RISK PERCEPTION AND COMMUNICATION ABOUT AGRICULTURAL BIOTECHNOLOGY IN DEVELOPING COUNTRIES: THE CASE OF BT EGGPLANT IN INDIA

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Mark Yiew Kim Chong

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RISK PERCEPTION AND COMMUNICATION ABOUT AGRICULTURAL BIOTECHNOLOGY IN DEVELOPING COUNTRIES: THE CASE OF *BT* EGGPLANT IN INDIA

Mark Yiew Kim Chong, Ph.D.
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Several researchers – most notably Lennart Sjoberg and his colleagues – have proposed that the moral aspects of risk provide a better explanation and prediction of risk perception than the psychometric or cultural model, neither of which accounts for moral concerns. This study is possibly the first to empirically assess if the moral, psychometric and cultural models can explain risk perception of agricultural biotechnology by end users in a developing country.

To answer the research question, a scenario was used to elicit perceptions of transgenic *Bt* (*Bacillus thuringiensis*) eggplant among 100 eggplant farmers in Maharashtra and 30 eggplant farmers in Tamil Nadu in India. The data suggest that economic benefits, safety concerns, and accountability are most salient to the risk perception of farmer end-users in India. None of the farmers objected to *Bt* eggplant on moral grounds. Nonetheless, their responses revealed a small number of alternative conceptualizations of morality.

This study concludes by suggesting that the psychometric, cultural, and moral models do not account for the risk perception of farmers in India. It proposes that any theory or model that purports to explain and

predict risk perception of agricultural biotechnology in the developing world may need to include economic benefits, safety concerns and accountability as key variables.

BIOGRAPHICAL SKETCH

Mark Chong studied in the Field of Communication in the Graduate School at Cornell University. His research focuses on risk communication and public perception of biotechnology in the developing world. He has been the recipient of research grants and awards from the United States Agency for International Development, Asia Rice Foundation USA, and the Cornell Genomics Initiative (ELSI Group).

Mr. Chong graduated with a Master of Science in Communication from Cornell University in 2002 and a Bachelor of Arts (Honors) in Communication Studies from the University of Calgary in 1990. Prior to Cornell, Mr. Chong worked for several years in international corporate and marketing communications.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: INTRODUCTION

Researchers have been interested in public perceptions of risk for a few decades now. This interest can be traced back to the controversial nuclear debates of the 1960s (Krimsky, 1992) and continues to the present day with the international debate on genetic engineering. Among the early risk researchers, Starr (1969) in particular, was instrumental in opening up the area of risk perception research when he showed (among other things) that risk acceptance was related not just to technical estimates of risk and benefit but also to subjective dimensions such as voluntariness (see Sjoberg, 2000).

Since the 1970s, two dominant modes of explanation – individualism and contextualism – have informed theory construction in risk perception (Krimsky, 1992). The individualist mode takes as its starting point of analysis the (atomized) thinking individual. The contextualist mode of analysis, on the other hand, emphasizes the context (e.g. social structure, group membership, cultural milieu) as the starting point. The most developed and influential theories of risk perception based on the individualist and contextualist paradigms are, respectively, the psychometric (or cognitive) and cultural theories of risk (Krimsky, 1992).

The Psychometric Paradigm

Despite their significant influence on risk perception research, *neither* the psychometric paradigm nor Cultural Theory accounts for moral or economic factors. The psychometric model was introduced in a paper by Fischhoff et al. (1978), with more extensive studies using a larger number of scales and respondents soon following this initial empirical work. Informed by cognitive psychology, Baruch Fischhoff, Paul Slovic and other champions of the model aimed to understand how people make judgments under conditions of uncertainty and focused on individual perceptions of the risk of modern technologies, disease and natural hazards (Krimsky, 1992). In particular, they identified the criteria lay people use to evaluate the risks posed by technological hazards and compared layperson and expert risk judgments (Gabe, 1995). Indeed, early risk perception research in the psychometric tradition showed that experts and laypeople often disagree about the extent of “risk” associated with a particular hazard even while they agree on the fatalities produced by a technology in any given year. These disagreements reflect fundamental differences in the way “risk” is defined by the two groups (Fischhoff, 1995):On the one hand, experts generally base their risk judgments on quantitative estimates such as annual mortality figures and the probability of harm. On the other hand, lay people’s risk perceptions are richer and more sensitive, taking into account other factors such as catastrophic potential, controllability, threat to future generations and voluntariness (Slovic, 1992). Hence, expert and lay people’s risk perception of the same hazards can be very different.

Many of the psychometric studies were laboratory studies that asked people to place risk events on a scale, make comparisons between the risks of different technologies and activities, and assess particular characteristics of hazards. Arguably, the most significant outcome from psychometric research in the 1970s was “the discovery of a list of risk attributes (e.g. Voluntary - Involuntary) that play a role in people’s assessment of the probability, frequency, or outcome of natural and technological hazards" (Krimsky, 1992, p. 17). Indeed, these risk attributes – e.g. controllability, dread, catastrophic potential, risk to future generations, voluntariness, equitability of consequences — have come to constitute the theoretical foundation of the psychometric paradigm. They serve an important heuristic function by acting as a filter through which individuals assess events in terms of their degree of riskiness. Thus, an activity that is perceived as involuntary will be rated as more risky than one that is perceived to be voluntary (Slovic, Fischhoff, & Lichtenstein, 1981; Krimsky, 1992). Basically, the psychometric approach asks the subject to rate a number of hazards on each of the risk attribute scales (9 to begin with, 18 later). After mean ratings are calculated for each hazard on each scale, the researcher produces a "Scale X Hazards" matrix that is subsequently factor analyzed. Three attributes – Dread, New - Old, and Number of Exposed – have been found to account for a very large share (about 80%) of the variance (Sjoberg, 2000).

The psychometric paradigm has been extremely influential in studies on risk perception (Gabe, 1995). It has been argued that the psychometric risk attributes offer both explanatory and predictive value – once an individual's assignment of attributes is known, it may be possible to predict his or her response to a particular hazard. In fact, risk attributes have been shown in a number of cases to be better predictors of the lay public's response to hazards than fatality statistics (Krimsky, 1992). In addition, it has "contributed an important scheme that has clarified the meaning of risk, provided insight into issues of acceptable risk, and informed public policy" (Krimsky, 1992, p. 18).

While extensive work on risk communication has been based on the psychometric approach (see Sandman, 1993), it has been criticized for making the assumption that risks are objective entities that exist independently of the complex social, cultural and institutional contexts in which people perceive them (Nelkin, 1989; Turner & Wynne, 1992; Gabe, 1995). Thus, psychometric studies have narrowly focused on the characteristics of particular risks and neglected the influence of the individual's membership in particular social, cultural and historical milieu (Nelkin, 1985; Gabe, 1995). In other words, psychometric studies tend to be overly reductionistic as they treat risk perceptions as the product of cognitive processing and ignore the larger social and cultural contexts in which people experience risks (Mehta, 2001). Moreover, scholars such as Sjoberg (2000) have shown that the explanatory or predictive efficacy of the psychometric model is not supported. An analysis of Swedish data, for example, shows that the perceived risk of nuclear waste is accounted neither for by dread nor by newness – two of the key psychometric risk attributes[1] (Sjoberg & Drottz-Sjoberg, 1994). Sjoberg (2000) also offers a number of additional reasons why the model is much less powerful than claimed:

1. While comprehensive, the classic 18 psychometric scales did not include an important dimension – the concept of interference with nature (i.e. tampering with nature, immoral and unnatural risk).
2. While 60-70% of the variance of perceived risks could be accounted for by the attribute scales, the results are misleading

[1] It is possible that cultural differences might explain part of the variance, but Sjoberg and Drottz-Sjoberg (1994) do not address this issue in their study.

> because “the high levels of explanation occur only when average ratings are analyzed across hazards…When individual data rather than averages are used, and each hazard is analyzed in a separate regression model, the proportion of explained variance is typically 20-25%, taken as an average over a set of hazards” (Sjoberg, 2002, p. 666). This implies that some other factors are at least as important as the psychometric factors devised by Fischhoff et al. (1978).

The Cultural Model

While researchers working in the cognitive psychological (i.e. psychometric) tradition have approached risk as an objective entity to be measured and explained, those working in the anthropological tradition have treated risk as a social construct. This tradition of research has its origins in the seminal work of Mary Douglas (1966, 1972) on risky behaviors in ancient cultures. Douglas and Wildavsky (1982) built on this work and questioned the ontological status of risk and recast it as a socially constructed phenomenon occurring within specific historical and cultural contexts. So, while the psychometric model treats individuals as atomized processors of information, the cultural tradition is interested in understanding the ways in which culture influences our understanding of the world around us. Thus, cultural risk theorists have traditionally been concerned with groups and institutions rather than individuals (Bellaby, 1990). Indeed, they offer a theoretical perspective that views people’s responses to risks in terms of the former’s utility in maintaining a social group’s chosen form of organization. In other words, the cultural model posits that “risks are defined, perceived, and managed according to principles that inhere in particular forms of social organization” (Rayner, 1992, p. 84). Thus, “people select certain risks for attention to defend their preferred life styles and as a forensic resource to place blame on other groups” (Royal Society Study Group, 1992, p. 112). Among other things, this tradition of research on risk perception has shed light on how value orientations (e.g. egoistic, social-altruistic values) influence individual perceptions of risk and underpin social movements (see Stern & Dietz, 1994).

The cultural model of risk perception is enshrined in an analytical framework widely known as the grid/group analysis – a typology that links individual risk selection to social context and organizational membership. “Group” refers to the degree to which someone is part of a bounded unit. Thus, the more one is incorporated into a bounded unit, the greater one’s choice is subject to group influence or control. “Grid” refers to the extent to which one’s life is constrained by externally imposed prescriptions. Thus, the broader and more binding the external prescriptions, the less open one’s life is to individual negotiation (Thompson , Ellis, & Wildavsky, 1990).

The grid/group scheme identifies four distinct worldviews or “cultural” biases that prompt different ways of responding to a hazard. These four worldviews are termed hierarchist (high grid/high group), egalitarian (low grid/high group), fatalist (high grid/low group) and individualist (low grid/low group) (Douglas & Wildavsky, 1982). According to the cultural mode, hierarchists have a tendency to trust those in positions of authority and will be mostly focused on risks that jeopardize the social order. Thus, they have a preference for risk management by expert committees and safety standards. Conversely, egalitarians tend to be suspicious of those in authority (e.g. experts) and are most concerned with risks generated by institutions. They are likely to emphasize accountability and prefer decision-making procedures that allow for a high degree of public participation. As the name suggests, fatalists tend to feel powerless and accept what is imposed on them as they view the occurrence and outcome of events as subject to fate and chance. Individualists are most concerned about constraints on the choices they make in life and support decision-making processes based on economic (particularly cost-benefit) considerations (Langford, Georgiou, Bateman, Day, & Turner, 2000).

The grid/group framework is fundamentally different from the attributes scales of the psychometric approach in its underlying assumption that social structure – not the physical attributes of phenomena – is the key determinant of risk perception. Thus, the framework is concerned primarily with the relationship between social organization and the selection of arguments and perceptions that support that social order.

According to Krimsky (1992), the cultural model has contributed to our understanding of risk perception in three ways. First, it has attacked the psychometric conception of the ontological status of risk. “Risk, though it has some roots in nature, is inevitably subject to social processes” (Thompson & Wildavsky, 1982, p. 148). Second, it offers a critique of the assumption that social behavior can be explained in terms of the aggregate of individual behaviors. Thus, it assumes that responses to risk are influenced primarily by group and social context and not individual cognition. Accordingly, "the proper scale of analysis of risk is sociological and not psychological. The order of explanation proceeds from the social context to the individual" (Krimsky, 1992, p. 20). Third, the cultural model has contributed testable models and hypotheses that allow researchers to establish relationships between social affiliation and risk selection.

The cultural model differs from psychometric approaches to risk perception in a number of significant ways. First, it assumes an active perceiver (Rayner, 1992). Second, this perceiver is an institution or organization that is motivated by imperatives that are quite different from those that drive individuals (Douglas, 1985). Third, the cultural model goes beyond the focus on perception of physical risks and looks at the social norms or values that are being threatened. Thus, organizational structure, not the physical attributes of the risk itself, is the basis of risk perception (Raynor, 1992). Fourth, while the psychometric approach emphasizes individual meaning, cultural analysis focuses on the creation of shared meaning among individuals, institutions and communities (Raynor, 1988, 1992). Hence, "methodological individualism that extrapolates from individual behavior to social action has no place in cultural analysis" (Raynor, 1992, p. 86).

Nonetheless, the considerable influence exerted by the cultural model at the theoretical level has not been matched by widespread empirical application of the theory – largely because of the time-consuming nature of the field studies that are required (Raynor, 1992). But more importantly, it has been found to explain only about 5% of the variance of perceived risk and adds virtually no explanatory power when combined with the psychometric “paradigm” (Sjoberg, 1997a, 1998).

On face value, the cultural model might appear to be ideally suited to a study of risk perception in an international context. However, the definition of “culture” used by cultural theorists differs vastly from the more explicit social categories (e.g. nationality, ethnicity, social class) used in other cultural studies (Brenot, Bonnefous, & Marris, 1998). In the cultural model, culture is defined according to adherence to a particular way of life and not in terms of membership in a national, ethnic or cultural group. Nonetheless, risk perception studies using the cultural model have been conducted in different socio-cultural contexts, including in Sweden and Brazil (Sjoberg, 1995), Austria (Seifert & Torgesen, 1995), the United Kingdom (Marris, Langford, & O’Riordan, 1996), and France (Brennot, Bonnefous, & Marris, 1998). Still, the results have been anything but compelling. The French study, for example, found that cultural biases explained at most 6% of the variance in risk perceptions.

To sum up, neither the psychometric nor cultural model seems to explain much of risk perception. In its original three-factor form, the psychometric model explains only about 20% of the variance of risk perception. The cultural model is even less successful than the psychometric model in explaining risk perception, explaining only about 5% of the variance (Sjoberg, 2000).

Integrative Approaches: Social Amplification of Risk

The psychometric and cultural model offer two somewhat diametrical paradigms. In an attempt to overcome the fragmented state of risk perception and risk communication research, Roger Kasperson and his colleagues (1988) developed a theoretical framework – “social amplification and attenuation of risk” – that could integrate findings from the psychometric and cultural schools of risk perception, media research, and from organizational responses to risk (Kasperson, Kasperson, Pidgeon, & Slovic, 2003). In essence, the framework is an attempt to explain why severe social impacts and strong public concern sometimes accompany risk events with seemingly minor physical consequences, and it does so by focusing on the various social processes underlying risk perception and response (Kasperson et al., 1988). The metaphor of amplification is used to “analyze the ways in which various social agents generate, receive, interpret, and pass on risk signals” (Kasperson et al., 2003, p. 15). How these risk signals are processed can affect the volume of information about an event and determine the salience of a message and thus lead to particular interpretations and responses by members of a particular social system. Thus, social amplification “stations" such as social groups and institutions (e.g. scientific institutions, government agencies, the mass media) and individuals (e.g. scientists, reporters, politicians) can process risk “in ways that can heighten or attenuate perceptions of risk and shape risk behavior" (Kasperson, 1992, p. 158). Significantly, social amplification may augment potential risks to the extent that they occur before, or even in the absence of, any actually occurring accidents or hazards (Kasperson et al., 1988). In turn, individual or collective behavioral responses may result in serious social or economic repercussions such as declines in residential property values, liability, insurance costs, loss of confidence in institutions, social and community conflict, and distrust of risk management institutions (Kasperson & Kasperson, 1996). Thus, whether undesirable consequences occur and the extent to which they do depend on the relative amplification or attenuation of the risks associated with a particular hazard or risk event. Indeed, the image of a ripple best captures the essence of the theoretical framework, for “risk processes can extend (in risk amplification) or constrain (in risk attenuation) the temporal and geographical scale of impacts” (Kasperson, 1992, p. 161).

