Ethics Debates on Food Technologies in the Three Regions of Europe, India and China

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This report represents Deliverable 4.2 for Global Ethics in Science & Technology (GEST), funded by the European Commission’s Seventh Framework Programme under grant agreement 266592. The report has been reviewed and accepted by all project partners.

February 2014
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Introduction

The aim of this deliverable is to identify the nature of ethical debates on food technologies in Europe, India and China and to compare how these are addressed by stakeholders in the different regions. It highlights how ethical issues reach the public and political agenda in the area of food; how and to what extent food ethics is incorporated into official government decision-making structures; how other actors or stakeholders including regulators, innovators, producers, consumers etc., deal with ethical issues related to food technology together with any structures or processes implemented to promote public trust.

It is clear that over the last 20-30 years there have been significant changes in each of the three regions of Europe, India and China in the way in which food security, safety and the food economy have developed and been perceived. These changes are due inter alia to advances in technology, together with changes in the roles of stakeholders and a growing awareness of the importance ethical considerations which incorporate consumer perceptions, animal welfare and environmental issues.

In the European context, the development of stakeholder values related to food has been characterised by a tension between “productivist” and “post-productivist” approaches to food production. The “productivist” agri-industrial model focusses on further increasing specialisation and homogeneous production, with production control and pricing shifting from primary producers (farmers) to highly competitive industrial distributors and highly industrialised multinational companies implementing global value chains, dependent on external inputs of water and energy together with patented, product specific, fertilizer and pesticides and increasingly, the use of scientific research to modify, control and maintain reproduction of crops and animals, while the “post-productivist” model has less emphasis on commodity production, and a greater focus on shorter-chain less intense farming, reducing environmental damage, animal welfare and a shift towards sustainable agriculture and conservation or restoration of valued landscapes and habitats. In recent years Europe has been the focus of a number of high profile food-related “incidents” or concerns which have had a significant impact on consumer confidence and which have resulted in major changes to the European regulatory structure with important consequences for the development, regulation, economics and politics of the agri-industry.

One consequence of these events has been a huge loss of confidence by consumers in the food industry and also in food regulators, and this has been accompanied by strong consumer demand for much greater consultation and input into all stages of the food chain and its regulation. These high levels of consumer sensitivity and much tighter coordinated regulation as a result of loss of consumer trust, has been an important factor in increasing support for the post-productivist model of food and agriculture in Europe and also in raising the awareness of an ethical approach to food production. This had a major impact on attempts to introduce GM food products into the European market in the decade between 1994-2004 where consumer perceptions of lack of consultation, labelling, choice and effective regulation and risk assessment were seen as violating ethical principles of autonomy, justice and non-malfeasance. As a result, despite potential economic benefits, GM food products remain effectively barred from the European market.

The situation in India has developed somewhat differently and has to be considered in relation to the social, political and economic development of that region. Unlike Europe, India does not demonstrate the same tension between “productivism” and “post-productivism” there are still on the one hand, increasing numbers of people experimenting with alternative agriculture, based on lesser resources
which is different to the dominant technological paradigm, while on the other hand, better off farmers are moving towards utilising additional and advanced technological solutions.

The proponents of GM technology base their arguments not only on the environmental sustainability of this technology where products are resilient to stress, but also consider the importance of food security; whereas opponents of GM technology argue that the GM technology will have negative impact on environment, biodiversity and also on socio-economic conditions of farmers. They also raise questions about an expensive R&D infrastructure and the adequacy of the present regulatory system. While there appears to have been no high profile risk incidents associated with non-GM foods in India, debate and deliberation on issues of risk and regulation related to GM foods have intensified in India over the last decade. The Department of Biotechnology (DBT) has proposed the setting up National Biotechnology Regulatory Authority (NBRA) as a regulatory initiative which would be set up as an independent, autonomous organization to provide a common platform/mechanism for regulation of biotechnology including agri-biotechnology.

There is also considerable public debate around finding the right balance between various technological choices for food production viz. transgenic, traditional breeding and organic, which is becoming a challenge as various power and risk related factors are at work in India. Hence while it is important to assess how to maximise possible benefits from new food technologies, Indian policy-makers have to consider any applications of new developments in this area in relation to their potential socio-economic impacts including traditional values. It would appear that even in the face of contemporary challenges of food insecurity, declining productivity, depletion of natural resources, increased risk from climate change, rising input costs, changing food habits, and extremely high post-harvest losses, India has had some success in identifying which of these technological choices is the most appropriate for meeting different objectives.

The Chinese case study focusses specifically on the issue of genetically modified agricultural products. Like India, China is a rapidly developing economy albeit operating within a completely different system of political governance. The rapid growth of the Chinese economy, its population and their greater purchasing power has on the one hand greatly increased demand for a wider range of foodstuffs, while at the same time the amount of land available for agricultural cultivation has been decreasing. Unlike the situation in Europe, and even in India, there has been very little public debate on the implementation of new technologies, including GM products into the Chinese food chain. Although the main stakeholder groups (consumers, producers and Government) appear to have markedly different attitudes towards GM foods, there is a lack of any regular (whether formalised or not) communication between them. The food safety and security agendas are therefore largely driven by the Government, which takes on the role of both regulator and funder of research into new technological developments with a strong emphasis on ensuring China develops and maintains an independent ownership of its GM intellectual property rights (IPR).

In China, the discourse supporting the introduction of GM foods and related technologies through innovation is developed from two intertwined systems. The first is the discourse of “developmentalism” which holds that only by giving full scope to the advantages of the biological technology and using the transgenic technology to transform products into productivity can China’s agriculture undergo fundamental changes. It further states that transgenic technology will be able to improve the inherent value of traditional agriculture because the reduced production cost and improved output brought by the transgenic technology will increase agricultural productivity. Besides, the development of GM foods
is perceived as a long-term trend of agriculture at the global level and will therefore be an important way to solve China’s food problems in the future. It concludes that great efforts should be made to promote the transgenic technology. The second approach is the discourse of “scientism” which, starting out from Deng Xiaoping’s judgment that “Science and technology constitute a primary productive force”, holds that GM foods with their high technology content naturally have their political legitimacy and that under the aura of science, the high authority and reputation of scientists and high technologies tends to foreclose reflection on the legitimacy and social consequence of GM foods, thus endowing them with an automatic correctness. However, having said this, it is recognized that it is the degree of acceptance of GM foods by consumers that will eventually determine the space of growth of GM foods. However the more recent surveys of the few that have been carried out tend to show that while there has been some improvement in urban consumer awareness of GM foods there has been at the same time a certain decrease in their acceptance.

The production and consumption of GM foods in China also faces potential risks. The first category is any general risks posed by GM foods to all consumers and the environment. The second category is China-specific risks which are mainly related to China’s existing agricultural situation and administration and lead to debates about the peculiarity of China in developing GM foods. The third category concerns industry security. Food security is a core issue for the Chinese government, which does not want to see the country’s industry security undermined either by foreign control of key technologies or by China’s own lack of technological preparation. The issue of industry security is therefore an important part of the debate about the risks of GM foods in China.
CASE STUDIES

Note: The full European Food Technologies Case Study document was previously completed as Deliverable 4.1 therefore only a summary of this document follows here, although the conclusions from the previous document are reproduced in full. However as they have not been included in an earlier deliverable, the whole text of the Indian and Chinese Case Studies are presented here.

EUROPEAN CASE STUDY (SUMMARY)

The introduction to this case study recognised the importance of the need for global food security and described the history of European food policy since the beginning of the 20th century demonstrating the move from traditional agriculture to a productivist model of industrially driven expansionist agriculture directed towards an agri-industrial approach of increasing levels of production through convergent applications of biotechnology which more recently, as the result of increasing environmental and other ethical concerns, followed by a move towards an alternative, post-productivist model with the focus shifting from intensive farming to shorter food supply chains, better added value for farmers and more sustainable, environmentally friendly, localised and pluralistic agricultural practices.

The key stakeholders in the different models are identified and in particular the growth of consumer awareness and the increasing role and influence of the consumer in their relationship with producers and the market particularly in relation to ethical and societal values throughout the whole food chain in relation to perceptions of risk, precaution, “naturalness”, animal welfare and the environment.

In recent years Europe has been the focus of a number of high profile food-related issues or concerns which have had a significant impact on consumer confidence and which have resulted in large changes to the European regulatory structure with important consequences for the development, regulation, economics and politics of the agri-industry. One consequence of these events has been a huge loss of confidence by consumers in the food industry and also in food regulators, and this has been accompanied by strong consumer demand for much greater consultation and input into all stages of the food chain and its regulation. These high levels of consumer sensitivity and much tighter coordinated regulation as a result of loss of consumer trust, has been an important factor in increasing support for the post-productivist model of food and agriculture in Europe.

Therefore failure to recognise and respond to consumer preferences and concerns may generate consumer protest and shifting of loyalties to different production systems. Hence the acceptance and trust of the consumer is important for economic viability and it is essential for any model of agricultural development to be able to secure positive attitudes in consumer perceptions of risk and ethical values in relation to methods of production, processing, packaging and distribution. Effective regulation is a key element in securing consumer trust and hence confidence in both products and processes.

INNOVATION

Some of the more recent technological developments are highlighted, together with their potential for impacting on food and agricultural practice. A number of high profile food-related issues in Europe were described and their impact on stakeholder attitudes and values in relation to food technology, together with the way they have influenced the European regulatory system for food and the consequences for the development, economics and politics of the agri-industry. However, the main technology focus in this case study has been on developments in agricultural applications of genetic
modification (GM) and nanotechnology and how these innovative technologies have and might be perceived in terms of risk and from ethical and consumer perspectives.

Of particular interest is a detailed discussion and analysis of the attempt to introduce GM into the European food chain, it’s subsequent failure and the large part this played in the role that ethical and other values now have in relation to agriculture in the European context and indeed the increasing support for the post-productivist model of food and agriculture in Europe. This is contrasted with current European consumer attitudes to nanotechnology applications in the food chain. Use of nanotechnology in the food chain does not appear to carry the same negative connotations or level of public concern as GM in Europe. Nanotechnology may therefore be a potential alternative technological approach to the use of genetic modification of plants and animals in the food chain. However one reason for the lack of consumer concern about nanotechnology may be because consumers are by and large unaware that nanotechnology already plays a significant role in many aspects of food production processing and supply.

**RISK**

In this section the European process of risk analysis for assessing and managing any real or potential food-related risks is described such as any physical, chemical or biological agents that may be harmful to health. Particular attention is given to the way that the process of risk communication has developed from its historical purpose of simply communicating to stakeholders the nature of a particular risk and the policy for managing it, to the current iterative process which takes into account both expert and consumer perspectives and perceptions of the nature of risk and the way in which it should be handled. In particular the impact that changes in risk communication have had for the way Europe handles potential risks from GM applications, including the issue of “substantial equivalence” in relation to novel foods, is discussed. The importance which the European consumer places on open and transparent labelling of novel foods, particularly in relation to GM products is discussed including the impact that European labelling regulations and the way in which the “precautionary principle” have been applied in Europe, have had in acting as a barrier to the introduction of GM products in Europe.

As a result, although some GM crops are grown in Europe these are generally for non-food applications and the only GM foods currently approved for food in the UK are those containing or produced from GM soya bean or GM maize. Manufacturers’ fears that European consumers may reject foods labelled as containing GM products may account for lack of such products being introduced. However, GM tomatoes clearly labelled GM and introduced in 1993 were readily accepted by consumers and suggest that consumers concerns are more to do with trust and a desire for transparency rather than simply concerns over the technology. The GM tomatoes introduced in 1993 were less expensive than traditional tomatoes and the case study demonstrates that willingness to pay can be an issue such that where products resulting from novel technologies offer a benefit to the consumer (such as lower cost) they are more likely to be accepted. However where there is no perceived benefit to consumers, they are unlikely to accept even a small theoretical increase in risk, particularly if at the same time, any possible benefits are likely to accrue only to manufacturers or distributors.

Thus the risk analysis paradigm as applied in Europe now incorporates much greater overt reference to the fundamental ethical principles of benevolence, non-malfeasance, autonomy and justice. This increased recognition of an ethical dimension to the process of risk analysis has been an important factor in the development of risk communication, including consumer consultation, as an important iterative process throughout risk analysis. Together with parallel concerns about the possible impact of
GM and other novel technologies on sustainability (another ethical issue), it has also been important in the development of the Precautionary Principle.

POWER & CONTROL
This section describes the different arguments by both proponents and opponents of GM crop and food technologies including arguments both for and against the utility of GM for global food security. The success of many European Civil Society Organisations (CSOs), in opposing GM technology including their ability to influence consumer opinion and maintain a consistency of public perceptions about GM foods and crops in the majority of EU member is highlighted.

The impact of this in producing uneasiness in policy debates and deadlocks in legislative processes as policy makers have found it impossible to reconcile standard risk assessment procedures with the public outcry against GM technologies is discussed as has the EU moratorium on GM products and the EU application of the precautionary principle. A consequence of this situation has been for the Power & Control discourse in Europe to lead to a controversial but pragmatic separation in decision making: that between science and politics (Sauter, 2005). The creation of the European Food Safety Authority (EFSA) has been the result of the attempt to mainstream scientific decision making in Europe, amongst others, on the risks of GM foods to human health and the environment. However while EFSA’s responsibilities lie in risk assessment, risk management is dealt with by the European Commission’s Directorate General for Health and Consumers. Political decision making on the other hand deals with approval of GM foods and can apply the Precautionary Principle to limit authorisation of new products and request post-market monitoring of environmental and health effects, even in the absence of strong scientific evidence to corroborate such requests.

This separation in responsibilities is problematic in itself, leading to disagreement amongst experts between scientific assessments, ethical values, including the more emotional aspects of the public discourse (e.g. unnaturalness, playing God, etc.). These eventually produce deadlocks in the policy debate. This is most evident at the European Commission level of decisions making, whereby the preferred policy process that is based on Committees with membership representing member states (and therefore reflecting the various public and policy discourses in Europe) is deeply dysfunctional and in a stalemate situation (Vazquez-Salat et al, 2010).

In relation to specific legislation guiding the regulation of GM foods, the European Union functions through a centralised procedure of regulations and directives whereby an agreement between member states results in legally-binding regulations which states must translate into their national legislation (von Schomberg, 1998). Legislation relating to genetically modified organisms (whether food, feed, crops or microorganisms) is also relevant to GM foods and involves a wide range of legal and guidance documents (see Deliverable 4.1 for details).

One can deduce that the central value that permeates the GM food legislation is Europe is that of “ Freedoms” in particular Freedom of Choice. In the absence of scientific arguments for an outright ban on GM products, legislators have accepted the immense pressure from CSOs and the widespread opinion of European citizens that “informed choice” is necessary in this issue, hence, enforced labelling and traceability. It should be noted that labelling is widely used in food products but only in relation to warning on allergens in the content or for religious prerogatives (e.g. Halal food). As such, the central value of “freedom of choice” has found a new use that brings it in direct opposition to commercial market forces while recalling the traditional discourse over fundamental rights.
Similarly, another basic value has been used in the Power & Control discourse and is reflected in the current legislation is that of “sustainability”. Although not a traditional value that is imbedded in Charters of Rights, Sustainability has been upgraded to a fundamental value linked to almost all S&T related discourses. In relation to GM crops/foods, Sustainability refers to the loss of biodiversity but also to the loss of traditional agricultural methods.

Both values of Freedom of Choice and Sustainability have controversial implications for policy initiatives. For instance, the policy framework makes traceability and labelling of food derived directly from GMOs, imperative. This is not the case for products from animals fed with GM material and not for industrial products like textiles or paper. Labelling is imperative when the GMO content exceeds 1% of the product. This by itself necessitates the use of sensitive biosensor equipment and a robust paper-trail of content origins, in both cases raising the cost of the product. But even more controversial is the so-called Zero Tolerance Policy for GMOs that are not (yet) approved in the EU, but are on the market in other countries. No amount of traces of such GM material in food products is allowed thus creating an even more restrictive regime on traceability.

The status of the legislative debate in Europe is very advanced compared with the rest of the world but there are still a number of open issues that prove significant barriers to a common resolution. For instance there are no common rules for the organisation of co-existence between GM and non-GM crops in agricultural practice. This issue, along with the relevant issue of liability (i.e. contamination of a non-GM crop by a GM crop), is not decided at EU level but by each single member state. This creates potential confusion since states could have different and even contradictory legislation with each other. At the same time, there are often contradictory votes within the European Commission by different states that shows a far from common EU view of the issue and even more worryingly, there are often different positions between Commission Directorates (e.g. health, consumer interests, trade, environment, agriculture etc.) (EPTA, 2009). This creates an even more damaging situation whereby policy debates take a radically different turn according to the values held by different departments. This situation could even get more complex if the current request by some member states to include socio-economic aspect in the risk assessment is accepted (Vazquez-Salat et al, 2010). This could create a more politicized scientific assessment process with great repercussions in the overall decision making.

One could conclude that there are considerable challenges in the Power & Control debate in Europe that relate to core values held by the main stakeholders and the European public in general. It is evident that the overall technological and trade conditions in the world, as well as in Europe, encourage the introduction of GM technology in food although also GM crops for non-food uses (e.g. for bioenergy) will be more available. This brings into the forefront of debates the value of sustainability in agriculture. Europe will be increasingly faced with a choice of how to apply sustainability in the sector and what type of agriculture to adopt. The two types of agriculture that we identified in the introduction (agri-industrial and post-productivist) represent diametrically different values systems and this will be the main battleground in this issue.

The new generation of GM applications targets, in addition to growers and producers, consumers directly. New crop varieties are designed to provide direct health benefits to consumers (e.g. via nutritional enhancement) that blur the border between pharmaceutical and food applications. Public reactions to such applications are not easily predictable since health biotechnologies tend to provoke less negative attitudes. Ethical concerns are also not easy to foresee since a new utilitarian perspective could result in radically different outcome in this case. Policies on consumer protection will need to be
relevant in a different type of risk discourse that is more relevant to values related to health research, such as dignity and rights, rather than the current one based on sustainability.

It is clear that in the Power & Control debate in Europe, public opinion is a decisive factor and the single most important influence in the final decision making. However, the future direction of public opinion’s influence in the debate is far from clear. At present, there appears to be less public opposition to GM food than ten or twenty years ago and even a positive attitude for GM technologies when applied to health. Lay morality is a pivotal influence but also an uncertain one since not the values themselves but the weighting applied to each of them might change with time. The greatest challenge in the Power & Control debate in Europe is to manage its complexity, secure a comprehensive information flow and discuss values and arguments at a similar level.

