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Risk & risk perception

A literature review

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Foreword

Risk is an important concept in many policy fields. There is a large literature on risk covering a range of disciplines from mathematics to psychology. Each of these perspectives can contribute to a better understanding of how risk is constructed, perceived and managed by experts and the general public.

This report investigates the literature on risk and risk perception across a range of disciplines in order to:

- Provide a better understanding of the diverse theoretical approaches to risk and risk perception and the available work on farmers' perceptions of risk;
- Contribute to improved policy outcomes in areas involving risk management, such as drought and import risk analysis; and
- Support the improvement of the communication of policy decisions.

The understanding provided in this report of how stakeholders and the broader community perceive risk should assist policy makers in developing better policy and more effective means for communicating government policies and programs in areas involving risk management.

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This report, an addition to RIRDC's diverse range of over 1000 research publications, forms part of our Human Capital, Communications and Information Systems R&D program, which aims to enhance human capital and facilitate innovation in rural industries and communities.

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Executive Summary

Risk is a challenge for modern society

Risk and risk perception are important concepts for rural policy and research. In recent years discussion of risk has increasingly focused on possible bad outcomes moving away from a traditional sense of risk taking as a potentially positive activity. Understanding how stakeholders and the broader community perceive risk can assist policy makers in developing better policy and more effective means for communicating government policies and programs in areas involving risk management.

Numerous factors influence how risk is perceived

The frequent mismatches between perceived risk and measurable probabilities of risk suggest that the following factors are clearly important in clarifying how people understand and respond to risk:

- Characteristics of risk influence how it is perceived – different types of risk generate different reactions (e.g. voluntary activities are deemed less 'risky' than involuntary ones, new risks are viewed differently from familiar ones);
- Psychological aspects of decision-making (e.g. formed opinions are more difficult to change; activities with demonstrable benefits can facilitate greater receptivity to risk; an event is judged more probable if its occurrence, or something similar, can be readily recalled);
- All people use speculative frameworks to make sense of the world and selective judgement in their responses to risk. Improved risk communication depends on appreciating that these 'non rational' factors are not necessarily incorrect and recognising the significant differences between the way 'the public' and 'experts' perceive risks;
- The general public often focuses more on unknown effects of risky activities; significantly negative consequences, irrespective of the 'low probability'; what the 'experts' do NOT know and why they cannot agree.

Declining trust in public institutions requires greater investment in building capacity for innovative risk communication

Declining trust in institutions responsible for science and technology may be exacerbated by continued reliance on older models of risk communication. Innovative risk communication models focus on: 'risk' as socially constructed; valuing different forms of knowledge; and improving public participation in risk assessment and management. Most advocates of these models recognise the significant challenges in facilitating more and inclusive dialogues with the public and recommend a range of capacity building strategies targeting the public as well as policy and scientific communities.

Further research on Australian risk perceptions is needed to improve policy outcomes

While many commentators agree that farmers tend to be risk averse, it is less clear *how different* farmers' and rural communities' risk perceptions are from the rest of society, because of a dearth of Australian research on these groups and on the influence of other socio-demographic factors. This research shortage needs to be redressed given that the success of a range of agricultural, NRM and rural policies and programs depends on understanding how farmers' (and rural communities) perceive risk and how those perceptions vary among individuals, groups and communities.

Introduction

Risk is an important concept in many policy fields. Within the Agriculture, Fisheries and Forestry portfolio, risk is central to the policy response to drought and to decisions about quarantine restrictions on imports, to name just two. Terms like "risk management" and "acceptable levels of protection" assume a degree of understanding of the concept of risk, acceptance of how it is measured and some level of consensus on how it should be managed. These are bold assumptions. There is a large literature on risk covering a range of disciplines from mathematics to psychology. Each of these perspectives can contribute to a better understanding of how risk is constructed, perceived and managed by experts and the general public.

This report investigates the various literature on risk and risk perception across a range of disciplines in order to:

- Provide a better understanding of the diverse theoretical approaches to risk and risk perception and the available work on farmers' perceptions of risk;
- Contribute to improved policy outcomes in areas involving risk management, such as drought and import risk analysis; and
- Support the improvement of the communication of policy decisions.

