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Science Communication:

Building Consensus on Crop Biotechnology

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Finding viable alternatives to solve the problems of food, feed, fiber, energy, and environmental degradation continue to be at the radar screen of scientists' research agenda. Agricultural or crop biotechnology has been identified as one of many strategies to complement conventional technology. Although merely another option in a scientist's toolbox, it has sparked worldwide interest and debate. On one hand, proponents of the technology talk about first generation crops such as biotech maize, soybean, cotton, and canola which spell higher yields, less pesticide use, and health and environmental gains. They also talk about the potential benefits of second generation crops that will directly benefit consumers by addressing nutritional and product concerns. Food safety, labeling, and patent issues are being discussed in addition to perceived human intervention in creation, sustainability, and distribution of benefits. The diverse scientific, political, economic, ethical, cultural, and even religious viewpoints have made crop biotechnology a recurring and contentious public issue.

Such a scenario has polarized interested publics or stakeholders of agricultural biotechnology resulting in confusion of mixed messages from scientists, academics, activists, industry, and consumers. Conflicting ideas and opinions have brought into focus different technological and social dimensions that divide not only stakeholders but countries as well. Liakopoulos (2002) says that biotechnology has now become a social phenomenon rendering it more of a social issue than a technological development. The polarity of views is what keeps the debate alive and allows issues to be addressed.

The lack of scientific understanding has compromised and aggravated the quality of debates. Argumentation, says Rasco (2008), invariably leads to political and ideological domains which are even more complicated than science itself. This same view was forwarded by the United Kingdom's Royal Society Report (Kinderlerer and Adcock, 2003) when it asserted that public debate about genetically modified (GM) food must consider wider issues than science alone.

Agricultural science is a communal process devoted to the discovery of knowledge and to open and honest communication (CAST, 2005). More often, policies and decisions about what technologies are appropriate and acceptable are decided by society rather than just analyzed from a scientific perspective. In the end, it is the farmer who decides what crop to grow, what seed to sow, and if he should grow a certain variety in the next cropping season or not. It is the housewife who makes the decision on what product to eat and buy from the market. Other actors in the process engage in the debate and discussion about the merits of a technology and influence how research is to move forward as well as which policies will be approved or not. Attitude and perception are influenced by other factors – politics, religion, socio-cultural, and economic – that further complicate the decision making process.

In the late nineties, Gibbons (1999) proposed "science's new social contract with society" which demands the participation of various stakeholders in knowledge generation and validation. This is essential for the development of socially robust knowledge, one that is transparent and participative. The blurring of society's stable categorizations into state, market, culture, and science no longer allows science to be merely a producer of knowledge. Instead, what is needed is a dynamic process where science and society jointly produce knowledge where actors generate accountability and audit systems. The social contract is open, socially distributed, and self-organizing. Science and society transform each other with boundaries becoming less restrictive and more permeable. Hence, progress in science and technology develops within a societal environment and is highly dependent on a receptive and appreciative society (Sinemus and Egelhofer, 2007).

GM Controversy

Biotechnology has been described as a powerful and promising technology that presents a range of economic, social, and environmental benefits. The public has easily accepted many products as a result of biotechnological intervention but these have been mostly in the medical field such as recombinant vaccines for hepatitis B, antibiotics, and hormones like insulin (Barzaga, 2008). Studies have shown that compared with other applications of gene technology, GM food or crop biotechnology is perceived to be less acceptable. Cloning of human cells and bioremediation are considered less acceptable than genetic testing but more acceptable than GM crops and food (Gaskell, et al., 2003). Other reasons for non-acceptance of GM food are the perception that the first generation products lack tangible consumer benefits and that benefits are accruing to industry alone while risks are being borne by consumers and the environment (Scholderer and Frewer, 2003).