**ETHICS AND PUBLIC PERCEPTIONS**

This section of the European Case study considers how the ethical principles of beneficence, non-malfeasance, autonomy and justice have influenced policy and regulatory framework and how they might be perceived by the different stakeholders in the European food chain. The important stakeholders in the European context are considered to be innovators (scientists and industry), farmers (primary producers), food manufacturers and distributors (secondary producers) and consumers and the perspective of each of these is considered, The environment is also considered as a “stakeholder” in as far as how the ethical principles are applied to environmental issues. These are then presented in the form of an ethical matrix which amongst other things can be useful in enabling a stakeholder to understand the perspective of other interest groups. However in addition to the consideration of the perspectives of individual stakeholders this section includes a broader consideration, in the context of the European Charter of Fundamental Rights, of how ethical values as well as public perceptions might properly be considered in relation to the introduction of innovative technologies into food and agriculture. The particular importance of transparency and the right of the consumer to information about ingredients and processes related to the food they consume is highlighted.

**CONCLUSIONS**

**Values and Food Production Paradigms**

As described in the introduction, the past three decades have seen a slow but steady revolution in Europe in terms of the preferred production mode for food. The dominant agri-industrial food production system is challenged by the more environment-friendly and grass-root initiated post-productivist model. This shift is less about change in production processes and more about changes in values systems. One could place it along the well-described shift from materialist to post-materialist value orientation that is evident in European societies in the last decades.

This value shift can be superimposed on the ethical continuum of Utilitarianism and Deontology. The obvious utilitarian gains of the agri-industrial model are becoming less significant than the sustainability and wellbeing gains of the post-productivist model. It seems that society is looking beyond the material gain in quantity and price in food and, as in Maslow’s pyramid, attempts to incorporate “higher” values that are required to actualise societal inspirations. These values are entrenched in the process of governance in Europe through its various treaties as Justice, Freedoms, Rights, Sustainability, Dignity, Solidarity and Equality. Our research has shown that some of these values are pivotal in the discourses on Food Technologies and they influence the arguments and perceptions that stakeholders hold.
The Three Main Discourses
The debate we witness in Europe in the area of Food Technologies covers the whole spectrum of the analytical framework that GEST is covering both in terms of discourse theme and in terms of the main societal values as they are described in the European legal documents. The discourses on Innovation, Risk and Power & Control have certain overlaps in terms of argumentation as one might expect in every discussion on highly complex scientific issues that affect lay perceptions and deep individual sentiments. Food is a par excellence issue in that respect as it represents science and lifestyle in equal measures in policy debates. As such, the discourse on Innovation and its focus on economic prerogatives cannot be clearly delineated from that of Risk with its focus on individual effects or for that matter from that of Power & Control that attempts to balance the two in a socially sustainable manner.

Similarly the categorisation of the main discourses in the dominant values system will inevitably suffer from delineation impracticalities since the values themselves are used more as guiding principles rather than defined legalistic concepts. The values of Justice, Equality, Sustainability, Freedoms and Rights that are dominant in European societies show significant overlaps (and even contradictions) when it comes to real life applications. Nevertheless, it is neither counterproductive nor undesirable to attempt a categorisation of a scientific debate in terms of values and discourses. It is needed in order to achieve certain clarity of source and purpose in the debate process and Food is a particularly appropriate issue to fit such categorisation.

The following matrix summarises the main arguments in terms of dominant value and type of discourse in Food Technologies.

Matrix 1 - Food Technologies Discourse and Values - Europe

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Justice/Equality</th>
<th>Sustainability</th>
<th>Freedoms/Rights</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Economic Development; Health Benefit Effects; Unaffordable Products</td>
<td>Disease resistance, Extreme Climate Crops; Bioenergy Crops</td>
<td>Choice between Agri-Industrial and Post-productivist Products</td>
</tr>
<tr>
<td>Risk</td>
<td>Adverse Health Side-effects</td>
<td>Crop Cross Pollination</td>
<td>Monopoly Market; Lack of Choice</td>
</tr>
<tr>
<td>Power &amp; Control</td>
<td>Substantial Equivalence; Precautionary Principle</td>
<td>Food Security; Food Monopoly; Crop Co-existence</td>
<td>Labelling of GM Products</td>
</tr>
</tbody>
</table>

Justice/Equality
We will take a value perspective in describing the matrix as this is most related to the theme of GEST as an ethics focused project. Justice and Equality are combined here since the overlap in the relevant argumentation is sufficient to make them indistinguishable from each other. Both refer to the attempt to uphold fairness in societal dealings, free of prejudice or preference of treatment for one group over another. As we have seen, the Innovation discourse that is based on these values (not necessarily referring to them directly) deals with two main arguments. The most straightforward one deals with the opportunity that the new Food Technologies provide for economic development and therefore prosperity for the whole society. This is an argument that is promoted for almost any new technology, the difference here being that the European food industry is such size that failure to adopt the new
technology will have dire consequences for a great number of people (employees or consumers) regardless of their social status. Equality as interpreted in this case in terms of access to work and food products for all, will be affected. Similarly, the argument goes, stopping a technology that can have direct health benefit effects runs contrary to our values of Justice and Equality, interpreted here as fair and equal access to wellbeing. The contrary argument sees an increase in Injustice and Inequality with new technology products that are prized higher than the equivalent “less healthy” ones and therefore being unaffordable for the less-well-to-do citizens.

The Risk discourse under these values focuses on rather technical details that any new type of food would raise, namely, whether it carries any risks to human or animal health. This discourse being the most fact-oriented one, is also the least conclusive in terms of values. Justice and Equality would prohibit the unnecessary taking of risks, particularly if these relate to specific groups. Here the argument states that Food Technologies (i.e the specific ones we’re dealing with) represent a huge risky experiment with the health and wellbeing of all citizens, therefore breaching the value of Justice in oppressing people to become experimental subjects against their own will.

The Power & Control discourse is the eventual battleground where Justice and Equality are enshrined in law. Here we have seen the interplay between two different arguments relating to risk assessment: substantial equivalence versus the precautionary principle. At a sufficient macro-perspective (i.e that of global debates) substantial equivalence provides a just and equal for all risk assessment process and its abandonment creates unfairness and inequalities in international relations. The opposite might be considered true for the precautionary principle at a micro-perspective (i.e. that of the individual society): it promotes fairness and equality for the citizens that do not agree with the status quo and are unwilling to become “research subjects” as described above.

**Sustainability**

As explained in the State-of-art report, the value of Sustainability refers mainly to environmental protection but from an anthropocentric view, meaning the upkeep of a nice environment for use by people of this and next generations. In that perspective, Sustainability in terms of Food Technologies relates to the way the food is produced and the reason for which it is produced. The Innovation discourse revolves around the specific characteristics of food crops and their relationship to the environment. For instance, the main arguments here promote these new technologies as a way to withstand environmental threats (diseases) and conditions (extreme climate) that otherwise would be impossible or too costly to achieve. As such, these technologies promote a cleaner and more sustainable environment. The same argument goes for the creation of bio-energy crops that could save the environment from existing polluting energy sources.

The risk discourse in Sustainability deals mainly with the issue of affecting the existing environmental by introducing alien crops that are impossible to separate from the current ones. Cross pollination appears to be inevitable and as a result the threat of diminished biodiversity and decreased sustainability is real.

As with the previous values, the Power & Control discourse is also the central battleground for the main arguments. In this case, the main policy issue is whether the existing environmental conditions are sufficient to produce a sustainable source of food for the increasing human population or not. Food security requires new ways of thinking on how to use the environment sustainably for the benefit of human kind and the new food technologies offer such possibilities. At the same time, the fact that these technologies are dominated by a small number of profitable enterprises could create the opposite effect: a world where biodiversity is dwindling while what remains is governed by few. It is
also doubtful that a “sharing” solution can be found, whereby both types of crops can be grown next to each other (co-existence), since there is inadequate knowledge and many legislative hurdles to deal with complications.

**Freedoms/Rights**
The values of Freedoms and Rights are so closely linked that they become almost interchangeable in scientific debates. Freedom to choose between various technologies is similar to the right to have a choice over the same technologies. In the Innovation discourse on food technologies both proponents and opponents promote similar argumentation that the citizens should have the right and the freedom to choose between products deriving from either agri-industrial or post-productivist types of agriculture. This usually, but not always, translates into choices between organic and non-organic foods in the European supermarkets, although there is a wider spectrum of production methods that fit one or the other type. What distinguishes the arguments is not the matter whether choice should exist but how society should achieve it. Labelling issues are closely related to this argumentation but belong to another discourse.

In terms of the Risk discourse guided by the values of Freedoms and Rights, one can find the rather sensitive (politically speaking) issue of Intellectual Property Rights. IPR in new food technologies can have significant effects in market availability and since food is essential to every society, IPR issues can create dangerous market shifts. For instance, extensive IPR protection could lead to monopolies while weak protection could lead to lack of innovation. As with other similarly essential industries (e.g. pharma), the Risk discourse in terms of Freedoms and Rights has taken a distinctive international character with not easily reconcilable perspectives.

The Power & Control discourse in Europe has concentrated mainly on the issue of labelling, whereby the Freedom to choose is associated with the Right to know. Despite considerable opposition by the food industry, labelling of products containing GM ingredients has been viewed as a basic Right and has been legislated as such. The only undecided issue is the level of tolerance for new technology (i.e. GM) ingredients that is acceptable for labelling purposes.

**Ethics and Public Perceptions**
When it comes to reflective discourses like that of Ethics or Public discourses, dominant values are not easily distinguishable in the debate since they permeate all argumentation. We have established that one can better describe reflective discourses with a traditional approach to ethics discourse analysis that includes the description of stakeholder perspectives in terms of ethical principles. This analytic approach, termed “ethical matrix” is inspired by the “principled approach” in standard bio-medical ethics (Bhuiyan, 2010).

**Matrix 2 - Food Technologies Ethical Matrix**

<table>
<thead>
<tr>
<th></th>
<th>Beneficence</th>
<th>Non-Malfeasance</th>
<th>Justice</th>
<th>Autonomy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Innovator</strong></td>
<td>Profitability. Advance science. Positive impact on Global Food Security.</td>
<td>No damage to reputation. No adverse market effects.</td>
<td>Respect of IPR. No unfair regulation or competition. Protection against trade</td>
<td>Freedom to develop, exploit and market the innovation.</td>
</tr>
<tr>
<td>Primary Producer (Farmer)</td>
<td>Profitability. Improved and/or more reliable yields. Better product consistency. Reduced production costs.</td>
<td>No increased heath or other risks to themselves, customers or end users. No environmental damage. No adverse animal welfare issues.</td>
<td>Ability to establish equitable trade deals with suppliers and customers. Regulations that provide a level playing field.</td>
<td>Ability to choose which crops and stock to farm. Ability to change product or supplier if market conditions change.</td>
</tr>
<tr>
<td>Secondary Producer (Manuf/Distrib)</td>
<td>Increased profitability. Improved product quality and company reputation.</td>
<td>No contaminants in products. No risks to health or the environment. Labelling of potentially harmful product components (e.g. allergens). Non-misleading marketing.</td>
<td>Ability to trade and market freely under equitable regulation. No unreasonably burdensome regulation.</td>
<td>Ability to freely choose suppliers, production methods, marketing and labelling strategies.</td>
</tr>
<tr>
<td>Consumer</td>
<td>A pleasing product in terms of quality and sensory characteristics, that fosters good health and well-being. Affordability. Convenience. Availability. Fosters social interaction.</td>
<td>Food Safety. No adverse health benefits. No adverse impact on the environment from either the product, its manufacture or wastes. No adverse animal welfare issues.</td>
<td>Effective regulation and risk analysis. Appropriate use of the Precautionary Principle. Fair trade and avoiding unfair competition. Provision through advertising and labelling of the necessary and accurate information on product, source, ingredients, manufacturing processes and</td>
<td>Ability to choose or not to choose a product produced using an innovative technology. Choice may be based on factual information or on perceptions. Effective and adequate labelling to enable an informed choice including a risk/benefit choice.</td>
</tr>
</tbody>
</table>
food available to them is genetically modified or not. It is questionable as to whether this is in fact true. A country itself may expose itself to any level or potential risk when there are no evident benefits. It might be argued that in consumers expect to make their own choices about the food they eat and see no reason for exposing arguments for introduction of this technology into a region food supply and strengthen food security particularly in the developing world. However these are poor inventions in a way that maximises financial gain while avoiding any negative impact on their brand or image may well find themselves in conflict with other stakeholders, who may see a right to open and transparent information as an essential factor in their freedom to choose and make decisions relating to a new innovation. Farmers who focus on their freedom to choose whether or not to grow GM crops or animals may find themselves in conflict with other stakeholders who prioritise protection of human health, the environment or animal welfare and who perceive GM products as having unidentified potential risks. An example might be a farmer who wishes to grow GM crops in an area in close proximity to another farmer growing organic crops which may then be at risk of contamination through cross-pollination with the GM organisms.

Thus an important factor for all stakeholders is to understand not only their own needs but also the needs and perspective of other stakeholders with whom they need to interact. Without an effective balance in the ethical perspectives of all stakeholders, novel innovations may stall through opposition or companies may be dis-incentivised from developing certain new technologies. This is, to a large extent what has happened following the European GM debate and is still a major factor blocking its introduction into the European food chain. Innovators and manufacturers believe that they should have the right to develop and market GM products. One argument used is that GM products can increase the food supply and strengthen food security particularly in the developing world. However these are poor arguments for introduction of this technology into a region such as Europe where food is plentiful and consumers expect to make their own choices about the food they eat and see no reason for exposing themselves to any level or potential risk when there are no evident benefits. It might be argued that in a country suffering chronic food shortages consumers will have few concerns about whether or not the food available to them is genetically modified or not. It is questionable as to whether this is in fact true.
as a number of developing countries have also expressed strong concerns about GM foods. While it is true that, in line with Maslow’s Pyramid of Needs, if people are struggling to meet their basic physiological needs and perhaps have only one source of food, they are unlikely to reject food from whatever source it comes, this does not mean that any concerns they may have can be ignored. However as individuals in societies increasingly have their basic physiological and safety needs met they have greater opportunities to express the ethical principle of autonomy or freedom of choice. They are also likely to have greater opportunity and perhaps inclination, to express more outward-directed or altruistic choices, for example in relation to other communities, animal welfare or the environment.

It is argued by some innovators and policy-makers that the benefits associated with GM foods are increasing and that consumer acceptance of GM products would lead to important economic growth. While there is some evidence that consumers are more likely to accept GM products if benefits can be clearly identified, the broader economic growth argument is likely to be outside the interest of most consumers in their everyday lives. While other stakeholders are well aware that consumer acceptance is the key to the success for their innovations and products in the market, they have repeatedly failed to understand or accept the perspectives and values that drive this consumer acceptance, choosing instead to insist that if consumers just understood the science or trusted them to explain it, all would be well. Patently this approach does not work. So what is it that consumers particularly in a European context, need to hear? Above all else, European consumers appear to value their freedom to choose which products they will buy and this is particularly true in relation to food. Although there is general recognition that providing consumers with information on real and potential risks and benefits associated with GM foods in general is important, this alone is not sufficient to secure consumer acceptance. A key issue of conflict in the GM debate is the insistence by European consumers that they should be able to make an informed choice on individual food products by having those containing GM to be labelled as such and a great reluctance on the part of manufacturers to attempt to market products for which this would be a requirement. A major concern of manufacturers is that consumers would reject foods labelled “GM” while the consumer perceives the lack of willingness to market products labelled “GM” as evidence of undisclosed risks which in turn reduces trust and strengthens their perception that GM products are unsafe. A better understanding of and willingness to address stakeholders fundamental ethical concerns and values and wherever possible find common ground, is crucial not only for GM foods but for the success of any novel innovation into the market.

REFERENCES for European case study


Ethics Debates on Food Technologies in China - Case Analysis of Genetically Modified Foods in China

In 2012, genetically modified organisms (GMOs) were grown in 28 countries around the world and China ranked 6th with approximately 4 million hectares of land planted with GM crops (James 2013). Of the total area of land planted with GM crops, more than 80% was grown with GM cotton (over 3 million hectares). Other approved GM crops include papaya, tomato, pimento and aspen. Even though the Chinese government has not approved the commercial cultivation of GM staple crops (wheat, corn and rice), two GM rice varieties and one GM corn variety were granted biosafety certificates by the National Agricultural GMO Biosafety Committee in late 2009, marking a major step forward in the commercialization of GM staple crops. In fact, issues related to GM foods have become a focus of public concern in China. This article presents an analysis of GM food cases in China within a framework based on innovation, risk, control and stakeholders.

BACKGROUND

The discussion of GM food cases in China cannot take place without reference to a GM cotton variety which was “suddenly” introduced to China in the 1990s and rapidly promoted, which lifted the curtain on GM technology in China and led to the establishment of the related regulatory system.

In 1992 and the subsequent several years, the cotton-growing areas in North China suffered severely from bollworms, with the per unit area yield in Hebei, Shandong and Henan declining by as much as nearly 30%. At that time, Chinese farmers generally used pyrethroid pesticides for bollworm control. Of the chemical pesticides produced every year, approximately 30% were used to control bollworms. However, in the course of time, the bollworms became resistant to pyrethroid pesticides. The farmers increased the amount of the pesticides used and the spraying frequency only to cause a large number of poisoning cases in humans and animals (Fan, 2002). In the period from 1992 to 1996, there were a total of more than 240,000 occurrences of poisoning caused by pesticides used for bollworm control. During the same period, bollworm outbreaks caused over RMB 10 billion in economic losses (Zhang, 1993; Qiu, 1998). The significant decrease in cotton production also impacted and endangered the textile industry and related industries. In this backdrop, a GM cotton variety developed by Monsanto was introduced to China in 1995. It performed excellently in subsequent tests.

In 1996, it began to be planted experimentally in Hebei, and Monsanto established its first office in China in Beijing. In the same year, the Singaporean D&PL China Pte., Ltd controlled by Monsanto established the joint-venture Hebei Jidai Cotton Seed Technology Co., Ltd. with Hebei Provincial Seed Industry Group Corporation to produce and sell GM insect-resistant cotton. In 1997, the State Council, on the basis of assessment of related reports, confirmed that the experiment of the insect-resistant cotton in Hebei was successful. Soon the Ministry of Agriculture approved the commercialization of the insect-resistant cotton variety of Monsanto. In 1998, the GM cotton variety began to be promoted widely in China. Monsanto demonstrated a huge advantage in the cotton seed market and quickly became the favored choice of cotton growers across the country.

