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Science Governance in the context of diverse interests and meanings: a Study of the debate on Genetic modification of Food in India

Dr. Jacob Kalle*
Consultant at Southern Regional Centre (SRC), Indian Council of Social Science Research (ICSSR), Hyderabad, India

***Corresponding author**
Dr. Jacob Kalle

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Abstract: The belief that scientific knowledge is objective, true, invariant and infallible has been challenged by the new approaches in the post-Kuhnian social studies of science. Scientific knowledge has been undergoing a cultural transformation from a disinterested and morally neutral enterprise to an enterprise that is intimately connected to values of profit and efficacy (industry) and political hegemony (military research) since the latter part of the 20th century. The IPRs regime of the WTO has made scientific knowledge which was hitherto a public resource into an intellectual property. In other words, the divide between the internal world of science and the external world of science has become porous. In this context the governance of science becomes a significant issue. Hitherto public support to science was based on the belief that the output of science would serve some public good and the governments across the world extended support to science. In this model, science is seen as providing objective, true and invariant knowledge and the members of the public are expected to have trust in science as it is a public good. In this model, the government and its agencies play an important role in deploying and regulating scientific and technological knowledge to solve problems in the real world. In the present context in which science has become an intellectual property, what are the terms of contract between science and society? What is the governance model, given the perceived risks for human beings and environment associated with the application of scientific and technological knowledge? What is the broad based governance model which can accommodate the conflicting values and interests of different stakeholders, while taking a decision on technological choice? How does science deal with the anxieties of the stakeholders in this context? In the Indian context, the public debate surrounding the commercialisation of the Genetically Modified Brinjal has brought into focus the relationship between science and society and the complex character of expertise in the public decision-making process. The paper drawing on the Post Normal Science (PNS) perspective argues that there should be a shift in the regulatory paradigm from a government-centred one to that of a governance-centred one.

Keywords: Genetic Modification, Brinjal, Governance, Post Normal Science.

INTRODUCTION

The Context

In India, the genetically modified[i] (insect resistant) cotton, popularly known as Bt-cotton, was the first and only non-food GM crop that was commercially released during the year 2002. GM Brinjal is the second genetically modified crop and the first food crop which has come close to commercial release during 2009. Had the Ministry given the approval for release of Bt-Brinjal, it would have been the first genetically modified vegetable to be grown anywhere in the world.

The GM Brinjal (specifically Bt Brinjal - after the specific technique used in the genetic engineering of this crop) was developed by scientists (located in both corporate as well as public institutions in India and abroad) to combat the Fruit and Shoot Borer (FSB) - a pest affecting the Brinjal crop in various parts of India. As the technique used to insert the relevant gene (Cry1AC) is a patented technology of Monsanto, their subsidiary in India, Mahyco held the patent rights and therefore stood to gain the economic advantages of the Bt Brinjal sales in the markets in India.

On 14.10.2009, the Genetic Engineering Approval Committee (GEAC), based on the reports of the Expert Committees -I and II, constituted during 2006 and 2009 respectively, had recommended the environmental release of Bt Brinjal. Thus, the decision of the GEAC on the safety of Bt Brinjal for

environmental release was based on scientific facts/data. The GEAC's decision evoked sharp criticism from both the general public as well as from the scientific community. Responding to the public's skepticism and ambivalence, the minister had placed the Expert Committee-II Report in the public domain and sought the views from the public and also from renowned scientists from both India and abroad.

In the Indian context, the national consultation in seven cities on Bt. brinjal can be seen as first ever initiative to move towards recognition of the fact the controversies around modern biotechnology cannot be resolved purely based on scientific risk assessment. On 9 February 2010, while recognizing the GEAC's status as a statutory body authorised to grant approval for the environmental release of GM organisms [1], imposed a moratorium on the GEAC's recommendation for the environmental release of Bt brinjal. The important question raised in this context is: Is science-based risk assessment an adequate approach to settle public controversies like that of Bt Brinjal?

