt Brinjal unless he avoids brinjal altogether, and this violates his right to eat Brinjal" (Proposition No.263, CEE 2010:37)*

With regard to feasibility of implementing the labelling system in a country like India, (Alam 2011:107) argues that given the nature of agriculture practiced, socioeconomic status of farmers, mode of marketing fruits, vegetables and other agricultural produce in the country make labelling impractical. To implement the labelling mechanism successfully, it will have to be preceded by a system for segregation, traceability and Identity Preservation of GM crops. But, given the small size of holdings in India, it is unlikely that transgenic and non-transgenic varieties of crops can be kept separate at the cultivation stage itself.

On the other hand, labelling must be preceded by a public education exercise so that the label offers the opportunity for informed choice. The real choice is an informed choice. Without educating and creating awareness among the lay public labelling would be meaningless.

At present there is no check on GM processed food and other items coming from outside the Country or being produced here viz. cotton seed oil produced from Bt. cotton in the country.

During the last few years cultivation of transgenic cotton has increased manifold from 29000 hectares in 2002 to about 10 million hectares in the Country now. Today, more than 90% cotton cultivated in India is transgenic. The cotton seed oil production as per information supplied by

the industry sources to the Parliamentary Committee on GM crops, has also gone up from about 400000 metric tonne in 2002 to 1210000 metric tonne in 2011. (Committee on Agriculture 2012, Para 7.23, Pp:245). When these foods are put on the market without labelling, people who would like to avoid GM food cannot exercise their informed choice (Seetharam 2010:11). However, a clear labelling regime is under consideration by the Food Safety and Standards Authority of India (FSSAI), Ministry of Health and Family Welfare in India (GAIN report IN1044).

The important question in this context is that which of these two philosophical approaches (utilitarian or autonomy and consent) ought to have upper hand with respect to labelling and consumer choice. It is important for the individuals to have the choices that allow them to exercise their preferences, whatever might be their origin.

5.3.6. System's unpreparedness to monitor GM food in India

Another important issue is the systems unpreparedness. The department of consumer affairs which administers the Consumer Protection Act, 1986 and which intimately connected with issues concerning the consumer rights, informed consumer choice in the country is unprepared for handling GM foods (Committee on Agriculture 2012, Para No. 6.148, Pp:226).

On the other hand, the clear labelling regime of GM food, is under consideration and not yet finalised by the Food safety and Standards Authority of India(FSSAI), Ministry of Health and Family Welfare in India. And also, the FASSI is not suitably equipped with in terms of the infrastructure and human resources to monitor GM food (Committee on Agriculture 2012 Para Nos. 6.152 to 6.156, Pp; 231-235). Further, there is a virtual absence of post market surveillance system in India. Despite several gaps in preparedness, the GEAC has approved Mahyco's Bt brinjal for commercial production.

5.4. Summary

The findings of the study suggests that consumer benefits, food safety, unknown health risks (lack of long term chronic toxicity studies, lack of Inter-generation studies, use of antibiotic resistance markers and Animal morbidity and mortality, impact on medicinal plants), cultural, religious, moral /rights based concerns like consumer freedom/ choice are most salient to the risk benefit perceptions of the society at large in India. The analysis of the consumer concerns clearly shows that in addition to the health and environmental safety, factors like economic, cultural, religious, and moral aspects will also play an important role in influencing social acceptance of GM food in India. Therefore, in India consumers have adopted integrated or holistic view, rather than reductionist views, about acceptance of Bt brinjal. Several studies have highlighted the unpredictability in terms of health and environmental risks associated with the GM technology, especially when dealing with the organic world. There is no consensus among the scientific community about the health and environmental safety of the GM crops. On the other hand, long term environment impact assessment and chronic toxicology studies of the effects of GM crops have not even been attempted till now.

With regard to consumer choice, it is argued that a system of choice that constrained a person's ability to act on the basis of his/her preferences such as cultural, religious and moral beliefs would compromise the principle of autonomy. At present, there is no labelling mechanism in place for GM food (either processed in India or imported) in India thereby consumers' will not be able to act according to their preferences whatever their origin. Several questions have been raised in this context: When the government cannot implement the labelling mechanism, does the government have the right to introduce a new technology? Does this mean that the consumer's

right to informed choice about their food is about to be trashed? A law and a system for the labelling of GM food must precede the introduction of GM foods.

The Bt brinjal debate in India clearly shows that the society at large may not be ready to accept GM food crop if it does not share the basic value commitments it is based on. What would be the governance model in which the conflicting values and interests of different social groups are acknowledged while taking decisions on the GM crops? In this context, precautionary motivated alternative PNS approach is appropriate where the scientific uncertainties and conflicting values and interests are openly acknowledge in decision making on emerging technologies. The democratic norms and transparency are the guiding norms in this approach.

Chapter VI
Values Underlying Regulation of GM crops in India

6.1. Introduction

The analysis of the farmers' (Chapter 4) and consumers' (Chapter 5) concerns from the previous two chapters, clearly shows that Bt.Brinal has become the pivot around which a number of social, economic, cultural and moral concerns came to be voiced. In the light of the above risk benefit perceptions, interests groups have raised various questions on the nature of GE technology itself and the control over technology. Much of the controversy and public distrust associated with the commercialization of GM foods has been the result of regulatory bodies failing to take into account the concerns related to nature of the technology, control over technology and social concerns of the public.

In the present changed context of knowledge production in which science has become an intellectual property, what are the terms of contract between science and society? In this context, what is the governance model that can ensure participation of stakeholders with diverse interests and meanings in a country like India? Secondly, the problem with new technologies is that it is not possible to know in advance the full risks of such technologies especially when dealing with the organic world. But the existing probabilistic models of risk assessment are based on the assumption that all the uncertainties can be quantified, which has been proven to be false. Third important issue is that the dominant risk discourse reduces all questions concerning governance of novel technologies to questions of risk. It is based on assumption that technological fixes were the most appropriate and efficient solutions to societal problems which has been proved to be incorrect. As a result, this dominant risk discourse largely hindered real integration of the social, cultural, and moral aspects of new technologies. To put it differently: Is scientific risk

assessment alone sufficient for closing the public controversies around emerging technologies? In this context, what should be the alternative governance model in which the uncertainties are openly acknowledged while making decisions on emerging technologies? The thesis argues that there should be a shift in the regulatory paradigm from a government-centered model one to that of a governance-cantered one.

In the process of grappling with uncertainties and assumptions about risks and methodology of risk studies that are associated with normal science are not adequate and hence there is a need to shift to Post Normal Science (PNS) which addresses these issues by incorporating the contextual specificities. As discussed earlier, PNS approach is useful for better management of complex problems in the context of facts are uncertain, conflicting interests and values and decision are to be made urgently. This approach emphasises the need for 'Extended Peer community' in evaluating technologies and the decisions on technological choices by facilitating deliberation and participation of impacted parties. Therefore, drawing upon the PNS approach, the primary aim of this chapter is to analyse public's concerns on the existing regulatory mechanism of GM crops in India.

6.2. Regulation of GM crops in India

With the vision of development guided by the notions of technical progress and modernisation through the application of scientific knowledge, the government set out to write the institutional framework of biotechnology under its sixth five-year plan in the early 1980s. In this plan, an agency called the National Biotechnology Board (NBTB) under the Ministry of Science and Technology was constituted to identify the needs and priorities in biotechnology. The NBTB was upgraded in 1986 into a full-fledged Department of Biotechnology (DBT)

In India, the regulation of all activities related to GMOs and products derived from GMOs was initiated with the notification of Rules for the Manufacture/Use/Import/Export and Storage of Hazardous Microorganisms, Genetically Engineered Organisms or Cells, 1989 (commonly referred to as Rules, 1989) under the provisions of the Environment (Protection) Act, 1986 through the Ministry of Environment and Forests (MoEF). The Rules, 1989 which created six competent authorities, are primarily implemented by MoEF and the Department of Biotechnology (DBT), Ministry of Science and Technology. The competent authorities created under the Rules, 1989 are: the Recombinant DNA Advisory Committee (RDAC); the Review Committee on Genetic Manipulation (RCGM); the Genetic Engineering Approval Committee (GEAC); Institutional Biosafety Committees (IBSC); State Biosafety Coordination Committees (SBCC); District Level Committees (DLC).

The chain begins with the Institutional Bio-Safety Committee, which is established under the institution engaged in GMO research for oversight and to interface with Review Committee on Genetic Manipulation (RCGM). RCGM functions under the Department of Biotechnology and is mandated with the responsibility of monitoring and regulating safety related aspects of ongoing research projects and activities including small scale field trials. There is a recombinant DNA Advisory Committee (RDAC) which is of an advisory nature and which recommends suitable and appropriate safety regulations in recombinant research, use and applications from time to time.

The Genetic Engineering Appraisal Committee (GEAC) is the apex body to accord approval of activities involving large scale use of hazardous micro-organisms and recombinants in research and industrial production from an environmental angle. More importantly, it is also mandated with the authority for approving the release of genetically engineered organism and products into

the environment including experimental field trials. GEAC functions under the Ministry of Environment and Forests. Then there are State Biotechnology Coordination Committees (SBCCs) who are mandated with the power of State level monitoring. SBCCs also have powers to inspect, investigate and take punitive action in case of violations. The last tier of the regulatory mechanism are the District Level Committees (DLCs) who are tasked with the role of monitoring the safety regulations in installations engaged in the use of GMOs/hazardous microorganisms and their applications in the environment. Apart from these six Committees, the Committee note there is a Monitoring-cum-Evaluation Committee, which monitors the compliance of regulatory procedures during field trials of GM crops.