Case studies illustrate how the dynamics of science and society affect technology acceptance and adoption. Poortinga and Pidgeon (2007) give a historical analysis of how a number of successive events dramatically changed public opinion about GM food in the United Kingdom (UK). Consumer and non-governmental organizations (NGOs) were able to pressure supermarkets to remove GM products from their shelves. These events included the non-segregation of products with GM and non-GM ingredients which was interpreted by the public as violating basic consumer right to choose products; the creation of Dolly, the cloned sheep, which sparked intensive public and media debate about the ethics of biotechnology; and the government's handling of the Bovine Spongiform Encephalopathy (BSE) or mad cow disease crisis which led to low public trust in government. Public response to these issues proved that public acceptance is very important for the acceptance of a new technology, and that consumers are a decisive factor for decision making not only at the national but also at the supranational level.

In addition, Canales (2007) adds other implications of the GM debate in the UK. It led to a six-year de facto moratorium on GM food from 1998 to 2004; affected the level of funding and support for public biotech research; contributed to the establishment of a biosafety regulatory system that is unable to overcome impasses and provide decisions, either for or against a submission; and created a negative climate for investment by the private sector. Aside from just being an internal turmoil, the events affected global public opinion on GM; raised international trade concerns and market acceptance issues with countries that traded with the European Union (EU); and increased the costs of research and regulatory approvals.

Acts of vandalism against academic or government research on GM by activists have also affected scientific endeavors and indirectly affected public opinion about GM. *Centre National de la Recherche Scientifique* (National Center for Scientific Research) in France lists more than 70 acts of vandalism in Germany, UK, France, and Switzerland. Destruction has often been accompanied by damage to property and threats or violence against persons (Kuntz, 2010). Even developing countries like the Philippines and Thailand have not been spared. Not only have these acts of vandalism delayed the conduct of research but in some instances have led some countries to stop further field trials or pull out their research altogether to another country with a more positive stance towards the technology.

Neglecting to identify the needs, interests, and concerns of the primary stakeholders or publics, referred by Sagar and Ashiya (2000) as the 'commoners' in the biotechnology arena, has been a major factor in the emergence of controversies. In addition to applications of individual technologies, concerns also involve the broader institutional and political context in which technologies are introduced. This realization has led to changes in mindset about the importance of engaging the public in a transparent debate about innovation processes to increase acceptance of and reduce resistance to their products.

Thus, several reasons are forwarded by Saner (2007) as to why the public must be involved in multi-stakeholder dialogue. These include: improved public policy, greater public confidence in government, stronger support for regulatory decisions, and a more informed and engaged public.

The 'Publics' and Crop Biotechnology

Studies in the United States (U.S.), Europe, and Asia generally confirm the results of the Environics International research in 2000 which studied 35,000 respondents from 35 countries on their attitude towards biotechnology. In general, consumers in the U.S. and Asia are more favorably disposed towards biotechnology than Europeans with significant minorities in most countries expressing reservations. Trends in the U.S. and Europe have fluctuated over time with European views being more negative throughout the 1990s before turning slightly more positive in recent years (Hoban, 2004). The Eurobarometer report entitled *Europeans and Biotechnology in 2005: Patterns and Trends* notes, however, that public opinion in the European Union towards biotechnology is not as negative as it is portrayed since public opinion is fairly divided and a common sentiment is that of disinterest. Generally, the European public does not seek out activities that demonstrate their interest in the topic (USDA GAIN Report, 2010). The latest Eurobarometer report (EuropaBio, 2010) indicates "confidence and optimism are on the rise" with 80% of respondents being in favor of biotechnology.

FAO (2004) reports that public attitude to agricultural biotechnology differs widely across countries. Attitude is generally related to income levels, with people from poorer countries having more positive attitude than those from wealthier countries who tend to be more skeptical in general. Attitude towards biotechnology and genetic engineering is complex and nuanced. Respondents from poorer countries are in general more likely to agree that the benefits of agricultural biotechnology exceed the risks; that biotechnology will be beneficial to them; and that it is morally acceptable. People from the Americas, Asia, and Oceania are far more optimistic about the future of biotechnology than the Africans and Europeans. In Asia, countries such as the Philippines and Indonesia are less skeptical about the benefits than Japan and the Republic of Korea which are more concerned about the potential risks. In general, most people make subtle distinctions in perception towards applications, considering the type of modification and the potential risks and benefits.

