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Perception of the risks and benefits of *Bt* eggplant by Indian farmers

MARK CHONG[1]*
Singapore Management University, Lee Kong Chian School of Business, 469 Bukit Timah Road, Singapore 259756

Abstract

Several researchers—most notably Lennart Sjoberg and his colleagues—have proposed that the moral aspects of risk provide a better explanation of risk perception than the psychometric paradigm or Cultural Theory, neither of which accounts for moral concerns. This study is possibly the first to assess empirically the perception of the risks and benefits of a transgenic food crop—transgenic *Bt* (*Bacillus thuringiensis*) eggplant—by farmers in a developing country such as India. It also aims to assess if the moral aspects of risk figure in Indian farmers' perception of *Bt* eggplant and if economic benefits outweigh perceived risks. To answer the research questions, a scenario was used to elicit perceptions of *Bt* eggplant among 100 eggplant farmers in the state of Maharashtra in India. The findings indicate that economic benefits, safety concerns, and accountability are most salient to Indian farmers' perception of the risks and benefits of *Bt* eggplant. Significantly, none of the farmers mentioned moral concerns as an issue. The findings also make clear that economic benefits outweigh perceived risks. This study concludes that economic benefits are more salient than moral concerns to Indian farmers' perception *Bt* eggplant. It also proposes that an alternative theoretical model incorporating economic benefits, safety concerns, and accountability as key variables should be developed and tested for end users in the developing world.

KEY WORDS: risk perception, biotechnology, developing countries, farmers

1. Introduction

A number of researchers—particularly Lennart Sjoberg and his colleagues—have proposed in recent studies that new theoretical models based on moral notions of risk such as "tampering with nature" or "unnatural risk" might provide a more successful explanation of risk perception than the psychometric model or Cultural Theory. Indeed, Sjoberg (2000) argued that the psychometric model in its original three-factor form explains only about 20% of the variance of risk perception, while Cultural Theory explains only about 10% of the variance. In a 1996 study on public perception of nuclear waste in Sweden, morality (denoted as "Unnatural and Immoral Risk") was added as a fourth factor to the traditional three-factor psychometric model. It turned out that morality was the only factor that had a significant beta value. Moreover, its introduction improved the

[1] The author conducted this study when he was a doctoral student in the Department of Communication at Cornell University.

*Author to whom correspondence should be addressed. E-mail: markchong@smu.edu.sg

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model's performance and single-handedly carried its explanatory power (Sjoberg, 1996). In a later study on public risk tolerance to nuclear waste, moral concerns were found to account for about 60% of the variance of risk perception and risk acceptance (Sjoberg and Drottz-Sjoberg, 2001). Furthermore, other studies (e.g., Sjoberg and Winroth, 1986; Sjoberg and Torell, 1993) indicate that the moral value of an action (i.e., whether it is morally good or bad) is a stronger predictor of the acceptability of risk than the probability of a positive or negative outcome or the value of such outcomes.

According to Sjoberg (2000), notions of morality are central to risk perception because "people construe risk on the basis of belief systems, not emotions as the original psychometric model implied, and not group dynamics as Cultural Theory posits" (p. 365). The notion of "unnatural risk" is significant in risk research, as most people harbor a deep skepticism towards the unnatural. More specifically, there is a powerful association between the concepts of "natural" and "safe" (and inversely, between "unnatural" and "risky") in many people's minds (Krimsky and Wrubel, 1996). Indeed, many anti-biotechnology groups have used moral concerns to justify the wholesale rejection of transgenic crops (e.g., Shiva, 2000), even as the Nuffield Council on Bioethics (1999) has emphasized the moral imperative to make transgenic crop technology available to the developing countries that want it.

In addition to morality, the role of economic factors in the perception and acceptance of agricultural technologies has also received some attention. For example, Chong and Scheufele (2002) found Thai farmer groups unreceptive to genetically modified "golden rice" because of fears that it would jeopardize farmers' economic self-sufficiency and increase their dependence on foreign-owned technology. Wu (2004) reported that African farmers' fears concerning difficulties in exporting food to the European Union due to the EU's precautionary stance against transgenic crops might have played a decisive role in African public resistance to US transgenic corn. David and Sai (2002) found that economic benefits such as yield improvements were the main reason Indian farmers in the state of Andhra Pradesh adopted *Bt* cotton. Likewise, village leaders in the "rice belt" of the Philippines consider improved yield the single most important criterion when making a decision to adopt a new rice variety—transgenic or otherwise (Chong, 2003). Hence, economic benefits (or the lack thereof) appear to be critical to the perception and acceptance of transgenic food crops.

2. Research Objectives

Eggplant is one of the most widely consumed vegetable crops in India. It is cultivated on 0.47 million hectares, mostly in the states of Orissa, Bihar, Karnataka, West Bengal, Andhra Pradesh, Maharashtra, and Uttar Pradesh. China and India are the world's largest eggplant producers—together, they account for almost 84% of world production (ABSP 2, 2003).