6.3. Concerns over the existing Approval and Regulatory mechanism

The concerns over the existing regulatory mechanism account for 28% (178 statements) of the total propositions in the consultation. Of the 178 propositions, 171 (96%) were made against the Bt-brinjal and remaining 7 (4%) statements were made in favour of the existing regulatory mechanism in India. The main concerns of the publics' are appended below in Table No.6.1

Table No.6.1 publics' perceptions on the existing regulatory mechanism on GM crops

	Sub Theme	**Number of Mentions**
	Lack of Independent testing mechanism for Biosafety	42
	No Transparency in regulatory process	22
	Conflict of Interest	9
	Lack of Trust in Risk Regulation	15
	Concerns over IPRs and PPP (public and Private partnership)	5
	Bio-Piracy	2
	Liability and Compensation mechanism in place/Responsibility	12
	Need for post Market surveillance	7
	Need public participation	18
	Upstream Public Debate on GM approach to Indian Agriculture	27
	Need Precautionary Approach	19

Source: Compiled from the CEE National consultation Report on Bt brinjal

6.3.1. Lack of Independent testing mechanism for Biosafety

One of the important reservations expressed against the functioning of the GEAC is its lack of independent testing mechanism in place for biosafety and risk assessment. In the case of Bt brinjal in India, the entire data presented before the GEAC comes from field trials conducted by Mahyco. Biosafety research and risk assessment face a number of obstacles and limitations to producing actual evidence regarding harm. The problematic result of these limitations is that they often lead to an outcome where the safety of GM crops is to be assumed from a lack of proof of harm to a proof of lack of harm. The following are the main concerns in this regard:

> *"Bt Brinjal cannot be accepted, without any independent testing, verification or long-term tests for health effects, on the principle of substantial equivalence when the company which owns the technology has been able to patent this very same Bt technology on the basis of substantial transformation and earns millions of dollars in patent or technology fees." (Proposition No.496, CEE 2010: 54)*

> *"There are serious inadequacies in the study design itself and all the studies claiming safety of the product have been either done or sponsored by the same company that is pushing the technology." (Proposition No.77, CEE 2010: 71)*

6.3.2. No Transparency in Regulatory Process

Another important aspect of the publics' concern is the transparency in the regulatory process. The regulatory regime should verify the information given by proponents through a public system of validating the data. Independent third party laboratories should validate the data.

> *"All regulatory data and bio-safety data should be available to the public." (Proposition No.35, CEE 2010:67)*

> *"One core issue is the competence, the transparency and the conflict of interest in the regulatory process prior to the grant of licence to market Bt Brinjal." (Proposition No.484, CEE 2010:54)*

6.3.3. Conflict of Interest

Conflict of Interest among the regulators is another important concern that was highlighted in consultation against the functioning of GEAC. The present GMO risk assessment procedures are dependent on information produced and owned by the very same companies whose products are being assessed.

> *"The so called "Expert Committee (EC II)" set up by the GEAC to conduct tests on Bt Brinjal has lost its credibility as many of the members are associated with the GM crop development company (Monsanto). How come we can rely on such a committee whose chairman now says, "We are not sure about the safety of Bt Brinjal"? Recently, the Chair of the EC II admitted in a media interview again that several tests on Bt Brinjal were not done and "without them, at this stage, we do not know whether Bt Brinjal is safe or not". (Proposition No.498, CEE 2010: 54)*

6.3.4. Lack of Trust in Risk Regulation

One of the sources of the lack of trust in risk regulation as cited by the participants was on the adequacy of existing regulatory mechanisms to ensure the safety of GM foods, especially when unpredictability/ uncertainty associated with GM crops. Another source of lack of trust as cited by the participants is the earlier spread of illegal/adulterated Bt cotton seeds in the market and the failure of the regulatory authorities in curtailing this spread. Here, Stone (2002) expressed that in Warangal in Andhra Pradesh, India the crops fail mostly due to spurious seeds, which are of inferior quality packed under a popular brand name. He feels that there is an urgent need for strict regulations at the point of seed sales.

> *"We doubt that the inquiry into the safety of Bt Brinjal is unbiased, rigorous and scientific." (Proposition No.486, CEE 2010:54)*

> *"India does not have regulatory systems in place to ensure that there will be no illegal, black market sale of seeds as was the case with Bt cotton" (Proposition No.466, CEE 2010:52)*

6.3.5. Bio-Piracy

Another source of concern in the consultation is plunder of the nation's rich agricultural biodiversity through bio piracy which highlights the loop holes in the existing regulation mechanism.

> *"There are chances of theft of the good traditional varieties which could not be patented as they are already in the public domain. They may be patented at a later stage by keeping their seeds in laboratories. There are also chances of transmigration of local species without our knowledge." (Proposition No.71, CEE 2010: 71)*

> *"No consent has been sought from the local biodiversity management committee (BMC), State Biodivesity boards and committees set up by village panchayats under the Biodiversity Act. These bodies have formed to conserve and promote sustainable use and equitable sharing of biodiversity" (Proposition No.16, CEE 2010: 66)*

6.3.6. Concerns over Public and Private Partnership (PPP)

There are several concerns on collaborative partnership between the transnational agriculture biotechnology R &D enterprises and public sector agriculture R&D organizations in the name of public private partnerships (PPPs). Several concerns have been raised about the challenges faced by the public sector institutions as a result of public private partnerships (PPPs). For instance Mahyco (a subsidiary of Monsanto) had entered MoU with two national universities in developing Bt brinjal in India. Several question have been raised on this PPP: on conditions of the MoU, information related funding sources, methodology of research, technology sharing, access to research material etc.

> *"The MoU between the public institutions that are to develop the Open Pollinated Varieties (OPVs) is not public, so the conditions under which the patents have been passed is unclear." (Proposition No.491, CEE 2010:54)*

> *"Scientists are unable to conduct independent research on GM crops as patents prevent full access to research materials and the ability to grow and study plants." (Proposition No.19, CEE 2010:66)*

6.3.7. NoLiability and Compensation mechanism in place

Owing to the unpredictable risks with the GM technology, there are several concerns seeking to place a liability regime and compensation mechanism before the introduction of GM food crop in India.

> *"After introduction of Bt Brinjal if anything goes wrong and farmers suffer due to that, will the government take responsibility and pay compensation?" (Proposition No.510, CEE 2010: 56)*
>
> *"From the health regulation point of view, who will take liability for eventualities such as adverse drug reactions occurring due to Bt consumption?" (Proposition No.516, CEE 2010: 56)*
>
> *"A law of liability must also be in place before commercial release is permitted so that companies are liable for health and environmental damage that might ensue." (Proposition No.36, CEE 2010: 67)*

6.3.8. No post-market surveillance System in Place

Several apprehensions have been expressed by the publics' on the need to place in Post Market Surveillance system to monitor the performance or any impact of the Bt brinjal.

> *"India completely lacks post-marketing surveillance and regulatory mechanisms. In such a scenario, how will we monitor any impacts of Bt Brinjal, once it is released in the open market and open environment?" (Proposition No.515, CEE 2010: 56)*
>
> *"A system of post-release monitoring must be put in place before commercial release is allowed into the environment to assess the performance and impact."(Proposition No.32, CEE 2010: 67)*

6.3.9. Need Precautionary Approach

As there is a lot of apprehension/uncertainty about the safety of Bt brinjal, the interest groups pleaded for the need of precautionary approach until appropriate regulatory mechanism in place. Interests groups have demanded for imposing moratorium on Bt brinjal.

"The complexity as well as inter-relatedness of species within ecosystems is such that the prediction of impacts from human interventions can not be made with certainty, nor can the time frame within which the impact will escalate be predicted. The precautionary principle is, therefore, paramount in giving clearance to any major or widespread intervention." (Proposition No.49, CEE 2010: 22)

"Absence of a regulatory framework and the protection of rights as well as the lack of biosafety measures in no way support the cultivation of Bt Brinjal in India." (Proposition No.507, CEE 2010: 55)

"India needs to follow a precautionary approach, examine all legislations and treaties (like Cartagena) before it approves Bt Brinjal." (Proposition No.483, CEE 2010: 53)

6.3.10. Need Public Participation

GMOs are not merely about inserting a gene into a plant it is much more fundamental decision about changing our way of farming, eating with far reaching implications for the economy, culture and polity. Therefore, several arguments were made for placing the institutional mechanism to engage the public and take the views of all the stakeholders into consideration before taking any decision.