Kasperson et al.’s framework hints at the important role played by opinion leaders, who represent the interests and concerns of their constituents (Laumann & Knoke, 1987). This can be particularly true in a developing country such as India, where general public knowledge of risk-related subjects such as biotechnology is low and where the mobilization of community opinion leaders is critical to the successful diffusion of innovations (Rogers, 1995). For example, the opinion leadership that farmer leader Sharad Joshi and his organization *Shetkari Sanghathana* exercised in the legitimization of *Bt* cotton in India is well documented (e.g. Herring, forthcoming; Shaikh, 2001, Oct 31).

The social amplification or attenuation of risk can also have an impact on stigma. The term has been used to describe “products, places, or technologies marked as undesirable and therefore shunned or avoided, often at high economic, social, and personal costs” (Gregory & Satterfield, 2002, p. 347). Accordingly, stigmatized residents, properties, places, products and other targets are often downgraded or blacklisted by observers who exhibit “anticipatory fears” of undesirable future outcomes such as a possible future decrease in the economic value of a property or the spread of a communicable disease by affected individuals (Edelstein, 1988). Since stigma is based on risk perceptions, people, products or places “can suffer stigma in advance of or in the absence of any demonstrated physical impacts” (Gregory, Flynn, & Slovic, 1995, p. 222). Furthermore, stigma does not refer to the mere existence of a hazard, but more importantly reflects a fundamental overturning or destruction of an existing positive condition (Gregory & Satterfield, 2002).

Nonetheless, empirical assessments of the “social amplification” framework are few and far between as it is extremely difficult to predict when the risk events that will produce amplification effects will occur (see Frewer, Miles, & Marsh, 2002). In the absence of prior knowledge of such risk events, empirical data collection aimed at assessing public perceptions of risk before and after the amplification (or attenuation) is at best, difficult.[2]

The Moral Model

In recent years, a number of risk scholars – most notably Lennart Sjoberg and his colleagues – have proposed that 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. In other words, they argue that “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” (Sjoberg, 2000, p. 365). The notions of “tampering with nature” and

[2] For a recent empirical validation of the social amplification framework, see the Frewer, Miles and Marsh (2002) study on British media coverage of the risks of transgenic foods.

“unnatural risk” are significant as most people harbor a deep skepticism toward 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 & Wrubel, 1996). Indeed, the “tampering-with-nature” factor was found to be a much stronger predictor of perceived risk than the traditional psychometric dimensions (e.g. new or dreaded risks), and it “absorbed most or all of the predictive power of these dimensions when entered in a common regression equation” (Sjoberg, 2000, p. 353). 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. As it turned out, morality was the only factor that had a significant beta value. Moreover, its introduction improved the model’s performance and added significantly to 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 & Sjoberg, 2001). Furthermore, Sjoberg and Winroth (1986) and Sjoberg and Torell (1993) indicate that the moral value of an action (i.e. whether it was morally good or bad) was a more important predictor of the acceptability of risk than the probability of a positive or negative outcome or the value of such outcomes (see also Sjoberg & Drottz-Sjoberg, 2001).

Nonetheless, it should be noted that Sjoberg’s operationalizations of morality – “tampering with nature” and “unnatural risk” – were derived from two studies on public acceptance of a nuclear waste repository[3] (Sjoberg & Drottz-Sjoberg, 2001) and public perceptions of nuclear disaster risk (Sjoberg, 1997b) in Sweden. It is possible that these notions are specific to the Swedish social context and to nuclear technology. Moreover, these notions of morality are just two of several possible operationalizations.

Interestingly, Sjoberg and Drottz-Sjoberg (2001) found stigma, "lack of fairness," and "risk to future generations" to be important predictors of public resistance to technological hazards. The term "stigma" has been used to describe "products, places, or technologies marked as undesirable and therefore shunned or avoided, often at high economic, social, and personal costs" (Gregory & Satterfield, 2002, p. 347). Accordingly, stigmatized residents, properties, places, products and other targets are often downgraded or blacklisted by observers who exhibit "anticipatory fears" of undesirable future outcomes such as a possible future decrease in the economic value of a property or a decrease in consumer demand for a product (see Edelstein, 1988). For example, public beliefs about Alar's carcinogenic properties resulted in a sharp decline in the market for apples (Gregory & Miller, 1998). Researchers also found that the selection of Yucca Mountain as a burial site for transuranic wastes would reduce the attractiveness of Nevada as a tourist destination (Slovic, Flynn, & Layman, 1991).

The "moral" aspect of stigma can be seen in the origins of the concept: the term originally referred to socially marginalized members of

[3] In this study, the single item with the strongest correlation with risk perception of nuclear waste was "the risk comes from an activity which is contrary to nature" (Sjoberg & Drottz-Sjoberg, 2001).

classical Greek society (e.g. criminals, adulterers) who bore a visual mark (e.g. a tattoo on the arm) to signal their undesirable status and/or the risk they posed to others in the society (Goffman, 1963). On a deeper level, stigma does not merely refer to the existence of a hazard, but more importantly reflects a fundamental overturning or destruction of an existing positive condition. Thus, stigma demarcates the transition from what was once considered to be “good” and “acceptable” to what is thereafter marked as blemished and hence to be avoided (Gregory and Satterfield, 2002).

The concept of “fairness” is perhaps best captured by the fairness hypothesis developed by Rayner and Cantor (1983), which posited that the key question for societal risk management is not “How safe is safe enough?” but rather “How fair is safe enough?” Accordingly, people are more concerned with notions of consent, liability and trust than they are with the probabilities and magnitudes of risk. These concerns are encapsulated by the following three questions:

1. Is the procedure by which collective consent is obtained for a course of action acceptable to those who must bear its consequences?
2. Is the principle that will be used to apportion liabilities for an undesired consequence acceptable to those affected?
3. Are the institutions that make the decisions that manage and regulate the technology worthy of fiduciary trust? (Rayner & Cantor, 1987, p. 4)

The Sjoberg and Drottz-Sjoberg (2001) study also found “risk to future generations” to be a significant predictor of public acceptance of risks. Interestingly, “risk to future generations” was one of the original risk attributes identified by researchers working in the psychometric tradition. The psychometricians viewed it as an emotional attribute, not a moral one. However, to the extent that the concept deals with notions of right and wrong (i.e. a technology is considered to be morally unacceptable if it poses significant risks to future generations), it can be defined as a moral attribute.

However, Sjoberg and his colleagues chose to focus on notions of “unnaturalness” and “tampering with nature” and ignore “stigma,” “fairness,” and “risk to future generations” as they found the first two notions to be the most important determinants of nuclear waste risk perceptions (see Sjoberg & Drottz-Sjoberg, 2001).

For many years, the NIMBY (Not in My Backyard) concept has also been used to explain public acceptance of technological risks such as nuclear power. NIMBY is a phenomenon whereby people acknowledge and profit from the benefits of a technology but simultaneously refuse to shoulder any of the associated burdens of risk (Armour, 1984; Gervers, 19987; Peelle & Ellis, 1987; Edelstein; 1988). Nonetheless, Sjoberg and Drottz Sjoberg (2001) found little evidence for the prevalence of NIMBY attitudes in the same study that highlighted the importance of stigma, fairness, and “risk to future generations.”

The important influence of moral concerns on public acceptance of biotechnology has been highlighted by several studies (e.g. Office of Technology Assessment, 1987; Lacy, Busch, & Lacy, 1991; Frewer, Howard, & Shepherd 1997; Evensen, Hoban & Woodrum, 2000). For the most part, discourse on the moral aspects of genetically modified food and agriculture has focused on the “universal principles of respect for well being (utilitarian approaches), rights (deontological approaches) and justice (contractarian-based approaches)” (Fraser, 2000, p. 147). These correspond to the three moral principles identified by The Nuffield Council on Bioethics (1999): the principle of “general welfare” enjoins institutions such as governments to protect and promote the best interests of citizens. The principle of “people’s rights” upholds their rights to freedom of choice as consumers. Last, the principle of “justice” requires the fair sharing of the benefits and burdens of policies and practices[4]. According to the Nuffield Council on Bioethics (1999), there is still a fourth principle – the “ethical status” of the natural world. In other words, “tinkering” with nature is intrinsically wrong. As biotechnology enables humans to manipulate genetic characteristics – which may involve the transfer of genes from one species to another – and change what many people accept to be immutable, it may be interpreted to contradict religious beliefs, such as the creation account in the Old Testament (Gilkey, 1968). As one critic put it, “when you start playing around with genes, you’re playing God” (Jukes, 1988, p. 249). Sjoberg’s notion of morality gets at this meaning of a transgression against the “natural order.”

In the United States, morality tends to revolve around utilitarian values (e.g. respect for health of consumers), but other moral concerns may be more dominant in other countries. For example, moral concerns in European and Asian cultures may have more to do with the integrity of

[4] Critics of biotechnology have often claimed that agricultural biotechnology violates one or all of these principles.

species, shape of the countryside and traditional life forms than utilitarian values (National Science Foundation, 2003).

CHAPTER 2: RESEARCH PLAN

While the psychometric “paradigm” and cultural “theory” have been the dominant models in risk perception research, and the social amplification framework and moral model have been offered as alternatives to these models, very few (if any) of these models or frameworks have been systematically applied to the study of risk perception in the developing world. Indeed, virtually all studies testing the four models (i.e. psychometric, cultural, social amplification, moral) have been conducted in Western, industrialized countries. This begs the question of whether the four models would also explain and predict risk perception in a developing country where social, cultural and economic conditions are quite different from those in the industrialized world. More generally, there arises the question of whether there can indeed be such a thing as a “universal” theory of risk perception that would be applicable to both developed and developing countries, or whether theories or models developed in western countries could be exported to developing countries.

Few issues in recent years have elicited such strong and polarized public reactions as genetic engineering and its applications. Indeed, the health and environmental risks, social implications, and ethical issues associated with the technology have elevated it to the status of a social phenomenon (Liakopoulos, 2002). As it involves the alteration, improvement or creation of life forms, genetic engineering has been known to confront certain religious beliefs and raise questions of morality, such as concerns that scientists are “playing god” or “tampering with nature” (Sparks, Shepherd, & Frewer,1994; Frewer & Shepherd, 1995; Evensen, Hoban, & Woodrum, 2000). Indeed, vocal anti-biotech groups and individuals such as Vandana Shiva (2000) frequently use moral concerns to justify the wholesale rejection of genetically modified organisms.

A recent report to the US-EC Task Force on Biotechnology Research (National Science Foundation, 2003) has urged more empirical studies on moral concerns regarding biotechnology, especially as these concerns are strongly emerging in various international arenas such as Europe and Japan. In particular, the report highlighted that concerns such as the integrity of species and the fate of traditional life forms may play an important role in influencing public responses to biotechnology.

The development and commercialization of transgenic crops for the developing world has been the focus of an international consortium funded by the United States Agency for International Development (USAID) and led by Cornell University called the Agricultural Biotechnology Support Project II (ABSP2). More specifically, the mission of ABSP2 is to “boost food security, economic growth, nutrition and environmental quality in East and West Africa, Indonesia, India, Bangladesh and the Philippines” through the development and deployment of transgenic crops such as *Bt* (*Bacillus thuringiensis*) eggplant (Agricultural Biotechnology Support Project 2, 2003).

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 II, 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 (ABSP II, 2003).

Currently, chemical pesticides are the most common form of pest control used by Indian eggplant farmers. However, excessive pesticide use poses significant risks to the health of farmers and consumers: for example, repeated pesticide application during the planting season has resulted in high levels of pesticide residues in the food chain. Moreover, pesticide use does not offer any guarantee against yield loss (which may be total) and in fact increases production costs for farmers and retail prices for consumers. Persistent pesticide use has also increased the resistance of pests to the chemicals, resulting in significant reduction in output and making pesticides less effective in long-term pest control (ABSP II, 2003).

Three groups in India – two from the public sector and one from the private sector – are developing transgenic *Bt (Bacillus thurigiensis)* 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. *Bt* eggplant looks set to become the first transgenic food crop to be commercialized in India and indeed in South Asia. 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 economic and social implications for farmers in the country (ABSP II, 2003).

The current development and impending introduction of transgenic *Bt* eggplant in India offers a timely opportunity to study risk perception of agricultural biotechnology in a developing country. More specifically, it provides the researcher with a unique opportunity to assess the explanatory value of the moral model in a developing country such as India. Broadly speaking, such a study would also allow the researcher to test if a model developed in the West can be exported to the developing world:

RQ1: Can the moral model (as advanced by Sjoberg et al.) explain risk perception of agricultural biotechnology by end users in a developing country?

RQ2: Do the other risk perception models developed in the western world (i.e. psychometric and cultural models) apply to developing countries such as India?

As this is an exploratory study, no hypotheses were included in the research plan. Nonetheless, the findings of this study may be used to develop hypotheses for subsequent testing and theory development (see “Conclusions”).

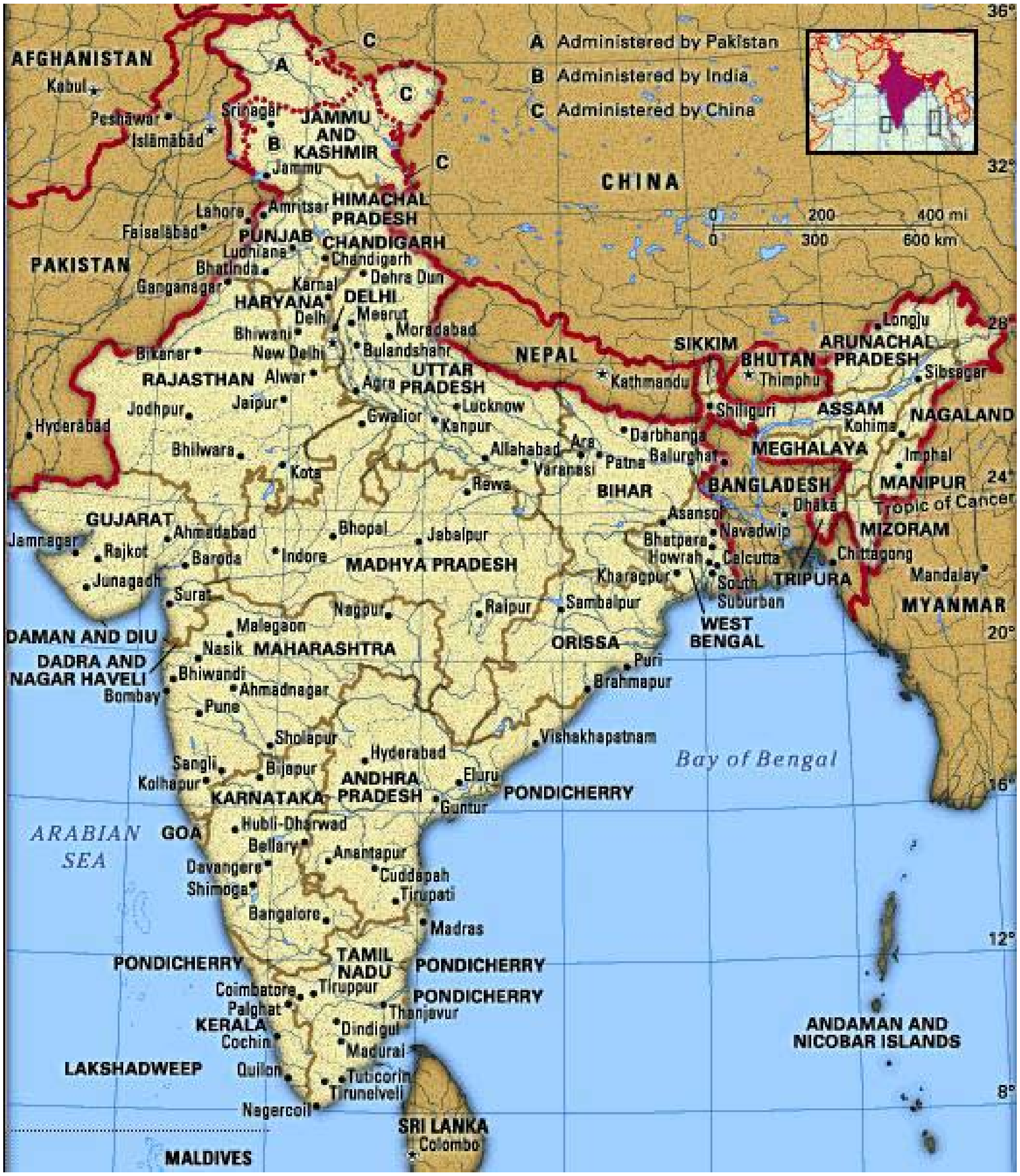

Figure 1: Map of India

CHAPTER 3: METHOD

Researchers working in the field can choose from a number of methods, including surveys, experiments and qualitative approaches. Surveys can provide information about the distribution of knowledge, perceptions, attitudes, past behaviors and behavioral intentions in a particular population (National Research Council, 1996). Surveys also facilitate bivariate and multivariate statistical analyses that make it possible to assess the relations between different variables and model the structure of public opinion or attitudes. Thus, survey results can provide answers to questions such as, "How do socio-demographic characteristics relate to perceptions?" and "Is knowledge related to behavior and attitudes?" (National Science Foundation, 2003). In addition, surveys are eminently suited to the task of testing explicitly formulated hypotheses (Bryman, 1988) and determining probabilities and relationships (Berkowitz & Donnertsein, 1982).