Each year, Indian eggplant farmers may lose a significant portion of their crop to a number of pests and diseases that include the highly destructive fruit and shoot borer. Collectively, these pests and diseases can cause eggplant farmers to lose up to 100% of their crop. Three groups in India—two from the public sector and one from the private sector—are developing transgenic *Bt* (*Bacillus thuringiensis*) varieties of eggplant that provide resistance to the fruit and shoot borer. The Indian Agricultural Research Institute (IARI) and Tamil Nadu Agricultural University (TNAU) are testing a variety that has the

Cry1Ab gene while the Maharashtra Hybrid Seeds Company (MAHYCO) is developing another that has the Cry1Ac gene. Given the widespread consumption and cultivation of eggplant in India, and considering that approximately 25% of the pesticides applied on eggplant are targeted at the fruit and shoot borer, commercialization of *Bt* eggplant has potentially significant implications for farmers in the country (ABSP 2, 2003).

The current development and impending introduction of transgenic *Bt* eggplant in India offers a timely opportunity to study risk perception of agricultural biotechnology by often-marginalized groups (e.g., farmers) in a developing country. Specifically, this study will look at perceptions of the risks and benefits of *Bt* eggplant by vegetable farmers in the state of Maharashtra. While there have been a number of studies on risk perception of agricultural biotechnology in developing countries such as Mexico, Philippines and South Africa (e.g., Aerni, 1998, 2002), almost all have focused on elite stakeholders such as policy makers, scientists and corporations. This study is significant in that it is probably the first to study the perception of the risks and benefits of a specific transgenic food crop by farmers in a developing country. To this end, three research question were developed:

RQ1: What are Indian farmers' perception of the risks and benefits of transgenic food crops such as *Bt* eggplant?

RQ2: Do the moral aspects of risk figure in Indian farmers' perception of *Bt* eggplant?

RQ3: Do economic benefits outweigh the perceived risks?

3. Method

As most people, even in the US and Europe, are not able to give correct answers to basic questions about gene technology (Duran *et al*., 1998), it is highly unlikely that farmers in a developing country such as India would have more than a minimal understanding of agricultural biotechnology and its applications such as *Bt* crops. To complicate matters, *Bt* eggplant is not available yet to farmers as it is still undergoing early stages of field trials. Given these limitations, a scenario describing the major risks and benefits of *Bt* eggplant (see Appendix 1) was developed and read to the farmer in a face-to-face interview setting. The scenario method is ideal for analyzing subjective reactions to phenomena and events (Lind and Tyler, 1981). For example, researchers such as Slovic *et al*. (1990) and Johnson (2004) have used scenarios to ascertain the effects of risk comparisons on public reactions to risk.

The scenario used in this study is based on a composite of the major risks and benefits of *Bt* transgenic crops identified by two sources: (1) current scientific literature on the topic (Wolfenbarger and Phifer, 2001; Shelton *et al*., 2002; Mendelsohn *et al*., 2003); and (2) five experts in entomology, plant breeding, ecology, soil and crop science, and international nutrition at a northeastern US university and one plant scientist at a leading Indian seed company. The understandings of the six experts were elicited, developed and consolidated into an influence diagram following a procedure outlined by Morgan et al., (2002). For purposes of clarity, the consolidated influence diagram has been deconstructed into its five component factors: (1) development of pest resistance; (2) gene flow to wild relatives; (3) impact on non-target organisms; (4) acceptance by Indian consumers; and (5) benefits (see Figs 1–5). The scenario was pre-tested on four farmers; minor changes to the wording of the scenario were made to clarify ambiguous points.

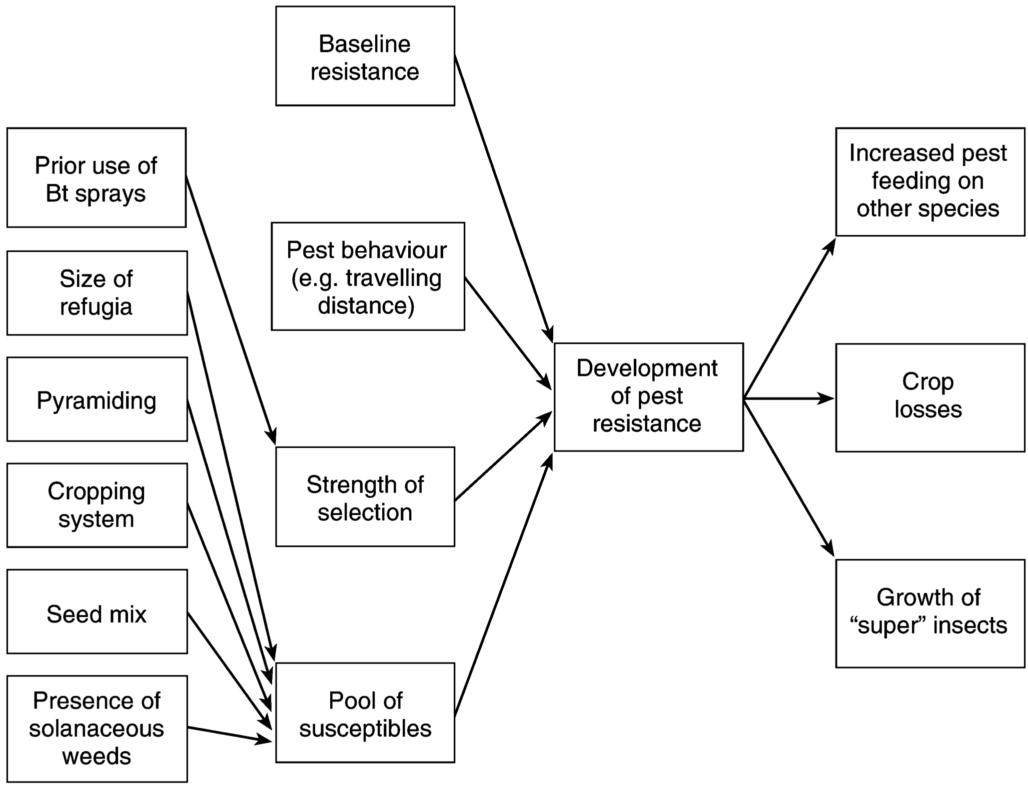

Fig. 1.