"A risk benefit analysis of every transgenic crop should be conducted with public participation." (Proposition No.69, CEE 2010: 71)

"Biosafety tests should be done in a participatory way not depending on the data given by the companies. Civil societies and research institutes should be involved. And the results should be made accessible to all." (Proposition No.382, CEE 2010: 45)

"A system of public participation in decision- making and in regulatory bodies must be put in place." (Proposition No.34, CEE 2010: 67)

6.3.11. Upstream Public Debate on GM approach to Indian Agriculture

As GM crop issue does have great public policy significance, publics have pleaded for the upstream public engagement on the entire GM approach to Indian agriculture. The public seems to argue for a comprehensive socioeconomic needs assessment of particular new technology right in the beginning where several issue like relevance, alternatives etc., can be discussed. As the issue is not only limited to whether to accept or reject Bt Brinjal, but that the entire GM approach for agriculture must be justified. Some participants argue for a holistic, rather than a reductionist approach on GM crops. Few participants pointed out that scientific invention alone is not the basis for large scale application of a technology; it is for society to draw up their limits. The following are the propositions in this regard:

> *"The need for a particular new technology must be discussed right in the beginning when it is proposed by a promoter. If after thorough research, no traditional or alternate solution can be discovered, only then should permission for research be given to the promoter of the concept." (Proposition No.17, CEE 2010: 66)*
>
> *"The environmental risk, relevance of technology and socioeconomic impacts must be critically looked into prior to approval of commercialization of such crops." (Proposition No.22, CEE 2010: 67)*
>
> *"Brinjal cannot be looked at in isolation; this debate is relevant to all GMOs in agriculture. Talking only about brinjal while ignoring the rest is akin to debating whether to add another floor to a house that is built on a heap of sand." (Proposition No.479, CEE 2010:53)*

6.4. Discussion

The analysis shows that publics' have raised various questions on the flaws and shortcomings with existing regulatory mechanism for GM corps in India. Bt brinjal debate in India is a classic example where the government has realised that decisions on techno-scientific developments can no longer be made by a technocratic ideology. The publics have adopted integrated/holistic view rather than reductionist view about the safety and acceptance of GM food.

The analysis of the farmers' and consumers' concerns from the previous two chapters clearly shows that in the light of contested knowledge claims and intrinsic uncertainty surrounding biological processes, the interest groups have selectively adopted differing values and interests based on their broader economic, social, cultural and moral perspectives. For example, the promoters of the technology advocated the beneficial impacts of the technology whereas other interest groups claimed that application of same technology involves unacceptable risk to health or to the environment.

This has resulted in a broad range of conflicting views among various interest groups on risk perspectives and if and how GM crops should be regulated. Several scholars have highlighted implicit uncertainties associated with scientific and technological advances and the problematic nature of the authority of science as an effective way of closing down policy issues. In this context, facilitating deliberation and participation of parties whose socio-cultural and economic lives are going to be affected may contribute to a broader range of concerns being addressed in decision-making processes for better management of complex problems. The PNS approach foregrounds such a model.Post-Normal Science considers more explicitly the competing values and interests of different groups and also acknowledges the scientific uncertainties in decision making on technological choices.

It is evident from the analysis that the publics' lack of trust in regulatory/approval process due to a) Changed context of knowledge production: PPPs and Bio-piracy b) Lack of independent testing mechanism, transparency, conflict of interest c) Absence of Liability and post release monitoring mechanism- unpredictable risks and uncertainties d) Need precautionary and participatory approaches in decision making and, e) Systems unpreparedness to regulate GM corps in India. The following is the detailed discussion on the above aspects.

6.4.1. Lack of Trust in regulatory process

Science is an expert system that traditionally has sustained high levels of public trust. In this model, science is seen as providing objective, true and invariant knowledge and the members of the public are expected to have trust in science as it is a public good. In this model, the government and its agencies play an important role in deploying and regulating scientific and technological knowledge to solve problems in the real world. But, the belief that scientific knowledge is objective, true, invariant and infallible has been challenged by the new approaches in the post-Kuhnian social studies of science.

With the late lessons such as Chernobyl and Fukushima nuclear disasters coupled BSE controversy in UK are significant in that they opened up the regulatory apparatus to the "unaccustomed glare of the public arena" (Salter and Frewer 2002:137). Previous paternalistic strategies like Public Understanding of Science or deficit model to build trust have failed and hence a more open position and dialogue is essential.

The literature on scientific trust primarily focuses on trust in experts, organizations and institutions. This type of trust is called as social trust. According to Connor and Siegrist (2010), when knowledge about a certain technology is limited, consumers rely on social trust to assess risks and benefits of that technology. The missing information is replaced by trust in order to tolerate the perceived uncertainty of the situation (Frewer *et al.*, 2003). Siegrist, Cvetkovich and Roth (2000:354) defined social trust as "*the willingness to rely on those who have a responsibility for making decisions and taking actions related to the management of technology, the environment, medicine or other realms of public health and safety*".

In case of Bt brinjal, following are the sources of lack of trust in regulation of GM crops: a) PPPs and Bio-piracy, Bio-piracy: Changed context of knowledge production b) Lack of independent testing mechanism, transparency, conflict of interest c) Absence of Liability and post release monitoring mechanism- unpredictable risks and uncertainties and, d) Systems unpreparedness to regulate GM corps in India.

6.4.2. Public Private Partnership (PPPs) and Bio-piracy: Changed context of knowledge production

As discussed in the previous chapters, scientific knowledge has been undergoing a cultural transformation from a disinterested and morally neutral enterprise to an enterprise with commercial interests since the latter part of the 20th century. The IPRs regime of the WTO has made scientific knowledge which was hitherto a public resource into an intellectual property.

We have completely compromised public science in the name of Private-Public Partnerships (PPPs). Welsh and Glenna (2006) argues that university research on GM crops increasingly mirrors the research profile of industry, with public good being defined in a way that promotes university industry relationships (Glenna *et al.*, 2007).

According to Haribabu (2004), there are three main factors that have contributed to the entry of private corporate enterprises in agricultural biotechnology R&D in India: Firstly, the steady deterioration of government investments in public agricultural R&D institutions. Secondly, the entry of big pocketed seed companies both multinational and national to make highly focused investments with an eye on patents. Lastly, Indian government through liberalisation process has initiated industry pro-active polices to attract private investments in R&D in various sectors of production including higher education and research.

With the entry of private agribusiness players, Indian science supported by pubic has very little independence today. Often in the name confidential business information, the private seed industry keeps secrets about the terms of collaboration. The pertinent question in this context is: who sets the norms regarding division of labour, material sharing, research disclosure, and credit sharing? The agriculture is so important an issue that it cannot be left to the private industry alone. That is where the Government intervention is required. In the present context in which science has become an intellectual property, what are the terms of contract between science and society? How does science deal with the anxieties of the stake holders in this context?

With regard to bio piracy a case was reported during 2010 in connection with one particular case pertaining to alleged misappropriation of 12 varieties of local brinjal varieties by M/s Mahyco (a subsidiary of Monsanto) and others to create the Bt Brinjal without prior permission from the NBA, the state biodiversity boards and the local biodiversity management committees. This is the clear case of violation of section 3 of the National Biodiversity Act (NBA) 2002 which mandates that when biodiversity is to be accessed in any manner for commercial, research and other uses, local communities who have protected local varieties and cultivars for generations must be consulted and if they consent, benefits must accrue to them.

Though NBA has recommended action against the U.S. agri-business giant Monsanto and its Indian collaborators who developed Bt brinjal, but it took so long time (almost a year) to investigate this case. The parliamentary Committee has also questioned the violations in the legal clearance of the Bt Brinjal and the weakness of the existing clearance mechanisms for genetically modification of organisms. (Committee on Agriculture 2012, Para 7.75 and 7.76, Pp:280-281).

6.4.3. Lack of independent testing mechanism, transparency, conflict of interest

In the case of Bt brinjal, the GEAC's recommendation was based on the biosafety tests conducted solely on the basis of data from field trials conducted by Mahyco. According to Purkayastha *et al.* (2010: 46), the lack of capacity to perform independent testing will have larger implications on the human health and environment. In this context, Krimsky (2004) argues that lack of independence in testing sets up the situation of bias in the outcomes of studies as a result of the funding effect, where results tend to correlate with the wishes of the funder. The analysis of the scientific evidence clearly shows that there is debate among the scientists on the nature and number of tests that need to be carried out in establishing human and environmental safety. Therefore, keeping in view the importance of brinjal which is an almost daily consumption for majority of in India, the government should set up a testing mechanism of its own.

Lack of transparency in the regulatory process is another source of contention and public's distrust. In India, the judiciary's role can be seen as a parallel to regulatory process, one where citizens can directly appeal. The Minister has referred to the Public Interest Litigation (PIL) filed in Supreme Court during 2005, to uphold transparency and accountability in the functioning of the GEAC (Ministerial note, Para 24, MoEF 2010:15-16). Prior to making decisions, scientific data should be made available to the public, and they should be given the chance to submit responses to the data. Therefore, all the field tests and approval processes need to be done in an open and transparent manner and with accountability to the public.

On the question of conflict of interest, as discussed in the chapter 3, the nature and number of tests that have been conducted have been the major source of difference of opinion among scientists. In this context, Millstone (2007) observes that scientists play a central role as advisors for policymakers in the introduction of technologies. They are the ones who develop innovations

on the basis of their inventions and often the ones who are called upon as experts to evaluate safety aspects. Unlike USA and EU, in India, the Department of Biotechnology (DBT) keeps control of all the GM crop applications from the R&D stage, rather than evaluating the product once they are ready to be marketed.

Parliamentary committee on GM crops has also pointed out at the conflicting role of DBT which acts as both promoter and regulator. DBT mandated with the promotion of biotechnology in the country, funds research projects on GMOs both in public and also private sector companies. On the other hand, DBT also regulates the transgenic products created through these projects through its adjunct Review Committee on Genetic Modification (RCGM). Further, the final approval for environmental/commercial release of GMOs is granted by GEAC which is co-chaired by a DBT nominee. Thus, DBT acts as both promoter and regulator of GM crops in India (Committee on Agriculture 2012, Para 8.119, Pp:373).