Meanwhile, the Chinese government was also stepping up its efforts to develop related biological technologies. In 1991, the former State Science and Technology Commission of China initiated a high-tech research project on the development of GM insect-resistant cotton varieties. In 1992, China created the first synthetic Bacillus thuringiensis fibroin gene, successfully inserted it into the genome of
cultivated cotton and generated a GM insect-resistant cotton variety. In 1995, the GM insect-resistant cotton research project was included in China’s 863 Program and also selected as a key technology for development in the 8th five-year plan period and an important commercialization project. In 1996, the “artificial transformation synthesis of insecticidal gene and protein coding and its application” was granted a national patent, making China the second country following the United States to have proprietary intellectual property rights in the GM insect-resistant cotton. During the 8th and 9th five-year plan periods, more than ten GM insect-resistant cotton varieties were approved at provincial and national levels.

By 2005, China had successfully developed more than 30 GM insect-resistant cotton varieties, which were grown in nearly all cotton-growing areas, with the cultivated area of GM insect-resistant cotton varieties accounting for more than 70% of the total cultivated area of all insect-resistant cotton varieties. With the improvement of their R&D capacity and their superior knowledge of the needs of domestic cotton growers, Chinese cotton seed breeding companies have achieved rapid development and gradually established a competitive edge in the market. At present, insect-resistant cotton seeds independently developed by Chinese companies have taken up more than 90% of the domestic market (Su, 2004).

The development process of GM cotton in China sheds important light on the development of transgenic technologies and products in China. As a mass commodity, cotton was a strategic resource in the 1990s with importance as high as grain in today. In the face of the great threat posed by bollworms to the cotton industry and with the traditional means of control ceasing to be effective, the Chinese government rapidly adopted and promoted the significantly advantageous transgenic technology, showing a high administrative efficiency in the process. It should be noted that at that time, the government was not without opposition. Scholars and politicians worried about the control of the industry by foreign companies and other stakeholders worried about profit losses such as traditional agro-chemical companies made a lot of efforts to prevent the entry of foreign GM cotton into the Chinese market, but in the face of the crisis of the cotton industry, the State Council and related government departments took decisive moves including experiments and tests, partial openness, and national promotion. Within only three years, the government approved the commercialization of the new technology and opened the domestic market to related foreign companies.

Meanwhile, the Chinese government adhered to the approach of integrating technology import and independent innovation by making deployments for the independent development of related technologies and established a GM cotton research system covering a variety of participating parties, where national-level research institutes and universities were responsible for basic research and basic research for application, provincial and municipal-level agricultural research institutes were responsible for applied research and experiments, and with the growth of the GM cotton market, cotton seed breeding companies and cotton associations also took part in the applied research and development of GM cotton. With their concerted efforts, China successfully developed its own GM cotton varieties within less than ten years. With respect to GM foods and related technologies, the Chinese government adopts a largely empirical approach, puts industry security in the first place, adheres to independent innovation, and is decisive in both decision-making and action.

Of course, the whole process has been not without flaws, prominently shown as the lack of concern on the part of the government, researchers and the public for the environmental impact of GM crops. Another problem was the lack of popularization of related scientific knowledge in the process of promoting new varieties, with the result that not only ordinary consumers but also most cotton growers
were ill informed about the transgenic technology. Even after a large wave of promotion of GM crops, the knowledge of the public about the transgenic technology is still very limited. The absence of a shared basis for discussion and the susceptibility of the public to anti-science rumors make the public prone to be emotionally charged opponents and make it very difficult to conduct an effective dialogue between researchers and the public and build consensus among different groups of people.

INNOVATION

The transgenic technology caters well to the trend of changes in the needs for agricultural technologies in China. First, as the demand for land-intensive technologies steadily decreases with the shrinking of China’s per capita cultivated land, there is a growing demand for alternative technologies, especially land-saving output-boosting and resistance-enhancing technologies which are favored by both governments and farmers. In this regard, the transgenic technology has a tremendous advantage. Secondly, the shortage of rural labor and the growing cost of the means of agricultural production have led to the rising demand for labor-saving technologies. With the constant improvement of farmers’ net income and the growing percentage of non-agricultural income in their total income, the cost of rural labor also keeps rising. The growing opportunity cost of rural labor in turn leads to the rapid increase in the prices of means of agricultural production including agricultural machinery, pesticides and fertilizers. In this respect, the transgenic technology, with the sundry benefits it offers such as insect resistance, drought resistance and herbicide resistance, lends itself well by saving the input of labor and other means of agricultural production by a substantial margin and is therefore well received by farmers.

In spite of many favorite views for GM food innovation, the Chinese government has held an overall prudential attitude towards GM foods. The success in cotton production has given the government, research institutes and agricultural enterprises a deep understanding of the importance of the transgenic technology. It has become a consensus that China should catch up with the developed countries in the transgenic technology and build its own transgenic technological strengths in agriculture and related fields. Besides, China has formed a relevant scientific research system and accumulated a large amount of knowledge about biology in both basic research and applied research, thus laying a solid foundation for further research and development. While stepping up the research of the transgenic technology, the Chinese government has been very prudent about the commercial production of GM crops. Over the past more than one decade, only a limited number of crops such as tomato, papaya and pimento have been approved for commercial cultivation, and no permission has been given for the commercial cultivation of any staple crop, except that biosafety certificates were granted to two GM rice varieties and one corn GM corn variety in 2009. According to China’s regulations, there is still a long way to go for commercial cultivation even after the issuance of the biosafety certificates. Up to the present time, no GM staple crop has been approved for commercial cultivation in China.

In addition to the GM cotton, the GM crops and products which have been granted the biosafety certificates since 1998 include tomato, papaya, pimento and animal vaccines. The tomato is an important vegetable loved by consumers around the world. It is also the most widely used species in GM research. According to statistics, a total of 652 GM tomato varieties were tested from 1985 to 2010 in the world. In 1994, a storable GM tomato variety developed by a U.S. company was approved for commercialization for the first time in the world. The research of GM tomato in China started early. In 1997, the GM Crop Biosafety Committee under the Ministry of Agriculture approved the commercial production of the HUAFAN No. 1 storable tomato variety developed by Huazhong Agricultural University (Wang and Chen, 2011). In addition, Chinese scientists have also made extensive researches in anti-virus...
tomato, insect-resistant GM tomato, herbicide-resistant GM tomato, male sterility GM tomato and pharmaceutical protein expression GM tomato.

Papaya is the top tropical fruit in terms of output growth in the world and has become the fourth most popular tropical and subtropical fruit in the world. Asia is the second largest producer of papaya. The growing of papaya in China, mainly in Guangdong, Hainan, Guangxi and Sichuan, has had a history of more than 300 years. During the 8th Five-year Plan period, Chinese research institutes, as part of a national science and technology development program, obtained a virus infection-resistant CP-modified papaya strain by cloning the CP gene in papaya ringspot virus (PRSV). After that, with the support of the national 863 Program, the relevant research institutes completed a series of tasks including disease-resistance tests of GM strains, breeding of disease-resistant varieties, related breeding techniques, and field tests and obtained a replicate gene-transformed papaya strain, which was approved by the GM Crop Biosafety Committee under the Ministry of Agriculture in 2006 for commercial production in Guangdong (Zhou and Shen, 2010).

GM rice research is one of the limited number of fields in which China has reached the world-leading level. Chinese scientists have completed the genetic fine-mapping, sequencing and sequence analysis of the genomes of a series of rice varieties and developed more than half of the materials for genetic modification of rice, including more than 50 genes for use in rice transformation. Important results have been obtained in the research of insect resistance, disease resistance, drought resistance, efficient utilization of nutrients, rice quality, high yield and herbicide resistance, and new breakthroughs have been made in the development of green super rice. A series of results have also been obtained in the research on the social and economic aspects of GM rice, especially through investigative research and quantitative analysis of the cost benefit of growing GM rice. In 2009, the GM Crop Biosafety Committee issued certificates for the production of two GM rice strains (GM insect-resistant HUAHUI No. 1 and Bt SHANYOU 63) in Hubei. In addition to China, the U.S. (having approved six GM rice varieties) and Iran have also recognized the safety of GM rice. In 2006, the Canadian government approved the import of the bar gene-modified herbicide-resistant rice variety and its use as food. The Mexico government did the same in 2007.

RISK

1. General risks. As with elsewhere in the world, China is concerned about whether the GM foods will cause harm to human health and/or the ecology and environment.

To begin with, the concern about the possible harm of GM foods to human health is mainly shown in two aspects. The first is toxicity. The worry of most people about GM staple crops is that the long-term intake of the substance containing the Bt toxalbumin in GM crops may cause harm to health. The supporters of GM foods cite research results as saying that the toxalbumin produced by the Bt gene is not toxic to all organisms, but only to specific ones. However, in spite of the fact that relevant research institutes that GM foods may have a negative effect on the human liver, kidney and immune system are still popular among the opponents of GM foods.

The second is allergens. There are many allergens in the nature. If allergens are introduced into new crop varieties through genetic engineering, it will have a negative effect on groups sensitive to the allergens. Therefore, plants inserted with any allergen gene are prohibited from commercialization. In the U.S., for
example, a new bean variety inserted with the 2-S-albumin found in Brazil nut which increases the content of sulfur-containing amino acid in the bean was denied approval for commercial production.

The opponents take the fact that the EU, ROK and Japan restrict the production and import of GM crops as a strong case for the government to take more restrictive measures. With respect to the U.S. where the transgenic technology is the most widely used, GM supporters tend to emphasize that GM beans, cottons and corns have already accounted for a significant proportion of crops grown there, while GM opponents tend to refute by saying that the GM crops approved for production in the U.S. are all tomato, potato and other foods that are eaten only occasionally, rather than staple crops such as wheat.

Next, there is the GM crops’ ecological impact to consider, especially as related to transgene escape. In the natural conditions, natural crossing will take place between some cultivated plants and nearby related wild species, with the result that the genes of the cultivated plants are introduced to the wild species. If the cultivated plants are genetically modified, their genes will escape to wild related species in this way and lead to the spreading of transgenes among the wild related species. The ways which lead to this result include the scattering of seedlings, the regeneration of mitigated tissues, and the spreading of pollens. The consequences include the induction of resistance in insects and weeds, cross-species transgene escape, mutations in natural species, gene pollution and disruption to the food chain.

Moreover, the impact of GM crops on biocenoses and the related risks have been partially ascertained by Chinese scientists. A ten-year study found that, although the harm of bollworms has been effectively controlled since the large-scale planting of Bt cotton varieties in the Yellow River and Yangtze River basins, the significant decrease in the use of broad-spectrum pesticides for bollworm control have provided conditions for the rampant growth of mirid bugs, causing a lot of harm to other species such as dates and grapes. In those regions, mirid bugs have replaced bollworms to become the most serious cause of plague of insects (Lu, Wu et al, 2010). Many people see this finding as evidence that the transgenic technology has major defects and poses serious risks. However, some GM supporters, including the author, believe that the finding is not a negation of the insect-resistant cottons but merely indicates that more efforts are needed in biological technology to develop new solutions. For example, mirid bug-resistant genes may be introduced to protect those plants affected.

2. **Peculiar risks.** The GM food technology faces two peculiar risks in China, one related to the small-scale peasant economy, the other related to the governance capacity.

The peculiarity of China’s agriculture poses a unique risk to the development of GM agriculture. China has 700 million peasants, but its total arable area only stands at 120 million hectares, with the per capita arable area being less than 0.1 hectare. In addition to a large population with relatively little arable land, the scarce variable land is unevenly distributed geographically. In some provinces in eastern and southern regions, the per capita arable area is even less than 0.05 hectare. Furthermore, the arable land is severely fragmented among the farmers. Therefore, the asylum method promoted in the world for reducing the ecological impact of the transgenic technology is not feasible in China.

Due to the huge number of rural villages and farmers, it is difficult for the Chinese government’s administration to fully cover all the villages. This, coupled with the fragmentation of administrative powers among regions, has undermined the efforts and effectiveness of such efforts to perform cross-region and multi-region enforcement. Even though the Chinese government has never approved the commercialization of any GM rice, GM rice products have been found in the market. From July 2009 to
February 2010, Greenpeace tested 43 rice samples and 37 rice flour samples in nine areas including Guangdong, Anhui, Fujian, Hubei, Hunan, Zhejiang, Jiangxi, Hainan and Hong Kong and identified illegal transgene content in seven samples, including three containing the Bt transgene and the rest with unidentified transgenes. The seven samples in question include four rice samples from Hubei, Hunan and Fujian and three rice flour samples from Guangdong (Greenpeace, 2010). A 2005 Greenpeace report stated that there were illegal transgene seed rice products in Hubei market. After that, the Agricultural Department of Hubei made an investigation and admitted in a declaration that some local companies were found to have expanded the scope of their seed rice breeding without authorization.

In 2009, Greenpeace sampled homegrown papayas in Beijing, Shanghai and Guangzhou and found that almost all of them are GM products. Those GM papayas were found to be grown by fruit growers in Hainan in violation of applicable national regulations. Up to now, commercial production of GM papayas has been approved only in Guangdong province and it is illegal in all other Chinese provinces. In addition, import of papayas into China is also prohibited. The GM papayas identified by Greenpeace were from Hainan and even Thailand. These acts of growing or importing GM foods are all illegal (Greenpeace, 2009).

3. Industry risks. In recent years, foreign agricultural multinationals have established their own home-based integrated agricultural production systems through cross-border M&As. There is a widely shared view that the integrated agricultural production system worldwide poses a threat to the agricultural security of developing countries and may deprive the rights to foods and survival of millions of people. The population which is excluded from the economic system may become a root cause of political and economic crises in developing countries. The multinational agricultural companies in developed countries, through such means as M&As, IPR control and specialized production, have implemented a vertical integration strategy with few developed countries as the center and gradually controlled the entire agricultural and food production chain from raw material supply to core processes to sales. As multinational agricultural companies become increasingly monopolistic in the global agricultural and food production industry, many individual formers and medium and small-sized farms in the world have gone bankrupt and developing countries gradually lose their independence in food production, facing a serious crisis in agriculture. Transgenic technologies are also mostly controlled by large-scale agricultural and chemical companies in developed countries. In this backdrop, the Chinese government keeps strong vigilance on the potential risks of opening the relevant markets (Magdoff, 1998; Shiva, 2000; Amin 2003).

POWER/CONTROL

1. Administrative system
China’s existing transgenic GMO biosafety regulatory system consists of several tiers:

At the national level are a joint meeting system comprising the seven ministries and departments including the Ministry of Agriculture, the National Development and Reform Commission, the Ministry of Science and Technology, the Ministry of Health, the Ministry of Commerce, the State Administration for Quality Supervision and Inspection and Quarantine and the Ministry of Environmental Protection, and the National Agricultural GM Crop Biosafety Committee responsible for the safety assessment of agricultural GMOs, with its office established at the Ministry of Agriculture.
At the State Council level are the relevant competent ministries including the Ministry of Agriculture, the Ministry of Environmental Protection, the Ministry of Science and Technology and the Ministry of

1 http://www.gov.cn/gongbao/content/2007/content_810307.htm
Education, where the Ministry of Agriculture is responsible for the supervision and administration of the safety of agricultural GMOs in the country; the Ministry of Environmental Protection represents the state to take part in the negotiation concerning relevant international biosafety treatises and is responsible for the implementation of the UNEP International Technical Guidelines on Safety in Biotechnology in China, the coordination concerning the Inter-ministerial Joint Meeting on the Protection of National Biological Species Resources, and the review and approval of all genetic engineering activities within the territory of China; the State Tobacco Monopoly Administration is responsible for the review and approval of any transgenic tobacco plant used as raw materials of tobacco; the Ministry of Science and Technology and the Ministry of Health are jointly responsible for the administration of all activities related to the sampling, collection, research, development, purchase and sale, import and export, and exit of any human genetic resources in China; the State Administration for Quality Supervision and Inspection and Quarantine is responsible for the exit and, entry inspection and quarantine of GM products including provincial cotton production analysis and the development of cotton production suggestions; and the State Forestry Administration is responsible for administration of all activities related to the research, experiment, production, operation, import and export of GM trees.

At the local level are the agricultural departments at the county level and above which are responsible for the supervision and administration of the biosafety of GMOs within the administrative areas of their own administrative responsibility.

2. Regulatory framework
As GMO biosafety involves diverse fields including scientific research, health, environment and agriculture, the related laws and regulations are very complicated. Nevertheless, China has basically formed a comprehensive integral regulatory system comprising applicable national laws and regulations, international treatises, administrative rules and local regulations, as broken down below:

(1) International treaties and conventions: On April 27, 2005, the State Council approved China’s entry into the Convention on Biological Diversity and on September 6 of the same year China became a member state of the convention. In addition, China is also a member state of the Cartagena Protocol on Biosafety.

(2) Domestic laws: Provisions concerning GMO biosafety are included in the Seed Law adopted on July 8, 2000, the Agricultural Law amended on December 28, 2002 and the Grain Law (Exposure Draft) proposed in 2012.

(3) State Council regulations: The Regulations on the Administration of Agricultural GMO Biosafety effective on May 23, 2001 which provides for the administrative and regulatory system of agricultural GMO biosafety is at present the most important legislation on GMO biosafety in China.

(4) Administrative rules issued by competent State Council departments which cover agriculture, forestry, scientific research, food safety, and import and export, including the Measures for the Implementation of the Administration of Biosafety of Agricultural Biological Genetic Engineering, Rules of the Administration of Tobacco Genetic Engineering Research and Application, Provisional Rules for the Administration of Human Genetic Resources, Rules for

2 http://www.gov.cn/gongbao/content/2000/content_60332.htm
3 http://www.gov.cn/gongbao/content/2003/content_62419.htm
4 http://www.gov.cn/gongbao/content/2003/content_62419.htm
5 http://www.gov.cn/gongbao/content/2001/content_60893.htm
At present, China's GM food administration system still faces various problems, including the lack of coordination and cooperation among different government departments; inadequacy of administrative measures; lack of public participation, communication and decision-making transparency. From the perspective of policies, laws and regulations, China's regulatory system for GM foods covers economy, trade, production and environmental protection horizontally and research, experiment, processing, production, operation and import and export vertically, but there is still not any specialized comprehensive legislation. The regulations issued by various competent government departments are not only jumbled but also unable to address major biosafety issues which fall outside their scopes. Moreover, the lack of coordination among different laws and regulations has led to overlapping, conflicts or omission in responsibilities among various departments.