Despite its popularity in social science research, the suitability of the quantitative survey for assessing people's knowledge of, or attitudes toward complex and controversial issues such as biotechnology has been questioned. Davison, Barns and Schibeci (1997) argued that quantitative surveys privilege "the aggregated views of uninvolved mainstream individuals, marginalize active minority viewpoints, and displace active forms of public debate" (p. 330). Thus, the survey may obscure the needs and voices of particular groups, especially in less developed countries where extreme poverty or incomplete electoral records can make it very difficult to get a representative sample of citizens (National Research

Council, 1996; Pimpert & Wakeford, 2002). It also has a tendency to focus on “hedonic rather than social values by asking respondents for their personal opinions” (Fischhoff, 1991, p. 843). And far from being a neutral tool for investigating public knowledge, opinions, attitudes or behavioral intentions, the survey can construct and shape public responses by (for example) oversimplifying the available choices available (National Research Council, 1996). Thus, salient issues, arguments or concepts may be overlooked simply because subjects were not given the opportunity to bring them up (Hisschemoller & Midden, 1999). Accordingly, researchers may shape survey questions in ways to ensure that the “desired” responses are elicited. Nonetheless, this potential for bias is not so much a problem of the survey method *per se* as it is of the people developing and using the survey - other methods are also vulnerable to the problem. For example, the choice of sampling frame (e.g. farmers who are known to be supportive of GMOs) can bias the results of in-depth interviews in the direction preferred by the researcher.

Many surveys also suffer from the assumption of the existence of a relatively unified “public” – even though there are several “publics” at any given time (Young, 1990). Surveys also convey a static view of social reality that does not account for the impact and role of change in social life (Bryman, 1988). Hence, they provide only a snapshot at a particular moment in history. Furthermore, surveys have been criticized for being politically biased (Winner, 1986).

Experiments are unique among research methods in that they are best suited for the testing of causal relationships. However, the results of experimental studies have traditionally been thought to lack external validity, as they are generally not based on random samples (see "Conclusions" for a fuller treatment of this topic). Other criticisms of experiments have focused on experiment subject awareness. In other words, experiment subjects (many of whom are college students) are usually aware of the possibility of manipulation and deception in experiments. However, they might be uncertain about what, if any, manipulation might have occurred if the researcher uses a good cover story (Berkowitz & Donnerstein, 1982). Moreover, subjects do not necessarily strive to seek out the experiment's true purpose nor are they especially good at determining the hypothesis of the experiment (or necessarily have the intent to confirm the hypothesis). Thus, subject awareness of the research hypothesis is not as prevalent as some critics claim. Even when the hypothesis is made explicit at the start of an experiment, many subjects try their utmost best to avoid confirming the hypothesis. Hence, subject acquiescence to the demand characteristics of the research situation (as and when it occurs) might be better explained by the subject's desire to "look good" than by an intent to confirm the hypothesis (Berkowitz & Donnerstein, 1982). Evaluation apprehension is also prevalent in experiments, but subjects' apprehension "should diminish as they learn that every experimenter…is not interested in assessing their personality or competence" (Berkowitz & Donnerstein, 1982, p. 251).

Like experiments, surveys can make subjects aware of the fact that they are being investigated. This awareness of being studied (i.e. reactivity) presents problems of validity in that people's responses may not be indicative of their normal views. Thus, a survey respondent's answer may be influenced by interviewer characteristics such as age, race or gender (Bryman, 1988). Like experiment subjects, survey respondents are also susceptible to hypothesis guessing, evaluation apprehension, and researcher expectancies. For example, a survey that aims to ascertain knowledge about genetic engineering may create apprehension among respondents with low education. Participants in sex research surveys, for example, may not reveal that they engage in certain sexual practices because of their desire to "look good" (Fick, 2001). Also, a pollster might look pleased when a subject gives the desired answer and inadvertently bias the response. Even "why" questions can change respondents' attitudes – even if only for a short period of time – by focusing their attention on easily accessible, plausible and verbalizable thoughts (Wilson, LaFleur, & Andersen, 1996). However, while subjects in both experiments and surveys are usually aware that they are being studied in some way, manipulation is not a standard feature of surveys (unlike experiments) and hence does not trigger the same level of subject sensitivity (Tashakkori, 1998).

In-depth interviews can provide the researcher with access to the life world of individuals and social groups and are thus ideally suited for achieving rich, in-depth understandings of how people think about particular topics and for investigating complex and sensitive issues. This results in a "fine-textured understanding of beliefs, attitudes, values and motivations in relation to the behaviors of people in particular social contexts" (Bauer, Gaskell, & Allum, 2000, p. 39). Unlike quantitative methods such as the survey, qualitative methods such as the depth interview recognize that people actively construct the social world in their everyday life and that these constructions form their life world, their "overarching" reality[5]. More specifically, the qualitative interview allows the researcher to:

a. Develop rich, in-depth descriptions that will enable the researcher to learn as much as possible about a hitherto little-known topic;
b. Learn about how a phenomenon is interpreted by an individual or group;
b. Identify the key variables and hypotheses for subsequent quantitative research (Lofland & Lofland, 1996).

Qualitative interviewing may meet one of several goals: It may result in a stand-alone study that provides a "thick description" of a particular life world; it may provide the empirical data needed to generate hypotheses for further research; and it may be used in combination with other methods (Bauer et al., 2000).

Nonetheless, data produced by in-depth interviews are more "raw" and seldom pre-categorized like survey data. As there are potentially many ways in which the same set of qualitative data could be categorized, even generalizing across a sample of interviews or written documents could become problematic. In fact, many qualitative studies are not even concerned with generalizing – they are just content to provide rich descriptions of the phenomenon under study (Trochim, 2002). Studies based on in-depth interviews are also generally not used to establish causal relationships.

[5] Thus, Farr (1982) defines qualitative interviewing as a method for discovering or establishing the existence of perspectives or viewpoints that are alternative to those of the interviewer.

As most lay people in the United States and Europe are not able to give correct answers to even basic questions about gene technology (Durant, Bauer, & Gaskell, 1998), it is unlikely that farmers in a developing country such as India would have more than a basic level of knowledge (if any) about agricultural biotechnology and biotechnological applications such as *Bt* crops. To complicate matters, *Bt* eggplant was still not available to Indian farmers at the time of this study, as it was undergoing only early stages of field trials. Furthermore, Indian farmers are generally unfamiliar with survey research protocols[6]. Given these limitations, the quantitative survey was judged to be unsuitable for use in this study. Experiments were also not feasible for this study as it was not possible to ensure a controlled research setting in the field which involved the manipulation of a variable and the testing and confirmation of an *a priori* hypothesis (see Tashokkori & Teddlie, 1998).

The use of narrative techniques received serious consideration prior to the development of the scenario. Since stories are the natural mode for humans to process information, the use of narrative techniques may allow researchers to gain access to a network of beliefs (Fisher, 1987). However, eggplant farmers in India do not typically *also* grow *Bt* cotton – the first and only transgenic crop to be commercialized in the country. Thus, Indian eggplant farmers would not have the requisite “well” of experience with transgenic crops that is vital to the development and articulation of personal stories.

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[6] Conversation with Dr. Ritesh Mishra, Research Scientist, Maharashtra Hybrid Seeds Company, February, 3, 2004.

Of all the research methods, the qualitative interview appeared best suited to this study, as it was a “green field” investigation with no precedent. As no *a priori* hypotheses were available (since this study was very possibly the first of its kind), the imperative was to get a “feel” for the area of inquiry or to develop qualitative distinctions as a precursor to the development of measurements (see Bauer et al., 2000).

For this study, 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 & Tyler, 1981). For example, risk researchers such as Slovic, Kraus and Covello (1990) and Johnson (2004) have effectively used the scenario of a hypothetical trial of an asbestos-installing firm to ascertain the effects of risk comparisons on public reactions to risk. The scenario used in this study is shaped by a composite of the major risks and benefits identified by three sources: current scientific literature on the topic of *Bt* transgenic crops (e.g. Mendelsohn, Kough, Vaituzis, & Matthews, 2003), qualitative interviews with technical experts, and discussions with representatives of Tamil Nadu Agricultural University and the Maharashtra Hybrid Seeds Company. The scenario was pre-tested on four farmers and minor changes were made to its wording to clarify ambiguous points.

After the scenario was read, the farmer was asked an open-ended question (“Please share with me any thoughts and feelings you may have about this new eggplant seed”), which was then followed by a number of probes. In addition, farmers were asked a number of closed-ended questions about problems encountered in eggplant cultivation, the extent of damage caused by the fruit and shoot borer, main sources of information on agricultural innovations, key adoption factors and demographics – in line with other objectives specified by the project's funder, ABSP2.

The state of Maharashtra and the southern state of Tamil Nadu were chosen as field sites mainly on the basis of pragmatic considerations. In addition to being one of the top eggplant-growing states in India, Maharashtra is home to India's number one hybrid and transgenic seeds company – the Maharashtra Hybrid Seeds Company (MAHYCO). MAHYCO also happens to be a strategic partner of ABSP2. The state of Tamil Nadu is home to the Tamil Nadu Agricultural University, which also has official links with ABSP2. Given the daunting task of locating and contacting the farmers, finding suitable transport, housing, and translation services, as well as completing the project within time and financial constraints, Maharashtra and Tamil Nadu appeared to offer the best possible resources for the research. From a market standpoint, the states of West Bengal, Bihar and Orissa would have been the "natural" choices as they are the top three eggplant-growing states in India. However, West Bengal's and Orissa's weak infrastructure and Bihar's reputation as a "lawless state" made them potentially risky choices.

Ninety eggplant farmers in the state of Maharashtra were interviewed using a stratified nonrandom sampling (also known as quota sampling) procedure. In stratified nonrandom sampling, "case or cases are selected nonrandomly (volunteer, available, and so on) from each subgroup of the population under study" (Tashakkori & Teddlie, 1998, p. 76). Given the incomplete records on eggplant farmers in Maharashtra and Tamil Nadu, random sampling (and its variants) was not a feasible option. In any case, representativeness is not an important criterion for this study, which is fundamentally concerned with studying varieties in themes, opinions, attitudes and worldviews that are hitherto unknown (and whose distributions are unknown) (Bauer & Aarts, 2000).

Stratified nonrandom sampling was selected from among the various nonrandom sampling procedures as it allowed the stratification of farmers according to well-defined geographic regions but took into account the fact that random sampling *within* each region was not possible because of incomplete records.

Maharashtra consists of four geopolitical regions – Marathwada, Khandesh, Western Maharashtra, and Vidharba. 30 eggplant farmers in Marathwada, 30 in Khandesh, and 30 in Western Maharastra were interviewed. 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) – with the help of MAHYCO. Within each district, a convenience sample of 30 eggplant farmers was interviewed (see Table 1).

Table 1: Number of Respondents By Region

MAHARASHTRA	
Marathwada region	30
Khandesh region	30
Western Maharastra region	40 (includes 10 from focus group)
TAMIL NADU	
Coimbatore region	12
Dindigul region	18
TOTAL	120

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 beliefs beyond that number (see Morgan et al., 2002). Ten additional eggplant farmers from Pune district (Western Maharashtra region) who were visiting a MAHYCO "farmers' day" were randomly selected and interviewed at a subsequent focus group session. 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[7] from MAHYCO who speaks Marathi was also present for all the interviews. The farmers’ responses were immediately translated from Marathi into English and recorded in English on tape. On average, each farmer encounter lasted about 20 minutes. The first five to ten minutes of each encounter typically consisted of “small talk” to “break the ice” with the farmer. Reading out

[7] The presence of the MAHYCO manager might have influenced the response of some farmers. However, his presence at the interviews was absolutely critical to the success of my fieldwork, as he knew where the farmers were located and provided immediate access to my respondents.

the *Bt* eggplant scenario in Marathi took about five minutes[8]; each farmer then typically took between one to five minutes to give his response. The last five to ten 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.

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.

A total of 30 farmers were interviewed in Tamil Nadu[9] --12 from Coimbatore district and 18 from the important eggplant-growing Dindigul district (see Table 1). The Coimbatore farmers comprise the universe of eggplant farmers who were participating in an Integrated Pest Management (IPM) project coordinated by the Agricultural Entomology Department of the Tamil Nadu Agricultural University (TNAU). The 18 Dindigul farmers constituted a convenience sample. All the interviews were conducted in the local Tamil language with the assistance of Indian translators who have a master's or Ph.D. in agricultural entomology. The farmers' responses were immediately translated from Tamil into English and recorded in English on tape.

To highlight risks and benefits that may be salient to Indian farmers, open-ended interviews with six technical experts were structured to elicit views on the risks and benefits of *Bt* transgenic food crops. The six

[8] This exercise was not uncommonly interjected with questions from the farmers.
[9] The fieldwork in Tamil Nadu was limited to 30 farmers because of serious difficulties in obtaining on-site logistical support and assistance.

experts were Dr. KV Raman (plant breeding), Dr. John Losey (entomology), Dr. Janice Thies (soil and crop science), Dr. David Pimentel (ecology), and Dr. Per Pinstrup-Andersen (international nutrition) at Cornell University and Dr. Usha Barwale Zehr of MAHYCO. The five key risks and benefits identified by the experts were: development of pest resistance; gene flow to wild relatives; impact on non-target organisms; acceptance by Indian consumers; and potential benefits.

CHAPTER 4: CONTEXT

Agricultural Biotechnology in the Developing World

According to Borlaug (2000), “The commercial adoption by farmers of transgenic crops has been one of the most rapid cases of technology diffusion in the history of agriculture” (p. 487). Millions of large and small farmers in both developed and developing countries have adopted transgenic crops and continue to increase the total acreage under cultivation – despite the ongoing debate and controversy on agricultural biotechnology in countries such as Britain and Italy. Some argue that this high rate of adoption “is a strong vote of confidence in GM crops, reflecting farmer satisfaction” (James, 2002, p. 2).

In the last five years, developing countries have gained an increasing share of the proportion of transgenic crops grown worldwide: from 14% in 1997, to 16% in 1998, to 18% in 1999, 24% in 2000, 26% in 2001 and 27% in 2002. The latest 2002 figures show that 27% of the global transgenic crop area of 58.7 million hectares was grown in developing countries (James, 2002).

In 2002, just four countries accounted for 99% of the global transgenic crop area. Nonetheless, it is significant that of these four countries, two (i.e. Argentina and China) are from the developing world. India, Romania, Uruguay, Mexico, Bulgaria, Indonesia, Colombia, and Honduras were the other developing countries that grew transgenic crops in 2002. In 2002, the dominant transgenic crops in terms of total acreage grown were soybean, cotton, canola and maize. Collectively, these four crops accounted for about 58% of the global transgenic crop area.