Several questions have been raised on the objectivity of the approval process of the Expert Committee-II in the light of the following facts[22] a) indication of external pressure on the Chairperson and members of GEAC; b) some sitting members have vigilance cases against them; c) some members have been part of the development process of Bt brinjal/associated with the consortium of developers, hence direct conflict of interest; and d) Some members happened to be reviewing their own institutions' data for approval.

Therefore, in addition to the regulatory regime working independently, it is crucial that the regulators themselves are independent to provide concrete answers for the purpose of public policy on emerging technologies.

[22] http://www.indiagminfo.org/ Retrieved on 12 August 2013

6.4.4. Absence of Liability and post release monitoring mechanism- unpredictable risks and uncertainties

As discussed earlier there is no consensus among the scientific community on the safety of the GM crops. Many studies have raised concerns regarding the unpredictability of modern biotechnology especially when dealing with the highly complex organic world (Le Curieux-Belfond *et al*., 2009; Andow and Zwahlen 2006; Weaver and Morris 2005). In the light of contested knowledge claims the publics' have lot of apprehension about the safety of the technology. On the other hand, GEAC has cleared Bt brinjal for commercial release without resolving liability issue.

The important questions that have been raised in this context are: In the absence of such liability system who would compensate poor farmers and consumers in the eventuality of crop loss and harm to bio-diversity health, environment, etc.? In the event of contamination, what is the notion of corporate liability? We have placed laws for Intellectual Property but there seem to be no laws for corporate violations of nature. One of the participants in the consultation argued in the following way:

> *"India has proven time and again its inability to pin liability on these transnational entities when things go wrong, tragically so, as in case of Bhopal. So, looking at the past experience, we will have no recourse when things go wrong, which they will, considering the lax regulatory process. With no liability and redressed system we have no right to contaminate our food with an alien gene and irreversibly threaten our biodiversity."(Proposition No.70, CEE 2010:71)*

With regard to post market surveillance, Amanor-Boadu (2004) argues that post-market surveillance system would assist policy-makers to capture information about both benefits as well as long term adverse effects on human health and environment.

The Parliamentary Committee on GM crops has also pointed out the lack of post market surveillance in India by referring to one particular example of as to how lacs of tons of Bt. cotton seed oil having gone into the food chain during last ten years without anybody in the government being aware of or concerned about it (Parliamentary Committee Report on GM crops, Para 8.122)

India is signatory to the Cartagena protocol which refer to uncertain effects of GMO on human health and environment in the risk assessment process. Therefore, as demanded by the stakeholders in the consultations, there is need to put post market surveillance mechanism in place to ascertain the both immediate but also delayed effects associated with the release of GMOs. Similarly, there is a need to place in liability, redressal and remediation regime before releasing the GMOs into the environment.

6.4.5. System's unpreparedness to regulate GM corps in India

The Parliamentary Committee on agriculture identified various flaws and shortcomings in the functioning of the regulatory mechanism meant for the purpose. The committee has observed that there is a lack of preparedness/ noncompliance with the mandate nature of various agencies who should ideally be involved at various levels of oversight and both, pre and post commercialization surveillance responsibilities in the context of transgenic crops like National Biodiversity Authority, Protection of Plant Varieties and Farmers' Right Authority, Food Safety and Standards Authority of India, etc., In the light of the flaws with the existing regulatory mechanism and also the still unclear ramifications of transgenic crops on bio-diversity, environment, human and livestock health and sustainability, the committee recommended that : till all the concerns voiced in their Report are fully addressed and decisive action is taken by the

Government with utmost promptitude, to put in place all regulatory, monitoring, oversight, surveillance and other structures, further research and development on transgenics in agricultural crops should only be done in strict containment and field trials under any garb should be discontinued forthwith. (Committee on Agriculture 2012, Para Nos.8.116, 8.121 and 8.125, Pp:370, 375 and 377).

6.4.6. Need for precautionary and participatory approaches

In the light of the conflicting knowledge claims (uncertain facts), conflicting interest and values (analysis from the Chapter 4 and Chapter 5) and system's unpreparedness to regulate and monitor GM crops in India, the public have demanded for precautionary and participatory approaches in decision making. Further, the decision making on Bt brinjal has implications for other GM crops which are under regulatory pipeline. At present there are many food/ non-food GM crops under regulatory pipeline at various stages. According to one estimate, of the 91 applications for field trials before the GEAC, 44 are GM food crops (GAIN IN 3083). Given the great public policy ramifications of the GM crops on the human health, environment, economic, social, cultural and moral spheres different social groups, the public have demanded for upstream public engagement and nationwide public debate on the entire GM approach to the Indian agriculture.

As mentioned earlier, in the present changed context of knowledge production, unpredictability with modern biotechnology and conflicting values and interest among the various social groups, there is need for alternative broad based governance model. In this context, the thesis argues for a shift in the regulatory paradigm from a government-centred model one to that of a governance-centred one.

6.5. 'Government' to 'Governance': PNS as an Alternative Approach

As discussed above and in the previous chapters there are various lacunas and shortcomings with the existing regulatory mechanism of GM crops in India. Public engagement is becoming a more and more important keyword both in the academic as well as in the policy realm in conceptualizing the relation between science, society and politics (Fochler Maximilian 2007). To describe these changes, Irwin (2006) has coined the term 'new scientific governance', to highlight that what is at stake in these developments and of how science is governed in society. Jordan, Wurzel and Zito (2005:492) argues that while the terms 'governance' and 'government' have for a long time been used synonymously in everyday as well as scientific usage, the recent discourse about governance situates both terms at opposing extremes, as two *"heuristic poles on a continuum of different governing types"*. According to Rhodes (1996) the term 'Government' is used to denote a traditional mode of ordering society, where power rests in the hands of formal public institutions and the state. In this mode, steering is accomplished through centralized means of exercising power, such as laws and regulations.

The framing of policy issues and the processes of regulation and implementation are centralized in this model of ordering society. 'Governance' describes a change in the meaning of government. According to Rose (1999:16–17) 'Governance' can be taken to imply that the development and control of science and technology is not simply a matter for government or 'the state'. Instead it is necessary to include a much wider range of actors—including industry, scientific organizations, public and pressure groups, consumers, and the market. The term 'governance' refers to new constellations of power that go beyond the structures, rules and processes of classical government. According to Borchelt and Hudson (2008), public

engagements in science will "*focuses on regular dialogue (two-way, symmetrical communications), transparency of the decision and policy-making process, and meaningful incorporation of public input into that process.*" The Participatory design should acknowledge that science and innovation are social, cultural and institutional activities.

In this context, Wilsdon (2005) argues that the preference for the term public engagement is related to the emergence of the concept of 'upstream engagement', which refers to both a need to generate early interest, and a more inclusive form of participation. Similarly, Zavestoski *et al.*, (2002) and Rowe *et al.*, (2005) argue that Upstream public engagement is seen as an opportunity for social values to be disclosed, debated and consciously incorporated into technological development before particular trajectories and attitudes become set. Early public engagement is therefore thought to enable a more reflexive and socially robust techno-scientific development

The challenge in the present day context is that the decisions are to be made on the technological choices in the face of uncertainty and conflicting values and interests. Scientific uncertainties have traditionally been conceived as and handled purely quantitatively. The predictive methods i.e. risk assessment, cost-benefit analysis, climate modelling and so on developed by the national governments have been proved to be inadequate d to effectively address the scientific controversies like nuclear disasters, BSE in U.K and resulted in increasing attention to the existence of uncertainties in policy relevant science (Jasanoff 2003 ; Funtowitcz and Ravetz 1993). In this context, the thesis as mentioned earlier, argues that the more participatory and contextualizing approach of post normal science, strengthened by the precautionary principle is a viable strategy when dealing with organic/biological world.

According to Funtowics and Ravetz (1992), problems that require that use of post normal science are ones where “facts are uncertain, values in dispute, stakes high, and decisions urgent”. As a strategy, post normal science requires the formation of an “Extended Peer Community” (EPC) in which a discourse occurs among all stakeholders affected by a problem. In such a participatory arena, science is but one of many sources of evidence, which together informs policy decisions made by the extended peer community. The EPC is a useful model to assess both scientific quality as well as social robustness of the knowledge production.

One of the important criticisms laid against the PNS approach is that it failed to address the issue of politics around public participation. Several questions have been raised as to how PNS can be done, who participates in the Extended Peer Community and how to manage interaction between scientists and non-scientists (Anna Wesselink and Rob Hoppe 2011; Yearley, S. 2000; Van der Sluijs *et al.*, 2005).

To extend PNS as a theory, they suggest that it is important to examine the politics of PNS more closely. According to Delgado *et al.*, (2010) the idea of public participation is also contested, and can easily be misused for instrumental purposes. The important questions raised in this context are: why these processes should be carried out? , who to involve? how to initiate them?, when is the right time to conduct them?, and where they should be generated and carried out?

The standardized way of employing one design, for example, the consensus conference without hardly any consideration of the concrete national or technoscientific context will not yield good results. In a recent reflexive contribution to social science methodology, science studies scholar Law (2004) a Science Studies scholar concludes that the choice and enactment of method always also is a political issue. Studies of the public perception of technologies however, indicate that the political issues may be assessed quite differently depending on the technology.