**Stakeholder groups (Reflective ethic and lay morality)**

1. **Producers**
   Whether the farmers adopt new technologies is dependent on their cost and promised return. Related researches find that, for example, insect-resistant GM crops are adopted by farmers on their expectation that they can reduce the use of pesticides and production cost and increase their productivity. Even though the price of GM seeds is several times more expensive than conventional seeds, the premium in price is still worthwhile in view of the many benefits brought by the GM seeds, including the saved cost in pesticides, reduced use of labor and prevention of pesticide-caused poisoning. Therefore, the farmers are generally willing to adopt these new technologies. In the long term, the degree of acceptance of the consumers for GM foods and the implementation of the GM food marking system may lead to changes in demand in the GM food market, and the uncertainty in this respect may lead to the fluctuation in the farmers’ expected return (Ma and Huang 2003, Zhao and Chen 2011, Zheng et al 2012). To sum up, short-term benefits may encourage farmers to adopt the transgenic technology within a certain period, but in the long term, they tend to take a wait-and-see attitude.

2. **Consumers**

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9 [http://www.gov.cn/gongbao/content/2002/content_61847.htm](http://www.gov.cn/gongbao/content/2002/content_61847.htm)
10 [http://www.gov.cn/gongbao/content/2002/content_61848.htm](http://www.gov.cn/gongbao/content/2002/content_61848.htm)
11 [http://www.gov.cn/gongbao/content/2002/content_61835.htm](http://www.gov.cn/gongbao/content/2002/content_61835.htm)
13 [http://www.gov.cn/gongbao/content/2005/content_63203.htm](http://www.gov.cn/gongbao/content/2005/content_63203.htm)
15 [http://www.gov.cn/fwxx/bw/lyj/content_397927.htm](http://www.gov.cn/fwxx/bw/lyj/content_397927.htm)
16 [http://www.szsmb.gov.cn/content.asp?id=17172](http://www.szsmb.gov.cn/content.asp?id=17172)
The degree of acceptance of the consumers for GM foods will eventually determine the space of growth of GM foods. Two surveys in 2002 and 2003 showed that approximately 67% of urban consumers were aware of the transgenic technology and approximately 60% accepted GM foods (Huang et al 2006). Relevant surveys in recent years indicated some improvement in urban consumer awareness of GM foods but a certain decrease in their acceptance of GM foods (Luo 2010, Zhou et al 2012). Researches find that the main determinants of consumers’ attitude toward GM foods are food safety and income. There is a positive correlation between food safety and the willingness to buy, and a negative correlation between income and the willingness to buy. Food safety is dependent on information symmetry and is mainly subject to the influence of media publicity and the degree of trust in the government. The views on the media have a strong influence on the degree of acceptance of Chinese consumers for GM foods. Foods usually have a low price elasticity. Consumption of foods accounts for a very small proportion in the spending of high-income families, and the reduced cost provided by GM foods has little influence on them. To the contrary, low-income families will be more attracted by the lower cost provided by GM foods and tend to adopt an accepting attitude towards them.

**GM Consensus Conference**

In order to better understand the public debate on GM foods, the Chinese Academy of Sciences (CAS) instigated the project “Science in Community” to provide a platform of dialogue where the participants (volunteers from the public) with no specialized knowledge have open discussions with experts about a science and technology topic closely related to everyday life. The purpose of the project was to expand the traditional channels of popularizing scientific knowledge by providing an opportunity of direct dialogue between experts and non-experts to enable ordinary citizens to acquire knowledge of the subject matter through the contact and interaction with experts. At the same time, the project tried to promote public involvement in science and technology policymaking by providing a platform for open discussion and exchange of views and also to enable the public to acquire knowledge and the experts and the government to be informed about the public opinion on related issues.

The main theme of the “Science in Community” project was GM Foods and the main activity in 2008 activity was organized by CAS and the local government (Xicheng District, Beijing) as a consensus conference with volunteer lay public. The number of lay public, selected to reflect socioeconomic and demographic diversity such as sex, age, level of education and occupation, was twenty. A preparatory meeting consisting of lectures by experts, on various aspects of GM foods (e.g. scientific process, health implications, safety legislation, ethics issues, etc.) followed by Q&A sessions took place. That was followed by a formal meeting with expert talks on the main themes and Q&A sessions between participants and experts.

The results of the consensus conference can be summarized as follows:

Chinese consumers, especially those living in large and medium-sized cities, are increasingly worried about genetically modified (GM) food. Consumers from Beijing who attended this consensus conference (2008) are particularly interested in the GM food safety and hope to get definite answers from participating experts, instead of just principles or theories. At the same time, consumers also want to know what GM food products are available on the market, what food products they consume on a daily basis contain GM material and what GM technology really is. When we looked at why consumers attended the conference and what they hoped to get from it, we found that they tend to understand new technologies based on their experience in daily work and life and also hope to benefit from professional advice and perspectives.
The participating consumers’ perception of GM technology has changed with the end of the consensus conference, most visibly evidenced by a shift from simple assessment of good or bad to a more complicated criterion of evaluation. They have come to the realization that GM technology has social, economic, political, cultural and other dimensions. They have also gained to some extent an objective understanding of the uncertainties and risks of this technology. On the other hand, the conference has aroused the enthusiasm of participating consumers in getting involved in the public decision-making process in the science and technology field and convinced them that their own rights should be upheld by taking actions themselves.

In general, this conference shows the following: first, the public are paying closer attention to the risks of biotechnology, in particular the risks that might arise from biotech application in our daily life as typically shown in GM food; second, the Chinese public in general trust the government and scientists, and direct dialogue between the public and the government and scientists helps boost this trust; and third, the public are cautious about the development of GM but are supportive of the country’s efforts in developing biotechnology, including GM technology.

3. Government

The Chinese government recognizes the expected benefits of transgenic R&D and its significance for achieving China’s grain and ecological security. The multifarious advantages of the transgenic technology in water conservation, labour-saving and yield improvement will provide an effective support in filling the future gap in the grain supply and safeguarding China’s grain security. Meanwhile, the Chinese government has attached a greater importance to ecological security. China’s arable land is less than two thirds of that of the U.S, but the amount of pesticides used in China is several times greater than that in the U.S. The great use of pesticides and chemical fertilizers, while increasing the per unit yield, has also deteriorated the environment. In this backdrop, the R&D in transgenic breeding technology is very necessary in China’s effort to reduce the use of chemicals and at the same time guarantee adequate grain supply. The transgenic technology is a high-cost, high-risk and high-return technology. By strongly funding and promoting the R&D of this technology, the government has stance to get tremendous benefits but also faces significant risks. First, the R&D requires a large amount of investment. The biological engineering technology is one of the 16 major scientific and technological endeavours prioritized in the Outline of the National Program for Long-and Medium-Term Scientific and Technological Development (2006-2020) and the R&D in transgenic rice alone has a budget of up to RMB 22 billion. In spite of a huge cost and significant risk, the expected benefits of the transgenic rice technology for China’s grain security are so great that the government still has a strong motivation to promote it.
# ETHICS AND PUBLIC PERCEPTIONS

Food Technologies Ethical Matrix

<table>
<thead>
<tr>
<th></th>
<th>Beneficence</th>
<th>Non-Malfeasance</th>
<th>Justice</th>
<th>Autonomy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Government</strong></td>
<td>Food security. Promoting transgenic technology. Industry security.</td>
<td>No damage to ecological security. No adverse social effects.</td>
<td>Establishing regulatory framework. Small-scale peasant economy. Improving governance capacity.</td>
<td>Prudent about the commercial application of GMO.</td>
</tr>
<tr>
<td><strong>Innovator</strong></td>
<td>Advance science. Commercial application of GMO. Profitability.</td>
<td>No damage to reputation.</td>
<td>No unfair regulation or competition.</td>
<td>Freedom to carry out transgenic technology research. New GMO technology patent protection</td>
</tr>
<tr>
<td><strong>Producer (Farmer)</strong></td>
<td>Reduce the use of pesticides and production costs. Maximizing the agricultural profit.</td>
<td>Increasing the degree of acceptance of the consumers. No environmental damage.</td>
<td>Ability to establish equitable trade deals with suppliers and customers.</td>
<td>Ability to choose which crops and stock to farm.</td>
</tr>
<tr>
<td><strong>Consumer</strong></td>
<td>Food safety. Affordability.</td>
<td>NO negative effect on the human health. No adverse impact on the environment.</td>
<td>Appropriate use of the Precautionary Principle.</td>
<td>The choice of GMO and Non-GMO. Effective and adequate labelling to enable an informed choice including a risk/benefit choice.</td>
</tr>
</tbody>
</table>

The shareholder groups in China – producers, consumers and the government, which lack regular communication – have markedly different attitudes towards GM foods and are difficult to reach even basic consensus on some issues. In China, the discourse on supporting GM foods and related technologies through innovation is shown as two intertwined systems. The first is the discourse of developmentalism which holds that only by giving full scope to the advantages of the biological technology and using the transgenic technology to transform products into productivity can China’s agriculture undergo fundamental changes. It further states that the transgenic technology will be able to
improve the inherent value of the traditional agriculture because the reduced production cost and improved output brought by the transgenic technology will increase the agricultural productivity. Besides, the development of GM foods is a long-term trend of agriculture in the world and it will also be an important way to solve China’s food problems in the future. It concludes that great efforts should be made to promote the transgenic technology. The second is the discourse of scientism which, starting out from Deng Xiaoping’s judgment that “Science and technology constitute a primary productive force”, holds that GM foods with their high technology content naturally have their political legitimacy and that under the aura of science, the high authority and reputation of scientists and high technologies tends to foreclose reflection on the legitimacy and social consequence of GM foods, thus endowing them with an automatic correctness.

The production and consumption of GM foods in China also faces potential risks. The first category is general risks posed by GM foods to the consumers and the environment. The second category is China-specific risks which are mainly related to China’s existing agricultural situation and administration and lead to debates about the peculiarity of China in developing GM foods. The third category concerns industry security. Food security is a core issue for the Chinese government, which does not want to see the country’s industry security undermined either by foreign control of key technologies or by China’s own lack of technological preparation. The issue of industry security is an important part of the debate about the risks of GM foods in China.

The statement that “the industrialization of new GM varieties shall be advanced on the basis of scientific assessment and legal regulation” in the No. 1 document of the central government in 2010 represents the determination of the Chinese government to develop the GM food technology. The Chinese government has a rather mixed attitude towards the GM food technology. On the one hand, it is prudent about the commercial application of relevant technologies, and on the other hand, it takes the R&D and independent possession of transgenic technologies as a strategic policy for supporting agricultural development at the national level.

References for the Chinese Case Study


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**Ethics Debates on Food Technologies in India: R&D Priorities, Production Trends and Growing Expectations**

**INTRODUCTION**

In the last sixty years or so Indian agriculture has passed through some major challenges of extreme shortage of food. Throughout the post Independence period of 1947 to 1952, India was dependent on food aid programmes of the USA and other major food suppliers like Canada Australia etc. It was in 1943 that in the Bengal famine, India had lost around 4-5 million people. With this backdrop, need for technological intervention for higher yields was widely felt all across the policy circles in Delhi. Eventually, Green Revolution was introduced in 1967-68, that dramatically captured peoples’ imagination of technology in the context of agriculture.

Green Revolution was embraced by the Indian government as a technological response to the rising gap between food demand and food availability. Green Revolution brought about significant changes in Indian agriculture; it transformed India from a food deficient country to a leading food producer. The Green Revolution resulted in a record grain output of 131 million tonnes in 1978/79. This established India as one of the world’s biggest agricultural producers. Yield per unit of farmland improved by more than 30% between 1947 (when India gained political independence) and 1979. The crop area under high yielding varieties of wheat and rice grew considerably during the Green Revolution.\(^\text{17}\) The agro-economic setting of India changed as capital intensive agriculture increased economic disparities between large farmers and small farmers.

However, Green Revolution has attracted intense criticism largely due to the inequalities it led to in Indian agriculture, its impact on environment and stagnation of benefits. Switching from traditional subsistence farming to industrial monocropping had negative effects on small farmers. They found themselves trapped in the cycle of high interest rates on seeds, fertilizers, and pesticides which they had to buy on credit. Because they were often only working with one dealer, there was no competition and prices were able to remain very high.\(^\text{18}\)

There was evidence of negative socio-economic and environmental impacts of Green Revolution leading to sharp controversies that are still alive today.\(^\text{19}\) The institutional and economic conditions for using the GR technology effectively and safely were not in place or the services needed for small scale producers to gain access to or to realize the benefits were inadequate, especially for the resource poor, the indigent and the marginalized and women.\(^\text{20}\)

Since then debates have hovered around solutions and possible way forward. The debate on the environmental impact due to excessive input used led to the introduction of various movements for organic production. Several states governments have come up with plans to support organic food production. However, a large number of people facing hunger, post-production losses of perishable and

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17 See [http://edugreen.teri.res.in/explore/bio/green.htm](http://edugreen.teri.res.in/explore/bio/green.htm)
18 See Sebby Kathryn (2010)
semi-perishable products are extremely high. This is estimated to be between 5.8 and 18 per cent and between 6.8 and 12.5 per cent respectively. Technological interventions are important to guide on this issue. At this point, India has double malnutrition burden. India is among the countries with highest prevalence of anemia affecting 75% children below 5 years, 51% of women of 15 to 59 years and 87% pregnant women.\textsuperscript{21} In the urban areas, there is growing problem of obesity and overweight and in poor and rural areas of underweight and anemia.

The other was about the debate on inequality in access to Green Revolution. It was claimed that large part of India was left out of Green Revolution, as it was confined only to the rich northern states of Punjab, Haryana, parts of Uttar Pradesh, Madhya Pradesh and Maharashtra. This has led to supplementary programmes like the one recently launched called BGREI (Bringing Green Revolution to Eastern India) under the Rashtriya Krishi Vikas Yojana (National Agriculture Development Plan, RKVY) in Assam, Bihar, Jharkhand, eastern Uttar Pradesh, Chhattisgarh, Orissa and West Bengal to address the issues of rice-based cropping system in these states. This supplementary program may go a long way in improving food security at the sub-regional level. Over the years the Indian Council of Agriculture Research (ICAR) has developed a comprehensive institutional infrastructure including four deemed universities, 47 Central institutes, 17 national research centers and 25 project directorates to carry out its research objectives. This may facilitate greater access to new technologies.

The impediments for enhanced food production, emanate not only from skewed access to technology but also from growing urbanization and market incentive structures that are adversely affecting area under cultivation across different crops. Brahmmanand et.al.(2013) finds the area under cereals as percentage of gross cropped area declined from 56.53% in 1991 to 51.74 in 2008 i.e. from 103.68 million hectares it has come down to 99.08 million hectares. At the same time, the area under oil seeds has expanded from 13% to 14% and expansion is also evident in other areas of urban demands like for fruits, where it has expanded from 1% to 3% and for vegetables where the expansion is from 2% to 4%. Kannan et.al. (2000) projects that there might be a continued shortfall of food grains of around 36 to 64 million tons in the decades to come. The other challenge is of necessary gadgets for farmers. About 85 per cent the farmers of India have small land holdings of less than two hectare, which restricts their full potential for production.\textsuperscript{22} The relevant size of gadgets for small and marginal farmers at a cost i.e. affordable requires new technological solutions. Overall cost of cultivation, largely an outcome of input costs, in any case has gone up in a major way, pushing up overall food prices.

In addition, the idea of targeting the frontier technologies for economic development is now gradually becoming an important component of public policy formulation in India. This has led to policy documents like the National Biotechnology Vision and the legislation such as the Patent Law and the National Biosafety Guidelines. The diffusion of biotechnology in such sectors as pharmaceuticals and industrial applications is particularly advocated, because of its strategic importance in enhancing overall manufacturing capability. However, in the agriculture sector, particularly in food crops, India has witnessed intense political debate which led to complete suspension of the whole process of GM commercialization in India.

The socio economic parameters for India are also not very impressive. According to Global hunger index 2013; India is one of the nineteen countries which have “alarming” or “extremely alarming” levels of hunger. GHI (global hunger index) measures three different dimensions of hunger including

\textsuperscript{21} AVARD (2013)

\textsuperscript{22} In India, 64.7% of holdings are marginal (upto 1 hectare) and 18.52% are small (01-02 hectare), which is 83.29% however out of this only 43.14% area is under cultivation.
Undernourishment, Child underweight and Child Mortality. Although India’s GHI has declined from 32.6 in 1990 to 21.3 in 2013, it is still very high relative to other developing countries. India ranks 63rd in GHI out of 120 developing countries which calls for institutional and financial synergies in strategies and policies.

In the next few pages, we try to explore how far innovation priorities reflect the current concerns and debates in the food sector, across its various stages of value change. We also try to explore associated linkages with risks and power structures. The last section draws our concluding remarks.

FRAMEWORK
As per the GEST project framework, this case study on food technology debates in India is based on three pillars viz. innovation, risk and power within which ethics discourse and public discourse are discussed as cross cutting themes. In Indian context there is predominant presence of socio-economic issues which requires special attention. In this case study we have tried to capture essential elements of socio-economic issues as an additional discourse.

The concerns about the impacts and implications of the emerging technologies can be described within the current framework as much as they relate to Europe. In case of India, socio-economic issues assume additional significance and deserve to be treated in an independent category. For example in case of GMOs the current framework is not sufficient to address issues raised under Article 26 of CBP. Other important issues in case of GMOs and biotechnologies and nanotechnology in agriculture are their impacts on small farmers and on biodiversity. In case of biotechnologies and nanotechnologies socio-economic issues that are not important in the European and US context are important in India e.g. impacts on livelihoods, jobs and affordable access to technology.

INNOVATION:
Technological changes have played an important role in Indian agriculture however, the total factor productivity (TFP) which at one point played a key role in overall growth of agricultural output has shown slowing down since 1980s. The growth rate, as calculated by various different authors range from 0.9 to 4.0. The slowing reflects declining inputs from agriculture R&D.

It seems that technological interventions are discernible at three different levels. They are agriculture biotechnology which includes both based on genetically modified crops and biotechnology applications which do not use techniques like genetic modification and lastly the organics, where, at this stage innovation related inputs are least. In addition to these are the techniques used traditionally for plant breeding. In this section we take up these categories for detailed discussions.

Agricultural Biotechnology
This is one area of agricultural R&D where both private and the public sector have increasingly enhanced their allocations. Since the setting up of the National Biotechnology Board in 1983 institutional

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23 Ramasamy (2013)
24 ibid.
frameworks have continuously evolved over the years. Major debates on innovation priorities in the agriculture biotechnology led the government to appoint a task force under the chairmanship of renowned Indian agriculturist M.S. Swaminathan. It was set up by the Ministry of Agriculture to deal with the objective of formulation of a long-term policy on applications of biotechnology in agriculture.