However, only maize is a staple crop in a number of developing countries (James, 2002).

Why isn’t agricultural biotechnology more extensively applied to crops that are relevant to small farmers and poor consumers in developing countries, such as banana, cassava, yam, sweet potato, rice, wheat and millet? The fact is that private companies have little incentive to develop transgenic varieties of such crops when poor farmers and consumers make prospects of a return on their investment bleak (Paarlberg, 2000). Furthermore, increasing protection of the intellectual property rights over agricultural biotechnology processes and products means that research institutions in the public sector face significant challenges in gaining access to the proprietary knowledge needed to develop transgenic varieties of orphan crops (e.g. cassava and millet) that form the staple diet of many poor people (Paarlberg, 2000). This worrying trend is aggravated by the alarming consolidation of the agricultural biotechnology industry over the last 15 years: only six of the 13 firms globally active in 1990 remain, and these control more than 80% of the world market (”Bayer Crop wants to overtake Syngenta as no. 1 by 06”, Sep 3, 2003). Not surprisingly, the productivity and nutrition needs of poor farmers and consumers have not been the main focus of private-sector biotechnology research.

According to the Asian Development Bank (2002), biotechnology must meet four conditions if it is to contribute to food security in developing Asian countries:

1. It must address problems faced by small farmers.

2. It must focus on the major crops, livestock and fish grown by small farmers.
3. The technology must be easy for small farmers to use, inexpensive and non-harmful to human health or the environment.
4. Policy development in developing countries must provide the necessary support and infrastructure.

At present, there are several promising developments focused on the needs of farmers and consumers in the developing world. For example, farmers in China are already benefiting from the use of *Bt* cotton: the unit cost of producing *Bt* cotton in the country is 20 to 30 percent lower than conventional varieties (depending on the variety and site). Moreover, *Bt* cotton offers superior net income and returns to labor compared to non-*Bt* varieties (Pray et al., 2000). The use of *Bt* cotton has also been associated with a significant reduction in the use of pesticides – from an average of 12 sprays per season to three or four. In turn, the smaller number of sprays translates into cost savings and health benefits for the farmer (Asian Development Bank, 2002).

Sweet potato is another case in point. The crop is an important staple food in Kenya, typically grown by small farmers. However, pests such as weevils and viruses have been known to reduce yields of sweet potato by up to 80% (Monsanto, 2003). Nonetheless, transgenic potato strains developed by the Kenya Agricultural Research Institute (KARI), Monsanto and several U.S. universities have shown resistance to the feathery mottle virus. Field trials of the crop are currently being conducted and yields are expected to increase by about 18-25%. In turn, higher yields are expected to increase farmer income by between 28-39% (Qaim, 1999; Odame, Kameri-Mbote & Wafula, 2002).

Other promising developing country-focused transgenic crops include a transgenic rice variety developed by Cornell University researchers that is resistant to abiotic stresses such as cold, drought and high soil salinity. When introduced in the field, it is expected that the transgenic rice could increase yields under poor conditions by up to 20% (Garg et al., 2002).

Nonetheless, biosafety, legal and capacity issues present a number of obstacles to the deployment of pro-poor transgenic varieties in the developing world. The choice of regulatory approach poses a particular set of dilemmas for officials: while economic imperatives to increase production are stronger in developing countries than in industrialized nations such as the U.S., the former tend to have weaker regulatory capacities to ensure that agricultural biotechnology is used efficiently and safely (Paarlberg, 2001). Indeed, risk assessment procedures in developing nations for new crop plants had not been well established prior to the advent of modern agricultural biotechnology. The situation is not helped by the very high costs of establishing the necessary regulatory infrastructure to monitor biosafety (Nuffield Council for Bioethics, 2003) and the historical subordination of biosafety concerns to productivity goals (Paarlberg, 2001). The predominance of small-scale farmers in developing countries (about 870 million) also poses significant challenges to effective regulation and monitoring (see FAO, 1988)

While proponents such as Michael Lipton argue that “the probable costs of the (mostly remote) environmental risks from GM crops to developing countries, even with no controls, do not approach the probable gains if GM crops concentrated on the local and labor-intensive production of food staples[10]" (Nuffield Council on Bioethics, 1999, p. 73), inefficient regulatory controls can have serious implications for the genetic purity of native cultivars, health of non-target organisms, and the development of pest resistance as well as "superweeds". In the case of *Bt* transgenic crops, for example, "grower compliance to a resistance management strategy is essential to delaying the development of resistance" (Shelton, Zhao & Roush, 2002, p. 863). But ensuring such compliance is a different matter altogether as many developing countries simply do not have the necessary resources and infrastructure. The proliferation of illegal *Bt* cotton seeds in Gujarat, India even before *Bt* cotton was commercialized highlighted the difficulty of monitoring the flow of transgenic materials in a developing country (Jayaraman, 2001).

Legal issues also present particular problems. Over the past 15 years, processes and products of agricultural biotechnology research have become increasingly protected as intellectual property (Lybbert, 2003). In particular, the 1980 court decision in *Diamond v. Chakrabarty* and the Bayh-Dole Act of 1980 encouraged the proliferation of patenting of plant biotechnology by both public and private-sector institutions (Graff et al., 2003). The two decades since these landmark cases have also seen increased licensing of public-sector technology to the private sector (Aitkinson et al., 2003). To complicate matters, ownership of IP rights for agricultural materials and technologies has become extremely fragmented, such that no single institution or company can provide a crop developer

[10] The need to safeguard valuable or vulnerable indigenous genetic resources might nonetheless motivate the adoption of a more precautionary approach in some countries (Paarlberg, 2001).

with the complete package of IP rights needed to ensure freedom to operate (FTO) (Aitkinson et al., 2003). Hence, “limited or conditional access to a wide range of patented technologies has been identified as a significant barrier to the applications of biotechnology in the development of new crops. This is particularly true for subsistence and specialty crops” (Aitkinson et el., 2003, p. 174).

There is also widespread concern that the intellectual property rights (IPR) system is inherently unfair to people living in poor, developing countries (Pistorius & van Wijk, 1999; Arends-Keunning & Makundi, 2000). Indeed, rapid consolidation in the agricultural chemicals and biotechnology industry over the last several years has concentrated the control of genetic engineering technologies and their associated IPR in the hands of a small number of (mostly Western) corporations: most of the technology that is needed to conduct commercial research on transgenic crops is owned by five major industrial groups of large agricultural biotechnology companies (ETC Group, 2002). Thus, even though the companies allow public and non-profit institutions to conduct biotechnology research on orphan crops with their proprietary technologies, they also want control over the commercialized product. Many groups fear that this control will have dire long-term consequences for the self-sufficiency of entire communities that become dependent on these technologies for their livelihoods (see Chong & Scheufele, 2002). According to Pushpa Bhargav of the Center for Cellular and Molecular Biology (CCMB) in Hyderabad, any group that controls food security in a country such as India – where 700 million people depend directly on farming for a living – controls the country (see Visvanathan & Parmar, 2002).

Together, these developments have made the transfer of pro-poor agricultural biotechnology to developing countries problematic: patented plant biotechnologies that could address food security in the developing world are no longer treated as public goods, and private companies are primarily concerned with getting a return on their R&D investment, maintaining control of their technologies, and mitigating repercussions from liability and public relations risks (Krattiger 2002; Council on Bioethics, 2003). Developers of pro-poor transgenic crop technologies (e.g. golden rice) also have to contend with the increasing number and complexity of IP rights that need to be licensed (Conway, 2003). Last but not least, public institutions in most developing countries do not have the capacity to understand, deploy and negotiate regarding biotechnology (Herdt, 1999).

In light of these challenges, a brief mention of the experience with golden rice might be instructive. Since 2000, golden rice has been promoted as a shining example of what agricultural biotechnology can do for the poor (see Chong & Scheufele, 2002). However, the technology underlying golden rice was enmeshed in around seventy patents owned by thirty-two companies and institutions worldwide (Kryder, Kowalski, & Krattiger, 2000). Indeed, negotiations over the required Material Transfer Agreements (MTA) delayed the development process by 12 months (Nuffield Council on Bioethics, 2003). The situation was vastly complicated by the difficult task of ascertaining precisely who owned the rights to a particular component or process of the technology – especially since the private sector is in a constant state of flux (Kowalski & Kryder, 2002). While free licenses for the associated IPs were eventually secured for golden rice, the necessity to obtain permission from all the IP owners could similarly hinder or delay the development and deployment of future pro-poor transgenic crops.

Nonetheless, several initiatives are afoot to facilitate the transfer of IP and agricultural know-how from institutions in the developed world to target beneficiaries in developing countries. The AATF (African Agricultural Technology Foundation), AGRORA and ISAAA are some examples. Funded by The Rockefeller Foundation, The United States Agency for International Development (USAID) and the United Kingdom's Department for International Development (DFID), the AATF is a "one-stop-shop" for acquiring royalty-free technologies, materials and know how for eventual deployment by Africa's resource-poor farmers. AGRORA – a joint effort between Cornell University's Mann Library, FAO, WHO and several scientific publishers – is an internet portal that provides scientists and researchers in sixty-nine developing countries (with GNP per capita of less than US$1,000) free access to academic publications that cover agricultural science (Vent, 2003). Access to this virtual storehouse of knowledge on agriculture will enable researchers in the developing world to keep pace with scientific developments in agricultural biotechnology and enable them to play a more meaningful role in technology development and management in their respective countries. In Asia alone, the International Service for the Acquisition of Ag-biotech Applications (ISAAA) has conducted training workshops to build national capacity in biosafety regulation, IPR management, and public communication about the risks and benefits of agricultural biotechnology.

Agricultural Biotechnology in India

Even though India has made tremendous strides in addressing food security and malnutrition in the past two decades, providing the urban and rural poor with adequate food and nutrition has been identified as one of the top five policy challenges facing India in the next 20-25 years (Pingali, 2002). One quarter of the world's poorest people live in India (Visvanathan & Parmar, 2002). 2.7 million Indian children still die every year – 60% of these deaths are linked to malnutrition – and 5 to 7 percent of all children suffer from VAD (see Paalberg, 2001; Kapil & Bhavna, 2002). Malnutrition in the country is caused primarily by poverty. Poverty in the rural areas, in turn, is caused largely by low agricultural productivity (Paarlberg, 2001).

Two-thirds of India's population (or 1 billion people) still farm for a living. Of these people, 75 percent own just one hectare of land or less, making them severely disadvantaged in terms of the amount of food they can produce (Swaminathan, 1999). Although clear numbers are not available, it is believed that the "poorest of the poor" constitute some of the farmers living on these marginally productive lands (Pingali, 2002).

Between the 1980s and 1990s, the productivity of Indian agriculture showed relatively impressive gains – annual rates of growth increased from 3.1 percent to 3.8 percent in that period (The World Bank, 2000). In the context of these gains, India occasionally reported surplus public food stocks, including 27 million tons of wheat in 2000 (some of which were left to rot in warehouses). However, poverty persists for 230 million Indians who remain food insecure because of the low productivity of their agricultural resources and lack of access to food (Paarlberg, 2001).

A number of factors account for low agricultural productivity in India. They include crop pests and diseases, low rainfall, low soil fertility and lack of irrigation. The first is particularly serious: Indian pigeon pea farmers, for example, may lose their entire crop to insect infestation. To combat pests and diseases, many Indian farmers resort to using farm chemicals such as pesticides and herbicides. However, farm chemical use comes with a high price tag: cotton farmers alone spend Rs 16 billion each year on insecticides while vegetable growers spend US$100-200 per hectare, despite the fact that insects continue to inflict US$2.5 billion in annual losses on vegetable production. The dependence of Indian farmers on pesticides has become so severe that it has escalated into a rural economic welfare issue (Paarlberg, 2001). In places such as Punjab, Andhra Pradesh and Karnataka, for example, the use of costly chemical inputs has forced many farmers into bankruptcy, which has caused a number of farmers to commit suicide ("Farmer suicides lead to GM moratorium call", Sep 26, 2000).

Agricultural biotechnology has the potential to address some of the problems endemic to Indian agriculture. For example, *Bt* cotton trial plots in different parts of India experienced substantially less pest damage and increased yields compared to conventional varieties. In fact, yield gains in India outstripped the performance of *Bt* cotton in other countries where the technology has been used to replace and enhance pest control using pesticides. Compared with conventional varieties, *Bt* cotton produced

80% higher yields and used almost 70% less pesticide (Qaim & Zilberman, 2003). While *Bt* cotton seed costs four times more than conventional cotton, its higher yield means that it is worth five times as much on the market (Whitfield, 2003). In addition to increasing agricultural productivity, transgenic crops could also help tackle some of the country's severe nutritional problems such as Vitamin A and iron deficiency. Indeed, some note that biotechnology development may even be indispensable to India's agricultural self-sufficiency – precisely because it will prevent the country from being exploited by those with access to the technology (Visvanathan & Parmar, 2002).

CHAPTER 5: DATA/FINDINGS

According to Bauer and Gaskell (2000), several qualitative criteria that are functionally equivalent to the quantitative criteria of reliability, validity, and representativeness can be established: triangulation; transparency and procedural clarity; corpus construction; thick description; surprise (as a contribution to theory and/or common sense); and communicative validation. Denzin (1978) used the term "triangulation" to refer to the combination of data sources to study the same phenomenon. Miles and Huberman (1994) defined triangulation as 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" (p. 267). The triangulation of methods and theoretical perspectives institutionalizes reflexivity in a research effort and forces the researcher to address the inconsistencies that are part of the research process (Gaskell & Bauer, 2000). It also offsets the weaknesses of one method with the strengths of another.

According to Denzin (1978), the four main types of triangulation are: data triangulation (i.e. using various data sources in a study); investigator triangulation (i.e. using different researchers in a study); theory triangulation (i.e. using multiple theoretical perspectives to interpret a study's results); and methodological triangulation (i.e. using different methods to study a research problem). By using the moral, psychometric and cultural models to interpret the results (methodological triangulation), using both in-depth interviews and a focus group (methodological triangulation), and seeking rival explanations for the data from a colleague (investigator triangulation)[11], this study fulfills some of the main requirements for triangulation.

This 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 centrally concerned with the idea of "saturation" (i.e. maximizing the variety of representations): the interviewing of 30 farmers in various eggplant-growing regions of Maharashtra and Tamil Nadu meets this requirement. Thick description is offered in this study through the extensive use of verbatim reporting of sources. The surprise value (determined with regard to either a common-sense view or theoretical expectation) of this study should become apparent in the discussion and conclusion sections of the dissertation. Significantly, qualitative research needs to demonstrate surprise value "in order to avoid the fallacy of selective evidence in interpretation" (Bauer & Gaskell, 2000, p. 347). Accordingly, surprise can be manifested in unexpected insights, open-mindedness to contrary evidence, or a change of view during the research process. Communicative validation, which involves the validation of the researchers' 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 & Gaskell, 2000, p. 348), especially given the practical difficulties in relocating the farmers who participated in this study.

[11] The colleague is an undergraduate in Cornell's Biology & Society program who has done fieldwork in rural Madagascar.

Coding

In qualitative research, coding *is* analysis: the process of reviewing, transcribing, synthesizing, and dissecting field notes while maintaining the relationship between the parts is the essence of qualitative data analysis (Miles & Huberman, 1994). Codes are “tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study” (Miles & Huberman, 1994, p. 56). In general, there are three methods for creating codes for qualitative data: the a priori approach, the inductive approach, and a third approach that lies partway between the first two approaches. The inductive approach was used for this study as it allows interview responses and field notes to suggest more empirically driven codes than a generic, prefabricated start list could (Miles & Huberman, 1994).

According to Miles and Huberman (1994), one of the most helpful inductive coding techniques is the one 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 (where the response consisted of only one sentence) or multi-sentence chunk.