In the Indian context, there is no political practice of engaging public in decision making on technological choice. The public consultations on Bt brinjal is first of its kind on any technology. The process of consultations has truly been a landmark as a process in democratic and transparent decision making. Thus, the government has set a precedent or institutional mechanism in place for the regulatory approvals on the emerging technologies which have potential to impact public health and environmental risks. This is timely move that Government of India is upholding the importance of science, transparency and public participation in its decision making. The questions of why, who, How, when, where of the public engagement need to be debated at the national level involving all the relevant stakeholders to evolve an institutional mechanism for the purpose of public engagement.

6.6. Summary

In this chapter an attempt has been made to examine the dynamic relations between science and technology on the one hand and the issue of regulation of risks arising out of the nature of knowledge produced and consequences of the application of such knowledge for human populations and environment.

In the context of the shift in the paradigm of 'world-in-itself' to that of the 'world-for-itself' the classical ‘government’ model of regulation is not appropriate, especially in the context of science and technology that seeks to transform the organic world, which is deeply embedded in the interests and meaning structures of different cultures. This transformation is fraught with uncertainties and risks for humans and environment. There is a need to move towards a model of regulation based on governance. In the process of grappling with uncertainties and risks assumptions about risks and methodology of risk studies that are associated with normal science are not adequate and hence there is a need to shift to post normal science which addresses these issues by incorporating the contextual specificities. However, the post normal science paradigm

has yet to articulate its theory of science and society fully in contemporary times and evolve a model of governance that is robust and addresses the specificities of different contexts. Maintaining plurality in perspectives and policy options may strengthen our ability to adopt to changing and uncertain future conditions, and ultimately lead to the identification of more sustainable pathways.

Chapter VII

Summary of findings and Conclusion

Biotechnology as a sector has crosscutting and complex impacts on various aspects of life and livelihoods in this large and diverse country where a majority of the population engaged in agriculture. The technology has many implications for the country's biodiversity, public health, and certainly on the economy. Further, applications of Agricultural Biotechnology in India have proved contentious with the debate spanning a wide range of economic, social, cultural and ethical issues in addition to the scientific ones. On 9 February 2010, following the public consultations, the then Minister for Environment and Forests (MoEF) Mr. Jairam Ramesh imposed a moratorium on the environmental/commercial release of Bt brinjal by invoking *precautionary principle*. This has been the first ever case in the Indian history where a series of public consultations were held and all the apprehensions of the public were given a patient hearing before taking a final decision on any technology. The national consultations on Bt. Brinjal in India can be seen in the light of the fact that the controversies around modern biotechnology cannot be resolved purely based on scientific risk assessment. Drawing upon the insights of Post-Normal Science (PNS) framework, the main thrust of the thesis has been an ex-post-facto analysis of the considerations employed for Minister’s moratorium decision on Bt brinjal in the Indian context.

The thesis has been organised into seven chapters including introduction and conclusion. The first chapter introduced various facets of the thesis attempting to capture the Post Normal Science perspective, rationale for the topic, research questions, objectives of the study, argument of the thesis, methods of analysis, structure of the study, and so on. In the second chapter a brief account of trajectory from green revolution to gene revolution, lessons learnt from Bt cotton

experience, and socio, cultural and religious and economic importance of Brinjal in India was presented. This chapter emphasises the need for the social embedded analyse of the technology before taking any decision. The third chapter is an appraisal and analysis of the various strands of evidences that have gone into the Minster's moratorium decision on commercial release of Bt brinjal. There were three main evidences namely scientific evidence, views from the state governments, and outcome of the public consultations.

In the face of conflicting knowledge claims, risks and uncertainties, various social actors tend to frame the controversies, depending on their respective values and interests. To arrive at the heart of what is at stake, as argued by Maeseele (2011), these controversies on emerging technologies should be approached from an identification of the competing values and interests at work, instead of starting from an unproblematized 'scientific consensus'. On the other hand, food safety is not purely a scientific concept to be defined and controlled exclusively by food scientists or scientific risk assessment. Food choices are framed by cultural, social, and material circumstances (Draper and Green 2002). Therefore, when examining risks, it is important to judge what is considered as acceptable risk beyond the frequency and probabilities of the impacts. The reductionist approach adopted by the dominant risk discourse reduces all questions concerning governance of emerging technologies to questions of risk. In this context, drawing on the data from the public consultations, a detailed analysis of the farmers' and consumers' concerns on Bt brinjal was presented in fourth and fifth chaptersrespectively.

Modern Biotechnology seeks to transform the organic world, which is deeply embedded in the interests and meaning structures of different social groups. This transformation is fraught with uncertainties and risks for humans and environment. In this context, public have raised various questions on the lacunae in the existing regulatory and approval mechanism of GM crops. In this

context, the sixth chapter presents an analysis of public concerns on the existing regulatory and approval mechanism of GM crops in India. This chapter argues for the shift in the regulatory paradigm from a government-centred model one to that of a governance-centred one in line with the Post Normal Science (PNS) approach which addresses the issues of scientific uncertainty and conflicting values and interests of different interest groups by incorporating the contextual specificities. The present chapter (seventh) is the summary of the findings of the study and concluding remarks

The following are the three main objectives of the thesis a) to understand various strands of evidence that have gone into government's moratorium decision on commercial release of Bt brinjal; b) to understand the concerns arising out of their interests and meanings articulated by farmers and consumer groups on Bt brinjal in public consultations; and c) to understand and analyse the publics' concerns on the existing regulatory and approval process of GM crops in India.

As discussed earlier, as a theory the Post Normal Science (PNS) theory links epistemology and governance and this framework is applied in the context of policy relevant science which typically deals with post normal problems where 'facts are uncertain, values in dispute, stakes high, and decisions urgent' (Funtowicz and Ravetz 1990).

Facts are Uncertain

The findings of the study indicate that according to the stakeholders, the facts produced by industry and regulatory body are not infallible. There are conflicting knowledge claims and there is no consensus on the consequences for health and environmental safety of the Bt brinjal among the scientific community. On the one hand, many scientists have raised concerns on the inherent

unpredictability with the GM technology especially when dealing with the organic world. Lack of transparency and conflict of interest were the other issues highlighted in this regard. Similarly, the analysis of the views of the state governments on the environmental release of Bt brinjal clearly shows that all the major brinjal growing states have expressed their concerns. The West Bengal, Orissa,Bihar, Andhra Pradesh states account for 30%, 20%, 11%, 6% of the total brinjal production in India. More than ten states including the above major brinjal growing states expressed their apprehensions on Bt-brinjal on various grounds including uncertainties associated with knowledge claims and have called for extreme caution. Hence questions were raised by consumers and society at large on the health and environmental safety of the Bt brinjal.

Values in dispute

The findings clearly indicate that the values of farmers and consumers on the one hand and those of the industry and regulatory bodies on the other are in conflict. For the biotechnology industry, life forms or parts of life, such as the seed (whether it is a Hybrid or GM) constitute physical means of production. Similarly, scientists tend to view the shift in the understanding life processes from phenotypic level to molecular level a gradual improvement over earlier understanding and does not constitute a paradigm shift. The farming community and civil society may argue that the genetically modified seed is a new concept and that is going to order agriculture in a qualitatively different way. It will have impact on their interests and change the meaning of agriculture. The new concept will destabilize the earlier meanings of agriculture and associated practices, environment and food. For farmers, consumers and society at large life forms carry religious and aesthetic meanings. Social groups attach a divine meaning to life and hence, any interference in life processes through genetic engineering amounts to interfering in divine creation. Further, it is a common feature of all cultures to attach meanings to what is

consumed as food. As a corollary, the important questions like: "Is it right to promote a technology which compromise the publics' cultural and ceremonial values?".

Stakes of the Different Stakeholders are high

The development of genetic engineering technology closely related to the stakes/ interests of several social groups such as industry, scientists and technologists, government, farming communities, and consumers. Stakes of the industry which invested its economic resources in developing Bt. Brinjal would like to sell the product to as many farmers as possible and in as many countries as possible with the motive of making profit. Making reasonable rate of profit is not disputed. However, making profit unscrupulously is immoral. The industry should establish the principle of transparency in its governance as it is acceptable to its shareholders and users of its product and the public at large. Historically, farming communities had the customary right to save the seed for the next season and also to exchange seeds. For the farmers the seed is both a material and a cultural resource that symbolizes food security. The Government of India enacted the Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act, 2001[23] adopting a *sui generis* system. It will establish intellectual property rights of farmers on their varieties and safeguard their varieties from piracy. But the industry which was unhappy on the PPV&FR Act, influenced the Government of India to go for the membership of The International Union for the Protection of New Varieties of Plants for UPOV membership, a move that would seriously undermine Farmers Rights. The UPOV system grants one right that is the breeders' right. There is no farmers' right in UPOV. It sought to undermine the comprehensive rights granted to

[23] http://agricoop.nic.in/PPV&FR%20Act,%202001.pdf retrieved on 24 September, 2013

farmers. Similarly, the genetically modified seed, which is a proprietary product protected by the patent law, will undermine the customary material and cultural right.