This report was the result of detailed discussions with representatives of farmers, NGOs, associations of seed industry, association of industry, representatives of the State Governments and representatives of media. Written submissions were also made by some stakeholders, particularly, State Governments. In this report there was a section on application of biotechnology in agriculture. This section categorically mentioned that the infusion of new technology is necessary to make Indian agricultural enterprises competitive and remunerative. It went to mention myriad applications of biotechnology in agriculture such as generation of transgenic crops/animals/microbes with improved traits, use of molecular markers, DNA-based diagnostics to monitor/eradicate pest and pathogens of crops, biotech-derived drugs/antibiotics/vaccines for animal husbandry, plant tissue culture, feed biotechnology, food biotechnology, bioremediation, functional genomics/proteomics/bioinformatics and nanobiotechnology. Further, it asserted that since there is public, political and professional concern about the transgenics with reference to their short and long-term impacts on human health and environment, their testing, evaluation and approval have to be stringent, elaborate and science-based. Larger public debates on priorities and sequencing of technological applications were well captured by the Swaminathan committee. It recommended that the general approach in this respect should be as follows:

- biotechnology applications, which do not involve transgenics such as biopesticides, biofertilizers and bio-remediation agents, should be accorded high priority. They will help to enforce productivity in organic farming areas;
- transgenic approach should be considered as complimentary and resorted to when other options to achieve the desired objectives are either not available or not feasible;
- high priority should be accorded in transgenic approach to the incorporation of resistance to insect-pests and diseases including viruses and to drought and salinity (i.e. biotic and abiotic stresses);
- transgenic research should not be undertaken in crops/commodities where our international trade may be affected, e.g., Basmati rice, soybean or Darjeeling Tea. (Wheat exporting countries like Canada and USA are abandoning their programmes for breeding transgenic wheat varieties and hybrids);
- the international guidelines being set up by the FAO-WHO Codex Commission for assessing and managing the health risks posed by GM foods should be closely followed. These risk analysis guidelines call for safety assessments to be conducted for all GM foods prior to market approval;
- In addition, core information about gene exchange taking place among modern cultivars, traditional varieties and wild relatives should be gathered to assess concerns of transgene escape and establishment. Data should also be gathered on the impact of transgenics on biodiversity in crop fields, as has been done on an extensive scale in the United Kingdom.

In India there was huge debate on protecting and conserving precious agro-biodiversity in their pristine purity. Suggestion has been that such areas should be earmarked as ‘agro-biodiversity sanctuaries.’ In such areas, the cultivation of GM crops should be prohibited. The above mentioned report supported this position. The recently appointed expert group by the Supreme Court, details of which we discuss little later, has also suggested that, release of GM verities for those crops should not be allowed for
which India is a centre of origin. This would have a bearing on the GM brinjal, known as Bt brinjal from the insecticide derived from the *bacillus thuringiensis* that was developed by major seed company Mahyco.

Private sector has played an important role in emergence of this sector. Monsanto and an Indian company Mahyco formed a joint alliance to develop and market Bt cotton. Later they gave licenses to nearly 300 seed firms in India and created a huge network for promotion of this option all across the cotton growing areas in India. J K Agri genetics was the only Indian company that came up with an alternative Bt option. The pipeline through field trials is quite long for the agri-biotech sector in India though at this point there is lull in the activities.

In summary, GM technology majorly relates to increasing yield, productivity, and environmental sustainability in the form of resilience to stress (drought, salinity, pest etc) and lesser use of insecticides. Socio-economic gains from GM technology like increased yield, productivity, production, reduction in labour cost have been identified by various authors. For farmers the trade-off is determined by many factors including cost of inputs and expected returns. But farmers are also vulnerable for failure on account of other factors like drought, excessive rain, poor quality of the seeds, and price volatility. Insurance to protect farmers from such factors, supply of quality seeds and educating them in proper use of technology are necessary to derive the best gains from GM technology but as this is not happening it results in less than optimum gains for farmers. Farmers are often unaware of the need for refugia or do not follow the norms related to that on account of ignorance.

One such example is Bt cotton which has been enveloped in controversies due to farmer suicides because of seed monopolies but still Bt cotton accounts for 93% of cotton grown in India.\(^{25}\) But these Bt cotton seeds are expensive and as they are hybrids farmers have to buy seeds every cropping season.\(^{26}\) In China public sector took the initiative to develop varieties that could compete with varieties developed by Monsanto or using technology obtained from Monsanto and this in turn helped to make seeds more affordable. More importantly it demonstrated the capacity of public sector to raise to the occasion and Monsanto could not become the most dominant player in the market. In India this did not happen and the failure of public sector has resulted issues relating to exorbitant seed prices, monopoly and competition in the market resulting in state governments intervening to bring down price of seeds. The innovation issue is thus linked with socio-economic issues and the diffusion of innovation is influenced by these issues in India. With India opting for more GM crops the lessons from Bt cotton are important.

**Non GM Biotechnology Research\(^{27}\)**

There is huge emphasis on developing non-GM options in agricultural sector by the public sector research institutions. This is largely to develop new varieties of different crops (See Table 1). The IARI developed a new rice variety having higher yield (37 q/ha) than Pusa Basmati 1. Pusa 1460 (IET 18990) by pyramiding bacterial leaf blight (BLB) resistance genes (xa13 & Xa21) in the background of Pusa Basmati 1 through marker assisted backcross breeding, which was released in 2007.\(^{28}\) Another rice variety, RP BIO 226 (IET 19046) is developed by Hyderabad based Directorate of Rice Research. This variety is a near isogenic line containing the bacterial blight resistance genes, Xa21, xa13 and xa5 developed in the

\(^{25}\) See Jayaraman, K.S (14 February 2012).
\(^{26}\) See Shiva, Dr. Vandana
\(^{27}\) This part is based on Chaturvedi (2013)
\(^{28}\) ICAR (2007)
genetic background of an elite fine grained rice variety, Samba Mahsuri. It is developed through marker assisted backcross breeding. The National Research Centre on Rapeseed-Mustard (NRCRM), Bharatpur, has developed the first Indian mustard hybrid namely NRC Sankar sarson (NRCHB 506), which was released in 2008. This hybrid of Indian mustard developed through heterosis breeding using moricandia cytoplasmic genetic male sterility system is the first CMS based hybrid of Indian mustard. It is largely seen as an important milestone in Brassica research programme of the country.

One of the major paradigm shifts in the working of the public sector funding agencies is to encourage network approach in agriculture biotechnology. This is being tried across various crops with different objectives, depending on the specific expertise of various agencies and scientists. The Department of Biotechnology (DBT) has been spearheading this network approach. As the Table 1 indicates this is being tried in wheat, rice, cotton, mungbean, tomato, mustard and millet. This is just an indicative list not an exhaustive effort for including all such initiatives. As is clear, key national institutions are being encouraged to collaborate with many smaller crop specific institutions. The idea is to develop superior genotypes for using biotechnological interventions like transformation, hetrosis breeding, molecular breeding and marker aided selection. There are two major projects in the area of functional genomics of rice.

Table 1: Non GM Agri Biotechnology from India Public Research Institutions

<table>
<thead>
<tr>
<th>Crop (Improved)</th>
<th>Nature of Technology</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice (Improved pusa basmati)</td>
<td>Marker Assistant Selection</td>
<td>Released (2007)</td>
</tr>
<tr>
<td>Mustard NRC-Sanker Sarson (NRCPB + NRCRM, Bharatpur)</td>
<td>CMS derivation from protoplant fusion**</td>
<td>Released (2008)</td>
</tr>
<tr>
<td>Improved Sanka Mahsuri (Directorate of Rice Research, Hyderabad)</td>
<td>- Marker Assistant</td>
<td>Released (2008)</td>
</tr>
<tr>
<td></td>
<td>- Bacterial Blight Resistant</td>
<td></td>
</tr>
</tbody>
</table>

* Resistance to bacterial blight dimension; ** High yielding hybrids


This is going to be of great significance in days to come, as public sector institutions realise their potential and also the fact that being late may adversely affect their ability to optimize returns on their potential. However, one point is extremely clear, public sector institutions due to access to quality germplasm and ability to introduce technology in their own popular hybrids, would have an important role in days to come. This may require a sea change in the working style and approach of public sector scientists.

Innovation discourse in non GM biotechnology research highlights the unused potential of that biotechnology as a supplement to other technologies in India. The idea is to develop superior genotypes by using biotechnology in traditional breeding resulting in better varieties and also varieties that could meet new and unmet needs. Increasing productivity and developing varieties that are more suited to different agro-climatic conditions through non-GM biotechnology is possible and desirable. The socio-economic issue here is food security; making access to such varieties affordable and enhancing productivity.
The realization of the potential of such innovations needs more investment in R&D, capacity building and also continued commitment to public sector R&D particularly plant breeding. Since the private sector is not likely to deploy these technologies in crops and regions where they do not see much potential for profit therefore public sector has to play an important role in this. The socio-economic benefits from these innovations in agriculture R&D are such that there is a need to replicate the green revolution model in gene revolution taking in to account environmental sustainability, needs of small and medium farmers and expanding the scope of such interventions to millets etc.

Research on Organics
Defining Organic Agriculture
The organic agriculture largely encompasses practices that facilitate environment friendly food production system. As per the definition of IFOAM (International Federation of Organic Agriculture Movements), organic agriculture is a production system that sustains the heath of soils, eco systems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved.

Meager Initiatives by government
At present, innovation in this area has very little systemic support. There are very few initiatives taken by the government to promote organic agriculture. The training and extension system for promotion of organic agriculture is weak, Mahale (2003) states that currently, no government scheme exists for organic agricultural extension services in the country. Organic agriculture needs to be linked up in one way or the other with the existing support services, as was done in Europe, where gradually agricultural universities opened a faculty for organic agriculture.

Some of the projects initiated by the government are National Project on Organic Farming (NPOF), National Horticulture Mission (NHM), Horticulture Mission for North East and Himalayan States (HMNEH), Rashtriya Krishi Vikas Yojana (RKVY) and Network Project on Organic Farming of the Indian Council Agricultural Research (ICAR). National project on Organic farming came into effect since the 10th Five Year plan with an outlay of Rs 57.04 Crore; the government has increased the funding in the 11th Five year plan to Rs. 101 Crore.

Low R&D Investments
Research and technological development conducted within functioning organic systems is essential to overcome some of the technical problems which still exists and to improve further increase in the potential of organic farming in the country. Current organic practices have been developed primarily by existing farmers who have been practicing organic farming by default due to lack of resources and finance against the background of scientific knowledge.

Significant public funding for research and development is crucial to boost organic farming sector further. Despite designating organic farming a major thrust area, India accounts for only $123 million in a $40 billion global organic food market. 29

Increase in Area under Management

29 See Charyulu Kumara (2010)
There are fervent supporters of organic agriculture in India who feel that organic farming can serve the purpose of meeting food security for the country and also for rural development and involvement of indigenous communities. Despite lack of support, there has been considerable growth of area under organic management in India since 2003-2004. Figure 1 provides information on yearly growth of cultivated area under organic management.

Figure 1: Cultivated area under organic management

![Cultivated area under Organic Management](image)

Source: National Project on Organic Farming, Dept. of Agriculture and Cooperation, GOI

With the phenomenal growth in area under organic management and growing demand for wild harvest products, India has emerged as the single largest country with highest arable cultivable land under organic management. India has also achieved the status of single largest country in terms of total area under certified organic wild harvest collection.\(^30\)

In order to encourage systemic support a National Centre of Organic Farming was established in 2004 which launched several institutional majors for extending support for soil testing, product certification, resource-base assessment, manpower development etc. At present, India has 4.4 million hectares (2010-11) under certified organic production (including wild harvest). India produces around 3.88 million MT of certified organic products which include basmati rice, pulses, honey, tea, spices, coffee, oil seeds etc. The export of the order USD 157 million. Table 2 refers to category wise production of certified organic products for the year 2010-11.\(^31\)

Table 2: Category wise production of certified organic products

<table>
<thead>
<tr>
<th>Products</th>
<th>Total Production (M.T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals (Except Rice)</td>
<td>171684.66</td>
</tr>
<tr>
<td>Coffee</td>
<td>13122.03</td>
</tr>
<tr>
<td>Cotton</td>
<td>552388.47</td>
</tr>
<tr>
<td>Dry Fruits</td>
<td>52369.09</td>
</tr>
</tbody>
</table>

\(^30\) See Yadav A.K , NCOF (2011)

\(^31\) See APEDA website
### Table

<table>
<thead>
<tr>
<th>Product</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh Fruits &amp; Vegetables</td>
<td>335863.11</td>
</tr>
<tr>
<td>Medicinal &amp; Herbal Plants</td>
<td>1792014.86</td>
</tr>
<tr>
<td>Oil Seeds</td>
<td>360837.17</td>
</tr>
<tr>
<td>Pulses</td>
<td>42721.61</td>
</tr>
<tr>
<td>Rice</td>
<td>176683.17</td>
</tr>
<tr>
<td>Spices-Condiments</td>
<td>129878.46</td>
</tr>
<tr>
<td>Tea</td>
<td>27684.26</td>
</tr>
<tr>
<td>Misc</td>
<td>221191.96</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>3876438.85</strong></td>
</tr>
</tbody>
</table>

Source: (APEDA, National Centre of Organic Farming)

### Certification

Largely public sector institutions are engaged in certification and ensuring quality for the products. 

Regarding certification, Ministry of Commerce had introduced regulation for organic products in 2001, whereby organic products can be exported only if they are certified by government-approved accreditation agencies. \(^{32}\). APEDA is the nodal agency which looks after the certification of products as per National Standards for Organic Production. In India, genetically modified organisms are not allowed in National Programme for Organic Production. This is due to incompatibility of the GMOs with Organic agricultural principles.

According to a report by ICCOA, global demand for organic products is growing at 15-25%, although this demand is concentrated in Europe and USA but new markets are also expected to emerge in the Asian region.

### Socio- Economic Issues

There are several socio-economic benefits which can be provided by organic agriculture in terms of quality products, price premiums for the products, independence in terms of technology and increased sustainability in agriculture. With increasing safety concerns, demand and awareness about food quality, organic agriculture can be seen as providing safer food, sustainable livelihoods to several farmers and a possible alternative to technologies like biotechnology. State governments have initiated several programs for sustainable agriculture focusing on organic farming. DST has sponsored research projects on this while NABARD has also been supporting projects that are oriented towards diffusion of organic agriculture among small and marginal farmers. In view of demands of farmers who lack access to irrigation or depend on rain only as major source of water, the need for developing an agriculture that could meet their needs is obvious. In this also there are many projects that are in demonstration phase now. Although these projects and area covered by them are not large, they have the potential to bring in enhancing innovation in organic agriculture and make it affordable. Some projects promote group and co-operative farming while some others train farmers in meeting norms in standards. The challenge lies in scaling up these efforts and in developing a policy framework that helps farmers to gain from organic agriculture.

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\(^{32}\) UNESCAP report “Exploring the potential of Organic Agriculture for Rural Poverty Alleviation in Asia and the Pacific”,

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Innovation discourse in organics is confined to low systemic support in terms of R&D extension, budget allocations and limited number of projects in promoting organic agriculture but despite the impediments, there has been considerable growth in organic output and the area under organic management.

**Traditional Breeding**

With the green revolution the base for research on food crops has got increasingly narrower. Given the growing incidences of malnutrition, micro-nutrient deficiencies and nutritional insecurity, it is important entry points are identified for possible technological interventions.

The current innovation priorities require focus on challenges like merging water crisis and research on additional genetic material for better verities. Indian agricultural innovation focused on water balance is extremely important consideration at this point. At the global level, demand for water is growing at 2.4% annually. It is estimated that 20% of globally cultivated area uses 70% of global water usage. In India, around 63 million hectare is irrigated area, most of which uses ground water. Around 80 million hectare of the cultivated area is rain-fed. In this backdrop, innovation in agriculture has to address draught resistance as a major source for technological intervention. The Water Technology Center at the Indian Agricultural Research Institute (IARI) is a lead research center, working on drought tolerance across various different crops. The center is working on drought tolerant wheat and rice varieties and has also worked on efficacy of different in-situ moisture conserving bio-engineering measures (viz. basin tillage, ridge and furrow, trench-cum-bund, bund) for enhancing crop productivity through pearl millet-mustard based cropping system in rainfed areas.

In case of planting material, it is the National Bureau of Plant Genetic Resources (NBPGR) which leads the research through its two divisions. Plant Exploration and Collection Division has the objectives to plan, coordinate and conduct explorations for collecting germplasm. Germplasm Evaluation Division is entrusted with the prime responsibility of characterization and evaluation of all the indigenous and exotic germplasm collections for their field performance and other important traits like resistance to biotic/ abiotic stresses and phytochemical attributes along with maintenance and regeneration. Apart from NBPGR, respective crop-specific research institutes maintain their own germplasm base as well. However, with the implementation of PVP&BR Act and Biodiversity Act new impediments have come up in sharing of seeds, planting materials and Biotech products. ICAR has institutions involved in collecting, classifying, analyzing and storing germplasm with NBPGR as national level institution.

Budget allocation for conventional breeding is mainly received from ICAR and CSIR with very specific monetary support from Department of Biotechnology. Plant breeding is encouraged by the government and the output is expected to increase. New innovations in plant breeding like Marker assistance technology have the capacity to increase yield and productivity and contribute to food security. Innovation priorities in this discourse are limited to certain technologies whereas there are several other technological options which are not utilized effectively.

Current R&D priority in this area is to focus on breeding tools and techniques such as Molecular breeding (genetic engineering, gene manipulation, molecular marker-assisted selection, genomic selection, etc)

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33 Brahmanand (2013)

34 Personal communication with Dr. Ravi Khetarpal
which is an application of molecular biology tools, often used in plant breeding. It is selection of the parent genes based on the traits. Integration of molecular breeding in current research priorities can serve as a key to improved yield and disease resistance. The major challenge faced today is to develop crops with complex traits which are insect resistant, drought resistant, flood resistant, and salinity resistant and presently there are three major crops rice, wheat and maize which have been paid attention.\textsuperscript{35}

Presently technology has not been exploited to its potential, where the ideal approach of Molecular technology is yet to come in India, germplasm collection has been not been used properly as half of the genes in the gene bank are not evaluated.\textsuperscript{36}

Focus has to be laid on orphan crops like sorghum and millets which constitute good mineral elements and nutrient value. Hymavathy (2013) argues that traditional foods like millets needs to be included in the food technology basket. Sorghum, finger millet, pearl millet and other minor millets have been the traditional diet of many communities, they have a dual advantage of being-less water intensive to grow, and more nutritious with higher mineral, dietary fibre and vitamin b content. She further adds that efforts are needed to develop RTE convenience foods from millets, technologies like blanching, acid treatment, malting, fermentation, dry heating and popping that reduce some anti nutritional factors and increase the digestibility and shelf-life of millet products would help.