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 – signaling that the analysis has run its full course (see Miles & Huberman, 1994).

To increase confidence in the internal validity[12] of one's findings, Miles and Huberman (1994) recommended asking a colleague (preferably from a different discipline) to look at the same data and come up with her own codes. Accordingly, I recruited a senior undergraduate (Biology & Society major) who has prior fieldwork experience in Madagascar to look systematically at the Maharashtra data so as to offer possible rival explanations for the data[13]. More specifically, the undergraduate colleague was asked to independently come up with themes that describe each sentence or multi-sentence chunk in the data set. The frequency with which each theme appears in the data is denoted under the heading, "Number of mentions." A similar approach was used by Lofstedt (1996) in his study on public perception of nuclear plants in Scandinavia.

To show more explicitly how the coding was carried out, two transcripts and their accompanying codes are shown below. The first transcript comes from an Aurangabad farmer while the second comes from a Jalna farmer:

> "If *Bt* brinjal increases yield and reduces the number of pesticide sprays, I will accept *Bt* brinjal. Applying pesticides is tedious and time-consuming work: if *Bt* brinjal reduces pesticide application, it will give me greater peace of mind."

[12] Kvale (1989) emphasized validity as a process of checking and questioning rather than a rule-based correspondence between one's findings and the "real world."
[13] The Tamil Nadu data was not coded by the colleague.

Coder A coded this response as “economic benefits” and “psychological benefits” while coder B coded “economics,” “pesticide reduction,” and “labor reduction.”

> “I’m ready to accept it. Look, I’m spraying pestictides at a 3-day interval and still sustain losses to my crops because of the fruit and shoot borer. *Bt* brinjal will give me both greater yield and cost savings.”

Coder A coded this response as “economic benefits” while coder B coded “yield,” “economics,” “*Bt* cotton,” and “health.”

Table 2 shows the results of my own attempt at coding the Maharashtra data:

Table 2: Maharashtra Farmers’ Perception of *Bt* Eggplant (Coder A) (N = 90)

Theme	**Number of Mentions**
Economic benefits	56
Health benefits/absence of risk to health	16
Need for safety assurances	12
Need for field trial/personal experience	7
Acceptance by the market	6
Social benefits	3
Trust in seed developer/regulator	3
Need for equivalent product quality	3
Economic risks	2
Labor saving benefits	2
Health risks	2
Psychological benefits	1
Insurance (against profit losses)	1
Absence of risks to environment	1

Table 3 shows the coding results of the second coder:

Table 3: Maharashtra Farmers' Perception of *Bt* Eggplant (Coder B) (N = 90)

Theme	**Number of Mentions**
Yield	36
Health	30
Economics	22
Bt cotton	16
More information	9
Guidelines	8
Company responsibility	7
Ethical issues	6
Marketability	5
Labor reduction	4
Climactic conditions	4
Pesticide reduction	3
No data	3
Environmental concerns	1
Population issues	1
Security	1
Technical understanding	1

Table 4 shows the results arising from our comparison, discussion, and negotiation of the two independent sets of codes.

Table 4: Maharashtra Farmers' Perception of *Bt* Eggplant (Coders A & B)

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

To show more explicitly how the different results of two coders were resolved into a single coding frame, I will explain the process underlying the resolution of the top five themes:

1. Economic benefits: We decided to subsume "yield" and "economics" from Coder B's results under a single, more encompassing code – "economic benefits" – that already appeared in Coder A's results. The decision was made after both coders agreed that yield could be classified as a type of economic benefit or outcome and that "economics" was too ambiguous a term to differentiate between risks and benefits. For example, coder B classified farmers' concerns over the cost of *Bt* eggplant seed under "economics."

2. Health benefits/lack of health risks: Both coders agreed after a discussion that “Health” (in Coder B’s results) was too broad and ambiguous and that “health benefits/lack of health risks” better captured the benefit and risk aspects of farmers’ health-related responses. In any case, Coder B included “safety assurances” under “Health.” When both coders re-examined the data together, Coder A’s original count of 16 mentions of “health benefits/lack of health risks” increased from 16 to 20.

3. Accountability: This code was created to distinguish between responses that emphasized the *fiduciary responsibility* of institutional actors in managing and deploying *Bt* eggplant technology from responses that articulated a need for official assurances of the safety of *Bt* eggplant. After both coders re-examined the data together, they agreed that the three mentions of “trust in seed developer/regulator” in Coder A’s results and the seven mentions of “company responsibility” in Coder B’s results were better described by the code “accountability.”

4. Lack of moral concerns: This theme was coded by Coder B (as “ethical issues”) but not by Coder A. Both coders agreed that “lack of moral concerns” constituted an important theme. When both coders re-examined the data together, seven mentions of “lack of moral concerns” were found.

5. Need for more information: This theme was created to capture statements made about the inadequacy of currently available information about *Bt* eggplant. When both coders re-examined the data together, it was found that “need for field trial/personal experience” in Coder A’s results and “more information” in Coder B’s results included several instances of “need for more information.”

Despite these changes, it is noteworthy that “economic benefits” and “health benefits/absence of health risks” still rank as the two most important themes.

Maharashtra

From Table 4, it is clear that farmers’ responses to the scenario focused on the economic benefits offered by *Bt* eggplant. 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.”

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 judgment 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 neighboring 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."

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 in the market because it does not need (or at least needs less) spraying and is thus free from pesticide residues. That is why consumers will purchase *Bt* eggplant over ordinary brinjal."

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."

After economic concerns, farmers' perception of *Bt* eggplant focused on health – specifically, the benefits and absence of risk to human and animal health (see Table 4). This finding is in line with earlier indications that risk decision-making by non-experts is often determined by safety and economic concerns (Krimsky & Plough, 1988). 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 relies 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 formed the third most important category of farmer responses to the scenario (see Table 4). 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."

None of the farmers in this study cited moral concerns (as defined by Sjoberg). When prompted[14], seven farmers in Ahmednagar explicitly stated they had no moral concerns regarding *Bt* eggplant:

> "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's more important." – 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 (also from Ahmednagar) likens *Bt* to a biological pest control method that is safer and more natural than chemical methods:

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[14] I had asked the translator to prompt farmers in Ahmednagar with the question, "Do you have any moral concerns about *Bt* eggplant?" Ahmednagar was the last stop in my itinerary.

> "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 (versus chemicals)."

Environmental issues do not figure prominently in the farmers' risk 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 Indian 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."

A number of farmers also used analogies to explain away the environmental risk posed by *Bt* eggplant, such as this Jalna farmer:

> "*Bt* cotton has not had any negative effects on the environment in the last two years, how can *Bt* eggplant have a negative impact?"

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."

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

Tamil Nadu[15]

In Tamil Nadu, economic benefits/performance (47%) and the need for field trials/personal experience (30%) were by far the top two categories of responses to the scenario. A chasm separates these two sets of responses from the next most important category – "negative

[15] The second coder was not involved in coding the Tamil Nadu data and thus had no input on the interpretation of Tamil Nadu results.

experience with pesticides" – which garnered a mention by only 7% of the farmers (see Table 6).

Table 6: Tamil Nadu Farmers' Responses to *Bt* Eggplant Scenario

Category	**Frequency of Mention**
Economic benefits	14
Need for field trial/personal experience	9
Agronomic performance	2
Negative experience with pesticides	2
Benefits to environment	1
Trust in institutions	1
Need for safety assurance	1
Ecological risk	1
Risk to animal health	1
Availability of alternative approaches	1
Inability to grasp intangible risk	1
Incoherent response	1

The focus on economic issues is in line with the Maharashtra findings and earlier research. For example, an Ottonchatram farmer said:

> "I'm ready to follow all the guidelines in order enjoy higher yield because I don't want to spend my money on pesticides. I would be willing to take some risk in order to enjoy higher yield and cost savings. When is the new seed going to be available?"

Another Ottonchatram farmer said:

> "If I can get better yield from *Bt* eggplant, why should I be worried about other things? I just want good yield."

While *Bt* eggplant does not offer higher yield *per se*, it can increase agricultural productivity by reducing expenditures on pesticides and crop damage inflicted by the fruit and shoot borer. In the minds of farmers, higher yield is analogous to higher productivity. Environmental and moral concerns are prominent for their absence. The marked emphasis on yield and economic factors is not surprising when considered within the context of the devastation wreaked by the fruit and shoot borer (up to 90%).

Compared to their Maharashtra counterparts, the need for field trials or personal experience of *Bt* eggplant assumes greater importance among Tamil Nadu farmers. A farmer in Thondamuttur gave this typical response:

> “Initially, I would not go for large-scale *Bt* eggplant cultivation. Instead, I will go for a pilot project with a small test plot. I want to see the results in a small area first. If the results are good, I will then go for a larger area.”

The salience of field trials and personal experience may be partly attributed to the relative lack of familiarity with *Bt* transgenic crops in Tamil Nadu (only four of the 30 farmers are aware of *Bt* cotton).

The absence of health issues from the list of top five issues is striking, all the more because health issues ranked as the second most important issue for the Maharashtra farmers. It is possible that health did not feature prominently in the Tamil Nadu farmers’ responses because eggplant is not a major vegetable crop in this region and thus not a significant part of the local diet (although this proposition needs to be validated).

Information Sources

Although not of theoretical interest for this study, the information sources used by Indian eggplant farmers are an important issue for communication planning and are thus of significant interest to the study's sponsor. As Table 7 makes clear, dealers are by far the preferred source of information on agriculture for the Maharashtra eggplant farmers.

Table 7: Maharashtra Farmers' Preferred Sources of Information (N=90)

Source/Channel	**Frequency of Mention**
Dealers	72
Company Representatives	30
Other Farmers	13
Personal Experience	12
Mass Media	12
State & University Extension	8
Farmer Days/Trial Plots	7
Advertising Materials	3
Marketplace	2
Retailers	1

Company sales representatives and adjacent farmers rank second and third respectively. It is significant that the top three sources of information are interpersonal and not mass media sources. The top three sources of agricultural information for Tamil Nadu farmers are dealers, adjacent farmers, and company representatives (tied at third place) respectively (see Table 8).

Table 8: Tamil Nadu Farmers' Preferred Sources of Information (N=30)

Source/Channel	Frequency of Mention
Dealers	22
Adjacent farmers	8
Private company representatives	5
Mass media	5
Friends/relatives	4
State agriculture department	3
Personal experience	3
University contacts (TNAU)	2

Once again, the top two sources are interpersonal sources – the mass media tie at third place with private company representatives.

Dealers are the preferred information source for the Maharashtra farmers largely because of their perceived trustworthiness, access**,** and familiarity to their farmer clients (see Table 9).

Table 9: Maharashtra Farmers' Reasons for Choosing Dealers as Preferred Source of Information (N=90)

Source/Channel	**Frequency of Mention**
Trustworthiness	31
Access, proximity, convenience	31
Regular contact, familiarity, close relationship	23
Dealer offers credit facilities	8
Dealer has good local network/ A conduit for latest information	7
Knowledgeable	5
Dealer shop is a rendezvous	2
Dealer takes farmers to trial plots	2
Dealer has farming experience	2
Dealer is the sole information source	1
Farmer is illiterate	1
Dealer gives product samples	1
Farmer has mutual understanding with dealer	1

CHAPTER 6: DISCUSSION

Even as Sjoberg and colleagues base their moral model on two rather narrow operationalizations of morality (i.e "tampering with nature" and "unnatural risk"), my data analysis shows that some Indian farmers use broader conceptions. For example, there is the notion that growing *Bt* eggplant is the "right" (i.e. moral) thing to do as it helps address food insecurity in the country:

> India's high population also makes it necessary for us to increase our agricultural yield – Ahmednagar farmer

> Besides, India has too many people – we have no alternative but to adopt this technology to increase yield in order to feed the population, as agricultural production is not keeping pace – Ahmednagar farmer

These responses reflect the notion of doing what is best for the society at large, as opposed to doing what is best for oneself. However, these altruistic values were counterbalanced by "selfish" motives that focused on one's best interests, even at the expense of harm to others:

> We have to spray pesticides on brinjals every two to three days. Because of this, we (the farmers) do not eat the brinjals we grow. We know that we are spraying every two to three days and there is a lot of pesticide residue on the brinjal. So we are not eating that. And the brinjal is totally made of those chemicals. We directly put them in the market and sell them. If this *Bt* brinjal is invented, then we can eat the brinjal because there will be less chemicals on the brinjal. I think *Bt* brinjal is necessary because when we are spraying 2-3 days, what happens is that new diseases are occurring in the human body. People are buying vegetables from the market and eating them. They do not know what the farmer is spraying on his farm…That's why heart attacks and all these new diseases are occurring – Ahmednagar farmer

> There's nothing unnatural about *Bt* brinjal technology if it brings me profit – Ahmednagar farmer

There were indeed two mentions of "tampering with nature." However, while recognizing the undesirability of tampering with nature, the farmers in question rationalized their acceptance of *Bt* eggplant by emphasizing that benefits to one's livelihood and to humanity take precedence over moral concerns about "tampering with nature":

> 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. Anyway, the use of pesticides is not good for health – Ahmednagar farmer

> "It is not good to interfere with natural processes, but if it is useful to human beings, interference is ultimately good and justified. However, if anyone is misusing the technology, such as changing the natural life cycle of plants, that is not good." – Ahmednagar farmer

Interestingly, none of the other operationalizations explored earlier – stigma, fairness, risk to future generations, and NIMBY – can be found in the data.

It should be noted that even though the *Bt* eggplant scenario (see Appendix 1) explicitly mentions that *Bt* eggplant involves the injection of a microorganism into the plant, none of the interviewed farmers voluntarily raised the issue of morality (in the way that Sjoberg operationalized it). Those who did (i.e. in Ahmednagar) only did so in response to prompts from the interviewer. The virtual absence of moral concerns (as defined by Sjoberg) may have something to do with the non-animal or human origin of the *Bt* gene. As a Pune farmer puts 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."

While moral concerns in industrialized western nations generally appear to be greater for genetic engineering than for other technological hazards, these concerns are focused on applications involving the use of animal and human genetic material instead of plants or microorganisms (Slovic, 1992; Frewer, Howard, & Shepherd, 1997). Similarly, Hindu scriptures warn against introducing animal qualities into human beings (or vice versa), but do not expressly forbid the introduction of microorganisms into plants (Playing God, 1997).

Three farmer responses alluded to risk factors in the psychometric model. The first two responses alluded to dread, while the third alluded to fear of unknown risks:

> I am concerned that if we transfer *Bt* from cotton to a food crop such as brinjal, there might be negative effects on human health – Aurangabad farmer

> I have concerns about the health effects of the *Bt* gene on human health since *Bt* brinjal is a food crop – Aurangabad farmer

> When I grew hybrid brinjal in the past, I experienced problems with wilt infestation. Local varieties, on the other hand, do not give me any wilt problems. So, I am concerned that when the local brinjal variety is crossed with *Bt*, I may experience the onset of new pests – Tamil Nadu farmer

Nonetheless, three (out of more than a hundred) responses do not appear to suggest that risk perceptions of farmers in India are influenced by the factors in the psychometric model.

This study indicates that perception of the risks and benefits of agricultural biotechnology by end users in developing countries is driven by economic benefits, safety concerns, and accountability. The primacy of economic considerations is borne out by previous research. For example, Chong (2003) found that village leaders in the "rice bowl" of the Philippines considered improved yield the single most important criterion when making a decision to adopt a new rice variety – transgenic or otherwise. Likewise, David and Sai (2002) and Kshirsagar, Pandey and Bellon (2002) reported that yield improvement – an economic benefit – was the main reason Indian cotton farmers in Andhra Pradesh and rice farmers in Orissa respectively adopted *Bt* cotton and new rice varieties. On the other hand, 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. Thai policy makers were also not supportive of "golden rice" because of fears that its cultivation in Thailand would jeopardize the country's lucrative jasmine rice exports to the European Union and Japan. More recently, 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) played a decisive role in African public resistance to imported U.S. transgenic corn. These studies – all conducted in developing countries – affirm the importance of economic considerations to the acceptance of agricultural biotechnology and support a risk perception model that includes economics as a key variable.