The Asian Food Information Center conducted three surveys in 2002 and 2003. A quantitative study (AFIC, 2003) among 600 consumers in Indonesia, China, and the Philippines concludes that majority of consumers are aware of the presence of biotechnology-derived foods in their diets and are not adverse to this situation. They have low technical knowledge on biotechnology, but are aware of food crops developed using biotechnology and are willing to try them. AFIC (2004) also did a study on consumers in the Philippines, China, and India. The findings show that most consumers adopt an open-minded position towards biotechnology foods. They have limited knowledge about food biotechnolgy but increasing knowledge level is associated with increasing positive acceptance of biotechnology food. Use of biotech to potentially produce food with enhanced nutritional value or requiring less pesticide for cultivation elicits very positive response. In a quantitative survey of perception, understanding, and acceptance of GM plants and animals among 2,454 respondents in six provinces of Thailand in 2004 (AFIC, 2005), findings show that respondents have heard about biotechnology and their most common source of information is television, then newspapers. But level of understanding is low, corresponding positively with educational level. Nevertheless, respondents strongly support research on biotechnology products with potential benefits such as food with enhanced nutritional value. Respondents in an AFIC consumer study from Japan, China, India, Philippines, and South Korea (AFIC, 2008) indicate readiness to accept the benefits of biotechnology-derived food in the light of the growing demand for high volumes of food.

A series of studies on *The Social and Cultural Dimensions of Agricultural Biotechnology in Southeast Asia: Public Understanding, Perceptions, and Attitudes towards Agricultural Biotechnology* were conducted in five countries: Indonesia, Malaysia, Philippines, Thailand, and Vietnam (Juanillo, 2003); as well as follow-up studies in Indonesia and Philippines (Torres et al., 2006). Eight stakeholder groups[1] identified as belonging to the so-called attentive publics of agricultural biotechnology define and represent biotechnology according to their own interests and priorities. Details of the results are discussed more in-depth in the different country chapters. Generally, however, stakeholders are moderately aware of biotechnology, have low access to information and information-seeking behavior, and prefer mass media (radio, television and newspaper) as source of information.

Mohr et al. (2007) studied the attitude, values, and socio-demographic characteristics that predict acceptance of genetic engineering and applications of technology in Australia. Findings indicate that general receptiveness towards science and technology is the primary predictor of genetic engineering (GE) acceptance. Significant predictors are pro-science-technology attitude, anticipated risks, trust in non-expert sources, the values of conservation (negatively), and self-enhancement. The study provides a context by which to understand acceptability of GE, that there is a greater chance of acceptance when a new technology product offers a solution to a medical problem or addresses highly valued personal benefits.

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1) Policy makers - individuals whose decisions and opinions have significant influence or impact on national policies, laws, and regulations relating to agricultural biotechnology as well as on the overall direction of the country's agricultural development programs.
2) Journalists - include media writers and broadcasters on television, radio, and print whose primary beat is science and technology.
3) Scientists - individual scientists who are not part of a country's crop biotechnology research consortium, but are often consulted by the mass media, NGOs, or other private groups for their individual scientific opinions or assessments relating to crop biotechnology.
4) Farmer leaders and community leaders - heads of farmers' associations, cooperative groups, town mayors, councilors, members of a community council whose opinions and ideas tend to influence the overall dynamics of community debates or discourse on crop biotechnology.
5) Extension workers - field level staff of agriculture ministries, university action research programs, or semi-academic research institutes who conduct outreach and information campaign programs on agriculture.
6) Consumers - urban supermarket-goers and buyers who tend to be middle-class and have had at least some college education.
7) Businessmen and traders - individuals who are directly involved in the food and agricultural industry.
8) Religious leaders - members of the Catholic clergy, pastors from Protestant churches, and Muslim clerics.

Role of Media

The media has been identified not only as the primary source of information on science and technology but also the preferred information source by consumers. Media plays a crucial role in providing people with the information necessary to make decisions about policy options and the potential risks and benefits associated with agricultural biotechnology (Scheufele, 2007). In addition, media allows citizens to gauge the climate of opinion around them and facilitates consensus building.