The issue in traditional plant breeding is of stagnating yield, with the advent of new technologies and changing innovation systems, millets and sorghum which were the primary diet of rural India in the past, are in a situation of crisis at present. There has been a staged decrease in total cultivated area under millets and their consumption also which is now addressed through giving a push to cultivation of millets and offering incentives for the same.

The socio economic issue in traditional plant breeding has been non controversial as it has been in use for many decades and is necessary to meet the challenges of stagnating yield and reducing vulnerability to biotic and abiotic stresses.. Traditional Plant breeding is a sector in which public sector is active and can provide new variety of crops for many farmers who cannot afford other technologies. In this case the Access, Equity, Inclusion perspective is important as traditional plant breeding in public sector should be supported to meet the needs for public goods and this calls for not only increased funding but also targeted interventions in terms of technology, extension services and planning.

\textbf{RISK}

Risk discourse on food technologies in India has mostly been centered on GM crops and packaged food. But for the purpose of present study, we focus on the issue of applying two different sets of food technologies viz. GM and non-GM technologies. Risk discourse basically emanates from the application of GM technology in food. In both these issues, the role and relevance of modern food technologies have been questioned in terms of risk they can possess to human, animal and environment health. In this section we would address concerns emanating from various debates in these areas. In this paper we are not getting into the issues related to packaged food. However, from the socio-economic perspective it is important to explore challenges from tradition breeding and organics.

\textsuperscript{35} Personal communication with Dr. Vibha Dhawan and Dr. Nidhi Chandana
\textsuperscript{36} Personal communication with Dr. Ravi Khetarpal
Any technology intervention in food articles is sure to create apprehensions on the minds of people regarding health and environment safety and risk analysis. These apprehensions tend to amplify when there are debates among the various stakeholders resulting in ambiguous claims and non-consensual outcomes. To address these prime concerns, there are various methodologies.

**GM Crops:**
Debates and deliberations relating to the GM crop have intensified in India over the last decade, though issues related to various concerns have been raised since late eighties (RIS 1988). Some Chaturvedi (2001\textsuperscript{37}, 2003\textsuperscript{38} and 2004\textsuperscript{39}) and Chaturvedi et al (2007\textsuperscript{40}, 2011\textsuperscript{41}, 2012\textsuperscript{42}, 2013\textsuperscript{43}) had ever since discussed the issues of risk and regulation related to genetically modified foods in India. Similarly, various other scholars, groups and committees have discussed and debated on this issue.

On the issue of regulatory mechanisms for bio-safety, the Swaminathan Task Force suggested that while the present system of granting approval for contained and open field trials for biosafety may continue to rest with the RCGM\textsuperscript{44}, the multi-locational farmer’s field trials for Value for Cultivation and Use (VCU) should be the sole responsibility of ICAR and the concerned company or institution. The Monitoring and Evaluation Committees (MEC) should report to GEAC, which may continue to handle biosafety and environmental safety issues of GM crop candidates until the proposed National Agricultural Biotechnology Regulatory Authority comes into existence. ‘Commercial release’/notification/registration, however, should be with ICAR/DAC as the release for use by farmers comes under the domain of the Ministry of Agriculture. No GM crop variety should be allowed to be released for use by farmers by any agency other than ICAR/DAC who has a system of VCU evaluation and also a regulatory mechanism for release and notification of varieties.

The ICAR was also suggested to devise a mechanism to concurrently run the VCU trial of such GM crop candidates for which GEAC clearance has been given and for which large-scale seed production/multiplication has been recommended by GEAC. An All India Coordinated Research Project (AICRP) solely for the testing of GM crop varieties should be organized by ICAR with the requisite technical expertise. Multi-locational and regional testing should be carried out with the help of the concerned State Agricultural University centers under the AICRPs. The Agricultural Production Commissioner of the concerned State should be given full details of trials with GMOs in the respective State.

One of the major concerns stems from genetic invasions. It was proposed that the State Agricultural Biotechnology Regulatory Advisory Board would also take steps to ensure that farmers are properly educated on the raising of ‘refugia’ and the adoption of Integrated Pest Management (IPM) procedures, so that the pest resistance properties of GM crops do not break down. It can also help to supervise the trials conducted with GM strains within the State.

\textsuperscript{37} Chaturvedi, S. (2001)  
\textsuperscript{40} Chaturvedi et. al. (2007)  
\textsuperscript{41} Chaturvedi et. al. (2011)  
\textsuperscript{42} Chaturvedi et.al. (2012)  
\textsuperscript{43} Chaturvedi et.al. (2013a)  
\textsuperscript{44} Please see Annex 1 for details on current Indian regulatory system.
On the issue of food safety, the Task Force felt that there was a need to put in place food safety standards. It said that Ministry of Science and Technology along with ICMR and Ministry of Health should take the lead and play a greater role in setting codex alimentarius standards in the area of GM foods. The safety impact should be assessed in the case of both animal feeds and human foods. DBT, ICMR, ICAR, CFTRI (CSIR), Ministry of Environment and Forests, Ministries of Agriculture and Health and the Law Ministry should jointly develop a National Food Safety Protocol, which covers both the production and post-harvest (processing and consumption) phases of GM crops. The protocol should cover all stages in the production, processing, marketing and consumption chain. It should take into account the potential impact of GM crops on the environment and the health of human and animal populations. As a signatory to the Cartagena Protocol, (i) biosafety clearance of these mechanisms may be expeditiously provided and operationalized, (ii) a Biosafety Data Base System be established and (iii) the trans-boundary movement of Living Modified Organisms (LMO) be monitored/regulated and provisions of the Advanced Informed Agreement (AIA) etc. be effectively executed. It also felt the need for putting in place a mechanism to facilitate segregation, identity preservation and certification and labelling of GM/non-GM products.

This report also looked into the risk from the socio-economic perspective. It acknowledged that since the cost of GM seeds being high, farmers will get indebted if crops fail. It said that a special insurance scheme for GM crops may therefore be devised and introduced by the Ministry of Agriculture. There is a need to explore the possibility of the seed company selling GM seeds providing farmers with an insurance cover, so that they may get some relief if crops fail. Switzerland adopted in 2003 a Gene Technology Law with a strong liability regime. A similar procedure may be advisable since a vast majority of farmers in India have smallholdings with no or poor risk taking capacity. A Technical Task Force may be set up by DAC for developing an insurance system for GM crops and animals. Companies selling GM seeds to small and marginal farmers should also provide them with insurance cover. An insurance system for GM crops needs to be developed speedily, so that small farmers who take institutional credit for buying expensive seeds do not suffer in case of crop failure. An integrated GM Seed-cum-Crop Insurance System will help to ensure that desirable new technologies confer benefits to resource poor small farm families.

The Task Force, in the end, also proposed that it will be advisable for the Government of India to prepare a Biosecurity Compact, comprising precise action plans to face the challenges such as (a) invasive alien species (introduced with the import of food grains and seeds); (b) sanitary and phytosanitary measures to avoid mycotoxins, salmonella and other forms of infections in food; (c) food, environment, and biosafety relating to GMOs and (d) bio-ethical considerations in research. Thus, the Task Force tried to deal with a range of issues related to risk and regulation of GM food in a balanced way. However, from this report at least it was confirmed that there is a risk associated with GM food and it is not completely safe for human consumption until scientifically proved.

Subsequently, the national deliberations led to various different responses by the policy makers. They may not have been as substantive as the Swaminathan Task Force Report but definitely brought in more action. High profile global NGOs like the Greenpeace entered in the scene and influenced the process. It was at this point that the then Minister for Environment and Forests Mr. Jairam Ramesh went ahead with public consultations. Later in his observations he mentioned the availability of scientific evidence of resistance of Bt Cotton to pests that it is supposed to kill. This and other factors led him announce an indefinite moratorium in introduction of Bt Brinjal in 2010.
Subsequently the Sopory Committee Report (August, 2012) and the Parliamentary Standing Committee Report (August, 2012) further added to the debate. Sopory Committee 2012 report found that Bikaneri Narma (BN) Bt cotton (variety) and the Bt NHH-44 (Bt hybrid), touted as the ‘first indigenous public sector-bred GM crop in India’ developed by the Central Institute for Cotton Research, Nagpur (CICR) and University of Agricultural Sciences, Dharwad (UAS) along with Indian Agricultural Research Institute (IARI), was contaminated by a gene patented by Monsanto. Having found lapses in the ‘BNLA106 event’, the committee held as ‘invalid’ the data obtained from bio-safety studies and field trials with BNBT as these were conducted with material that contained Monsanto’s ‘MON531 event’. The committee’s finding raised disconcerting questions over the claims made by developers, the role of regulatory body, the public sector research institutions and their ethical standards. BNBT was earlier approved by the Genetic Engineering Appraisal Committee (GEAC), the apex regulator in 2008 and it was cultivated in about 8,400 hectares in Kharif of 2009. The developers had claimed that the event engineered into BNBT and Bt NHH 44 is a distinct event called BNLA106.

The indictment by this Committee led many activists and groups to project the BNBT case as a real life illustration demonstrating the potential of ‘contamination’. The committee’s conclusion that contamination either in the form of out crossing or admixture had occurred in UAS-Dharwad raised two pertinent points: one, the threat of contamination does exist admittedly; two, this possibility then exists for all future field trials and GM-based products in the R&D and commercialization pipeline too. The Parliamentary Standing Committee (PSC) on Agriculture in its 2012 report titled ‘Cultivation of genetically modified food crops-prospects and effects’ elicited views of various persons/stakeholders on the risk factors associated with GM crops. In particular, it incorporated views of three scientific studies and reports and sought explanations from various departments/experts/institutions on these reports. These scientific studies and reports were IAASTD Report, Report of Six Science Academies and Report of Prof. David Andow on Bt Brinjal.

In between, some CSOs filed a writ petition before Supreme Court. The Supreme Court appointed a Technical Expert Committee (TEC) with the major term of reference to review and recommend the nature of sequencing of risk assessment (environment and health safety) studies that need to be done for all GM crops. TEC in its final recommendations sought a ban on research and commercialisation of all GM crops in India. It said that “based on the deliberations of the TEC and particularly the examination/study of the safety dossiers, it is apparent that there are major gaps in the regulatory system. These need to be addressed before issues related to tests can be meaningfully considered. Till such time it would not be advisable to conduct more field trials.” (TEC, 2013) It also highlighted challenges in institutional governance and in the regulation of these crops. The Supreme Court has yet to announce its verdict on this TEC input.

The socio-economic issue here is affordability and sustainability. As hybrids are the preferred option by private sector seed price is an issue. There is another risk involved with this technology that of insects developing resistance, gene flow and potential for damage to biodiversity.

Risk discourse in GM technology in India is a highly debated topic with concerns raised by farmers, NGOs and several scientists regarding the safety of GM foods. The role of modern food technologies in terms of risk they possess to human health, environment and contamination has been questioned. Balancing benefits from innovation with risks calls for more attention to socio-economic issues and technology regulation A socio-economic assessment of such technologies is necessary to ensure that societal benefits are maximized while risks are reduced or minimized while no player is able to exert undue power and benefit from that.
Organic Agriculture

Export Oriented Organic Market

At this stage, organics is largely seen as an export opportunity where idea is to earn foreign exchange. Accordingly the support structures are also geared towards the possible exporters and elite consumers within the domestic markets. Indian organic industry is entirely export oriented, running as contract farming under financial agreement with contracting firms. The typical character of Indian organic food market is buyers/consumers driven rather than producers/supply driven. This is because of low awareness about organic food and its benefits when compared to organic food. The producers/suppliers have no upper hand in the market. Thus, the capital driven policies coupled with lack of open local market for sale of organic produce may negatively influence the bottom-up response on organic farming discouraging small farm holders who have currently no access to organic agricultural technology. Organic commodities which are receiving much attention in the international arena for potential price premiums and exports from India are given in Table 3.

Table 3: Organic commodities produced in different areas

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Scope/ Opportunity</th>
<th>Potential Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>Demand for Organically produced lint. To cut down on chemical use</td>
<td>Maharashtra,A,P, Karnataka, Gujarat</td>
</tr>
<tr>
<td>Sesame</td>
<td>Demand for organic sesame seed for medicinal and confectionary use</td>
<td>Gujarat, Rajasthan</td>
</tr>
<tr>
<td>Niger</td>
<td>Demand for niger seeds produced organically for bird feed in Europe</td>
<td>Tribal areas in different states</td>
</tr>
<tr>
<td>Lentil</td>
<td>Preference for Indian lentil in world markets, organic product to fetch price premium</td>
<td>U.P</td>
</tr>
<tr>
<td>Safflower</td>
<td>Growing market for safflower petals as natural food dye and herbal products</td>
<td>Maharashtra</td>
</tr>
<tr>
<td>Finger Millet</td>
<td>Scope to export finger millet flour as heath food ingredient</td>
<td>Karnataka,Orissa, Jharkhand</td>
</tr>
<tr>
<td>Medicinal herbs</td>
<td>Need for residue free crude drugs</td>
<td>All over India</td>
</tr>
<tr>
<td>Ginger</td>
<td>Demand for residue free table verities</td>
<td>Gujarat</td>
</tr>
<tr>
<td>Soybean</td>
<td>Demand for organically produced DOC for livestock feed</td>
<td>M.P</td>
</tr>
</tbody>
</table>

Source: (Venkateswarlu.B, 2007)

Shortage of Key Inputs

Besides the export oriented market structure of organic farming in India, there is lack of awareness among the farmers about potential benefits from organic farming vis-à-vis conventional farming.

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45 See Charyulu Kumara (2010)
46 (Pandey and Singh, 2012)
In addition many experts and well informed farmers are not sure whether all nutrients with the required quantities can be made available by the organic materials. The small and marginal cultivators have difficulties in getting the organic manures compared to the chemical fertilizers, which can be bought easily, if they have financial ability.47

There is unavailability of bio-mass and output markets for organic products compared to chemical fertilizers, in addition proper usage of biomass and biofertilizers also needs expertise which is still an evolving process in the Indian case. Using chemical fertilizers for farming is a more established process within the farmers; biomass and output markets for organic products are not easily available. Indian farmers have been practicing organic farming in the form of conventional farming methods since ages, but the input costs of organic products are higher relative to the industrial inputs used in modern farming methods, hence small farmers find it difficult to practice organic farming.48

Production Inefficiency
Technical challenges facing certified organic agriculture revolve around sourcing organically produced seed and fodder, consistent product quantity and quality, traceability, liability insurance of growers and processors, appropriate product attributes and pack size. Labour demands in organic farming could deter younger generations from farming, but unemployment could be alleviated, since the labour is more evenly spread during a growing season. Commercial challenges include narrowing profit margins, regulatory overload, increased competition and the need for constant innovations to stay ahead of consumer trends.49

As a result focus on issues like yield barriers continues to be a major challenge. National Academy of Agricultural Sciences (2005) has pointed out that organic farming should not be confined to the age old practice of using cattle dung, and other inputs of organic/biological origin, but an emphasis needs to be laid on the soil and crop management practices that enhance the population and efficiency of below-ground soil biodiversity to improve nutrient availability. In that context it further points out that performance of cultural techniques for weed control and that of biopesticides for pest management need to be evaluated under field conditions, preferably under cultivators’ management conditions.

Fertilizer consumption in the country has been increasing over the years and now India is the second largest consumers of fertilizers in the world, after China. As a result of over emphasis on chemical fertilizers and imbalanced fertilizer use, efficiencies have become abysmally low resulting not only in high cost of production but also causing serious environmental hazards. Measures to soil health improvement need to be comprehensively centred on addition of soil organic matter in substantial quantities over time.50 For promotion of these inputs in conjunctive use with chemical fertilizers, and to promote organic farming, there is a need to formulate and define standards for unregulated organic and biological inputs and bring them under quality control mechanism.51

Another constraint in adopting organic farming in India relates to water availability, particularly in arid and semi arid regions where rainwater is not sufficient for obtaining the desired yield. Absence of surplus rainwater for harvesting and long periods of low soil moisture can limit the overall biomass production for recycling, green leaf manuring and on-farm composting (Venkateswarlu, 2007). Non

47 See Narayanan. S (2005), NABARD, pg: 58
48 Personal communication with Dr. Vibha Dhawan
50 Twelfth Five Year Plan (2012-2017), Planning Commission, Government of India
51 Twelfth Five Year Plan (2012-2017), Planning Commission, Government of India
availability of organic supplements pooled with non availability of water can lead to a decline in the yield during conversion period; small and marginal farmers are reluctant to take the risk of decreased yields during the initial conversion periods to make the farms organic friendly. Conversion to organics from high- yielding conventional systems often results in a drop in gross yield of the marketable commodity, the degree of drop might vary considerably.\textsuperscript{52}

Costly Certification process
Organic certification is considered to be essential to assure quality of the products, and the cost of certification is very high; it cannot be afforded by small and marginal farmers. (Pandey and Singh,2012) point out that access to certification, cost involved therein and a time lag of three years (conversion stage) often constrains farmers especially small land holders in India from adopting organic farming. In the Hindu newspaper’s annual environmental report, P.V. Satheesh, Director of the Deccan Development Society, wrote, “It’s a sobering thought that the farmers producing the best and cleanest food must pay extra to certify, instead of inorganic foods being certified as potentially bad for our health.”\textsuperscript{53} There is a need for arranging low cost certification process which falls in line with promoting organic agriculture in the country. The new found governmental passion for organic farming should be translated into an enabling policy for small farmers, the repressive certification system must be redefined in India. This can happen only through a Community Certification process.\textsuperscript{54}

Lack of Financial Assistance
In spite of the adoption of NPOP during 2000, the state governments are yet to formulate policies and a credible mechanism to implement them. \textsuperscript{55} The organic supply chain currently suffers lack of infrastructure and high costs linked to handling small quantities for growing niche markets. Marketing and the distribution chain for organic products are relatively inefficient and costs are higher because of relatively small volume.\textsuperscript{56} No financial support as being provided in advanced countries like Germany is available in India. Support for the marketing of the organic products is also not forthcoming neither from the state nor from the union governments.\textsuperscript{57}

Socio- Economic issues
Socio – economic issues like high price of organic products makes this technology exclusive for the elite. The reason for expensive products is labour cost as it requires more workers for tasks like hand-weeding, preparing manure and applying it , quality control, etc, whereas conventional farming makes use of chemicals and synthetic fertilizers with relatively lower cost of production as these are often subsidized. The other issue relates to yield which is relatively less compared to GM crops or crops developed using traditional breeding and that are geared towards chemical intensive agriculture. Small and marginal farmers cannot take the risk of low yields for the initial 2-3 years on the conversion to organic farming. There are no schemes to compensate them during the gestation period.\textsuperscript{58} While there is a premium for organic produce that alone may not be a sufficient incentive if farmers can be better off by practicing chemical and energy intensive agriculture. The need for more support in terms of technology, extension and monetary and non-monetary incentives has to be explored by policy makers so that farmers gain the

\begin{footnotesize}
\textsuperscript{52} ESAP report, IAASTD
\textsuperscript{53} See Ecoworld website (http://www.ecoworld.com/atmosphere/effects/organic-farming-in-india.html)
\textsuperscript{54} See Satheesh P.V (2013)
\textsuperscript{55} See Narayanan. S (2005), NABARD
\textsuperscript{56} See Charyulu Kumara (2010)
\textsuperscript{57} See Narayanan. S (2005), NABARD
\textsuperscript{58} See Narayanan. S (2005), NABARD, pg: 60
\end{footnotesize}
most by practicing sustainable agriculture that has distinct socio-economic advantages in terms of environmental sustainability and health.