The vastness of the subject of risk is not to be underestimated. Bernstein has argued, "…Risk touches on the most profound aspects of psychology, mathematics, statistics and history. The literature is monumental, and each day's headlines bring many new items of interest" (Bernstein 1996). While the following report does not claim to be exhaustive, it does identify some key issues, which may be of relevance to policy makers and stakeholders interested in questions of risk, risk analysis and risk management.

Risk and uncertainty

What is risk?

While risk is a term used daily, its more conventional, technical meaning is used to refer to:

> A combination of the probability, or frequency, of occurrence of a defined hazard and the magnitude of the consequences of the occurrence: how often is a particular potentially harmful event going to occur, [and] what are the consequences of this occurrence? (Harding 1998: 167)

One might presume that this definition is straightforward. However, the term risk is highly contested. The following explores some of the different emphases and nuances associated with 'risk'.

In recent years risk has come to prominence with a stronger "dread" element to the term than was previously the case. When Ulrich Beck (1992) coined the phrase, "risk society", he was identifying a form of disaster risk associated with industrialisation and extreme, although in probabilistic terms often highly unlikely, catastrophic events. This position has been described as a feeling that "…immediately we are in the midst of terribly low probabilities of awfully terrible events" (Douglas and Wildavsky 1982: 39). This shift is of particular interest as it may have implications for policy makers if the newer, more negative interpretations of the term become more widespread in the general community.

Graubard summarises this change as follows:

> It is perfectly obvious that the concept "risk" has taken on wholly new dimensions in recent decades and is today being reflected on in ways that would have been almost inconceivable even a few years ago. The older idea, that risk is essentially a wager, which individuals take in the hope of gaining something significant, substantial, has almost disappeared from common parlance. Risk today is conceived principally as danger…" (1990: v)

This revised use of the term is reflected in work which defines risk as "the possible loss of something of value" (Blomkvist 1987:89), which disregards the possibility that risky behaviour can have an upside, or the more extreme definition of risk as "catastrophe in its latent form" (Friedman 1987:67). In their work on managerial risk taking, MacCrimmon and Wehrung (1986) also focus on the negative aspects of risk (MacCrimmon and Wehrung 1986).

However, these newer definitions are not universally accepted. Douglas points out that:

> "'Risk' is the probability of an event combined with the magnitude of the losses and gains that it will entail. However, our political discourse debases the word. From a complex attempt to reduce uncertainty it has become a decorative flourish on the word 'danger'" (1992: 40).

The outcome of this use is that that the word risk "has been pre-empted to mean bad risks" (Douglas 1990:3). Merkhofer (1987:2) uses a definition of risk that allows for a number of possible outcomes, not all of which are bad. Adams (1995: 30) suggests that risk "is defined, by most of those who seek to measure it, as the product of the probability and utility of some *future* event". He argues, "the decisions that are made in the face of uncertainty involve weighing the potential rewards of an act against its potential adverse consequences" (Adams 1995: 3). This shift away from the technical probabilistic roots of the term to an interpretation of risk as "danger" (Douglas 1992: 44) has implications for policy makers using the language of risk in communicating policy decisions. Other writers have resigned themselves to the "new" use of the term but lament the passing of the older meaning (Wharton 1992: 5)

Ballard suggests that in industry, "Risk = Frequency x Consequences". This definition suggests an expectation of system failure and risk management is about ensuring that "events which happen often must have a low consequence, or events involving serious consequences must be rare" (Ballard 1992:100). This approach is consistent with the concept of a predetermined, acceptable level of risk, which is managed. By contrast to the Beck approach, Bernstein concludes that there has been a transformation of "the perception of risk from chance of loss into opportunity for gain, from FATE and ORIGINAL DESIGN to sophisticated, probability-based forecasts of the future, and from helplessness to choice" (1996:337). This may be the case for the complex financial risk management instruments described at the end of Bernstein's book as examples of how risk management has evolved, but the balance of the literature suggests this may be an exception.

The variety of these approaches to risk are further support for Slovic's claim that 'risk' is not something that lends itself readily to objective quantification or a single definition, but rather is socially constructed. That is, risk

> "… Does not exist 'out there,' independent of our minds and cultures, waiting to be measured. Instead, human beings have invented the concept *risk* to help them understand and cope with the dangers and uncertainties of life. Although these dangers are real, there is no such thing as 'real risk' or 'objective risk.' The nuclear engineer's probabilistic risk estimate for a nuclear accident or the toxicologist's quantitative estimate of a chemical's carcinogenic risk are both based on theoretical models, whose structure is subjective and assumption-laden, and whose inputs are dependent on judgement." (Slovic 1999: 690).