The primacy of economic benefits may have quite a lot to 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 are eking 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 or environmental 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 and environmental concerns would pale in importance[16]. Fessenden, Fitchen and Heath (1987) showed that general quality-of-life issues such as the economic well being of the community could affect the reception of risk information. Thus, "the need to safeguard local jobs outweighed concerns about a relatively low-level (one in 100,000) lifetime cancer risk" (p. 96). It should also be noted that cultural issues such as food are 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 alternatives. To most people, ethical principles have a price (Chandon, Wansink, & Laurent, 2000). Hence, even an advocate of "white meat" may consume beef when fish becomes too expensive to purchase (Wansink & Kim, 2001).

The farmers' stark focus on economic benefits versus environmental or ecological risks can be understood in light of Hamstra's (1995) report

[16] Maslow's Hierarchy of Needs indicates that fundamental physiological and security needs must be met before higher-level needs become a priority.

that important benefits offered by transgenic products can outweigh the risks associated with genetic technology. More specifically, his study shows that perceived benefits have a greater statistical influence on consumer acceptance than do perceived risks. Gaskell, Allum, Wagner, Kronberger, Torgersen, Hampel, and Bardes (2004) also found that perceptions of benefits outweighed perceptions of risks in judgments about transgenic food. This can be especially so if the product is perceived as satisfying a positive goal such as increasing yield or reducing pest infestation (see Huffman & Houston, 1993). Conversely, a perception of the absence of consumer benefits may be sufficient condition for the rejection of transgenic foods (Gaskell et al., 2004).

Can the farmers' focus on economic benefits be explained by economic theory? According to the utility principle – sanctified by the U.S. Supreme Court and popular among policymakers – individuals weigh potential costs and benefits and take the course of action that optimizes the advantages and minimizes the risks that will accrue to them (Rayner & Cantor, 1983). The principle might conceivably account for some of the following farmers' responses:

> If the experience with *Bt* cotton is anything to go by, *Bt* is important for increasing farmers' yield. I will adopt *Bt* eggplant even if the seed is more expensive than normal seed – Jalgaon farmer

> The fruit and shoot borer takes away 50,000 to 60,000 rupees per acre from the value of my eggplant crop. Any variety that confers resistance against the fruit and shoot borer would be most welcome by me – even if the seed cost were higher. I want to grow it this year! – Ahmednagar farmer

> I am ready to accept it because of the benefits. I am not worried about the cost of the seed as the spraying costs are even higher. As for the environment, it's not in our hands but in the hands of god – Ahmednagar farmer

Thus, in situations where maintaining the status quo means putting up with a high level of negative economic, health or other impact (e.g. continued heavy use of pesticides), even quite risky technologies may be normatively acceptable to end users (Thompson, 2003). This is especially so when the perceived risks associated with the non-adoption or non-availability of the new technology are high (see Graham & Wiener, 1995). Moreover, the environmental risks associated with agricultural biotechnology "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, p. 12). It should also be noted that several state governments have been promoting the benefits of agricultural biotechnology to the "knowledge economy" and have not accorded environmental factors as much importance as economic considerations (Srinivas, 2002). Thus, it is not surprising that a majority of the Indian farmers found the environmental and ecological risks associated with *Bt* eggplant acceptable.

Nonetheless, aggregated individual choices do not always predict collective preferences (Arrow, 1951) and incommensurables cannot always be reduced to dollars and cents (Self, 1975). Further, the theory of bounded rationality argues that the human agent is not optimal. Instead, he is "only" nearly optimal with respect to his goals as resources allow. This is so because utility functions are often unknown to the agent who has to make a choice. Hence, he must often act with insufficient or incomplete knowledge – i.e. using estimates – and estimates can vary widely (Simon, 1957). Nonetheless, this study was not set up to empirically test which of these economic theories might account for the farmers' responses. To the best of my knowledge, no study has looked at economic theories in the context of food biotechnology in the developing world.

The farmers' focus on accountability may reflect a general preference for assurances in the face of risk uncertainty – in other words, people want to know with certainty whether a particular agency is responsible for ensuring safety (see Johnson & 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 & Neresini, 2004). Accordingly, 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 (Bruce, 2002).

The virtual absence of moral concerns among the eggplant farmers seems to cast some doubt on the universality of Sjoberg's contention that notions of “unnatural risk” and “tampering with nature” are central to risk perception. In other words, these findings suggest that moral notions might not be universally important and can be mitigated or relegated by socioeconomic conditions. This discovery constitutes the “surprise value” (with respect to a common sense view or theoretical perspective) that was advanced earlier as one of the “validity” criteria of qualitative research.

Significantly, none of the experts interviewed for this study mentioned moral issues as a risk factor. Their focus on the ecological, environmental and market aspects of *Bt* transgenic food crops was not surprising considering their scientific (5 experts) and economics (1 expert) background. Nonetheless, the absence of moral concerns from the experts’ interview responses indicates that they did not consider morality to be an important risk issue. Indeed, experts in the Nuffield Council on Bioethics (1999) emphasized the moral imperative to make transgenic crop technology available to the developing countries that want it.

Sjoberg (2002) has proposed an alternative model of risk perception that can be developed on the basis of four factors: attitude to the risk, risk sensitivity, technology-specific risk factors, and moral aspects of the risk in question. However, the particular moral issues so central to Sjoberg’s operationalization of his model are conspicuously absent from the farmers’ responses. Conversely, economic benefits – so vital to the Indian farmers’ perception of technological risk – 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 model seems to lack the explanatory or predictive power that is fundamental to a good theory (see McLeod et al., 1999). Equally significant, neither the psychometric nor cultural model accounts directly for economic benefits, safety concerns and accountability. These discrepancies present researchers with an opportunity to build and test a new theory that incorporates these three variables. This is an important task as it has the potential to result in an alternative model that has true explanatory and predictive value for end users in developing countries.

Just as Frewer, Howard and Shepherd (1997) have shown the inappropriateness of generalizing from global risk perception models to specific technologies such as genetic engineering and its applications, Sjoberg's operationalizations of morality may not be suitable for studying risk perception of *agricultural* biotechnology, as they were derived from studies on public perception of nuclear risks (and not from a general public perception of risk perspective). Having said that, however, Frewer and her colleagues (1997) did find "unnaturalness" to be an important determinant of underlying concern about genetic engineering, although these concerns specifically focused on applications involving human and animal genetic material.

However, 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.

Information Sources

The findings in this study indicate that dealers can play a critical role in communicating about the risks and benefits of transgenic food crops such as *Bt* eggplant. According to eggplant farmers in Maharashtra, dealers are the preferred source of information on agricultural innovations because they are trustworthy, accessible, and familiar. Trust is an important factor in determining risk perception and how risk communication is interpreted (Lofstedt, 1996). Several risk studies have established a strong correlation between trust and risk perceptions (e.g. Renn & Levine, 1991; Slovic, Flynn, & Layman, 1991; Frewer et al., 1996; Siegrist, Cvetkovich, & Gutscher, 2001). For example, Siegrist and Cvetkovich (2000) have shown that people who have social trust in the scientists and companies involved in risky technologies perceive more benefit and less risk than people not having trust in those actors. Priest (2001) also reports that trust in scientific institutions, food retailers, biotechnology corporations and agricultural producers are the best predictors of encouragement for the development of biotechnology applications. Where technologies involved in food production (e.g. genetic engineering) are concerned, trust in the source of risk information may be as important in determining consumer reactions as the content of the risk communication itself (Frewer, Howard, Hedderley, & Shepherd, 1996). If the public does not have trust in a risk communication source, “information may not be accepted, protective measures may not be taken, and mental as well as behavioral overreactions may occur” (Jungermann, Pfister, & Fischer, 1996, p. 252).

Accessibility is also an important factor in determining whether an individual uses a particular communication channel. A channel’s accessibility is defined by an individual’s frequency of contact with the channel and the cost of using it (Chaffee, 1986). Thus, the higher the frequency of contact and the lower the cost (e.g. financial, time, energy), the more accessible a channel is. The Indian dealer scores high on accessibility as he is visited whenever farmers need to purchase seeds, fertilizers or pesticides and because he is within easy physical reach of his clientele (hence lower cost). Channel use is also influenced by an individual's beliefs about whether a particular channel will provide the desired information – in other words, a channel will be sought out if it provides gratification of certain needs (Chaffee, 1986). Thus, seven of the 90 Maharashtra farmers rated dealers as a preferred channel as they were perceived to be an information conduit by virtue of their excellent networking (see Table 6). Of course, it also helps that many dealers have an undergraduate degree in agricultural science and are thus perceived to be knowledgeable about technical agricultural issues (see Table 8). Some dealers even have on-site diagnostic facilities for use by farmers.

That many farmers cite familiarity as a key reason for using dealers as the preferred information source gets at the important notion of social relationships. Indeed, the local dealer shop often serves as a social rendezvous for the farmers in a particular village. In his classic study on Cumbrian sheep farmers, Wynne (1992) shows that the nature of social relationships and networks forms the foundation for trust. Lewenstein (1992) shows in his study of industrial life insurance that the regular contact between agents of two industrial life insurers and their lower-class clientele facilitated the public communication of science information to an audience that did not have regular access to mass media such as newspapers, movies or books. Hence, the "weekly visit from the insurance agent provided one of the few opportunities for contact with reliable, useful, and well-produced information about health" (Lewenstein, 1992, p. 362). Similarly, the close relationship between eggplant farmers and dealers and the former's lack of access (or exposure) to the mass media make dealers a "natural" information channel. It is precisely the intimate contact that dealers have with farmers that puts them in a strong position to know the needs and problems of their clientele and hence be able to provide useful information to risk communicators.

It also helps that the dealer is an *interpersonal* communication channel. Indeed, the actual adoption and spread of innovations through a social system is significantly linked to personal influence (Rogers, 1995). So, while farmers (in the industrialized world) typically first learn about an agricultural innovation through the mass media, adoption of the innovation is more likely to be influenced by interpersonal sources (Rogers, 1995). This is because interpersonal channels are more likely to have "normative" content, while media channels tend to have "informational" content (Chaffee, 1986). The farmers' lesser dependence on mass media sources of information may be partly explained by the low level of literacy and education among the farmers. In any case, Indian newspaper coverage of science and technology issues is extremely small. For example, less than one percent of the total print area in Indian English-language dailies is devoted to news about science and technology (Dutt & Garg, 2000).

Given its important role, the dealer can be likened to a "social amplification station" (Kasperson et al., 1988). While extension agents are often positioned as the de facto public communicator, this study indicates that they fare even worse than the mass media as a preferred information source (see Table 6 and 7). Several farmers highlighted that state extension officers never visited their farms and that it was extremely difficult to get useful information from government departments. Indeed, falling state budgets for agricultural extension has resulted in a collapse in state-level extension systems (World Bank, 2004). Hence, any effective communication about the risks and benefits of *Bt* eggplant must proactively involve the dealers.

Nonetheless, communicating to eggplant farmers about the risks of transgenic crops is currently a tall order. While none of the 90 farmers (and the 10 in the focus group) expressed any concern with the need for a refuge area, the poor compliance with technical specifications for *Bt* cotton in India has caused concerns in the scientific community (Jayaraman, 2002). This state of affairs has been attributed to the Indian government’s failure to educate farmers about the risks of transgenic crops as well as the serious difficulties faced by farmers (given their very small land holdings) in setting aside land to meet refuge criteria (Jayaraman, 2002). Regular monitoring of *Bt* cotton by the Department of Agriculture to ensure compliance to Genetic Engineering Approval Committee (GEAC) guidelines appears to be nonexistent: a 2002 report by David and Sai showed that farmers in their study had not been visited at all by any governmental functionary.

CHAPTER 7: CONCLUSIONS

The findings of this study suggest that economic benefits, safety concerns, and accountability are most salient to the risk perception of farmer end-users in India. None of the farmers interviewed for this study objected to *Bt* eggplant on moral grounds. Nonetheless, their responses revealed a small number of alternative conceptualizations of morality. These conclusions may be generalized to commercial vegetable farmers in India.

External validity, which means representativeness or generalizability (Kerlinger, 1986), has traditionally been defined as the extent to which findings can be generalized across target persons, settings, times and messages (Cook & Campbell, 1979; Jackson, 1992; Reeves & Geiger, 1994). A study's external validity has traditionally been based on its surface representativeness, which is related to the use of techniques such as random sampling. Accordingly, representative samples of individuals or events/situations will produce results that are more generalizable to the population in question (see Tashakkori & Teddlie, 1998).

But before answering the question of this study's generalizability, a distinction needs to be made among three types of representativeness: sample representativeness, ecological representativeness, and variable representativeness. Sample representativeness has to do with how representative the sample reflects the characteristics of the population under study. Ecological representativeness is concerned with whether changes in the social setting may change the relationship between the variables under study. Variable representativeness has to do with whether a variable (e.g. aggression) has the same meaning in different social contexts. For example, in the case of a variable such as aggression, can the researcher assume that the aggression that is found in an American suburb would be the same as that found in a European suburb (Kerlinger, 1986).

Addressing the issue of sampling representativeness, Shapiro (2002), argued that generalizability depends less on indicators of surface realism such as random sampling than it does on an understanding of social meanings and of the causal relationships between and among variables. Mook (1983) was also getting at the same idea when he proposed that the generalizability of research findings to other persons, settings, times and messages rests on a thorough understanding of the social phenomenon under study. Thus, “People in the same social category act similarly because they tend to give the same social meaning to things and respond with similar social behaviors. The active ingredient is not the category, but the antecedent social meanings/social behaviors and the social and psychological factors” (Shapiro, 2002, p. 494). Thus, several authors (Basil, 1996; Berkowitz & Donnerstein, 1982; Courtright. 1996; Mook, 1983) pointed out that other kinds of sampling, including purposive samples, are legitimate ways to effectively explore theoretical relationships and that boundary searches may be better at ensuring generalizaibility than random sampling (Shapiro, 2002).

In extending this concept of generalizability to theory building, Shapiro (2002) argued that surface representativeness is not always a good barometer of contribution to theory as “a nearly infinite number of surface similarities in person, setting, time, and message might influence the outcome of a study. Varying these endlessly is an endless process" (p. 497). To build theory that contributes to generalizability, Mook (1983) proposed " thinking through, case by case, (a) what conclusions we want to draw and (b) whether the specifics of our sample or setting will prevent us from drawing it" (p. 386).

Similar to experiments, qualitative studies typically use nonrandom sampling. Thus, they cannot lay claim to surface representativeness, and the results of qualitative studies are not generalizable in the traditional sense. However, qualitative research (e.g. ethnographic studies) can potentially shed light on the social meanings people attach to events, situations or messages and thus fulfill the "alternative" criteria of generalizability (see Shapiro, 2002).

If a study's generalizability is related to its ability to illuminate social meanings and contribute to theory development, then the findings of this study are generalizable to the extent that they offer a first glimpse into the social meanings Indian vegetable farmers attach to eggplant and eggplant cultivation. More specifically, the findings indicate that eggplants and eggplant farming have predominantly economic meanings for the Indian farmers – they are a source of livelihood for the farmer and his family. Nonetheless, I emphasize the words "first glimpse" as none of their responses were grounded in actual personal experiences with *Bt* eggplant. With "real" experience, the meaning or meanings they attach to the crop and its cultivation could change. Which brings us to the concept of ecological representativeness – if the meanings Indian farmers attach to *Bt* eggplant and its cultivation change after they have had experience[17] with the crop, then this study may be said to have little ecological representativeness. But this is a question that will remain unanswered until the commercialization of *Bt* eggplant and the implementation of a follow-up study.

Do the specifics of the sample and setting prevent the generalization of the conclusions in this study to other people, settings, and times (see Mook, 1983)? In accordance with Shapiro's (2002) arguments, the fact that my study was based on a nonrandom sample should not detract from its potential contribution to theory building.