Risk discourse in organics is not a contentious topic in India as it does not possess any risk to human health and environment, the only risk involved is low yield as compared to GM or conventional breeding. All the regulations and standards regarding certification of organic products have been clearly laid by the regulatory agencies. But as standards are set by agencies and others with farmers having no control over it the power and control dimension is obvious. The paradox here is as organic agriculture becomes more global it is becoming oriented more towards global needs in terms of standards, demands and consumer acceptance. In many countries organic culture is linked with community supported agriculture and urban agriculture and/or state sponsorship as in case of Cuba. While India can learn many lessons from such initiatives, organic agriculture’s potential for delivering socio-economic benefits should not be lost sight of. For instance urban agriculture promotes better use of land, can result in better access to food and result in employment and is also found to be empowering women.

**Traditional Breeding**

Global demand for food in 2050 has been presented as one of the crucial challenges ahead and production has to increase substantially to counter this challenge. Food security is an international issue present on every government’s agenda.

Productivity stagnation is the biggest challenge GR verities are facing at this stage. Efforts are on to explore options that different crops may come up with particularly drought- and pest-resistant varieties. In absence of adequate R&D investment traditional breeding as a research tool has limited options. The need is to have crops with traits like submergence-tolerant rice and drought-tolerant maize, provide options that reduce farmers’ risk and improve incentives for sticking to traditional breeding.

The socio-economic issues in traditional plant breeding are linked with access, equity and inclusion. Less importance is given to marker assistance selection (MAS) and molecular breeding which have emerged as a valuable tool for plant breeding has resulted in less than optimum use of this technology. It is a technique which does not replace traditional breeding but improves its efficiency. The scope for Private-Public Partnerships in this can be explored.

Traditional plant breeding is a well established practice in India where risk assessment is not required and the Risk discourse is less controversial as compared to GM. Experience with plant breeding has been so extensive that it has no ill effects on environment is already proven. The challenge lies making it more relevant in future.

**POWER**

In India, major debate on the need for rigorous scientific studies of safety aspects of food crops has polarised not only the scientists but also the scientific institutions and Ministries. Currently, all GM crops are evaluated for safety and efficacy as per the protocols and procedures prescribed under the rules 1989 of Environment Protection Act (EPA, 1986) and biosafety guidelines issued from time to time. The Review Committee on Genetic Manipulation (RCGM) and Genetic Engineering Appraisal Committee (GEAC) are the committees they provide case by case clearance based on procedures for comprehensive safety assessment. There are opinions that precautionary principle should be invoked in the cases where
safety is not clear. However, the necessary guidelines do not refer to the same; as a result, there is little scope for his usage.

The Food Safety and Standards Authority of India (FSSAI) has been established under the Food Safety and Standards Act, 2006 as a statutory body for laying down science based standards for articles of food and regulating manufacturing, processing, distribution, sale and import of food so as to ensure safe and wholesome food for human consumption. The FSSAI Act stipulates that, ‘no person shall manufacture, distribute, sell or import any novel food, genetically modified articles of food, irradiated food, organic food, food for special dietary uses, functional food, nutraceuticals, health supplements, proprietary foods and such other articles of food which essential may notify’. In this way, FSSAI has responsibility for all different kinds of food, however in practice the GEAC is the agency dealing with approval of all GM organisms including GM food.

The Ministry of Consumer Affairs, Food and Public Distribution notified mandatory labelling of all GM foods sold in packaged from 1st January 2013. This was based on a 2006 proposal from the Ministry of Health. Bansal (2013), points out that the regulation does not specified tolerance label i.e. the label beyond which a specific food would be regarded as a GM food, as the legislation make our not only primary products but also processed products which may be derived from GM ingredients like edible oil, additive and flavours and meat and animal products fed with GM feed. It was largely with in this dilemma that India had withdrawn an official order from Ministry of Commerce in 2007 banning import of all GM food products in India.\(^5\)

Climate change poses a major challenge to agricultural production. The National Mission for Sustainable Agriculture, launched under the National Action Plan on Climate Change, seeks to devise adaptation and mitigation strategies for ensuring food security. As the impact of climate change could transcend geopolitical boundaries, we must actively engage with all national and international initiatives to chalk out a climate resilient development strategy.

Focus has to be laid on technologies like Marker assistance selection (MAS) and molecular markers which can provide equitable access of technology to the farmers with improved productivity. Presently, there has been less than optimum use of Non-GM technologies in developing countries including India.

Power and control discourse in India relates to the government agencies handling the regulatory system of GM technologies in India where public opinion is not playing an active role in decision making. Several questions have been raised on the safety of GM foods due to which an infinite moratorium has been imposed on the introduction of Bt Brinjal in 2010. The Supreme Court appointed Technical Expert Committee (TEC) on field trials of GM crops; final report has highlighted challenges in institutional governance and in the regulation of these crops. The Court has yet to announce its final verdict on this expert input.

**Organics**

National Project on Organic Farming (NPOF) is a continuing central sector scheme since 10th Five Year Plan. Planning Commission approved the scheme as pilot project for the remaining two and half years of 10th plan period with effect from 01.10.2004. NPOF is being implemented by National Centre of Organic Farming at Ghaziabad and its six Regional Centres at Bangalore, Bhubaneswar, Hisar, Imphal, Jabalpur

\(^5\) See Chaturvedi (2013 a) for details.
and Nagpur. Besides working for realisation of targets under NPOF, NCOF and RCOFs are also performing specific roles in promotion of organic farming.\textsuperscript{60}

There is a growing demand for organic products worldwide, and certification of organic products is a prerequisite for ensuring quality and preventing fraud. Standards and regulations for organic farming vary from country to country, and generally involve a set of production standards for growing, storage, processing, packaging and shipping which includes:

- No human sewage sludge fertilizer used in cultivation of plants or feed of animals
- Avoidance of synthetic chemical inputs not on the National List of Allowed and Prohibited Substances (e.g. fertilizer, pesticides, antibiotics, food, etc.), genetically modified organisms, irradiation, and the use of sewage sludge;
- Use of farmland that has been free from prohibited synthetic chemicals for a number of years (often, three or more);
- Keeping detailed written production and sales records (audit trail);
- Maintaining strict physical separation of organic products from non-certified products;
- Undergoing periodic on-site inspections.\textsuperscript{61}

In India, the regulatory system is defined by National Program on Organic Production and it is regulated under two acts namely Foreign Trade development and Regulation Act (FTDR) and Agriculture Produce, Grading, Marking and Certification Act (APGMC). The NPOP (National Standards for Organic production) standards for production and accreditation system have been recognized by European Commission and Switzerland as equivalent to their country standards. Similarly, USDA has recognized NPOP conformity assessment procedures of accreditation as equivalent to that of US. With these recognitions, Indian organic products duly certified by the accredited certification bodies of India are accepted by the importing countries.\textsuperscript{62}

(Maity and Tripathy, 2011) point out that presently in India, there are six authorized accreditation agencies which have been approved by the Ministry of Commerce, Government of India. They are APEDA (Agricultural and Processed Food Product Export Development Authority), Coffee Board, Spices Board, Tea Board, Coconut Development Board, Cocoa and Cashew nut Board.

In addition there are four certification agencies accredited by APEDA. NSOP (National Standards for Organic production) has been formulated by Department of Commerce, Govt. of India for National Program for Organic Production (NPOP). Any production certified as per NSOP may use the term, “Organic”. A product can be labeled as, “For Export only” when it has been produced in India to an Organic Standard other than NSOP for example EU Regulations, IFOAM etc.\textsuperscript{63}

Power and Control discourse in organics is skewed towards political will and involvement of indigenous communities. Agriculture in India is subject to political interventions with the objectives of dispensing favours for electoral benefits. Subsidies and other supports from both the Central and the State governments, government controlled prices of inputs like chemical fertilizers, the public sector units’ dominant role in the production of fertilizers, government support/ floor prices for many agricultural

\textsuperscript{60} NCOF
\textsuperscript{61} NCOF
\textsuperscript{62} APEDA
\textsuperscript{63} (Maity and Tripathy, 2011)
products, supply of inputs like power and water either free of cost or at a subsidized rate etc are the tools often used to achieve political objectives.  

There is a growing demand for organic products worldwide and in India. The market for organic products is niche with high returns and products are considered to be safer compared to GM products. Indian standards have been clearly laid for the certification of organic products where the accreditation system has been recognized by European Commission and Switzerland as equivalent to their country standards where recertification of organic products is not required during exports.

**Main Actors**

In case of organics the Organic Farming Association of India (OFAI) has emerged as an important institutional linkage. It has established major network of farmers for distributing organic seeds. The objective of this organization is to lobby with government agencies and departments to pay more attention to sustainable agriculture and to assist farmers in successfully moving out of chemicals.

There are several groups of NGOs and concerned scientists who have come up against the GM crops. The NGOs have demonstrated on roads, pressurised the Environment Minister, moved Supreme Court and encouraged scientist to raise their key concerns through letters and submissions. In April 2009, the Union of Concerned Scientists (UCS) published a report ‘Failure to Yield’ confirming that after 20 years of research and 13 years of commercialisation, GM crops have failed to increase yields” and that “traditional breeding outperforms genetic engineering hands down. In a letter written to the Prime Minister of India in 2009, as many as 17 distinguished scientists from the U.S., Canada, Europe and New Zealand pointed out that the claims relating to higher yield and protection of environment made for GM crops are absolutely false. There are also NGOs which have placed literature in favour of GM crops. For instance, Foundation for Biotechnology Awareness and Education (FBAE), based in Bangalore, has tried to rationalize the debate and placed their own views on the matter.

Major actors in terms of regulating food technologies in India are Indian Council of Agriculture Research (ICAR) and Department of Biotechnology (DBT) which are apex national organizations involved in planning, conducting and promoting research, education, training and transfer of technology.

**Policy Debate**

With regard to the institutional arrangements, the Task Force was of the view that GEAC should consist of members with the requisite expertise and should be headed by an outstanding biosafety and biotechnology experts. The structure of the Atomic Energy Regulatory Board could be suitably adapted for establishing an autonomous statutory National Biotechnology Regulatory Authority (NBRA) in the place of the existing GEAC. With rapid growth in R & D efforts in biotechnology, a statutory and autonomous National Biotechnology Regulatory Authority will soon become necessary. The NBRA should have two wings – one for agricultural and food biotechnology and the other for medical and pharmaceutical biotechnology. NBRA is essential for generating the necessary public, political, professional and commercial confidence in the science based regulatory mechanism in place in the country. The Task Force while taking cognizance that agriculture is a state subject, said that it will be desirable to establish a State Agricultural Biotechnology Regulatory Advisory Board in each State to

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64 See Narayanan. S (2005), NABARD, pg 62
65 Dogra (2012)
maintain liaison with NBRA and to ensure that steps are taken to prevent the illegal release and proliferation of GM seeds.

**Concluding Remarks**

Debates on food technologies in India highlight several challenges that Indian food production in particular and agriculture in general is going through contemporary challenges of food insecurity, declining productivity, depletion of natural resources, increased risk from climate change, rising input costs, changing food habits, and extremely high post-harvest losses.

Food production techniques have diversified and have moved beyond their domain where multi-polar convergences are appearing across cutting-edge technologies like bio-sensors, genomics, biotechnology and nanotechnology. It is important that technology-led path brings in prosperity for the farming community which is being emphasized at different points by the policy but it is equally important to ensure that technology brings in prosperity which is not debasing sustainability of the agriculture itself. It assumes all the more importance, in a country like India, where agriculture retains its primary importance in terms of employment generation.

In India, more and more people are experimenting with indigenous practices of alternative agriculture, based on lesser resources and largely different from the dominant technological paradigm, though it has yet to reach the proportions where it may pose stiff challenge. This change is not only about the production process but also reflects farmers’ stress emanating from declining returns even when inputs are disproportionately enhanced. This paradigm is hardly getting any major recognition when considerations for systemic support comes up and consequently much lower support in terms of R&D inputs as compared to their counterpart in dominant technological paradigm. However, a counter trend where additional and advanced technological solutions by better off farmers is also discernible. This is largely led and supported by private sector seed firms and adopted by elite farmers.

Table below which clearly describes the linkage between technologies and the three discourses.

**Table 4: Matrix on Food Technologies**

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Socio-Economic Considerations</th>
<th>Environmental Sustainability</th>
<th>Global/External Factors</th>
<th>Access, Equity, Inclusion (AEI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biotechnologies (GM/Non-GM)</td>
<td>Costly R&amp;D Infrastructure with scope to enhance yield</td>
<td>Resilient to stress (drought, salinity, pest etc.)</td>
<td>Patents, Collaboration</td>
<td>Large Players MNCs, Food Security</td>
</tr>
<tr>
<td>Traditional Breeding Technologies</td>
<td>R&amp;D Set-up Available with stagnating yield</td>
<td>Vulnerable to biotic and abiotic stresses</td>
<td>Indigenous strength</td>
<td>Presence of domestic enterprise</td>
</tr>
<tr>
<td>Organic Approach</td>
<td>Low Input Cost, scope to</td>
<td>Vulnerable to biotic and</td>
<td>Minimal External Control</td>
<td>Local Farmers</td>
</tr>
</tbody>
</table>

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The ethical matrix above tries to establish a linkage between the technologies and their socio-economic aspects, environmental sustainability, influence of global/external factors and equitable access. The proponents of GM technology base their arguments on the environmental sustainability of this technology where products are resilient to stress. On the contrary the opponents of GM technology argue that the R&D infrastructure is very expensive and the regulatory system is weak in India.

The three discourses on Innovation, Risk, Power and Control are overlapping while Socio-Economic aspects issues cut across them. There is a substantial body of literature available on possible impact of technologies beyond the heath and the environmental dimension. The term ‘Socio-Economic’ may seem to be too vague or too broad but it is possible to identify the key issues involved and link that with technology assessment.

The key lessons from this analysis of food technologies in India are as below:

1) Innovation issues cannot be divorced from broader concerns relating to socio-economic impacts and less than optimum use of innovation can result if they are ignored. But considering them in innovation policy and management of technology will result in better benefits to society thereby enhancing more acceptability and wider diffusion.

2) Power and control through technologies should be understood in terms of impacts and how they can result in distorted markets, less than optimum use of technology and result in resistance. The examples from India show that regulation is often a contested terrain as different stakeholders are involved. The stakeholders who are questioning the technology and power and

<table>
<thead>
<tr>
<th>Risk</th>
<th>Biotechnologies (GM/Non-GM)</th>
<th>Recurrent high input cost</th>
<th>Gene Flow, Contamination, Human Health, Place of Origin</th>
<th>International Conventions/Laws, Trade Barriers, Labeling, Traceability</th>
<th>Limited access due to high cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Breeding Technologies</td>
<td>Affordable with Public support</td>
<td>Minimal Risk</td>
<td>Minimal Risk</td>
<td>Accessibility; Inclusive</td>
<td></td>
</tr>
<tr>
<td>Organic Approach</td>
<td>Viable depending on demands</td>
<td>Minimal Risk</td>
<td>Niche Market and Standards</td>
<td>Overhead makes it Exclusive</td>
<td></td>
</tr>
<tr>
<td>Power and Control</td>
<td>Biotechnologies (GM/Non-GM)</td>
<td>Targeted gains</td>
<td>Unpredictable outcomes</td>
<td>MNCs, International Conventions/Laws (e.g. Codex), Trade, IP Regime</td>
<td>Control over production, process and markets</td>
</tr>
<tr>
<td>Traditional Breeding Technologies</td>
<td>Declining yield and economic returns</td>
<td>Pollution and Health issues</td>
<td>Less External Control</td>
<td>Accessible and Inclusive</td>
<td></td>
</tr>
<tr>
<td>Organic Approach</td>
<td>Niche market; High returns</td>
<td>Perceived to be Safe</td>
<td>Global standards</td>
<td>Accessible and Inclusive</td>
<td></td>
</tr>
</tbody>
</table>
control through that often use the socio-economic discourse to highlight their concerns and also to make counter claims on benefits and risks. This results in controversies that are often taken to different fora for resolution as all stakeholders are not evenly placed in terms of power and control. Using these fora directly/indirectly to question and regulate technology is not a phenomenon unique to India. While controversies are inevitable attention to socio-economic issues and taking them into account in regulation and policy is a must.

3) Various technological options have to be assessed and promoted for maximizing the gains from technology. It is here the assessment in terms of socio-economic issues can play an important role in policy formulation. For instance as discussed elsewhere technological options like non-GM biotechnology, traditional plant breeding and organic agriculture can be supplemented with GM biotechnology in agriculture and laying too much emphasis on one technology can result in skewed outcomes.

4) Food technologies have to play an important role in enhancing food security, ensuring better productivity and environmental sustainability. Access, Equity and Inclusion can be a criteria in deciding and applying technologies while socio-economic issues have to addressed in different phases from deploying innovation to protecting farmers from vulnerabilities and risks arising from technologies.