After the scenario was read to the farmer in the field, he was asked an open-ended question (i.e., "Please share with me any thoughts and feelings you may have about this new eggplant seed"). The open-ended question was then followed by a number of probes.

Ninety eggplant farmers in the state of Maharashtra were interviewed using a stratified nonrandom sampling procedure. Given the incomplete records on eggplant farmers in Maharashtra, random sampling (and its variants) was not a feasible option.

Maharashtra consists of four geopolitical regions—Marathwada, Khandesh, Western Maharashtra, and Vidharba. Thirty eggplant farmers in Marathwada, 30 in Khandesh, and 30 in Western Maharastra were interviewed in the first quarter of 2004. Thirty was chosen as the "magic number" as very few new concepts tend to emerge after 20–30 interviews, such that the interviewer hears mostly familiar concepts beyond that number (Morgan *et al.*, 2002). Vidharba was not included in the study as it is not an important vegetable-growing region. In each region, the major eggplant growing districts were identified—Aurangabad and Jalna (in Marathwada), Dhule and Jalgaon (Khandesh), and Ahmednagar (in Western Maharashtra). Within each district, a convenience sample of 30 eggplant farmers was interviewed (see Table 1). Basic demographic information on the farmers can be seen in Table 2.

Ten additional eggplant farmers from Pune district (Western Maharashtra region) who were visiting a "farmers' day" organized by the Maharashtra Hybrid Seeds Company were

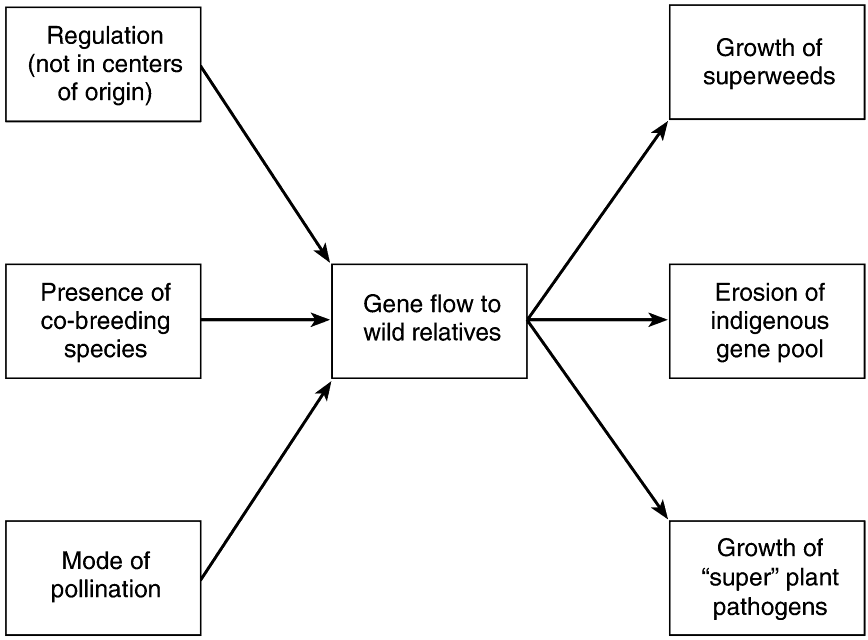
Regulation (not in centers of origin)
Presence of co-breeding species
Mode of pollination
Gene flow to wild relatives
Growth of superweeds
Erosion of indigenous gene pool
Growth of "super" plant pathogens

Fig. 2.

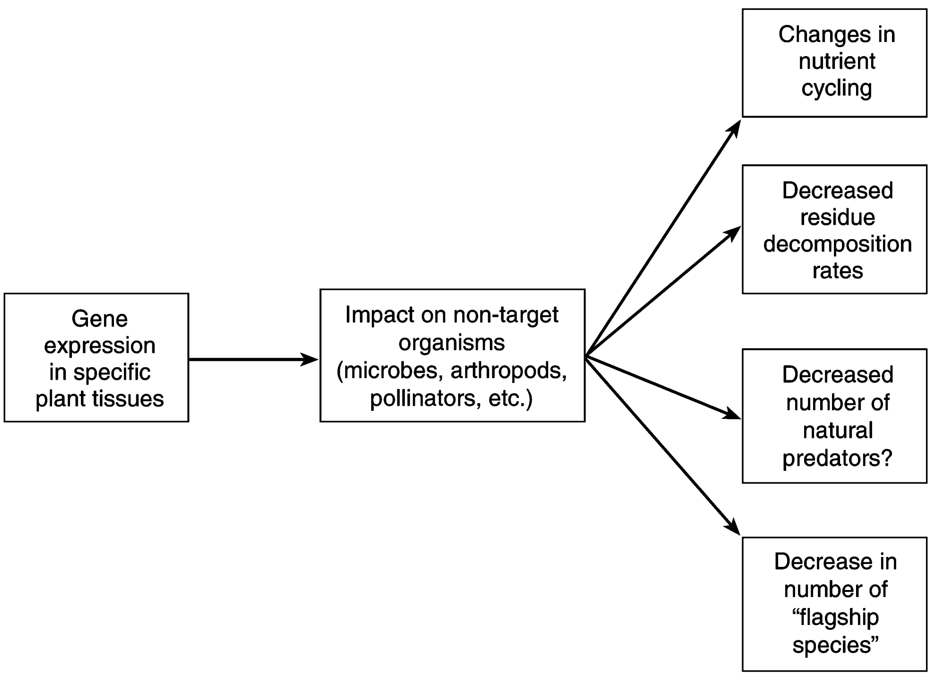
Gene expression in specific plant tissues
Impact on non-target organisms (microbes, arthropods, pollinators, etc.)
Changes in nutrient cycling
Decreased residue decomposition rates
Decreased number of natural predators?
Decrease in number of "flagship species"