Measuring risk: probabilities and quantification

Given the link between risk and uncertainty, it is not surprising that there are processes that attempt to reduce risks by increasing certainty in decision making. One of the most common techniques for doing so is by allocating probabilities to both desirable and undesirable outcomes. As Smithson notes, "If there is any approach to ignorance that bears a creditable claim to generalizability and rationality simultaneously, it is probability. Virtually all modern accounts of uncertainty refer to the concept and theory of probability as a benchmark" (Smithson 1989: 41).

Unlike mathematical functions such as addition or subtraction, however, probability theories remain in Smithson's words "mental and social creations, despite even the most ardent realist's exhortations on behalf of objectivity and rationality" (Smithson 1989: 41). Different schools of thought debate whether it is in fact possible to calculate the probability of a single event and the role for subjectivity in that calculation. The "relative frequentists" understand probability in terms of the odds of a particular event over the long run. The implications of this approach are that the probability of a single event cannot be calculated (Smithson 1989:55; Morgan and Henrion 1990) as "the probability is actually a property of a theoretically infinite sequence of trials rather than a single event" (Morgan and Henrion 1990: 48). It is a misunderstanding of this conception of probability that can lead to errors such as extrapolating probabilities from very small samples. The alternative view of probability is the subjectivist or personal view, which "defines probability in terms of degrees of belief" (Smithson 1989:59). Probabilities are based on either personal belief or "incomplete prior evidence with some subjective judgments" (Smithson 1989:). This approach allows more easily for the calculation of the probability of a single event. By its nature, however, the subjectivist approach to probability calculation highlights how values are part of the equation.

Probability has limitations as a predictive risk management tool, because it is based on past events. According to Bernstein (1996: 35) data based in the past constitute a sequence of events rather than a set of independent observations that are required in the laws of probability. He points out that the challenges for probability are the contrasting tasks of having to look into the future while interpreting the past and balance opinions with what is 'known'.

Risk perception

What counts?

There has been a considerable amount of empirical research undertaken on the way people perceive risk, how they manage it and how they live with it. An important starting point is that, in some important instances, perceptions of risk do not appear to correlate with measurable probabilities of risk and therefore other factors are clearly important in understanding how people understand risk. This can have an important impact on the ability of policy makers to communicate risk analysis decisions in cases where such mismatches occur. It has been suggested that societies select particular risks for attention and that risks are therefore "exaggerated or minimized according to the social, cultural, and moral acceptability of the underlying activities" (Covello and Johnson 1987: viii). Personal experience, memory and other factors influence the way people perceive risks and these may ignore the probability of the event's occurrence – thus risk perception is socially constructed (Spangler 1984:7; Garvin 2001:450). In addition, it appears that people have a level of risk with which they feel comfortable and will adjust the riskiness of their behaviour in the presence of safety measures. Adams calls this tendency the individual's "risk thermostat" and uses it to explain why people tend to drive *faster* when they have airbags and child restraints fitted in their cars (Adams 1995).

Different types of risk generate different reactions. For example, voluntary activities are not seen as risky as involuntary activities and new risks are regarded differently from familiar hazards (Finucane 2000: 31). Natural disasters do not generate the same level of moral indignation as the type of man made hazards described by Beck and his followers. As Blomkvist argues, "Moral indignation puts damage in another light, and the costs are probably perceived as much higher when they are man-made disasters, or even caused by a group of people whose willingness to avoid damages to other people has been doubted." (1987: 107) These so-called "modern risks" seem to be of special concern to the public due to their potential for catastrophe, inequities between the generators of the risk and those bearing its consequences and the possible irreversible nature of the consequences (Merkhofer 1987: 5). Examples include the accidents at Chernobyl and Bhopal where all these factors were present.