Media defines what the general public understands about the technology, and at the same time provides the environment by which public opinion is formed, about what is often perceived as a controversial, if not a contentious, issue. On one hand, it is able to set the agenda and tone for what the public will deem interesting or important. The agenda-setting influence of the news media goes beyond merely focusing public attention on a particular topic. It pervades the communication process, the understanding and perspective on the topics in the news (McCombs, 2002). The media facilitates dialogue and debate between and among different segments of society. Debates need not only be adversarial but a process towards arriving at a consensus or agreement (Khan, 2008). On the other hand, media can receive information from many disparate sources and can add to the confusion of messages. Media frames how issues are portrayed in the news and provides insights into formation of public opinion.

De Vreese (2005) defines the concept of framing as organizing and structuring information so that it is socially shared and provides meaning to reality. This involves deliberate identification of an aspect of a perceived reality, and giving a corresponding interpretation and evaluation. The frames or thematic slant by which articles are written by journalists such as social progress, public accountability or governance, new research, and public engagement or conflict contribute to how readers view a technology.

Marks and Kalaitzandonakes (2003) argue that bias in reporting events depends on unfolding events and scientific and risk management controversies. News stories offer the public with definitions of social reality where an occurrence is turned into a newsworthy event; a newsworthy event into a story; which is then communicated to the public. With biotechnology often tagged as a contentious topic, it is expected to be presented by the media as a polarized issue. Nevertheless, journalists' training and practice of presenting both sides of the issue allows for objectivity and fairness in reporting.

Controversy carries news value and creates a peak in media coverage. Biotechnology, according to Brossard et al. (2007), needs to be looked at from an issue-cycle perspective where attention to the topic is not constant but at varying levels due to triggering events. Mass media coverage, thus, has the potential to strongly influence public opinion particularly during critical peak coverage. In addition to determining what topics garner coverage, it is also important to know who provides relevant information and the extent to which a topic is covered and how (Thomson and Dininni, 2005).

Science Communication in Crop Biotechnology

Advances in science and the resulting technologies and products have expanded the ways by which people at many levels of society view the world. Science, therefore, has a responsibility to help societies make a transition "from an obsession with growth to achievement of a dynamically stable and sustainable ecological and economic system." Scientists have an obligation to become involved with policy makers and the public in finding and implementing solutions or means of adaptation to issues that are both local and global in scope (Report of the North American Meeting, 1998). Hence, the need for scientists to be proactive in policy and decision making. A recommendation in 2008 by an "Expert consultation on agricultural biotechnology for promoting food security in developing countries" (APAARI et al., 2008) stressed the need to train scientists to be communicators in science; not just on biotechnology but on diverse issues of agriculture, food security, environment, and science.

The role of multiple publics or attentive stakeholders with complex and evolving levels of awareness, understanding, and perception towards crop biotechnology cannot be underestimated. Engaging science and society has led to a discipline called science communication. It is a process of generating new, mutually acceptable knowledge, attitude, and practices. The process of negotiation involves trust that leads to mutual understanding, rather than through statements of facts (Gregory and Miller, 1998). Hence, communication is necessary to enable stakeholders to participate in the social processes of debate and decision making. It is a complex process in an evolving environment that involves interfaces between a number of publics or stakeholders, different messages, a wide variety of communication channels, and varied outcomes.

Velasco (2005) describes science communication as fostering understanding, appreciation, and application of science and the scientific process in a manner that encourages participation by various stakeholders. This suggests creating an environment that encourages dialogue between and among scientists, policy makers, and the public for it to thrive. Science communication focuses not only on the content or the product of science but also on the process that leads to the outputs. Put in another way, science communication is the "art of facilitation, mediation, and consensus-building on science issues that impinge on human and national development." In the context of biotechnology, it is the stakeholders or the attentive publics who have a critical role in framing the debate, shaping policy, influencing public opinion, and creating greater awareness and understanding of the field.