Fig. 3.

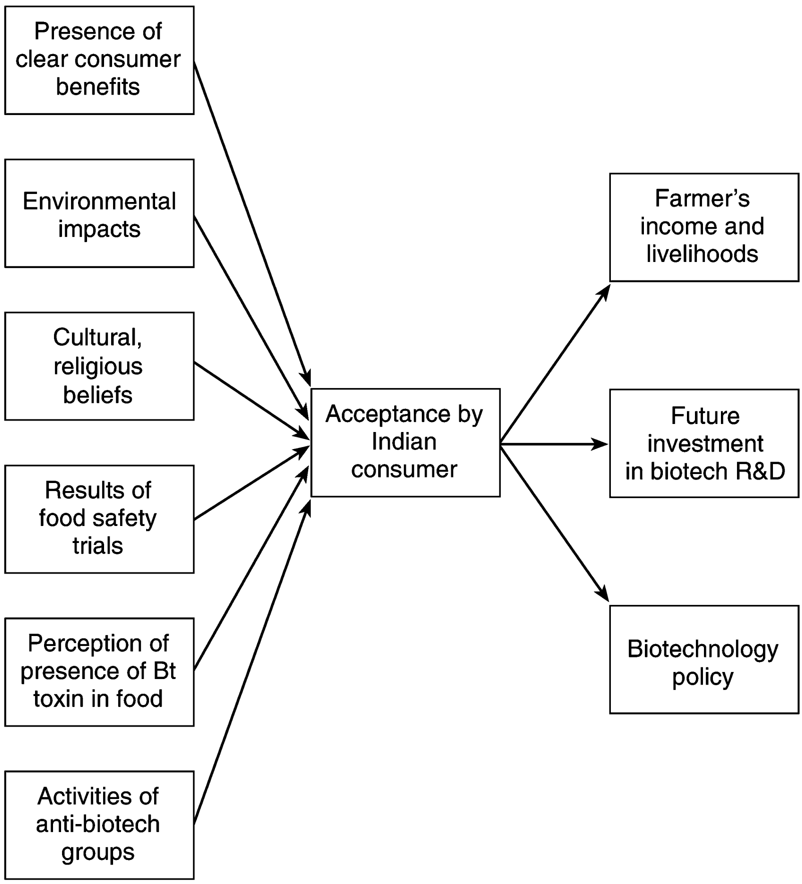

Fig. 4.

selected randomly and interviewed at a subsequent focus group session. The responses from the focus group session were analysed using the inductive coding procedure developed by Strauss and Corbin (1990).

All interviews were conducted in the local Marathi language with the assistance of a local translator who has a postgraduate degree and field experience in agricultural extension. A local manager from MAHYCO also accompanied the researcher to all the interviews. The farmers' responses were translated immediately from Marathi into English and recorded in English on tape. On average, each farmer interview lasted between 20 and 30 minutes. The first five to 10 minutes of each interview typically consisted of "small talk" to "break the ice" with the farmer. Reading out the *Bt* eggplant scenario in Marathi took about five minutes; each farmer then typically took about five minutes to give his response. The last five to 10 minutes of the interview involved asking the farmers a list of close-ended questions, including questions about the key problems encountered in eggplant cultivation, the extent of damage caused by the fruit and shoot borer, main sources of agriculture-related information, key adoption factors, and demographics (see Appendix 2).

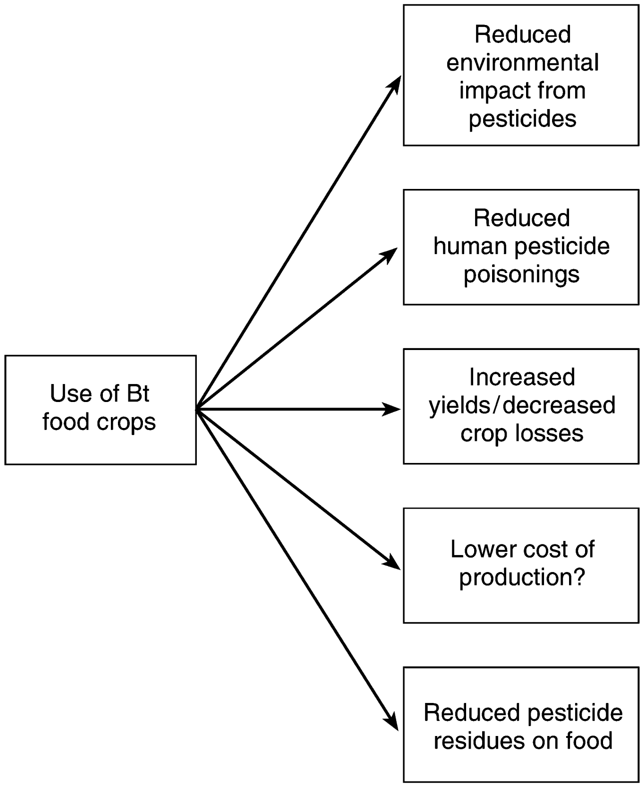

Fig. 5.