Nonetheless, insights gained from this study may not be generalizable to subsistence farmers in India. Vegetable farmers primarily grow crops (e.g. eggplants) for sale to the market and are thus categorically different from subsistence farmers who grow crops almost exclusively for their own consumption[18]. While vegetable farmers almost always have access to irrigation facilities and are thus better off economically, subsistence farmers do not. Eggplant farmers belong to the former category and are thus mainly interested in obtaining a profit from the sale of their crops in the market. Moreover, as pointed out earlier, farmers' responses in the pre-trial stage could differ from their responses in the post-trial stage.

The psychometric, cultural and moral models have each made an important contribution to our understanding of risk perception. While these theories have often been pitted against one another, the plausibility

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[17] The importance of experience is partly supported by the data – seven of the 90 farmers (non-focus group) in Maharashtra and nine of the 30 farmers in Tamil Nadu emphasized the need for some personal experience with *Bt* eggplant before they could form any judgment of the technology.

[18] Personal interview with Dr. K.S. Nair, March, 8, 2004.

of one theory does not necessarily negate the plausibility of other, competing theories (see Xie, Wang, & Xu, 2003). Indeed, Rayner and Cantor (1983) highlighted the need to develop a broad interdisciplinary perspective that incorporates moral, legal, cultural, economic, and other factors.

Nonetheless, due to financial, time and human resource constraints, this study focused on the moral model. More specifically, it set out to assess if Sjoberg's moral model explains end-user risk perceptions of agricultural biotechnology in a developing country. Using Sjoberg's narrow operationalizations of morality, the answer to the question would appear to be "no." Thus, those who wish to understand risk perception of agricultural biotechnology in the developing world should exercise caution when using his concept of morality as a theoretical "prism."

The finding that the moral model does not explain Indian eggplant farmers' risk perceptions also raises the question of how "universal" the model really is. Despite its preliminary nature, this study suggests that the moral model may not be universally applicable. To more specifically address the second research question (i.e. "Do the other risk perception models developed in the western world apply to developing countries such as India?"), my study indicates that theoretical perspectives developed in Western, industrialized nations may not account for the very different socio-cultural and economic realities in the developing world. Indeed, people (researchers included) frequently "underestimate how and by how much others see the world differently than we do" (Fischhoff, 1996, p. 844). For example, Raymond, Mittelstaedt and Hopkins (2003) found that blue-collar workers in Korea ranked belongingness as their most important need, even though self-actualization ranks highest in Maslow's Hierarchy of Needs. Given the vast difference in the socioeconomic contexts of developed and developing countries[19], economic benefits could have a potentially crucial influence on the way new technologies are perceived and accepted. Nonetheless, this does not mean that a model or theory (e.g. the moral model) that is not "universal" is not useful. It merely means that any model or theory – whether psychometric, cultural, moral or otherwise – may need to be modified to better explain phenomena in different socioeconomic settings.

Nonetheless, this study suggests that any model or theory that purports to have explanatory and predictive power for end users in developing countries may need to include economic benefits as a key variable. While further validation is absolutely needed, this study may have contributed to theory by identifying a "new" and potentially important variable that is not part of the psychometric, cultural or moral models of risk perception. Building a theory of risk perception that is salient to developing countries is a research priority, as a theoretically driven understanding of risk perception is critical to the development of effective risk communication strategies and programs by international agencies (see Gurabardhi, Gutteling, & Kuttschreuter, 2004).

Limitations

The conduct of this study was beset with a number of challenges in the field, including the potentially biasing effects of having a seed

[19] 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).

company representative follow the principal investigator and interviewer on all the farmer visits. While the involvement of the company representative was critical to the success of the fieldwork (mainly because he was familiar with the local geographical terrain in the way that neither the principal investigator nor the translator was), his mere presence might have acted to bias the farmers' responses in favor of *Bt* eggplant as they were aware that he was representing the company that was planning to introduce the transgenic crop. This was exacerbated by the fact that, in a number of cases, the representative and interviewed farmer were on familiar terms. The same argument could be made for the farmers' listing of seed company representatives as one of the three most important sources of information on agricultural innovations. The farmers' likely desire to "look good" in the eyes of the company representative constitutes a type of reactivity that has been extensively studied by researchers (see Trochim, 2002).

Another challenge encountered during fieldwork was the short summary translations provided by the field translators. Even though all the translators had the requisite background for the job, and the principal investigator repeatedly reminded them to "tell things as they are," the translators' summaries of the farmer's responses were invariably shorter than the farmers' own words. When quizzed on why that was the case, the translators offered one of two explanations:

1. The farmers "went off tangent" while giving their responses. In other words, there was no need to translate the "tangential" content, as it was not pertinent to the question.

2. The farmer's "responses" consisted mostly of "question asking." In other words, they were mostly asking the translators questions to find out more about *Bt* eggplant so they could form better judgments.

In hindsight, three plausible explanations could be offered for the translators' short summary translations:

1. The translators provided short summary translations to "cover up" for their English-language deficiencies. This is a distinct possibility as English is not their first language.
2. The local Indian languages (i.e. Marathi and Tamil) are relatively more "verbose" than English. Hence, the English translations would invariably appear shorter than the original Indian sentences.
3. The translators were not sufficiently "conscientious" in their work. In other words, they were "not sufficiently motivated" to provide more detailed translations of the farmers' responses as doing so involved more application on their part.

No matter what the real reason or reasons were, it is clear that a degree of mental editing was going on during the translation process. This editing might have filtered out important nuances that could have further illuminated how the farmers perceived the risks and benefits of *Bt* eggplant.

This study was also constrained by the unavailability of *Bt* eggplant at the time of the fieldwork. The farmers' total lack of experience with the crop very probably contributed to their short responses. Nonetheless, it should be pointed out that even farmers in developed countries such as the

United States generally also give extremely short answers – sometimes even one-liners – to questions posed by researchers.[20]

This study was also limited only to farmers. Despite their importance, farmers are just one of two major end-user groups – Indian consumers are the other. Indeed, India consumers will ultimately decide if there will be a market for *Bt* eggplant. If the majority of Indian consumers accept *Bt* eggplant, then the findings in this study seem to indicate that *Bt* eggplant would be widely adopted by farmers and grown for the market. Unfortunately, studies on consumers' acceptance of transgenic food in the developing world have been sorely lacking and thus represent a promising area for future research.

Last, it should be noted that the theoretical plan for this study – to test Sjoberg's moral model – was developed only after the principal investigator reached the field site. The original research objective had been to test a mental models approach to risk communication in the case of *Bt* eggplant; however, this proved to be unfeasible in view of the farmers' virtual lack of knowledge on the topic and was ultimately aborted.

Suggestions for Further Research

Trials of *Bt* eggplant in Indian farmers' fields are anticipated to begin in 2005 or 2006. This development would present researchers with an opportunity to test and validate hypotheses suggested by this study's preliminary findings:

[20] Conversation with Dr. Cliff Scherer, Department of Communication, Cornell University, June 2004.

H1: Economic benefits are negatively correlated with risk perception of agricultural biotechnology by end users in a developing country.

H2: Safety concerns are positively correlated with risk perception of agricultural biotechnology by end users in a developing country.

H3: Accountability of key social actors (e.g. seed companies, regulators) is negatively correlated with risk perception of agricultural biotechnology by end users in a developing country.

The validation of these hypotheses does not invalidate the psychometric, cultural, or moral models. Indeed, the plausibility of one theory or model does not necessarily exclude the plausibility of other theories or models (see Xie, Wang, & Xu, 2003). Instead, the validated hypotheses could help elaborate some of these existing models by adding new dimensions that would enhance our understanding of risk perception in the developing world. Thus, perceived economic benefits and safety concerns might both be incorporated into the social amplification and attenuation of risk framework. For example, the absence of compelling economic benefits might facilitate the amplification of risks by social amplification stations such as the media, while the presence of economic benefits might facilitate attenuation. Conversely, the absence of safety concerns might facilitate the attenuation of risks, while the presence of safety concerns would achieve the opposite effect. Accountability might also be incorporated into emerging theories of trust (see Poortinga & Pidgeon, 2003).

Nonetheless, the concept of accountability has not been fully explored in the risk perception literature. More specifically, it has not been carefully explicated and operationalized in risk perception research. “Accountability” perhaps comes closest to the concept of “commitment” that Kasperson, Golding and Tuler (1992) listed as one of the four dimensions of social trust – both terms refer to the responsibility to fulfill certain expectations. If “commitment” and “accountability” are indeed similar (if not equivalent), then Kasperson et al. perhaps came closest to explicating accountability when they defined “commitment” as the “fulfillment of fiduciary obligations or other social norms” (p. 170). Thus, future research first needs to explicitly operationalize and explicate “accountability” before it can be incorporated into existing models of risk perception.

Future research on risk perception of agricultural biotechnology in developing countries should not stop at farmers but instead include other groups that have a stake in the commercialization, cultivation, and use of *Bt* eggplant. For example, the responses of consumers, policymakers, nongovernmental organizations, and religious groups should be studied (see Chong & Scheufele, 2002, for an example). A more comprehensive study that includes a broader range of stakeholders can present decision-makers with a more complex picture of risk perceptions (and their influences) across Indian society and thus help in the development of appropriate policies and communication (see Aerni, 2002a). Future research can also overcome some of the limitations of the current study by limiting the physical presence of intermediaries (e.g. seed company representatives) at the interviews and employing two translators (one of whom could act as a devil's advocate).

APPENDIX 1: THE *Bt* EGGPLANT SCENARIO

"As you know, eggplant 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 eggplant 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 eggplant you are growing now. *But unlike ordinary eggplant, the new variety is 'injected' with a microbe from the soil that gives the plant its protective qualities*. The name of this new variety is *Bt* eggplant, 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* eggplant seed will cost a few times more than ordinary eggplant seed. Moreover, nobody can predict at this point whether consumers will accept the new type of eggplant. Climactic conditions can also influence the level of yield farmers get from using *Bt* eggplant.

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 eggplant. If not, *Bt* eggplant 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* eggplant may also lead to the growth of "superweeds" and other unforeseen environmental problems. So, while there are benefits in using *Bt* eggplant, there are also some risks. "

1. Please share with me any thoughts and feelings you have about this new eggplant 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 II: TRANSCRIPTS OF MAHARASHTRA INTERVIEWS

Aurangabad

Farmer 1

I don't have a clear-cut picture of *Bt* brinjal because the research has not been published by the government and the media has not communicated anything on this technology. But once government scientists prove that the *Bt* gene cannot harm human, animal and environmental health, I am ready to take it.

Farmer 2

Incapable of giving any intelligent response

Farmer 3

If *Bt* brinjal: does not affect human or animal health, I will definitely adopt it.

Farmer 4

I will adopt *Bt* brinjal – I will follow all the guidelines suggested for the cultivation of *Bt* brinjal. The only risk factor is the cost of the seed. I have seen the results of *Bt* cotton and the boll retention and reduced pesticide application in a neighboring farm. If the same technology is transferred from *Bt* cotton to *Bt* brinjal, if the damage inflicted by the fruit and shoot borer can be reduced by at least 50% without the use of pesticides (which is very costly), I will save money on the use of pesticides and profit from the use of *Bt* brinjal. I will adopt *Bt* brinjal if it increases my profits. Also, I am ready to follow all the guidelines recommended by scientists with regard to the refuge area.

Farmer 5

If *Bt* brinjal increases yield and reduces the number of pesticide sprays, I will accept *Bt* brinjal. Applying pesticide is tedious and time-consuming work: if Bt brinjal reduces pesticide application, it will give me greater peace of mind. With conventional brinjal varieties, there is a problem with pesticide residues. But with *Bt* brinjal, there is no residue problem, so it is actually beneficial to human health.

Farmer 6
My main considerations are yield and cost savings. Therefore, I am ready to adopt *Bt* brinjal.

Farmer 7
I've had the chance to observe the results of *Bt* cotton in a neighboring plot, and I've seen that it gives good results and requires less pesticide. I am ready to accept *Bt* brinjal because it will have the same effects as *Bt* cotton.

Farmer 8
I will adopt *Bt* brinjal. 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* brinjal.

Farmer 9
I have no concerns about risks. If a company introduces *Bt* brinjal in the market, I am sure it will already have carried out the necessary tests to ensure that safety is not compromised, or the company will not do it.

Farmer 10
I don't care whether it is a *Bt* or non-*Bt* variety. If I get better yield from a particular variety, I will adopt it.

Farmer 11
I am concerned that if we transfer *Bt* from cotton to a food crop such as brinjal, there might be negative effects on human health.

Farmer 12
Currently, we are spraying powerful pesticides on brinjals, pick them within 12 hours of spraying and transport them to the city markets for sale. Yet, there are no adverse effects on consumers' health. So how can *Bt* brinjal be more risky than current varieties and practices?

Farmer 13
I am ready to take any risk in order to enjoy higher yield. *Bt* cotton is eaten by animals and there haven't been any side effects on them.

Farmer 14

My neighbor is a cotton grower. As far as I can see, *Bt* cotton does not have any bad effects on animal or consumer health. So *Bt* brinjal should similarly not have any ill effects on human beings or animals.

Farmer 15

I have concerns about the health effects of the *Bt* gene on human health since *Bt* brinjal is a food crop.

Farmer 16

There is no problem if it uses the same technology as *Bt* cotton.

Jalna

Farmer 17

The fruit and shoot borer is the main problem. If the problem is solved by the *Bt* in brinjal, then I am ready to accept *Bt* brinjal. Nowadays, there is too much pesticide residue in food and beverages – more than the recommended proportions. Just look at Coca-Cola! We get oil from *Bt* cottonseed and that oil is not harmful to people. So how can *Bt* brinjal be harmful to people and animals?

Farmer 18

If *Bt* brinjal is recommended by the government, if it is proven to be safe for human and animal health, I will adopt it.

Farmer 19

I’m ready to accept it. Look, I’m spraying pestictides at a 3-day interval and I still sustain losses to my crops because of the fruit and shoot borer. *Bt* brinjal will give me both greater yield and cost savings. If *Bt* cotton oil is edible, then *Bt* brinjal should also be edible

Farmer 20

I will adopt it if there are no risks. Specifically, I want to know that *Bt* brinjal can sell in the market – because it is an edible crop.

Farmer 21
Since *Bt* brinjal is recommended for use in daily eating, and it's not harmful to health, I have no problem in adopting it. Even if the seed is more costly, I'm willing to grow it because I can save on pesticides.

Farmer 22
It is the company's duty to test whether it is safe for consumption. I want to get the assurance from company representatives and experienced farmers that it's safe before I will adopt it.

Farmer 23
I can't tell whether it's edible or not. If the company can show me evidence that it is safe for human consumption, I will adopt it. It is the company's responsibility to do so.

Farmer 24
If I can get good yield and a good price on the market, I am not concerned about any environmental effects. Oil extracted from *Bt* cotton is consumed by human beings and yet does not have ill effects. If the same gene is introduced into *Bt* brinjal, then what is the problem?

Farmer 25
Poor understanding of scenario. Could not give any cogent answer.

Farmer 26
The necessary tests should be conducted before it is released to the market. But *Bt* cotton has not had any negative effects on the environment in the last two years, so how can *Bt* brinjal have a negative impact?

Farmer 27
I will adopt it only if it sells in the market. But it should be tested and its effects evaluated before it is commercialized.

Farmer 28
The introduction of the *Bt* gene in brinjal is a good thing because I will get 100% yield and the same taste as the local variety!

<u>Farmer 29</u>
No ill effects have been found in *Bt* cotton. Similarly, *Bt* brinjal shouldn't have any negative impacts on human, animal or environmental health. If pesticides cannot kill a man, how can *Bt* be detrimental to human life?

<u>Farmer 30</u>
I will adopt *Bt* brinjal as it will enable me to grow brinjal during the Kharif season. Currently, I only grow brinjal in the summer when it is pest-free.