Once people have determined an assessment of a particular risk, their opinions can be difficult to change (Covello et al. 1984:226; MacCrimmon and Wehrung 1986: 41). This seems to be particularly the case if they feel they know something about the subject – research has found that people are more likely to be swayed by expert opinion in areas about which they know nothing than on topics they believe they understand (Siegrist and Cvetovich 2000). People are also selective in the evidence they will accept and more likely to see less risk in cases where they see benefits from the activity (Ross and Anderson 1982:149; Siegrist and Cvetovich 2000: 714). Supporters of the import of a new product are therefore more likely to accept the associated risk than its opponents who will regard it as riskier.

Values and "non-rational" factors in risk perception

The use of probabilities, decision trees and other allegedly 'objective' processes for assessing risk suggests that risk can be measured impartially. It has been pointed out that "…some claim that scientists are immune from ideological bias and that risk assessments merely reflect a dispassionate distillation of current scientific knowledge" (Finucane 2000:19). However, as suggested above, the calculation of probability is not a value-free activity. This is particularly true in cases of events which have never occurred or which occur rarely: judgment is inevitably required to select relevant factors required to calculate the risk involved and then to determine the appropriate risk management strategy. This situation inevitably raises the question not just about judgement, but also "whose judgment?" The incorporation of apparently "non-rational" factors into the risk assessment process needs to be recognised. As Rothman argues: "That some of the sources of an individual's perceptions are nonrational does not mean they are incorrect. The perceptions of all of us, liberals and conservatives alike, are influenced by nonrational factors" (Rothman and Lichter 1987:395). Finucane even suggests "the longstanding consensus is that both scientific elites and issue publics (e.g., journalists) show greater evidence of ideological thinking than samples of the mass public."(2000: 19)

In fact, all individuals faced with uncertainty tend to rely on heuristics, which are speculative frameworks that they use to guide their investigation of possible solutions to problems or to make sense of the world. In the area of risk, Tversky and Kahnemann (1982) have undertaken a study of the heuristics that people generally apply in reducing the complex tasks of assessing probabilities to manageable judgments. They have identified three important heuristics employed when making judgments under uncertainty: *representativeness*, *adjustment* and *availability*. *Representativeness* is used to assess the

Shark Attack!
(The availability heuristic and visceral risk)

Shark attacks are a good example of events whose probability is greatly over-estimated by the general public due to the newsworthiness of such an event and the visceral nature of the individual's reaction to the occurrence.

The International Shark Attack File indicates that only five people were killed by unprovoked shark attacks in 2000. Fifteen times as many people were killed by falling coconuts. (New Scientist 2002)

probability that A resembles B. For example, if people are given the information that Steve is shy and has a passion for detail and then asked what Steve's occupation is likely to be from a list, they are more likely to select librarian than airline pilot (Tversky and Kahneman 1982:4). *Adjustment from an anchor* involves calculating outcomes in light of incomplete computations or from information given as a starting point.

While these heuristics help simplify complex judgments, 'experts' and 'non experts' alike are prone to error and bias (Tversky and Kahneman 1982; Spangler 1984:7). Nonetheless, the availability heuristic is generally regarded as the most important for understanding risk perception, although it has been argued that this still only explains a small amount of the variance found between perceived risks (Sjöberg 2000). The *availability* heuristic relates to the ease with which an instance is brought to mind. People tend to think that events are more probable if they can recall an incident of its occurrence, and may more readily recall sensational reports of disaster than careful scientific analyses of the opportunities and dangers of new technology (Sunstein 1999).

Public perceptions are often influenced by risks that have a particularly catastrophic downside, however small, or which have had a high profile: "discussion of a low-probability hazard may increase its memorability and imaginability and hence its perceived riskiness, regardless of what the evidence indicates" (Slovic et al. 1982:465). This tendency to over-estimate high profile or memorable events is an example of the availability heuristic and is borne out elsewhere in the literature (Wharton 1992:10; Margolis 1996:100). The spectacular devastation wrought by the recent bushfires in Canberra, many people's direct experience of the chaos, and the extensive coverage by the media means that the events are likely to remain at the forefront of the public memory and will have particular effects on policy responses to bushfire planning.

Spectacular events help to illustrate how certain types of risk invite different quality responses. Margolis distinguishes between statistical risk and "visceral risk", which he describes as "an intuitive sense of things … reflect[ing] a sense of more than normal apprehension or vigilance or wariness in connection with some statistical risk" (Margolis 1996:45). The dichotomy between statistical and visceral risk does not necessarily correspond with the expert/lay distinction, "…since visceral risk reflects enhancement of our routine state of vigilance, obviously visceral risk cannot be reduced to statistical risk, even for an expert in statistical risk" (Margolis 1996:45).