Different stakeholders namely farmers, consumers, NGOs, Environmental groups, People from Industry, scientists, officials and politicians in various states have participated in the Consultations. This paper is an attempt to understand and analyse the values and interests of different stakeholders on Bt Brinjal and also values underlying the regulation of GM crops. This paper , based on PNS (Post Normal Science) perspective posited that, given the uncertainties associated with knowledge and conflicting values, technological choices have to be made more democratic and transparent way by not only taking into account the interests of various groups, but also environmental considerations. It is also asserted that there should be a shift in the regulatory paradigm from a government-centred model one to that of a governance-centred one.

The paper is divided into six sections including the introduction and conclusion. While the first section introduces the context, the second section deals with need for the precautionary and participatory approaches in decision making on technological choice. The third and fourth sections focus on Post Normal Science perspective and GM Brinjal debate respectively. The conclusion part is presented in the last and sixth section.

Decision on Technological Choices: Precautionary and Participatory Approaches

What have been the reasons for this seemingly so strong and sudden rush towards a democratisation of science/society relations? This interest could partly be a result of critical questioning of the authoritative role of science in decision making. Controversies, such as the BSE (Bovine Spongiform Encephalopathy) in United Kingdom, Chernobyl (Ukraine) and Fukushima (Japan) Nuclear disasters, Bhopal Gas tragedy etc. have showcased the failure of traditional expert systems owing to their problematic entanglement with the policy world. In this context it is worth mentioning the words from one of the important figures in the science system. In 2003, the editor of Science, Leshner A [2], wrote on the "Public Engagement with Science":

"Some people are not so happy about how central science and technology are in their lives. [...] One traditional response of the scientific community to what it views as a lack of appreciation or misinterpretations by the public has been to mount so-called public understanding or education campaigns designed to "enlighten" the populace, either about science in general or specific issues in particular. [...] But simply trying to educate the public about specific science-based issues is not working. Many science sceptics are already quite well educated, but they relate more to the risks of science and technology advances than to their benefits. Moreover, given the uncertainties in science, the best science-based strategy is not always as clear as we would like and as many in our community might claim. [...]

The centrality of science to modern life bestows an obligation on the scientific community to develop different and closer links with the general population. That convergence will help evolve the compact between science and society so that it will better reflect society's current needs and values. We need to move beyond what too often has been seen as a paternalistic stance. We need to engage the public in a more open and honest bidirectional dialogue about science and technology and their products, including not only their benefits but also their limits, perils, and pitfalls. We need to respect the public's perspective and concerns, even when we do not fully share them, and we need to develop a partnership that can respond to them"[2].

The two broad rationales that have been identified by Leshner for public engagement (or) dialogue with science are: a) to build public Trust in Science, b) to handle the uncertainty and c) Decision on trajectory of a scientific or technological innovation, may not be based on scientific expertise alone. In this section, the above mentioned three reasons will be discussed in detail.

Changed Context of Knowledge Production: Public Distrust

According to Neidhardt *et al*. [3] the Public support to science from the external world of science is based on the assumption that science is a public good and advances in scientific knowledge contributes to productivity of the economy and consequent wealth generation and public health. This assumption and

belief brings science in close contact with public policy and policy making. But, rationalist-empiricist theories of knowledge characterize scientific knowledge as rational, universal, invariant and atemporal, having its own autonomous dynamics. The Post–Kuhnian approaches in the social studies of scientific knowledge questioned the received view of science and demonstrated that : a) the earlier conception that science is a morally neutral and disinterested pursuit, autonomous from wider society and culture, is no longer tenable; b) all knowledge including scientific knowledge is socially caused; c) the boundary between the internal and the external worlds is not rigid but porous, and d) there are intimate links between the context of discovery that is the process of production of knowledge and product of science (descriptions, explanations, models and theories).

Several scholars have highlighted this cultural transformation of science from 'public knowledge' into 'intellectual property' and how research process is increasingly getting privatized [4,5,6,7,8, 9]. In the present context, in which science has become an intellectual property, our concerns are: what are the terms of contract between science and society and what is the governance model that can ensure participation of stakeholders with diverse interests and meanings in a country like India?