Jalgaon

<u>Farmer 31</u>
I will adopt it if it increases yield, but not if it causes harm to humans or animals.

<u>Farmer 32</u>
I will adopt it if it is not harmful to human or animal health.

<u>Farmer 33</u>
I am confident *Bt* brinjal will increase yield because *Bt* cotton increases yield.

<u>Farmer 34</u>
I'm confident it will increase yield. And everything is digestible. People's digestion capacity has increased. In my village, one farmer has drunk insecticide and he is still alive – he has developed resistance to chemicals!

<u>Farmer 35</u>
I know about *Bt* technology from my brother, who is a *Bt* cotton farmer. And I don't see any disadvantages in the technology. The microbe is beneficial as it protects the cotton plant against bollworms.

<u>Farmer 36</u>
If it increases yield, it is a good thing. Moreover, there is a problem of insecticide residues on vegetables. We have been spraying more and more insectide to control the fruit and shoot borer problem. And the residues remain on the vegetable – that's harmful to people. The *Bt* gene does

away with the need for sprays and there will be no residues on vegetables, so *Bt* brinjal is “pure.”

Farmer 37
I will adopt it as both *Bt* cotton and *Bt* brinjal increase farmer’s yields. And I will follow all the necessary guidelines.

Farmer 38
I will adopt it. And I am not worried about health effects, as it is the responsibility of the company to test it fully and ensure that it is safe for consumption.

Farmer 39
If the *Bt* seed increases yield, then I don’t mind that the seed is a few times more expensive than non-*Bt* seed. I will also follow all the rules and regulations.

Farmer 40
If it sells in the market, then I will adopt it – but I have no advance idea how the market will respond to it.

Farmer 41
If the experience with *Bt* cotton is anything to go by, *Bt* is important for increasing farmers’ yield. I will adopt *Bt* brinjal even if the seed is more expensive than normal seed. I have been spraying 2 types of insecticide on brinjal and it hasn’t been harmful to my health. So, how can *Bt* brinjal be more harmful than that?

Farmer 42
Even if climactic conditions are not favorable for *Bt* cotton, I will still adopt it because normal cotton and brinjal varieties require so many sprays and hard work.

Farmer 43
I will adopt *Bt* brinjal if it can sell in the market. Farmers are spraying so much insecticide on vegetables and there hasn’t been any harm to humans. So, how can *Bt* brinjal be harmful?

Farmer 44
I will adopt it if it can sell in the market and if it can maintain the quality, shape, taste and appearance of ordinary brinjal. But it is the company's responsibility to show trial plot and test results on the safety of *Bt* brinjal.

Farmer 45
If it can indeed be proven safe for consumption and if I get more yield, then 100% I will adopt it.

Dhule

Farmer 46
I compare *Bt* cotton to *Bt* brinjal. If *Bt* cotton oil and Bt cotton cake does not harm animals, the same should be true for *Bt* brinjal.

Farmer 47
I want to increase yield of brinjal, so I will adopt *Bt* brinjal. If *Bt* brinjal does not perform well in face of bad climactic conditions, I will not blame *Bt* brinjal as bad climactic conditions will also adversely affect ordinary brinjal.

Farmer 48
I will adopt it in order to enjoy high yield. *Bt* brinjal will also bring me higher income than *Bt* cotton on a per acre basis.

Farmer 49
I have seen the good performance of *Bt* cotton this year. So similarly, I believe that *Bt* brinjal will give my crop better protection against the fruit and shoot borer and give better yield.

Farmer 50
I will wait for other farmers to experiment it and see the results before adopting it myself.

Farmer 51
I will adopt it as it gives higher yield.

Farmer 52
Every farmer should adopt it because it increases yield!

Farmer 53
I think customers will accept *Bt* brinjal because it will have the same shape, color and taste as ordinary brinjal.

Farmer 54
I will adopt it as it gives high yield. I do not have any health risk concerns, as I trust that the company will perform the necessary tests. I am willing to follow all the guidelines in order to enjoy the benefits offered by *B*t brinjal.

Farmer 55
I will wait for other farmers to experiment it and see the results before adopting it myself.

Farmer 56
I've heard that *Bt* cotton has given good yield this year, so I would be interested in adopting *Bt* brinjal.

Farmer 57
I will wait for other farmers to experiment it and see the results before adopting it myself.

Farmer 58
I will adopt it if it increases yield.

Farmer 59
I am ready to adopt because my experience with *Bt* cotton shows that it is not in any way harmful to health.

Farmer 60
I will adopt it even if the seed costs more because I want higher yield. But it should only be released in the market after the necessary tests have been performed.

Ahmednagar

Farmer 61

I am currently spraying pesticides on brinjal three times per week. With *Bt* brinjal, I can cut down on the number of sprays, save money and thus increase my yield. While the seed may be a few times more expensive than normal seed, I can spray less and thus save more money and manpower in the process...I can enjoy 50-70% savings in my cost of production!...Farmers here are highly dependent on revenues from vegetables because earnings from sugar cane (traditionally the key crop of W. Maharashtra farmers) have been falling…India's high population also makes it necessary for us to increase our agricultural yield.

Farmer 62

We have to spray pesticides on brinjals every two to three days. Because of this, we (the farmers) do not eat the brinjals we grow. We know that we are spraying every two to three days and there is a lot of pesticide residue on the brinjal. So we are not eating that. And the brinjal is totally made of those chemicals. We directly put them in the market and sell them. If this *Bt* brinjal is invented, then we can eat the brinjal because there will be less chemicals on the brinjal. I think *Bt* brinjal is necessary because when we are spraying 2-3 days, what happens is that new diseases are occurring in the human body. People are buying vegetables from the market and eating them. They do not know what the farmer is spraying on his farm…That's why heart attacks and all these new diseases are occurring….If it is necessary to set aside 20% of the plot as refuge, I will follow the guidelines. Even if the farmer has just one acre of land, it will not be a problem to set aside 15-20% of his land.

Farmer 63

Seed cost is not a barrier for me. I am ready to adopt *Bt* brinjal because it reduces the number of sprays and I will get more yield. I'm ready to follow all the guidelines given by the government.

It is not good to interfere with natural processes, but if it is useful to human beings, interference is ultimately good and justified. But if anyone is misusing the technology (e.g. changing the natural life cycle of plants), that is not good.

<u>Farmer 64</u>
Presently, I am cultivating 5 acres of brinjal and I'm spending 50,000 to 60,000 rupees for 5 acres on pesticides and getting 3 to 4 lakhs income from this acreage. If I can get *Bt* brinjal and get 2 to 3 lakhs income from just 2 to 3 acres, I will enjoy greater benefits. It will also reduce pesticide cost from 50,000 rupees to 10,000 to 12,000…With *Bt* brinjal, I can reduce my brinjal acreage from 5 to 1.5 acres and devote the remaining land to planting other crops.

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. Anyway, the use of pesticides is not good for health.

<u>Farmer 65</u>
I will adopt *Bt* brinjal and increase my acreage under brinjal!

Genetic engineering is not so bad because it's going on everywhere and science is ultimately for the benefit of mankind.

<u>Farmer 66</u>
It reduces insecticide sprays and increases yield. In any brinjal field, the parameters do not give any yield anyway, so devoting 15-20% of the parameter to a refuge area is not a big deal…Although the seed cost is higher, I can save money on pesticides and save labor (i.e. spraying) time. It is better to purchase *Bt* seed than spend money on pesticides.

<u>Farmer 67</u>
I will adopt *Bt* brinjal as it reduces spraying and increases yield. Besides, India has too many people – we have no alternative but to adopt this technology to increase yield in order to feed the population as agricultural production is not keeping pace.

<u>Farmer 68</u>
I don't have a problem with the more costly *Bt* brinjal seed, as it will give me higher yield.

<u>Farmer 69</u>
Although *Bt* brinjal seed is more costly than ordinary seed, I am ready to purchase it as pesticide costs are much higher than seed cost and it will

also reduce my physical exertion…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's more important.

Farmer 70
I will adopt it because it increases yield and disease resistance.

Farmer 71
If it allows me to cut costs on pesticide, I will adopt it.

Farmer 72
I will adopt it as it cuts down on the losses (up to 90%) incurred by fruit and shoot borer infestation…Sometimes, I do not spray on my crop (to save costs) when the market demand is very low. But if the market demand picks up suddenly, I may not be able to sell anything as up to 90% of my crop might be damaged by the fruit and shoot borer. So, *Bt* brinjal gives me some form of insurance.

Farmer 73
The fruit and shoot borer takes away 50,000 to 60,000 rupees per acre from the value of my brinjal crop. Any variety that confers resistance against the fruit and shoot borer would be most welcome by me – even if the seed cost were higher. I want to grow it this year!

Farmer 74
No cogent response.

Farmer 75
I am ready to accept it because of the benefits. I am not worried about the cost of the seed as the spraying costs are even higher. As for the environment, it's not in our hands but in the hands of god.

Farmer 76
Seed costs are much less than the cost of pesticide. If I can prevent up to 30% of the damage inflicted by the fruit and shoot borer, it will be better to use *Bt* seed. And it is not bad to use bacterium as it is not visible to us and it is not harmful to our health…We consume curd – it is prepared using microorganisms and it's not harmful to human beings!

Farmer 77
I'm ready to adopt because it will give me greater yield and reduce the number of sprays.

Farmer 78
I want to see the results of a trial plot first.

Farmer 79
I'm interested because I will get higher yield and be able to reduce the number and cost of sprays. I am currently spraying three sprays per week, yet my crop still sustains 20% damage from the fruit and shoot borer.

Farmer 80
I spend 50,000 rupees to spray my 5-acre brinjal plot. This amount will be saved if I use *Bt* brinjal.

Farmer 81
Economics is the only consideration. There is no alternative to interfering with nature's cycle.

Farmer 82
I will adopt it as it increases yield.

Farmer 83
I will adopt it as it increases yield and India's population growth necessitates an increase in food production.

Farmer 84
I will adopt it as it increases yield.

Farmer 85
I will adopt it as it increases yield.

Farmer 86
I will adopt it as it increases yield.

Farmer 87
If we launch *Bt* brinjal, yield will automatically increase and supply and market prices will decrease.

<u>Farmer 88</u>
I have seen the results of *Bt* cotton yield in a nearby farm and I am impressed. But *Bt* brinjal MUST cut down on pesticide application, and it must effectively kill the fruit and shoot borer...There's nothing unnatural about *Bt* brinjal technology if it brings me profit.

<u>Farmer 89</u>
I will adopt it because it will increase yield. 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 (versus chemicals).

<u>Farmer 90</u>
I spend 10,000 to 20,000 rupees on pesticide. *Bt* brinjal will allow me to save this expense.

APPENDIX III: TRANSCRIPTS OF TAMIL NADU INTERVIEWS

Thondamuttur

Farmer 91

Initially, I would not go for large-scale *Bt* brinjal cultivation. Instead, I will go for a pilot project with a small test plot. I want to see the results in a small area first. If the results are good, I will then go for a larger area.

Although hybrid varieties have higher yield, local varieties fetch a better market price because consumers prefer them. Hybrid varieties look good but it doesn't give any taste.

Farmer 92

I will accept *Bt* brinjal if my adoption criteria are met…I've stopped applying pesticides altogether as I've been disappointed with the results. It's a waste of my time and money. That is why I've completely converted to organic farming. For example, I now apply ash as a form of pest control.

Farmer 93

I don't know how *Bt* brinjal will perform in the face of the climatic conditions here, so I will decide whether or not to adopt *Bt* brinjal only after seeing the performance of the crop. One of my friends is growing hybrid brinjal. He is enjoying full yield (i.e. no crop losses). But the market price for it is very low because consumers prefer the local varieties.

Farmer 94

I have no prior experience with *Bt* brinjal. So, I am only able to tell you my concerns after I have had the chance to grow it.

Farmer 95

I don't use chemical pest control because insects quickly develop resistance to the pesticide. Instead, I use biological control in the form of pheromone traps. I don't have any confidence in chemical-based pest control. Hence, I would be willing to try *Bt* brinjal.

Consumers like my pesticide-free brinjals because they have better appearance and taste. They also fetch a higher market price than brinjals grown with pesticides. I recently gave up on the use of chemicals (after 30 years of using them) as they are not working. I am ready to adopt any chemical-free technology.

Farmer 96
I have only been cultivating brinjal for 2 days and hence don’t have enough experience with the crop to comment on *Bt* brinjal.

Farmer 97
At the beginning, I will only try *Bt* brinjal on a small scale. I want to get good results from the new seed before going further and expanding the area under cultivation.

Ottonchantram

Farmer 98
I’m ready to follow all the guidelines in order enjoy higher yield because I don’t want to spend my money on pesticides. I would be willing to take some risk in order to enjoy higher yield and cost savings. When is the new seed going to be available?

Farmer 99
I am eagerly waiting for the seed! And I would be willing to follow any guidelines in order to enjoy the benefits of higher yield. If it is recommended by the university, I will accept it.

Farmer 100
I will adopt it as it will give me higher yield.

Farmer 101
If it can save me a lot of money on pesticide application, I can easily go for *Bt* brinjal. The risks are not at all a problem for me. And the refugia is just a procedure I have to follow.

Farmer 102
If I can get better yield from *Bt* brinjal, why should I be worried about other things? I just want good yield.

Farmer 103
Right now, I don't know what the environmental impact of *Bt* brinjal would be – I can only comment after I have had the chance to try *Bt* brinjal and evaluate it. I want to try *Bt* eggplant out to evaluate the results and performance.

Farmer 104
I can only make comments after trying out *Bt* eggplant on a trial plot.

Farmer 105
No coherent comment.

Farmer 106
The environment is already polluted by the prevalent use of farm chemicals. If *Bt* brinjal cuts down on the use of chemicals, it would actually be better for the environment.

Farmer 107
I have been using Dow Agro's Tracer (an insect growth inhibitor) in the past two months to control fruit and shoot borer infestation. It has been very effective, cutting down the infestation by as much as 85-90%. I will adopt *Bt* brinjal if it is more effective than Tracer and if it does away with the need for chemical application.

Farmer 108
I don't care about the environment. Money is the main problem for me.

Farmer 109
I am most concerned about making enough money. If *Bt* brinjal increases yield, I will adopt it.

Farmer 110
Making enough money is the most important thing. If *Bt* brinjal increases yield, I will adopt it.

Farmer 111
Making enough money is the most important thing. If *Bt* brinjal increases yield, I will adopt it.

Farmer 112
I will adopt *Bt* brinjal if it does not affect the flowering of the crop and if it increases yield.

Farmer 113
I will adopt *Bt* brinjal if it increases yield.

Farmer 114
When I grew hybrid brinjal in the past, I experienced problems with wilt infestation. Local varieties, on the other hand, do not give me any wilt problems. So, I am concerned that when the local brinjal variety is crossed with *Bt*, I may experience the onset of new pests.

Farmer 115
I am interested in growing *Bt* brinjal as I don't want to spray any pesticide on my crop. We are spraying pesticides on brinjal only because we want to get better price for our produce.

KARADIMADAI

Farmer 116
I welcome the introduction of *Bt* brinjal, especially if it is profitable. I am willing to follow the strict guidelines to reduce the risks. I will grow it on a small plot, and if I am convinced (about its performance), I will grow it on a larger area in the next season. If Tamil Nadu Agricultural University gives me the assurance and technical advice, I will adopt it.

Farmer 117
I am interested in adopting it if it reduces plant protection costs and I am willing to follow any guidelines to mitigate the risks.

Farmer 118
I am willing to grow both *Bt* and non-*Bt* brinjal in order to compare the results. But if *Bt* brinjal negatively affects other crops on my farm, I would not be willing to cultivate it.

Farmer 119
I am willing to adopt it. Why should I be worried about unknown risks?

Farmer 120
I'm not willing to take the risk. I'll simply avoid the November-January season so that my crop will not be adversely affected by fruit and shoot borer infestation (which is highest during these months).

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