In addition to the farmer interviews, face-to-face interviews were conducted with two local Indian experts in anthropology and agricultural extension to gain further insight into the farmers' responses.

4. Coding

This study used the inductive coding technique developed by Strauss and Corbin (1990). In accordance with this technique, interview responses were collected, transcribed and reviewed line by line. The unit of analysis was a sentence or multi-sentence chunk. In the process, thematic categories or codes were created for each sentence (in cases where the response consisted of only one sentence) or multi-sentence chunk.

Table 1. Number of respondents by region (N=100).

MAHARASHTRA	
Marathwada region	30
Khandesh region	30
Western Maharastra region	40 (includes 10 from focus group)

Table 2. Key demographics of Maharashtra farmers (N=90).

Gender	*Male (100%)*
Age	42.1 years (average)
Farming experience	22.3 years (average)
Education	
Illiterate	10% (9 farmers)
Elementary or secondary education	76.7% (69 farmers)
Tertiary education	13.3% (12 farmers)
Farm size	
1 hectare or less (very small)	6.7% (6 farmers)
More than 1 hectare	93.3% (84 farmers)

As recommended by Miles and Huberman (1994), coding took place simultaneously with data collection. In addition to driving ongoing data collection, this practice reveals potential sources of bias, reshapes the researcher's perspective for the next data collection opportunity, and highlights incomplete or ambiguous data for attention. Data coding and recoding was conducted until a "saturation point" was reached—that is, until all the farmers' responses could be readily classified and sufficient numbers of themes had emerged—signalling that the analysis has run its full course (Miles and Huberman, 1994).

To increase confidence in the internal validity of the findings, a senior college undergraduate who had fieldwork experience in Madagascar was asked to look systematically at the same data and come up with her own codes so as to offer possible rival explanations for the data (this information is available on request from the author). (see Miles and Huberman, 1994). Table 3 shows the results arising from the comparison and consolidation of the two independent sets of codes. The frequency with which each theme appears in the data is denoted under the heading, "Number of mentions."

Bauer and Gaskell (2000) have established five qualitative criteria that are functionally equivalent to the quantitative criteria of reliability, validity and representativeness. These

Table 3. Maharashtra farmers' perception of *Bt* eggplant (N=90).

Theme	*Number of mentions*
Economic benefits	58
Health benefits/absence of risks to health	20
Accountability	10
Lack of moral concerns	7
Need for more information	6
Marketability	5
Need for safety assurances	5
Need for personal experience or experiential information	4
Social benefits	3
Absence of risks to environment	3
Concerns about health risks	2
Economic risks (i.e., cost of seed)	1
Psychological benefits	1

five criteria are: triangulation; transparency and procedural clarity; corpus construction; thick description; surprise (as relevance marker); and communicative validation. Triangulation is a way to arrive at the finding "by seeing or hearing multiple instances of it from different sources, by using different methods and by squaring the findings with others" (Miles and Huberman, 1994: 267). By using a focus group and seeking rival explanations for the data from a colleague, this study fulfills some of the requirements for triangulation. The study's clear description of the rationale underlying the selection of respondents, development of the interview guide (i.e., the scenario), and method of data collection satisfies the criterion of transparency and procedural clarity. Corpus construction is concerned centrally with the idea of "saturation" (i.e., maximizing the variety of representations): the interviewing of 30 farmers in various eggplant-growing regions of Maharashtra meets this requirement. Thick description is offered in this study through the extensive use of verbatim reporting of sources. The surprise value of this study will (hopefully) become apparent in the discussion and conclusion sections of the article. Communicative validation, which involves the validation of the researcher's analysis by obtaining agreement from the respondents, is not a feature of this study. Nonetheless, communicative validation "cannot be a *sine qua non* for the relevance of research" (Bauer and Gaskell, 2000: 348), especially given the practical difficulties in relocating the farmers who participated in this study.

5. Results

Farmers' responses to the scenario focused on the economic benefits (at the same time, the farmers listed higher yield as the number one criterion for adopting a new crop variety; see Table 4) (58 mentions) offered by *Bt* eggplant (see Table 3). These perceived economic benefits comprised anticipated cost savings resulting from the reduced use of pesticide and paid labour; increased yield resulting from reduced pest damage to the crop; higher market prices for the crop; financial insurance against serious crop damage; and cost savings

Table 4. Key adoption criteria of Maharastra farmers (N=90).

Criteria	*Number of mentions*
Higher yield	80
Superior/better product quality	18
Reduced pesticide application/expenditure	17
Better resistance to pests	14
Market demand/acceptance	12
General cost savings	6
Higher/good market price	4
Results of trials	4
Higher profits	3
Safety to health	2
Experience of innovative farmers	1
Good taste	1
Less uncertainty in yield	1
Maintain current yield levels	1

accrued to the lower cost of *Bt* seed vs. pesticides. Indeed, many farmers show a financial shrewdness that belies their generally low level of formal education. The following comment from one Ahmednagar farmer is revealing:

> "Presently, I am cultivating five acres of eggplant and spending 50,000 to 60,000 rupees on pesticides for these five acres and getting three to four lakhs' income from this acreage. If I grow *Bt* eggplant and get two to three lakhs' income from just two to three acres, I will enjoy greater benefits. *Bt* eggplant will also reduce pesticide costs from 50,000 rupees to 10,000 to 12,000…With *Bt* eggplant, I can reduce my eggplant acreage from five to one-and-a-half acres and devote the remaining land to planting other crops."