Any questions that we raise about safety and potential risk in the Indian context will have to be from the perspective of Indian cropping environment and resource-endowments of the highly differentiated peasantry in terms of size of land holdings, access to resources including reliable and complete information about technology. Therefore, the analysis of the concerns of the farmers' group shows that economic benefits and risks, ownership over technology, affordability, marketability, right to choose, plurality of knowledge systems, sustainability and compatibility of the technology, relevance, food security, unpredictability/unknown risks and health safety are the most salient to the perceptions of the farmer in India. As a corollary, the following are the important questions raised by the farmers group in the consultations: How objective is an evaluation, how safe is safe enough? Who owns the technology? Is technology affordable? Can private science work for public benefit? What is the need, relevance, and who decides? Is the technology sustainable? Is it possible to grow refugia in India given they own small size of land holdings? Is it possible to introduce co-existence (growing Bt and Non Bt crops in close vicinity) measures in India? What is the fate of the non-Bt and organic growers, if their crop gets contaminated with Bt gene, who takes liability for the damages? Without co-existence measures, what will be the impact of the effects contamination/gene flow on environment, Biodiversity in general and brinjal diversity in particular? Is it moral to take away farmers' right to choose non Bt seeds? Is it possible to implement traceability, segregation measures in India? If not, what is impact on marketability in domestic market or on exports of brinjal or exports of other vegetables?

The analysis of the consumer concerns indicates risk benefit perceptions of the consumers' are driven by following aspects: Price benefits, food safety, Health risks (lack of long term allergencity chronic toxicity studies, lack of Inter-generation studies, use of antibiotic resistance markers and chemical like glyphosate and Animal morbidity and mortality, Impact on medicinal plants), unpredictability and unknown health risks, cultural, religious, moral concerns, freedom of choice, and so on. As a corollary, the following are the important questions raised by the consumers group in the consultations: In case of any adverse health impacts are reported from eating Bt.brinjal, who would be liable to pay compensation? How would the liability be fixed and what would be the quantum? How will GM food be labelled in a country where food grains and vegetables are sold in weekly markets and individual street vendors? When the government cannot implement the labelling mechanism, does the Government have the authority to introduce a new technology? Is it moral to take away consumers' right to choose non-Bt varieties? Is substantial equivalence an adequate measure of bio-safety? In the absence of any kind of preparedness or safeguards, what would be the liability of the government for approving such food crops?

In terms of environment, what are the consequences of gene flow from Bt fields to non-Bt fields? Who will pay the compensation for Environmental losses? Therefore, the cost benefit analysis, which is generally concerned with economic benefits and costs, now has to reckon with social and environmental costs as well.

The analysis of the concerns and questions raised by the social groups clearly indicates that the Bt brinjal debate in India not only originate from risk in scientific understanding, but rather from a wide ranging concerns such as economic, social, religious, political, moral and environmental considerations. In other words, the publics' have adopted holistic approach to risk. But, from the

beginning, the regulatory bodies such as the GEAC has been trying to frame the Bt brinjal debate in such way that it can be solved only through the science based risk assessment. As a result, the approval processes are heavily hinged on the risk science based on probability models despite the fact that civil society actors have time and again questioned this narrow mandate of the GEAC (Shah 2011: 31). If we closely observe the approval process of the Bt-brinjal, whenever the civil society organisations express their concerns on the tests conducted and various other aspects, the GEAC constitutes an Expert Committee with scientists treating all the concerns of the public as concerns of risk and safety.

Decision making on Bt Brinjal is Urgent

The decision making on the Bt brinjal is particularly important as several private seed companies and public sector research institutions are working on the development of various genetically engineered (GE) food crops. According to Global Agriculture Information Network (GAIN) report IN 3083, out of 91 applications for field trial before the Genetic Engineering Appraisal Committee (GEAC), 44 are GM food crops. There is pressure from industry that developed Bt Brinjal and other proponents of genetic modification of food including scientists to see that Bt brinjal is approved for commercial release at the earliest. The other stakeholders who either oppose or those who insist on the need more independent tests to ensure safety demand that the decision be announced for not approving for commercial introduction. In this context, the question of how to regulate GM crops in India becomes prominent.

With regard to regulation and approval, the following are the main public concerns on the existing regulatory mechanism of GM crops in India: Lack of Independent testing mechanism for Biosafety, lack of transparency, Conflict of Interest, absence of post release surveillance, absence

of Liability and Compensation mechanism, concerns over IPRs and PPP, Bio-Piracy, absence of long term environmental impact and chronic toxicology studies. On the other hand, serious concerns have been raised on the systems unpreparedness to regulate the GM crops. The parliamentary committee on GM crops has also highlighted the systems unpreparedness/ virtual non-existent nature of various agencies who should ideally be involved in various oversight in both, pre and post commercialization surveillance responsibilities in the context of transgenic crops like National Biodiversity Authority (NBA), Protection of Plant Varieties and Farmers' Right Authority (PPV&FRA), Food Safety and Standards Authority of India (FSSAI), Department of Consumer Affairs (DCA) etc.

The important question raised here is that : Is it right to release the GM corps when various players in the system of governance, who have some role or the other in the regulation, management, handling, oversight, distribution, consumer affairs, human health, livestock health, etc. are unprepared to shoulder the responsibility of ensuring that any potential harm or damages are eliminated ? In the light of the above, the public have expressed their lack of trust in the existing regulatory mechanism and demanded for precautionary approach and upstream public engagement prior to the approval of GM crops. They have also demanded for the initiation of nationwide public debate on not only Bt brinal but also on the entire GM approach to Indian Agriculture.

Therefore, failing to adequately deal with uncertainties, conflicting values and interests undermines the quality of the knowledge and consequently the quality of the decisions in policy relevant science. Under the above conditions, Article 15 of the Cartagena Protocol on Biosafety to which India is signatory would call for implementation of the precautionary principle to protect the environment and human health. The precautionary principle that "one should not

undertake activities about which there is scientific uncertainty about their impact" should guide the discourse on safety of genetic engineering (Haribabu 2004). Such precautionary research is emphasised by post-normal science**.** Here, PNS as an alternative approach advocates that, the decision making under the above conditions should not be restricted to scientists only, but should also involve impacted parties and the general public, through 'extended peer review' (Funtowicz and Ravetz 1990, 1993). This requires new interdisciplinary contacts and integration (internal extension of the peer community) on one hand, and new knowledge partnerships with policy makers, NGOs, industry, media, and the public (external extension of the peer community) on the other hand, to meet the challenges of quality control in the assessment of complex risks (Funtowicz 2006).

There have been many ways as a response to the new challenge some form of the extended peer community is being organised in different countries namely 'focus groups', 'citizen juries' 'consensus conferences' 'public consultations' and so on with some degree of legitimacy to encourage dialogue. Here the idea is to treat all the stakeholders either the counter-experts or lay publics, as potential peers, sharing the definition and management of a problem so as to mobilise resources of local knowledge and understanding which complement the generalized knowledge of scientific experts. There is no standardized approach to doing Extended Peer Community (EPC) and this will be very different for varying issues. Therefore, no single template will improve democratic accountability in diverse settings and contexts. In India, except the public hearing in Environmental Impact Assessment (EIA) of development projects, there is no political tradition of public engagement in decisions related to technological choices. In the case of Bt brinjal in India, public consultation mode of Extended Peer Community (EPC) was adopted, in which all the publics' irrespective of whether they have stakes or not were invited to participate.

The Minister personally sat through the entire process of seven consultations. Thus, by holding public consultation prior to the decision on Bt brinjal, the Minister adhered to Principle 10 of the Cartagena Protocol on Biosafety to which India is a signatory.

According to Nupur Chowdhury *et.al,* (2010:18) the process of arriving at the decision to call for national consultations was unprecedented in two ways, First, that decisions on emerging technologies that bear an environmental and health risks, should not only be based on scientific risk assessment but also should undergo a process of public engagement in order to gauge the social acceptance of that technology. Second, that the scientific assessment report of expert committees on such technologies should be made public and comments invited on the report prior to a decision being taken. The decision, therefore, seems to establish two critical parameters – social engagement and transparency in environmental regulation and has been lauded as a wise decision by a number of experts in India (Press Trust of India 2010).

The consultations have certainly enriched and democratised the process and has been useful for airing multiplicity of situated positions which exist in society. Maasen and Weingart (2005: 4 &10) refer to public participation in technical decision making as the 'democratisation of expertise' and argue that it allows societies to address the lack of public trust and the empowerment of citizens. Visvanathan, S. (2014) views that the public consultation on the Bt-brinjal in India actually strengthened the democratic process. Thus, the Minister has set a precedent or pioneered an institutional mechanism in place for the regulatory approvals on the emerging technologies which have potential to impact public health and environmental risks. This is a timely move that the Government of India upholding the importance of science, transparency and public participation in its decision-making process regarding the technological choices.

Therefore, formulation of regulatory policies and implementation strategies have to be evolved by eliciting a broad-based participation of stakeholders- scientists, technologists, social scientists, farmers, industry and civil society organizations. As discussed earlier, judgments on the acceptable level of risk are never purely scientific when the weighing of incommensurable costs and benefits involves trade-offs among diverse values (Barbour 1980:175).