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In India, the regulation of all activities related to GMOs and products derived from GMOs is governed by “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 are primarily implemented by MoEF and the Department of Biotechnology (DBT), Ministry of Science and Technology through six competent authorities: 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), and; District Level Committees (DLC). The Rules, 1989 are very broad in scope and essentially capture all activities, products and processes related to or derived from biotechnology including foods derived from biotechnology, thereby making GEAC as the competent authority to approve or disapprove the release of GM foods in the marketplace.

The Food Safety and Standards Act, 2006 (FSSA, 2006)

Following the promulgation of the Food Safety and Standards Act, 2006, which empowers the Food Safety and Standards Authority of India (FSSAI) to regulate genetically modified (GM) foods, MoEF published Notification No. S.O. 1519(E) dated 23-8-2007 in the Gazette of India. This notification exempted “food stuffs, ingredients in foodstuffs and additives including processing aids derived from Living Modified Organisms where the end product is not a Living Modified Organism” from Rule 11 of the Rules,1989. At the time of Notification No. S.O. 1519(E), the FSSAI had yet to publish rules that described how GM food stuffs (i.e., processed foods containing one or more ingredients derived from a genetically modified organism) would be regulated under the FSSA, 2006 and consequently MoEF published a series of additional notifications that have kept Notification No. S.O. 1519(E) in abeyance so that GM foods could, as an interim measure, continue to be regulated under Rules, 1989.

The FSSAI now intends to meet its regulatory obligations by implementing a safety assessment and approval process for GM foods that leverages existing regulatory capacity within the Government of India, notably within DBT, MoEF and the Indian Council of Medical Research (ICMR).

Table 1 Responsibilities of governmental authorities as regards the regulation of GMOs in India (excluding pharmaceutical applications).

<table>
<thead>
<tr>
<th>Activity</th>
<th>Responsible Authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contained research (laboratory and greenhouse)</td>
<td>RCGM (DBT)</td>
</tr>
<tr>
<td>Event selection trials/BRL 1 trials</td>
<td>RCGM and GEAC (MoEF)</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Food safety assessment of GM foods (viable and processed)</td>
<td>FSSAI</td>
</tr>
<tr>
<td>Environmental risk assessment of GM organisms</td>
<td>GEAC</td>
</tr>
<tr>
<td>Approval for commercial release of GM foods (processed)</td>
<td>FSSAI</td>
</tr>
<tr>
<td>Approval for commercial release of GM foods (viable i.e. LMOs)</td>
<td>GEAC</td>
</tr>
<tr>
<td>Approval for environmental (commercial) release of GM organisms</td>
<td>GEAC</td>
</tr>
</tbody>
</table>

1.1 ORGANIZATIONAL STRUCTURE
In order to manage the administration of the regulatory program for GM foods, the FSSAI will establish a new secretariat within the FSSAI, namely the Office of GM Foods and the GM Food Safety Assessment Unit

Initially staffed with two Scientific Officers, the Office of GM Foods will be responsible for:

- Coordinating the receipt of GM food safety applications;
- Conducting administrative reviews of applications;
- Verifying submitted documents;
- Managing communication and correspondence with applicants;
- Managing the tracking of applications;
- Providing a secretariat function for the GMFSAU and Expert Committee on GM Foods (e.g., meeting coordination, report taking, document tracking); and
- Managing communications and outreach with stakeholders and the public (e.g., ensuring that information about GM food regulation, policy and decisions are made promptly available on the FSSAI website).

The GMFSAU will be comprised of a multi-disciplinary team of scientists trained in GM food safety assessment and will include each of the following (at a minimum): molecular biologist; biochemist; immunologist; food allergenicity specialist; toxicologist; nutritionist. The GMFSAU will be situated at the National Institute of Nutrition, Hyderbad. NIN has experience in GM food safety assessment and already provides science advice to RCGM and GEAC in this regard. Further the Scientist at GMFSAU will have to access to the library and other facilities at NIN for accessing the latest literature on the subject. The GMFSAU will report administratively to the Director, NIN and operationally to the FSSAI. The FSSAI and NIN will be committed to ensuring that the member scientists of the GMFSAU have the appropriate combination of subject-matter expertise, are free from conflicts of interest, and are provided with opportunities to maintain and enhance their scientific knowledge and safety assessment experience.

The FSSAI will also establish the Expert Committee on GM Foods which will: oversee a public consultation process1; consider and respond to comments received during public consultations; and recommend any conditions to be stipulated for product approvals keeping in view the safety assessment report by GMFSAU. The Expert Committee on GM Foods will be comprised of the following members:
The steps in the interim process are as follows:

1. Applications for a GM food safety approval will be submitted to the Office of GM Foods. Applications must meet the information and data requirements as described in the “2008 Guidelines for the Safety Assessment of Foods Derived from Genetically Engineered Plants” and companion protocols. A proforma will be developed by FSSAI to standardize the format of the application.

2. The same application and assessment procedure applies to GM events that may be developed domestically or imported (see section 1.3 below).

3. The Office of GM Foods will complete an administrative review of each application to verify submitted documentation and to ensure that each required section of an application has been completed (e.g., applicant name and address). This is not a technical review. Applications that are deemed complete will be entered into an application tracking system and an acknowledgement will be provided from the Office of GM Foods to the applicant within 10 days. Applications that are deemed incomplete will be returned to the applicant with an explanatory letter also within 30 days. Applicants will be permitted to re-submit applications without prejudice when errors or omissions have been corrected. 

4. The application is provided to the members of the GMFSAU and the safety assessment process begins: Applicants will not be permitted to communicate directly with members of the GMFSAU and vice versa. Communications between applicants and the GMFSAU will be facilitated by the Office of GM Foods and may occur during one or more of the following three stages:
   - During product development and prior to submission of an application to the FSSAI (e.g., during BRLI and BRLII confined field trials) when product developers may seek guidance or clarification about experimental protocols and design, data collection and/or data interpretation relevant to the “2008 Guidelines for the Safety Assessment of Foods Derived from Genetically Engineered Plants” and companion protocols;
   - Dossier development; and/or
   - During the GM food safety assessment by the GMFSAU when the Unit may seek clarification or additional information from the applicant. It is common that during a safety assessment, the evaluators may require clarifications about information, data or studies and these can be requested from the applicant. Additionally, the evaluators may encounter deficiencies in the information provided by the applicant (e.g., a required study may not have been provided or

The process for selection of scientists and experts will be laid down separately.

1.2 THE INTERIM PROCESS: APPLICATION, SAFETY ASSESSMENT AND DECISION MAKING

The steps in the interim process are as follows:

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   - Dossier development; and/or
   - During the GM food safety assessment by the GMFSAU when the Unit may seek clarification or additional information from the applicant. It is common that during a safety assessment, the evaluators may require clarifications about information, data or studies and these can be requested from the applicant. Additionally, the evaluators may encounter deficiencies in the information provided by the applicant (e.g., a required study may not have been provided or
required data may be missing). In both of these cases (clarifications and deficiencies) the safety assessment stops until the additional information is provided by the applicant. If the applicant cannot or does not provide this information within a reasonable amount of time, the application will be returned to the applicant and the file will be closed.

5. Upon completion of the safety assessment, the GMFSAU will prepare a Safety Assessment Report that summarizes the information that was taken into account during the safety assessment and states the decision of the GMFSAU as to whether the GM event that is the subject of the application may be considered as safe as its conventional (non-GM) counterpart in the context of its proposed uses as food. The safety assessment, preparation and submission of the Safety Assessment Report should be completed within the prescribed period of time (90 days) excluding the time required by an applicant to address any clarifications and/or deficiencies (which may extend the total time of the assessment to 6-12 months).

6. In cases where NIN is involved in performing any studies for safety assessment of GMOs, the GMFSAU will co-opt two or three additional excerpts from outside NIN to give opinion. The Safety Assessment Report will be submitted to the FSSAI.

7. The CEO, FSSAI will convene the Expert Committee on GM Foods which will consider the Safety Assessment Report, oversee the public consultation process and make a recommendation to approve/not approve the subject event. This recommendation will be taken in a timely fashion (within 90 days of receiving the Safety Assessment Report).

8. In the case of **GM foods that are not LMOs**, the FSSAI will take a decision to approve/not approve the subject event based on the recommendation of the Expert Committee on GM Foods.

9. In the case of **GM foods that are also LMOs**, the FSSAI will forward the recommendation of the Expert Committee on GM Foods to the GEAC.
   a. GEAC will take a decision to approve/not approve the subject event based on the recommendation of the Expert Committee on GM Foods provided by the FSSAI. This decision will be taken in a timely fashion.
   b. Decision-making should be determined by the recommendation provided by the FSSAI to the GEAC. However, if it is decided that other non-safety considerations should also be included in the decision-making process, GEAC will ensure that these are consistent with the *Rules, 1989*, the *FFSA, 2006* as well as any other pertinent obligations that India has under international agreements. The inclusion of non-safety considerations must be carefully considered as a matter of policy and then defining regulations and guidance should be developed. This is essential to ensure that there is consistency and impartiality in how such considerations may be used to inform product-specific decisions.
   c. The GEAC will communicate its decision to the FSSAI.

10. The FSSAI will publish decision summaries of all GM food approvals and these will be posted on the FSSAI website.

11. The approval of an event by FSSAI or GEAC will apply to all foods that contain that event, whether imported or produced domestically. This will exempt the need for food importers and processors to submit applications to the FSSAI for the safety assessment of the same event.

### 1.3 OTHER KEY OPERATIONAL ELEMENTS

1. The FSSAI will assess GM foods at the level of an “event3”. Approvals will apply to foods derived from the event, its progeny (including derived hybrids and varieties produced through
conventional plant breeding) and any food stuffs that contain ingredients derived from the approved event and its progeny.

2. The safety assessment of an event will include the evaluation of the whole or primary food product in the forms that are commonly consumed in India. For example, the food safety assessment of a GM soybean event may include compositional and nutritional data for raw soybean seed as well as processed fractions of soybeans, such as toasted meal, defatted non-toasted meal, protein isolate, protein concentrate and oil. It will not include the safety assessment of biscuits that include soy oil as an ingredient (see point 1 above) as the soy oil will have been evaluated during the approval process for the subject soy event to be as safe as conventional soy oil.

3. Processed foods that contain ingredients derived from an approved GM event will not be subject to further regulation.

4. The Scientific Panel on Genetically Modified Organisms and Foods will have the responsibility of discussing issues related to regulatory policy and will provide strategic advice to the FSSAI. The Panel will have no responsibility for, or role in, product-specific safety assessments and subsequent decisions to approve/disapprove these products.

5. While applications to approve GM livestock feeds are submitted to GEAC, GEAC may seek comments based on GM food safety assessment from FSSAI on such applications as these feeds may potentially enter into the food chain.

6. All rules, regulations, policies, standards, guidance and decisions related to the regulation of GM foods will be made publicly available by the FSSAI and GEAC.

**1.4 THE DEVELOPMENT OF GUIDELINES**

The FSSAI will notify guidelines that clearly describe the regulatory framework for GM Foods. These guidelines will provide details about the interim process for the regulation of GM foods as described below and will be in place until such time as new regulations are notified under the FSSA, 2006:

- The scope of the interim process;
- Application procedures and process;
- GM food safety assessment procedures and process including the format of the safety assessment report A genotype produced from the transformation of a single plant species using a specific genetic construct. For example, two lines of the same plant species transformed with the same or different constructs constitute two events.
- Decision-making procedures and process;
- Time standards;
- Protection of information;
- Draft standard for GM foods for incorporation in regulations;
- The role of the Scientific Panel on Genetically Modified Organisms and Foods;
- The purpose, constitution and operations of the Office of GM Foods, FSSAI; and
- The purpose, constitution and operations of the GMF SAU,
The “Guidelines for the Safety Assessment of Foods Derived from Genetically Engineered Plants” and the complementary GM food safety protocols that were approved by GEAC and RCGM in 2008 are will be adopted and implemented by the FSSAI. The 2008 Guidelines provide a safety assessment framework that is consistent with international standards developed by Codex Alimentarius. Additional guidance will also be developed for documentation and quality standards for applications submitted to the FSSAI.

1.5 CAPACITY BUILDING

The FSSAI is committed to ensuring that sufficient institutional, financial and human resource capacity is put in place to implement this interim process and will work to achieve this by participating in, and building upon, initiatives already taken up by MoEF and DBT. In particular, the FSSAI will provide the necessary administrative and technical training to establish:

- The Office of GM Foods;
- The GMFSAU, including advanced training in GM food safety assessment for the GMFSAU member scientists;
- Diagnostic laboratories for detection of unapproved GM events, including advanced training in sampling and detection methodologies, test validation and potentially developing a nationally (or internationally) accepted laboratory certification scheme. The capacity that is built under the interim system will be transitioned to the permanent food safety assessment and approval process for GM foods that will be established when the necessary rules and/or regulations for GM foods are notified under the FSSA, 2006.
OVERALL CONCLUSIONS FROM THE THREE CASE STUDIES.

It is clear from the case studies described above that there are a number of important factors which affect the way in which policy is elaborated and established in relation to the development and implementation of innovative food technologies in the three regions. Most important appear to be not only the identity of the key actors involved but also their position in relation to power and control in influencing implementation. Other important considerations are food security and socio-economic factors, particularly in relation to both local and national economies as well as the implications for global competitiveness. The role of ethical values and the degree to which these play a part in policy making in relation to implementation of new technologies appears to depend on the extent to which such values influence the factors mentioned above.

In a European context, consumers appear to play a much greater, and indeed a crucial role in developing policy and influencing the extent to which innovative food technologies are introduced into the food chain. Indeed the European consumers’ response to technologies such as genetic modification in the food and agriculture industry, based on ethical values, risk perceptions and trust has carried considerably more weight in the market than economic considerations, resulting over the last decade, in the effective ban on GM food products in Europe. However, it would be a mistake to assume that this role of European consumers applies only to the case of GM foods. The impact of the consumer has been very similar in relation to other food technologies, particularly where there has been a high-profile risk event, such as the case of BSE or salmonella in eggs. In the European context there are important trigger factors such as transparency, risk perception, fairness, trust and freedom of choice that underlie and influence the extent to which consumer opinion impacts on policy and the introduction of novel food technologies. It is useful to consider this largely “grass-roots” expression of values in Europe with the extent to which it can be seen to operate in the different political, societal and economic situations of both China and India.

The Chinese case study, focuses specifically on the use of genetic modification in agriculture, and illustrates an approach to the introduction of innovative food technologies which is influenced by a somewhat different relationship between the State and its citizens. Policy related to the use of biotechnology in food production appears to be influenced largely by Chinese scientific research closely allied to government policies related to the need to ensure economic independence and control as well as a more ideological perspective on the ability of science to deliver economic benefit. Although the public concern about and perceptions of risk of GM food are increasing in China, there appears to be relatively little direct engagement either with public interest groups or grass-roots Chinese consumers to ascertain whether there are any ethical or other values held by citizens, that may impact on the introduction of innovative food technologies. However, at the same time, the Chinese government appears very aware of the need to protect its citizens from any risks associated with GM products and recognises that there is little point in seeking to introduce GM staples into the food chain if these are likely to be rejected by Chinese consumers. This demonstrates that the Chinese government takes seriously both its ethical responsibility to protect its citizens from harm together with an acknowledgement of their right to choose whether or not to consume GM food products. Although trust in government, regulators and scientists may be higher in China than in Europe, it may well be that the principle of consumer informed choice through informative labelling of foods produced using new
technologies is still an important grass roots issue if novel food technologies are to be accepted in the region.

In India, it is clear that innovation issues cannot be divorced from broader socio-economic impacts that include effects on small farmer communities, the environment, labour costs, traditional agriculture, etc. Stakeholder debates are often based on the socio-economic discourse to highlight concerns and develop claims on benefits and risks while their uptake in regulation and policy is a must. Risk discourse is important for regulation and safety of GM products in India and food security is a major preoccupation for policy makers. While for non-GM biotechnology, traditional plant breeding and organic agriculture are as important as GM biotechnology in agriculture, however they have varying degrees of importance when policy choices have to be made. Food policy in India is also influenced by various interest groups and/or trade bodies in which socio-economic considerations (based on Access, Equity and Inclusion) are expected to be the key value considerations. This appears to have produced a number of very pragmatic policy choices that aim to sustain and develop organic agriculture while at the same time making room for sustainable implementation of new biotechnology innovations.

**Regional Commonalities**

If one were to draw overall common conclusions in the three regions, one could identify certain similarities that also provide an implicit roadmap for collaboration in the area. It is for instance evident that public multi-stakeholder debates are increasingly becoming the norm and not the exception in all regions. The proximity of food to consumers/citizens and a strong and increasingly educated and assertive civil society in the three regions are changing the rules of policy debates. Policy agendas are becoming more influenced by the outcomes of public debates and these in turn are likely to become increasingly multi-actor and multi-stakeholder events. Research on perceptions and social dimensions of new food technologies may therefore become an increasingly important consideration in the policy process.

An increase of the consumer voice in the policy debate will result in a shift of balance in the Power and Control spectrum. As a result the changing dynamics of the debate mean that the existing risk assessment paradigm is increasingly questioned and in some cases overhauled as the shift from traditional to high-tech agriculture results in a shift in the risk assessment paradigm as well. Long-term effects and low exposure risks are also becoming prominent elements in the assessment process that requires increased collaborative activities in constructing a new common risk assessment procedure.

While there are similar concerns in all three regions in relation to issues of risk and safety and how these are expressed; the mechanism to deal with these still varies considerably from region to region. The precautionary principle plays a major role in the European context, and is also now taken into account by WTO and Codex Alimentarius. However in India, instead of the precautionary principle, the focus is on placing confidence in an increasingly stringent regulatory framework for food safety with the introduction of a new Act and a new regulatory body. For China, although the precautionary approach operates in relation to introduction of GM staple foods, the ideological Scientistm position of the inherent benefits of new technologies is still an important consideration.

Despite these differences, in the context of a global market in food products, it is desirable to clarify common parameters for the uptake of the concept as a common approach to global risk assessment standards.
Moreover, food security and local socio-economic considerations are a key policy input for non-European governments and a great influence in their decision making processes. In any common collaborative activity in the food sector between the three regions, food security has to be accepted as a valid indicator of potential impact and value assessment of new technologies while a commonly understood socio-economic analysis is a must in advising policy activities.

Finally, engagement of public and specific stakeholders in food debates is increasingly seen as an integral part of the policy process. Participatory TA exercises occur to some extent in all three regions (e.g. consensus conference) but formal institutional structures are missing in China and India. Some context-based structures that presuppose common understanding of methodological parameters in public engagement should be developed in order to pursue collaborations that will see an integrated policy input in the three regions.