The higher output (hence, greater supply and lower market prices) expected to result from the use of *Bt* eggplant is not perceived to be a deterrent as farmers expect to be compensated by higher sales. Said a Pune farmer at the focus group session:

> "Although *Bt* eggplant will give higher yield, it will also sell more on the market because it does not need spraying and is thus free from pesticide residues. That is why consumers will purchase *Bt* eggplant over ordinary eggplant."

Another Pune farmer used a similar line of reasoning:

> "Because *Bt* eggplant will cost less to produce, farmers can sell it at a cheaper price on the market, and consumers will consequently buy more. Therefore, higher sales volume will make up for lower market price."

Among the eggplant farmers who have grown *Bt* cotton (i.e., 15 out of 90) or who have seen or heard about the performance of *Bt* cotton, the use of analogy in judgement making was universal. For example, an Aurangabad farmer said:

> "I have seen the results of *Bt* cotton and the reduction in pesticide application in a neighbouring farm. If the same technology is transferred from *Bt* cotton to *Bt* eggplant, and if the damage inflicted by the fruit and shoot borer can be reduced by at least 50% without the use of pesticides, I can save money and profit from the use of *Bt* eggplant."

After economic concerns, farmers' perception of *Bt* eggplant focused on health (20 mentions). More specifically, they focused on the health benefits (i.e., reduced application of pesticides and reduced pesticide residues on the crop) and the absence of risk to human and animal health (see Table 3). For instance, an Aurangabad farmer said:

> "With conventional eggplant varieties, there is a problem with pesticide residues. But with *Bt* eggplant, there is no residue problem, so it is actually *beneficial* to human health."

Another Ahmednagar farmer makes clear the perceived health benefit of *Bt* eggplant:

> "We have to spray pesticides on eggplants every two to three days. Because of this practice, we do not eat the eggplants that we grow. We know that there is a lot of pesticide residue on the eggplants because we are spraying every two to three days! So, we are not eating that stuff. The eggplant is totally made of those chemicals. But we put them directly in the market and sell them anyway. If *Bt* eggplant is invented, we will be able to eat the eggplants we grow because there will be less chemical residue on the vegetable. I think *Bt* eggplant is necessary because when we spray every two to three days, what happens is that new diseases are occurring in the human body. People are buying vegetables from the market and eating them. But they do not know what the farmer is spraying on his vegetables."

Like the perception of economic risk and benefit, farmers' perception of the health risk and benefit posed by *Bt* eggplant relied heavily on the use of analogy. According to an Aurangabad farmer:

> "Animals and human beings are eating by-products of *Bt* cotton and there are no health problems. So there is no question about the health risks of *Bt* eggplant."

Another farmer (from Ahmednagar) places *Bt* eggplant within the realm of the familiar by comparing it to a staple food item:

> "We consume curd daily—it is prepared with the help of microorganisms and it's not harmful to human beings. Why should Bt eggplant be any different?"

The need for accountability in connection with *Bt* eggplant's safety to human or animal health (10 mentions) formed the third most important category of farmer responses to the scenario (see Table 3). Said a Jalgaon farmer:

> "I will adopt *Bt* eggplant if it can sell in the market and if it can maintain the quality, shape, taste and appearance of ordinary eggplant. But it is the company's responsibility to show trial plot and test results on the safety of *Bt* eggplant."

It is revealing that none of the farmers in this study cited moral or ethical objections. On the contrary, seven farmers explicitly stated they had no moral concerns regarding *Bt* eggplant (see Table 3). Indeed, the farmers adopted a characteristically pragmatic attitude:

> "Interfering with nature is not good, but our business is agriculture and that means that we *have* to interfere with the natural environment to some extent."—Ahmednagar farmer

> "There's nothing unnatural about *Bt* eggplant technology if it brings me profit!"—Ahmednagar farmer

> "It doesn't matter whether it is *Bt* or non-*Bt*. To control the pest attack and reduce spraying cost and physical exertion that goes with pesticide spraying—that is more important."—Ahmednagar farmer

> "It is not good to interfere with natural processes, but if it is useful to human beings, interference is ultimately justified."—Ahmednagar farmer

Farmers also used analogy to express their perception of the moral risk (or lack thereof) posed by *Bt* eggplant. A Pune farmer compared *Bt* to a vaccine:

> "The polio vaccine protects children from polio disease. Similarly, *Bt* protects eggplants from the fruit and shoot borer. The microbe is good for the plant! Why should we have moral objections to it?"

Yet another farmer (also from Ahmednagar) likens *Bt* to a biological pest control method that is safer and more natural than chemical methods:

> "There's nothing unnatural about *Bt* technology as bacteria is not harmful to anyone—it's a biological method for controlling the pest. That is why it is a good technology (vs. chemicals)."