Scientific Risk assessment and Uncertainties

It is obvious that technological interventions always come with some benefits as well as associated risks. Assessment of such risks is important before taking any decision on the particular technology. Hence, scientific risk assessment plays a primordial role in the decision-making on the emerging technologies. Stirling and Gee [10] defined Risk as the 'magnitude of a possible hazard' multiplied by the 'probability that a hazard will occur'. Thus, the basic steps of risk assessments are to identify the possible hazards associated with a given technological invention and to calculate the magnitude and the probability associated with each hazard occurring. The exercise is commonly performed by scientists with expert knowledge in relevant fields. Importantly, the practice of risk assessment is based on the assumption that every hazard can be accurately predicted and its respective probabilities calculated using scientific methods. But, most important real-life environmental and health issues display complexity, scientific uncertainty and conflict of interest, posing serious challenges to this assumption [11]. In this context, Stirling & Gee [10] argue that to express all uncertainties in quantitative terms and treat these as if they will be sufficiently reduced through more research is misleading.

The expectation that scientific expertise will provide reliable, objective, true knowledge and thereby close down policy controversies is no longer tenable. Decisions about the relationship between technology and society are deeply political. In this context, Leshner [2], states that the best political decision, as well as the trajectory of a scientific or technological innovation, may not be based on scientific expertise alone. Societal values and interests come into play in deciding which uncertain path to choose. Hence, dealing with the uncertainties openly and explicitly will improve the quality of the information upon which decisions are based, which may lead to better risk management. Therefore, it is important to acknowledge uncertainties in policy-relevant science and decision making which is at the core of the Precautionary Principle[ii] .

Social Acceptance of Risk

Technology cannot be separated from the social context where it is introduced. Food, in general, has profound cultural, social, moral, and historical meanings, and these meanings are crucial to individual and social identity and well-being. The dominant risk discourse driven by technocratic ideology tend to describe risk on grounds of strictly scientifically determined standards, whilst the public differently conceptualize risk by plethora of other arguments such as economic, political, social, ethical and religious considerations [12−14].

There are two important dimensions of risk: (a) judgment on the acceptable level of risk and; (b) the time element. Judgment on acceptable level of risk is never purely scientific when the weighing of incommensurable costs and benefits involves trade-offs among diverse values [15]. Therefore, the decision on the acceptable level of risk is always a negotiated outcome mediated by power relations among the actors and the institutions they represent. Secondly, the time dimension refers to how long a particular technology is safe. With regard to time element, the question is : what is the time frame over which, for example, in the case of Genetic Modification technology, Bt toxin can provide resistance against FSB in GM brinjal?

Controversies around genetic modification of food suggest that innovations have to be socially acceptable in terms of safety, equity, and sustainability, environmental safety and the cultural considerations. Therefore, although risk assessment can be a useful tool for decision making on its own, it is inadequate for addressing the many social, ethical and cultural concerns relevant to the future of food production [16]. Therefore, Leshner [2] calls for transparency considering the downsides of science and for an open and bidirectional dialogue to build mutual respect and trust, and, ultimately, a partnership. However, only

focusing on risk prevention is not enough to make a technology acceptable to a sceptical public.

Post Normal Science (PNS) : Extended Peer Community

The theoretical framework of PNS has been used to study the public engagement ('extended peer group') who contributed their inputs as additional pieces of evidences that formed the basis for the policy decision - to impose moratorium on the release - invoking the 'precautionary principle'. The theoretical framework of PNS has been used by the STS researchers to study the interface of science and policy, particularly where there is a high degree of uncertainty in the scientific understanding of the systems under study as also where the stakes are high in the process of decision making – a typical example being risks associated with climate change [17]. It comprises not only a focus on problem situations where facts are uncertain, values in dispute, stakes high and decisions urgent [18].The presence of irreducible uncertainty and complexity in environmental and technological policy issues necessitate the development of alternative problem-solving approaches and interfaces between science and policy, in which uncertainty is acknowledged and science is consciously democratized [19]. Their ideas primarily concern replacing 'truth' as the standard for evaluating science, with a focus on 'quality assurance' based on increased participation in knowledge generation. PNS is seen as a space for presenting evidence and mutual learning, and carrying out what Ravetz [20] terms "negotiation in good faith"—a ''long way from science and a longer way from politics''.