Participation of societies, publics, and policy makers in the developmental stages of emerging technologies such as biotechnology is now more noticeable. From the 'public' denoting unidimensional, monolithic subjects dependent on experts, the trend is now for 'publics' playing different roles (consumer, citizen) at different time periods and becoming active or inactive depending on context (i.e., geography and culture) and circumstance (Einsiedel, 2009). Bauer et al. (2001) describe biotechnology as an ongoing dramaturgy" where the end is not yet defined, but where many actors are working on the plot for different audiences."

As a sphere of activity, science communication consists of three sub-domains. They are scientific communication (professional communication); technical communication (semi-popular science communication); and popular science communication (public communication of science and technology). These sub-domains are priority areas and are not exclusive of other areas of interest such as the public understanding of science (Jamias, 2000).

Science communication uses a combination of communication strategies, both interpersonal and mediated, based on specific information needs and requirements. A public involvement continuum proposed by Health Canada (2008) illustrates the different communication levels that are based on specific objectives and the appropriate methods to use (Table 1). Communication spans from efforts to inform, gather information, discuss, engage, and partner with stakeholders.

Table 1. Different levels and methods of the public involvement continuum

Level	Type	When Used	Methods
1	Inform or educate	• Decision already made and public should know results • Need for acceptance of proposal before decision is made	• Social marketing • Community mapping • Fact sheets • Information kits • Public awareness campaigns • Press release
2	Gather information	• Policy decisions still being shaped • Factual information is missing • Information on opinions is missing	• Meetings with stakeholders • Community or public meetings • Focus groups • Public hearings and seminars • Surveys
3	Discuss	• Need two-way info exchange • Input may shape policy directions, program delivery • Opportunity exists to influence final decision	• Bilateral meetings • Info technology-based methods (interactive website, electronic conferencing, online discussion groups, e-mail lists) • Issue conferences • Technical consultations • Workshops

Level	Type	When Used	Methods
4	Engage	• Citizens can shape policy directions • Citizens should talk to each other on complex, value-laden issues	• Constituent assembly • Roundtables • Citizen's panel
5	Partnering	• Develop programs in partnership • Want to empower citizens or groups to manage process • Citizens or groups want to develop solutions themselves	• Consensus conference

Summarized from The Health Canada Policy Toolkit for Public Involvement in Decision Making. (http://www.hc-sc.gc.ca/ahc-asc/pubs/_public-consult/2000decision/pol-continuum-eng.php)

Science communicators come from both the public and private sectors and from multi- and inter-disciplinary fields. They can be scientists, academicians, government and industry representatives, media practitioners, extension workers, and farmers. All of them are linked by a noble goal – to bridge the gap between science and society. By generating, processing, and utilizing information in various forms to aid decision making, people are able to transform information into knowledge that results into action. Matsuura (2008) says that access to accurate information empowers people by giving them the information that can help them gain control over their own lives. Empowerment gives citizens the capacity to engage in public debate and to hold the government and other institutions accountable for decisions made. In an environment where there is plurality of opinions, providing a venue for informed discussion and free flow of information contributes to critical assessment and review. Citizens are then able to make crucial decisions as a result of the process of discernment.

Summary

Debates surrounding the acceptance and adoption of crop biotechnology have put the focus on other variables beyond science itself. The polarization of stakeholders due to conflicting and mixed messages, and the presence of divergent information sources, among others, affect public opinion on science in general, and biotechnology in particular. Communication is one of several key variables needed to create an enabling environment for biotechnology. Hence, various stakeholders need to be part of the process of science communication wherein new and mutually acceptable knowledge, attitude, and practices are negotiated leading to mutual understanding. This deliberate and strategic approach to encourage participation and transparent debate encourages decision making and consensus building on the technology. This requires an institutionalized communication plan and a trained cadre of science communicators who not only understand content but have the requisite skills to communicate such information. Science communicators will, thus, play a contributory role as catalysts for change in making possible an informed public, science-based decision making, and higher capability, equity, and empowerment among stakeholders.

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