Hindu religious leaders consider cloning humans as "playing God" and, therefore, morally reprehensible; Hindu scriptures also warn against introducing animal qualities in human beings or vice versa (Playing God, 1997). Nonetheless, when the "foreign" element that is introduced is not animal or human in origin, there appears to be less resistance. As a Pune farmer put it:

> "*Bt* is found in the soil and not from an animal, so there is no question of morality. It is more important that farmers are getting higher yield."

Environmental issues did not figure prominently in the farmers' perception of *Bt* eggplant. Although the scenario makes clear that transgenic crops pose potentially serious environmental risks, the farmers displayed almost universal indifference. This is despite the ongoing campaign by the Ministry of Agriculture in encouraging farmers to adopt more environmentally friendly agricultural practices such as organic farming and biological methods of pest control. The following comments from three Jalna, Pune and Ahmednagar farmers (respectively) are typical:

> "If I can get good yield and a good price for my eggplant on the market, I am not concerned about any environmental effects."

> "We are only interested in earning more money so that we can have a better life for ourselves and our families. Let the environmentalists worry about the environment!"

> "As for the environment, it's not in our hands but in the hands of god."

> The results reported here were supported by findings from the focus group session—farmers in the focus group focused on economic benefits (8 mentions), health benefits/lack of health risks (2 mentions), and the lack of moral concerns (1 mention) (see Table 5). The salience of economic benefits can be seen from the following quote:

> "We want *Bt* eggplant—as early as possible! Everyone here feels the same way. Even though the yield of *Bt* eggplant is higher, it can sell in the market because *Bt* eggplant does not need spraying and is thus free from pesticide residues. That is why consumers will purchase *Bt* eggplant over ordinary eggplant."

6. Discussion

This study indicates that Indian farmers' perception of *Bt* eggplant farmers is driven primarily by economic benefits. The primacy of economic benefits may have quite a lot to

Table 5. Focus group farmers' perception of *Bt* eggplant (N=10).

Theme	*Number of mentions*
Economic benefits	
- Higher consumer demand	3
- Cost savings	2
- Increased yield	2
- Higher profits	1
Health Benefits/Lack of health risks	2
Lack of moral concerns	1

do with the uncertainty of the farmer's livelihood (especially in rain-fed farming systems) in a developing country such as India. In other words, farmers who have to deal with the unpredictable elements (i.e., the monsoons) and eke out a living from week to week may simply not have the luxury of focusing on longer-term and less tangible issues such as the moral ramifications of genetic technologies. If farmers cannot confidently predict the outcome of their harvest and whether they would have enough income to meet their family's basic needs, it seems quite natural that moral concerns would pale in importance. Moreover, Indian farmers' perceptions of *Bt* eggplant have focused on economic issues because it is often the only area where risks and benefits can be directly perceived and experienced by the farmer (as opposed to the less tangible and immediate moral or environmental risks) (Wangikar, 2004). Indeed, general quality-of-life issues such as the economic well being of the community can affect the reception of risk information. Thus, Fessenden *et al*., (1987) found that local concerns about a relatively low-level (i.e., one in 100,000) lifetime cancer risk in a community were outweighed by the imperative to protect local jobs. Cultural issues such as food are also steeped in economic values (Ten Eyck, 2001). Thus, even consumers with clearly stated food preferences (e.g., local over imported crayfish) could behave quite differently in the face of lower prices or other economic considerations and choose competing costly alternatives. To most people, ethical principles have a price (Chandon *et al*., 2000). Hence, even an advocate of "white meat" may consume beef when fish becomes too expensive to purchase (Wansink and Kim, 2001).

The farmers' stark emphasis on economic benefits versus environmental or ecological risks can be understood in light of Hamstra's (1995) report that important benefits offered by transgenic products can outweigh the risks associated with those products. More specifically, his study shows that perceived benefits have a greater statistical influence on consumer acceptance than do perceived risks. Gaskell et al. (2004) also found that perceptions of benefits outweighed perceptions of risks in judgements about transgenic food. Conversely, a perception of the absence of consumer benefits may be sufficient condition for the rejection of transgenic food (Gaskell *et al*., 2004).

It is not unusual that a majority of the Indian farmers found the risks associated with *Bt* eggplant acceptable, especially when a comparison is made with the risks associated with alternatives such as non-adoption or non-availability of the new technology (see Graham and Weiner, 1995). In situations where maintaining the status quo means putting up with a high level of negative economic, health or other impacts (e.g., continued heavy use of pesticides), even quite risky technologies may be normatively acceptable to end users (Thompson, 2003). This is especially so in the case of transgenic crops, as the associated environmental risks "have been characterized in terms of negative effects on the environment itself, effects that eventuate in harm to human health only through extremely indirect, convoluted, and highly contingent further causes" (Thompson, 2003: 12).

The farmers' emphasis on accountability possibly reflects a general preference for assurances in the face of uncertainty—in other words, people want to know with certainty whether something is safe or unsafe (Johnson and Slovic, 1998). It may also reflect a general concern with communication issues, and more specifically, with the question of whether stakeholders have been informed of the related risks, been given a chance to make informed decisions, and whether the necessary precautionary measures have been taken (Hornig, 1993). Indeed, the opposition to some biotechnological applications in Europe appears to stem in part from the perceived absence of public accountability in the governance of technological risks (Bucchi and Neresini, 2004). Bruce (2002) argues that risky technologies such as transgenic crops need to be seen in terms of a social contract between promoters of the technology and the public. To ensure wider acceptance of new biotechnological applications, certain conditions such as regulatory safeguards and avenues of redress would have to be fulfilled by the promoters and regulators.