Technology development should be on the basis of an understanding of the needs of the peasantry and consumers based on the relevance, sustainability and plurality. The stakeholders should be involved right from the beginning of the design of technologies rather than participating in the use of technology developed by others. In this context, Shah (2011) argues that the debate needs to broaden its frame from science-based assessment of consequences to evaluating society-oriented causes and objectives. Hence, instead of promoting GM crops as a technical fix to complex agronomic and socio-economic problems, a detailed broad based needs assessment study in the Indian context is warranted in the light of socio-economic and environmental consequences of Green revolution and Bt cotton adoption. Article 26 of the Cartagena Protocol on Biosafety (CPB) emphasises the need to understand socio economic considerations (SECs) in the context of handling Living Modified Organisms (LMOs) and their importance within the broad policy framework. It has been pointed out that Article 26 is perhaps one of the most significant aspects of the protocol from the perspective of developing countries (Chaturvedi *et al* 2007). Here, the scope of socio economic analysis of new technologies should not be based only on a narrow utilitarian analysis focusing on the average profitability of farm but extend to ones considering a wider variety of human values and concerns. Here, the issue is not only limited to whether to accept or reject Bt brinjal, but the entire GM approach to Indian agriculture must be debated. It should not be accepted just because Bt gene is available for

licensing. It amounts to promoting supply driven innovation rather than demand driven innovation. A thorough Needs Assessment must constitute the first step. Which trait in a crop does the transgenic crop attempt to address? Are there alternative approaches? Has the conventional breeding failed to solve the problem? What are the apprehensions on Bt Binjal hybrids? And how to go ahead with Bt food crops? Who decides on this solution, how was it arrived at? Who does it benefit? The whole decision regarding GM crops and Bt birnjal was based on a reductionist view of science being the solution to higher productivity. The decision on whether we need GM crops at all should be debated at a much broader and wider level through upstream public engagement. The scope of socio economic analysis of new technologies which is generally based on a narrow utilitarian cost-benefit analysis now has to reckon with social, environmental costs and wider variety of human values and concerns. There are other countries like Norway which ask pertinent questions that go beyond biosafety like, 'is this socially and ethically justifiable?' as the regulators look at impact assessment of GM crops. In order to answer such questions, there is a need to adopt widespread, broad-based democratic processes of eliciting views and expert opinions. (Kuruganti 2006).

To conclude, in the present changed context of knowledge production in which science has become an intellectual property and also in the context of the world becoming-for-itself the classical 'government' model of regulation is not appropriate, especially in the context of science and technology that seeks to transform the organic world, which is deeply embedded in the interests and meaning structures of different cultures. This transformation is fraught with uncertainties and risks for humans and environment. What should be the appropriate governance model in which the uncertainties are openly acknowledged and which accommodate the economic, social, religious and moral concerns of the various interest groups while taking

decisions on the emerging technologies?. There is a need to move towards a model of regulation based on governance.

The thesis argues that there should be a shift in the regulatory paradigm from a government-centred model one to that of a governance-centred one. Unlike the government model where the framing of policy issues and the processes of regulation and implementation are centralised in the hands of formal public institutions, the governance model refers to inclusion of wide range of actors into policy domain such as: industry, scientific organisations, pressure group, consumers, farmers, market and the public at large. In the process of grappling with uncertainties and assumptions about risks and the methodology of risk studies that are associated with normal science are not adequate and hence there is a need to shift to post normal science which addresses these issues by incorporating the contextual specificities and by recognising the knowledge held by technology users and consumers of the products of technology. Regulators should carry out independent tests and put out the results in public domain. Take the results to publics to review the moratorium decision through public consultations. Achieving more democratization of science through consensus based on publics' rationality should form the basis for decision. Technology development should be seen as a means to achieve social justice, equity and sustainability. As Bijker *et al* (2009) put it; the social and scientific appraisal of emerging technologies thus needs to be based on a methodology that can combine scientific expertise with democratic participation of public at large.

Therefore, the controversies around genetic modification of food suggest that innovations have to be socially acceptable in terms of safety, equity, and sustainability, environmental safety and the cultural considerations. In order to produce such innovations, stakeholders should be involved from the beginning of the innovation process as co-participants, and incorporate their

perspectives in the innovation process. Methodologies have to be evolved to make technology development a participatory creative activity. Democratic norms and transparency should be overarching guiding principles that govern the process of negotiation (Haribabu 2004)

Post Normal Science is a new paradigm to look at the technological choices which hitherto were based on the knowledge of experts: Scientists, technologists, and policy makers. Post Normal Science is a departure from this conventional and received perspective on technological policy options. It is an evolving perspective; this has to be applied to various contexts of technological choices to evaluate its robustness. It calls for more empirical studies to examine technological choices and adoption in various contexts. The empirical studies are to be conducted by involving a wide spectrum of stakeholders whose lives in different domains are going to be changed either directly or indirectly with the introduction of the emerging technologies.

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Annexure-I

Views from Domestic and International Experts

Source www.moef.nic.in

Views of the Scientists from Abroad

(i) **Professor G.E Seralini** from France who in a detailed report has pointed out several flaws in the EC-II report and concludes that "the risk on human and mammalian health is too high for authorities to take the decision to commercialise this GM brinjal"

(ii) **Dr. Doug Gurain-sherman** of the Union of Concerned Scientists, Washington DC which says that "serious flaws in the EC-II report on evaluation of gene flow risks from Bt-brinjal"

(iii) **Professor Allison Snow and Professor Norman Ellstrand** of the Ohio State University that identifies several shortcomings in the EC-II report concerning gene flow from Bt-brinjal to wild and weedy relatives;

(iv) **Dr. Nicholas Storer** of Dow AgroSciences (A private US company much like Monsnato) who does say that Bt-brinjal does not pose unreasonable adverse risks to the environment or to human and animal health but who calls for careful implementation of resistance management strategies and points out that Bt-technology should not be seen as a silver bullet to managing lepidopteran pests in brinjal;

(v) **Dr. Jack Heinemann** of the University of Canterbury, New Zealand who questions the consistent yield increases claimed for Bt-cotton and says that the Bt-brinjal tests conducted in India would not meet careful international standards;

(vi) **Dr. David Andow** of the University of Minnesota, USA who says that this reading of EC-II report is sufficient to lead him to question the adequacy of environmental risk assessment but it is not sufficient for him to conclude that the environmental risk assessment is erroneous. According to Dr. Andow "GEAC set too narrow a scope for environmental risk assessment

(ERA) of hybrid Bt brinjal, and it is because of this overly narrow scope that the EC-II is not an adequate ERA. …….most of the possible environmental risks of Bt brinjal have not been adequately evaluated; this includes risks to local varieties of brinjal and wild relatives, risks to biological diversity, and risk of resistance evolution in brinjal fruit and shoot borer (BFSB)".

(vii) **Dr. David Schubert** of the Salk Institute of Biological Studies, USA who says that Bt-brinjal should definitely not be introduced in India since it poses serious environmental and health risks, will increase social and political dependence on private companies and will entail higher costs at all levels of the food chain; and

(viii) **Dr.Judy Carman** of the Institute of Health and Environmental Research, South Australia who has analysed Mahyco's biosafety dossier of 2008 in great detail and who says that her doubts and questions have not been answered at all in the EC-II report.

Views of the Scientists from India

Several leading Indian scientists have also communicated to the Minister both in support of and against the release of Bt-brinjal citing various health and environmental safety concerns. Following are the few Indian scientists who communicated to the Minister in supported of Bt-brinjal:-

(i) A noted microbiologist, **Dr.M.Vijayan** of the Indian Institute of Science, Bangalore,also the President of Indian National Science Academy, has made the suggestion of limited release of Bt-brinjal hybrids in limited areas and ensuring that its sale would be monitored through mandatory labelling. But, mandatory labelling is impractical here because our retail market is fundamentally different from that of the USA and also it is extremely difficult to monitor limited usage in practice.

(ii) **Dr.N.S.Talekar**, Scientist, who has worked on the brinjal shoot and fruit borer at the World Vegetable Centre, Taiwan and is now with the Mahatma Phule Krishi Vidyapeeth, while justifying the use of Bt-technology, has strongly warned against the use of Bt-brinjal in its

present from saying that the manner in which the proponents of the product are recommending to farmers to use this technology is faulty and unscientific and would lead to disaster.

(iii) **Dr. G.Padmanabhan** of the Indian Institute of Science, Bangalore who debunks several domestic and international criticisms of Bt-brinjal, makes a strong plea for commercialisation of Bt-brinjal, but also makes the point that we need a statutory body with regulatory authority and RandD capabilities to govern all aspects of GM crop cultivation in the country once they are released for commercialisation.

(iv) **Dr.Deepak Pental**, Vice Chancellor of Delhi University, who supported GEAC's decision to release bt-brinjal for general cultivation, has cautioned on two points : one, that as India is centre of origin of cultivated brinjal, transgenes can move to the wild germplasm though this should not unduly alarm us and two, that we will not be able to differentiate between Bt-brinjal and non-Bt-brinjal, making labelling impossible.

(v) **Dr. Raj Bhatnagar** of the International Centre for Genetic Engineering and Biotechnology, New Delhi has sent a highly technical communication to the Minister which implies that there is no health risk whatsoever by eating Bt-brinjal.