The post normal science paradigm has yet to articulate its theory of science and society fully in contemporary times and evolve a model of governance that is robust and addresses the specificities of different contexts". I use PNS as a sensitising concept to understand the Bt brinjal controversy in India.

GM Brinjal Debate : Interests and Meanings

The approval of Bt Brinjal for commercial release by the GEAC was challenged by the civil society, as well as some eminent scientists. Responding to the national outcry, the government announced nationwide public consultations during the year 2010, sought the views of the state governments and experts from India and abroad.The analysis of the scientific evidence clearly shows that there is no consensus within the scientific community on the health and environmental safety of Bt Brinjal. Prominent scientists have highlighted several flaws in the scope and adequacy of the Expert Committee-II Report. Further, the instances of deep division, lack of transparency, conflict of interest among the Expert Committee members cast doubts on the ability of experts and veracity of scientific knowledge to provide complete answers to the policy questions.

In the face of contested scientific knowledge claims and intrinsic uncertainty surrounding GM crops, the interest groups may all base their arguments on their contrasting risk-benefit perspectives, interests and values within the dynamic discourse of knowledge formation. These framing battles tend to be based on competing values/meanings and interests.

This paper presents a glimpse of the social meanings and interests that different stakeholders attach to GM Brinjal. The genetic engineering technology can generate conflict between the interests of the seed companies and scientific community that produce genetically modified seeds and the interests and values of the farmers and consumers. For industry and scientific community see no change in the meaning of crops with genetic modification. For the biotechnology industry, life forms such as the seed (either GM or Non-GM), constitute physical means of production, whereas for farmers and other sections in the society, life forms carry religious and aesthetic meanings [21].

Farmers are not a homogeneous group, in terms of resource endowments. Therefore, we can find varied interests among the farmers groups in relation to their landholding size and resource endowments. In case of Brinjal, about 1.4 million small and marginal farmers in India grow this crop [22]. On the other hand, unlike the GM cotton, GM Brinjal is a food crop and majority of the produce is being consumed in India. In India, about 9.5 million tonnes of Brinjal is produced in a year in 0.58 million hectares, nearly all of which is internally consumed [23]. As food is a cultural marker, it is a common feature of all cultures to attach meanings to what is consumed as food. Food choices are framed by cultural, social, and material circumstances [24]. Apart from the risk and safety issues, several concerns have been raised by consumer groups in the public consultations on Bt Brinjal in India. Hence, stakeholders have raised several questions on various aspects, namely, economic benefits and risks, ownership over technology, accessibility, right to choose non-Bt seeds, rights of the organic farmers, plurality of knowledge systems, relevance, compatibility, sustainability, unpredictability with the technology, Brinjal diversity, food security, health and environmental risks, decision making on technological choice, etc.

Apart from the above, state governments indicates more than ten states including the major Brinjal growing states expressed their concerns on different grounds and called for extreme caution on commercial release of Bt Brinjal. According to one estimate, of the 91 applications for field trials before the

GEAC, 44 are GM food crops. Given the great public policy ramifications of the GM crops on human health, the environment, economic, social, cultural and moral spheres different social groups, the public have demanded an upstream public engagement and a nationwide public debate on the entire GM approach to the Indian agriculture. Once public values and interests are understood, these can be more effectively introduced into risk assessment and risk management practices.