Nonetheless, the virtual absence of moral concerns among the eggplant farmers seems to limit the universality of Sjoberg's theoretical perspective that notions of "unnatural risk" and "tampering with nature" are central to risk perception. In other words, these findings suggest that moral notions may not be universally important and can be mitigated or relegated by socioeconomic conditions.

Sjoberg (2002) has proposed an alternative model of risk perception that is based on four factors: attitude to the risk, risk sensitivity, technology-specific risk factors, and moral aspects of the risk in question. However, the moral issues so central to Sjoberg's model are conspicuously absent from the farmers' responses. Conversely, economic benefits—so vital to the Indian farmers' perception of *Bt* eggplant—are missing from the proposed model. Thus, even though it has been put forth as a more powerful alternative to the psychometric model and Cultural Theory, Sjoberg's moral "paradigm" does not seem to explain risk perceptions of farmers in a developing country. These discrepancies present researchers with an opportunity to build and test a new theoretical model that is based on three variables: economic benefits, safety concerns, and accountability. Nonetheless, the perspectives set forth in this exploratory paper offer only a starting point—the formulation of any alternative model will require further research and validation.

7. Conclusions

While it may be argued that the information presented in the scenario was purely hypothetical from the farmers' viewpoint, it was quite possibly the only feasible elicitation technique available as none of the farmers had any prior experience with, or knowledge of, *Bt* eggplant.

Nonetheless, this study indicates that researchers who need to understand risk perception of agricultural biotechnology in the developing world should exercise caution when using morality as a theoretical "prism." Despite its preliminary nature, this study indicates that Sjoberg *et al.*'s morality perspective may not be universally applicable. More generally speaking, theoretical perspectives developed in Western, industrialized nations may not account for the very different socio-economic realities in a developing country such as India. Indeed, people (researchers included) frequently "underestimate how and by how much others see the world differently than we do" (Fischhoff, 1996: 844). The vast difference in the socioeconomic contexts of developed and developing countries seems to exercise a significant influence on the way new technologies are perceived and accepted (according to the World Bank (2000), 1.1 billion people, or 21.6% of humanity, survive on just US$1.08 or less a day. At least 799 million people—most of them in the developing world—are undernourished (FAO, 2002)). Thus, any theory of the perception of technological risk and benefit that purports to have explanatory power for end users in developing countries may need to include economic benefits, safety concerns and accountability as key variables. Building a theory of risk and benefit perception that is salient to developing countries is a research priority, as a theoretically driven understanding of perception is critical to the development of effective risk communication (Gurabardhi *et al.*, 2004) by international agencies such as the USAID.

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Appendix 1: The *Bt* eggplant scenario

"As you know, brinjal farmers in Maharashtra such as yourself stand to lose a large portion of their crop each year to pests such as the fruit and shoot borer. These farmers—like you—have been trying to control the pests by spraying pesticides, but pesticide application has a number of disadvantages.

To address this problem, a private company and two public institutions in India are now working to develop a new type of brinjal seed. This new seed is expected to offer significant protection against the fruit and shoot borer. At the same time, farmers who use the new seed will not need to spray any pesticide against the borer, nor will they need to invest in new equipment, tools, or fertilizers. The scientists who are developing this new variety say that it will look, feel and taste just like the brinjals you are growing now. But unlike ordinary brinjals, the new variety is 'injected' with a soil microbe that gives the plant its protective qualities. The name of this new variety is *Bt* brinjal, and it works in basically the same way as the *Bt* cotton that has been introduced in Maharastra and elsewhere in India. *Bt* is not known to be harmful to human or animal health.

However, experts have also cautioned that there are some risks: *Bt* brinjal seed will cost a few times more than ordinary brinjal seed. Moreover, nobody can predict at this point whether consumers will accept the new type of brinjal. Climactic conditions can also influence the level of yield farmers get from using *Bt* brinjal.

There are also some environmental risks: farmers adopting the new seed will need to follow strict guidelines, such as setting aside a small part of his plot to growing ordinary brinjals. If not, *Bt* brinjal will lose its ability to protect itself against the borer after a few years and farmers will then need to use even more pesticide than before to control the damage inflicted by the pest. If not carefully managed, using *Bt* brinjal may also lead to the growth of "superweeds" and other unforeseen environmental problems. So, while there are benefits in using *Bt* brinjal, there are also some risks..."

Please share with me any thoughts and feelings you have about this new brinjal seed.

Is there anything you find objectionable about the new seed?

Basic Prompts:

- Can you tell me more?
- Anything else? Don't worry about whether it's right, just tell me what comes to your mind
- Can you explain why?

Appendix 2: additional questions

1. Farmer's name
2. District/Taluka/Village

3. How big is your farm?
4. How many hectares of eggplant do you grow?
5. Which varieties of eggplant do you grow?
6. What are the main problems you face in eggplant production?
7. On average, how much of your eggplant crop is lost to damage caused by the fruit and shoot borer?
8. How many times do you spray your eggplant crop (per week)?
9. Have you ever cultivated *Bt* cotton?
10. What are your key criteria when considering whether or not to adopt a new crop variety?
11. What are your key sources of agricultural information?
12. What are your key reasons for using these information sources?
13. Farmer's age
14. Length of farmer's farming experience
15. Years of experience in cultivating eggplant
16. Farmer's level of education