On the other hand two stalwarts of the Indian science namely Dr.M.S. Swaminathan and Dr.P.M.Bhargava have opposed the commercial release of the Bt-brinjal on several grounds as appended below:

(i) **Dr. P.M.Bhargava**, one of India's most eminent biotechnologists who arguably was amongst the earliest to coin the term " genetic engineering" and who is a nominee of the Supreme Court on the GEAC. He has raised number of doubts on the integrity of the GEAC process itself. He has provided a detailed point-by-point critique of the Expert Committee-II (EC-II) report that has formed the basis of GEAC's recommendation to commercialise Bt-brinjal. Dr. Bhargava has claimed that the Chairman of EC-II had agreed with his assessment that eight essential tests had not been conducted by Mahyco. Another fact he brought to the notice of the Minister was that an expert committee set up by the GEAC in 2006 (EC-I) had asked for several tests to be

conducted but one-third of the EC-II members who were also members of EC-I chose to discard the need for these studies while evaluating Bt-brinjal as EC-II.

(ii) **Dr M.S. Swaminathan** India's most distinguished and senior-most agricultural scientist who was one of the key architects of the Green Revolution whose own research foundation is working on GM technology, has said that we need to be concerned with three issues here (i) chronic toxicity since brinjal is an element of such frequent consumption in India; (ii) independent tests that command credibility and not depend only on data provided by the developers themselves; and (iii) the need to have an independent regulatory system that will be in a position to study all aspects of GM technology in agriculture and arrive at a measured conclusion. Dr. Swaminathan has also agreed with the view since brinjal itself contains natural toxins; we have to be extra-careful on Bt-technology. In his communication to the Minister, Dr. Swaminathan, had suggested two important steps, to be taken in national interest before a decision on the release of Bt brinjal for commercial cultivation and human consumption:

(a) Conserve India's genetic heritage in brinjal :

"My Postgraduate thesis at IARI [Indian Agricultural Research Institute] in 1949 was on Brinjal and non-tuber bearing Solanum species. I have studied our rich genetic wealth in this wonderful crop. What will be the long-term impact of numerous local strains being replaced with one or two varieties with Cry1Ac gene from Monsanto? I suggest that during 2010, ICAR [the National Bureau of Plant Genetic Resources], along with Dr. Anil Gupta of the Indian Institute of Management, Ahmedabad [he maintains a national database on indigenous knowledge and farmers' innovations], should both collect, catalogue and conserve the existing genetic variability in brinjal. Such a collection must be carefully preserved, before we permit the extinction of the gifts of thousands of years of natural evolution and human selection." (para 23, Jairam Ramesh 'Speaking Order')

(b) Assess the chronic effects of consumption of Bt-brinjal :

"The second step which needs to be taken is to ask the National Institute of Nutrition, Hyderabad and the Central Food Technological Research Institute, Mysore to undertake a careful study of the chronic effects of Bt brinjal on human health. This is analogous to the studies carried out on the impact of tobacco smoking on the incidence of lung cancer in human beings." (para 23, Jairam Ramesh 'Speaking Order')

Annexure –II

Views of Honourable Chief Ministers' of Different States

Source www.moef.nic.in

Kerala State

Kerala has taken a policy decision not to allow GM crops, even for trials, until the debate on the issue of GM that is going on the world over is settled for ever and highlighted the following points:-

"GM crops are not economically viable for the farmers, GM crops and foods lead to unimaginable health hazards, GM crops contaminate the local and wild varieties, the damages of which are irrevocable and, such contamination of our traditional varieties cause irreparable damage to food security of the country, GM denies the farmer right to choose what he/she wants to sow in his/her farm, and ultimately and the country's sovereignty over food and agriculture will be endangered".

They further stated " We are convinced that the Genetic Modfication of corps is not a solution for hunger as has been wrongly advocated by the proponents of the GM, because the genetic modification is done not to increase productivity, but to control mainly the insect pests or the weeds……..there are several, cheaper and environment-friendly options to control the pests and weeds or even to improve productivity……the state government is very concerned about the protection of its biodiversity since 35% of the country's biodiversity is in Kerala. One of the main concerns among the scientific community and policy makers is about the environmental contamination of genetically modified organisms…..Kerala is a State heavily dependent on international market for its agricultural commodities. Any contamination from genetic

modification can cause further damage to the trade prospects of the State …… Kerala is also an important centre of diversity of medicinal plants and heritage of traditional medicines like ayurveda. Serious concerns have already been expressed by the Ayurveda practitioners on GM research being undertaken on various crops……the State has already declared an Organic Farming Policy, Strategy and Action Plan in 2008, accordingly, the entire food crops would be converted to organic within five years and the cash crops within another five years….. this will, part from helping to feed the people with non-poisoned food, enhance our export possibilities with a high premium …..Considering all these, the Government of Kerala has taken a decision to prohibit all environmental release of GMos and keep the State totally GM free"

Karnataka State

Karnataka State has highlighted the following points

a) Brinjal is grown in about 15000 Ha in Karnataka with an annual production of about 3.60 lakhs tons. This accounts for 3.5% in area and 5.0% in production of the total vegetable crops in the State. About 50 varieties of brinjal are grown by the farmers. Many of these are local varieties, which are hardly sprayed with pesticides, because pest management in traditional brinjal varieties is fairly easy, as these varieties are grown in specific geographical locations and congenial seasons. Any occurrence of pests can be controlled by spraying commonly used botanical or bio-digester extracts. As such, there has been no demand from the farming community for a new variety in brinjal.
b) Bio-safety of Bt brinjal, though assured by scientific fraternity supporting Bt brinjal, is based on assumption without long-term research. The bio-safety of Bt brinjal with respect to soil, flora and fauna particularly beneficial micro-organisms, which are highly useful in enhancing the soil health, is a matter of great concern, which needs to be suitably

examined. Therefore, the nutritionalists, human and animal health care professionals and environmentalists need to look into all these issues on a long-term basis to assess the bio-safety of Bt brinjal.

c) Local and traditional brinjal varieties are being widely used in Indian Systems of medicines like Ayurveda, Sidha and many traditional home remedies. The Bt gene in traditional brinjal varieties could pose potential danger to preparation of such medicines.

d) The farmers are not depending on external agencies for supply of seeds of local varieties at present. However, introduction of Bt brinjal will make the farmers totally dependent on Multi National Companies for supply of seeds which is not a healthy trend and hence certainly not in the interest of the farmers

In view of the above, the environmental release of Bt brinjal should be deferred till the issue is thoroughly examined from all the angles by taking into account the views of all the stakeholders and conducting a long term research for its bio-safety and its consequent contributions to food security and farmers well being.

Bihar State

“the issue was carefully considered by the Rajya Kisan Ayog. The Ayog after deliberations with farmers, agricultural scientists and agriculture officers was of the opinion that there should be an adequate number of trials to see its performance in different agro-climatic conditions in the State. Such trials should be held involving agricultural research institutions in the State.. the Ayog also noted that no data has been provided on the commercial aspect of cultivation Bt-brinjal which is so important from the point of view of farmers who are mostly small and marginal farmers. The Ayog is therefore not in favour of introduction of Bt-brinjal in the State at this point of time.

West Bengal State

"Use of technically modified seeds represents a radical departure from the cultivation of the traditional hybrids. In cultivation of GM-crops, it is important to look at each crop on a case specific baiss and assess its specific risk profile. There are clear reasons to be concerned about commercial cultivation of Bt. Brinjal. One of the worries is about "gene spills" or the contamination of the landraces by the engineered variety. This means that it has potential to threaten bio-diversity, destabilize important ecosystems, and limit the future agricultural possibilities in a region…..there remains vital question of the impact of Gm-crops on human health, particularly when genetic engineering introduces the possibilities of physiologic or biochemical effects on the target varieties. The current generations of commercially available crops also raises concerns linked to pesticide uses as Bt-crops are designed to internally create their own pesticides. While in the short term, one might expect some decrease in pesticides use; in the long run it may not be very effective. In the developed countries, particularly in Europe, consumers can have choice between non-GM products and Gm-products, but in our country the retail markets are not developed enough to make such a distinction. This leaves consumers without any choice.

Further, there are also concerns about the economics of use of Gm-crops in developing countries. The commercial producers of Bt-brinjal seeds claim that poor farmers will benefit from cultivation of the crop through higher productivity, but in reality it may not be so in the long run. The farmers may not only become dependent on the monopoly supplier for the seeds but also for other inputs as 98% of the World GM seed market is controlled by only six companies……the matter needs through examination by the experts in the field"

Orissa State

"in view of the fact that 82% farmers of Orissa are small and marginal, they are dependent on indigenous varieties of brinjal for its cultivation. It may lead to monopoly of a few seed producers in the country, detrimental to interest of the farmers of Orissa. Further, there have not been sufficient trials on this crop in the State, the Govt. of Orissa does not support the introduction of Bt.brinjal at this stage unless and until sufficient trials are made and interests of small and marginal farmers of the State are safe guarded."

Andhra Pradesh State

"The State Government have examined the issue in detail. It is clear that the data generated, tests conducted and the information disseminated by GEAC are not sufficient for suggesting the commercial release of Bt.brinjal……. until safety parameters in terms of the environment, human and animal health are clearly established, release of Bt.brinjal for commercial cultivation is to be differed. Further requested the Government of India to involve the state research institutions in conducting trials and in development of the data base on the safety of G.M technology in general and Bt.brinjal in particular"

Chattisgarh

"Before giving permission for commercial cultivation of Bt-brinjal, all tests to establish full impacts, including negative impacts, on human and animal helath and on the environment should be carried out"