'Government' to 'Governance'

The paper argues that there should be a shift in the regulatory paradigm from a government-centred model one to that of a governance-centred one. Governance has been defined as the ''conscious management of regime structures with a view to enhancing the legitimacy of the public realm'' [25] by engaging with stakeholders and incorporating their perceptions. Unlike the government model where the framing of policy issues and the processes of regulation and implementation are centralised in the hands of formal public institutions, the governance model refers to inclusion of wide range of actors into policy domain such as: industry, scientific organisations, pressure group, consumers, farmers, market and the public at large. In the process of grappling with uncertainties and assumptions about risks and the methodology of risk studies that are associated with normal science are not adequate and hence there is a need to shift to post normal science which addresses these issues by incorporating the contextual specificities and by recognising the knowledge held by consumers of the products of technology.

As discussed earlier, one of the key elements of the PNS, apart from the scientific quality, as defined by Funtowicz & Ravetz [26], is to increase the social robustness of the knowledge production, by assessing the conflicting interests and values of the different interest groups through the extended peer community process. People hold different values and beliefs about the way societies sustain quality of life for their members. The first step, therefore, is to analyze people's value orientations and interests. In the post-normal domain, scientific and technical discourse is no longer restricted to expert communities, but needs to be inclusive of non-specialist participants and all those who wish to contribute to resolution of the issue. These extended peer communities will not necessarily be passive recipients of the materials provided by experts. They will also possess, or create, their own 'extended facts'.

This paper argues for regulators to carry out independent tests and put out the results in public domain. Achieving more democratization of science through consensus based on publics' rationality should form the basis for decision. Technology development should be seen as a means to achieve social justice, equity and sustainability. As Bijker *et al*. [27] put it; the social and scientific appraisal of emerging technologies thus needs to be based on a methodology that can combine scientific expertise with democratic participation of public at large.

CONCLUSION

Bt Brinjal debate in India is a classic example where the government has realised that decisions on techno-scientific developments can no longer be made by a technocratic ideology. The publics have adopted integrated/holistic view rather than reductionist view about the safety and acceptance of GM food crop'. Therefore, there is a need for a socially embedded analysis of GM crops in the context of the wider socio-technical system. In this paper, an attempt has been made to examine the dynamic relations between science and technology on the one hand and the issue of regulation of risks arising out of the nature of knowledge produced and consequences of the application of such knowledge for human populations and environment. In the context of the shift in the paradigm of 'world-in-itself' to that of the 'world-for-itself' the classical 'government' model of regulation is not appropriate, especially in the context of science and technology that seeks to transform the organic world, which is deeply embedded in the interests and meaning structures of different cultures. This transformation is fraught with uncertainties and risks for humans and environment. There is a need to move towards a model of regulation based on governance. In the process of grappling with uncertainties and risks assumptions about risks and methodology of risk studies that are associated with normal science are not adequate and hence there is a need to shift to post normal science which addresses these issues by incorporating the contextual specificities. However, the post normal science paradigm has yet to articulate its theory of science and society fully in contemporary times and evolve a model of governance that is robust and addresses the specificities of different contexts.

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Notes

[i] The term 'genetically engineered' is often used in place of 'genetically modified'. I use 'genetically modified,' because this is the terminology consistently used by many authorities internationally, including the Food and Agriculture Organization of the United Nations; the World Health Organization; Codex Alimentarius; European and Indian legislation; peer

reviewed studies by industry and independent scientists; and the international media. It is also consistent with the Cartagena Protocol's term 'living modified organism (LMOs)'. Genetic modification involves transfer of gene(s) from an organism belonging to one species of a taxonomic group to the food crop that belongs to a species of another taxonomic group. The source of the genes may be a plant species, animal species or a bacterium. Therefore, in genetic engineering, genetic traits from any species like bacteria, virus, fungi, plants or animals can be introduced into a desired plant species. Crops produced through this process are called 'transgenic' or 'genetically engineered/modified' crops. For example, the 'Bt' widely used in genetically modified crops is Bacillus thuringiensis, a common bacterium that produces insecticidal proteins [28].

[ii] The most widely cited formulation of the Precautionary Principle is from the Rio Declaration on Environment and Development, Principle 15: *'In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage lack of full scientific certainty shall not be used as a reason for postponing cost effective measures to prevent environmental degradation' [29].*

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