Differences between expert and lay person perceptions

While there will be perceptions and responses to risk common across a range of groups in society as suggested earlier, it remains that conflicts often arise between experts and the broader community about acceptable risks (Covello et al 1984). The research suggests that these conflicts arise from differences in the way the public and 'experts' perceive risk (Douglas 1992: 11), which is of particular concern to policy makers basing their decisions on scientific advice. A number of differences in layperson and 'expert' perceptions of risk are explored below.

One of the noted differences between expert and lay perceptions of risk is how the general public might perceive risk in more binary terms: either an event happens or it doesn't. In this sense, there is a certain rationality in focusing on the

Should I fly?
(The probability of a single event)

"Probability expresses a tendency for a system failure to occur which applies equally to any population but, because it is the application of a ratio to what is essentially a binary condition, it must always be wrong in all cases. For example, 100 aircraft are about to embark on a flight and it has been computed that each plane has a 99% chance of arriving safely. But in practice, each plane will either arrive safely or it will not, i.e. in any individual case such a ration has no sensible meaning. If 99 aircraft arrive safely and 1 crashes, then for the 99 safe arrivals the prediction is overly pessimistic but for the one that crashed it is overly optimistic. For a passenger considering a flight in one of those aircraft the significant consideration is not the probability, but whether it *will* arrive safely."
(Jackson and Carter 1992)

magnitude of the undesirable outcome rather than on its probability. Jackson and Carter have argued, "Whereas probability will deal with the likelihood of the occurrence of an event *within a population*, possibility focuses on particular events" (Jackson and Carter 1992:43 – emphasis added). To the lay person contemplating the possible introduction of foot and mouth disease or a nuclear accident, a one off event, the "what if" scenario is important even if expert opinion suggests it is highly improbable. Similarly, as Bernstein points out "people with a phobia about being struck by lightning place such a heavy weight on the consequences of that outcome that they tremble even though they know that the odds of being hit are tiny" (Bernstein 1996:105). "We tend to see risks in and "either/or" way: either the risk is significant (so it is treated as if it were something like 50/50) or it is negligible (so it gets treated as if it were zero)" (Margolis 1996:85).

One of the ways differences between expert and lay opinions like these is explained is that the two groups have "rival rationalities", suggesting that the lay person looks at risk more broadly than the expert whose expertise is narrow and therefore likely to "miss something" of importance to the broader community (Margolis 1996:35). Margolis argues, "in the usual story, what is accounting for the stubborn conflicts is less what experts *see* that other people *miss*, but what ordinary people *feel* about risk that experts *neglect*" (Margolis 1996:81). Recent empirical research bears out this observation, indicating that the public is more concerned about what the experts don't know and have a much stronger belief in the existence of "unknown effects" (Sjöberg 2001). Perhaps not surprisingly, Sjöberg found that "the public was much more sceptical about the completeness of expert knowledge than the experts themselves were" (Sjöberg 2001). Related to this mismatch of perceptions, research also indicates "some kinds of information that the scientist regards as highly pertinent and logically compelling are habitually ignored by people. Other kinds of information, logically much weaker, trigger strong inferences and action tendencies" (Nisbett et al. 1982:116).

But what *don't* we know

"It is in the logic of things that the statement "there is no risk" really means "we have no evidence for a risk", and the latter statement can be read as "we have no evidence *yet* for a risk"(Sjöberg 2001:190).

Rowe and Wright challenge the view of writers like Margolis who appear to yearn for the general public to have more faith in experts (Margolis 1996). They are very concerned about the conferral of the term "experts" suggesting that these often denote the holder of a particular position rather than the holder of relevant knowledge (Rowe and Wright 2001:342) and suggest that "difference in expert/nonexpert risk judgments, if they exist, do not imply that one set of judgments has greater validity than another" (Rowe and Wright 2001:356)

In fact, 'expertise' itself might invite suspicion. Margolis (1996) notes that the public may distrust a small subset of experts in particular fields. Unlike areas such as medicine in which non-experts are generally happy to trust the advice of their general practitioner, in this context the expert on their health, or car repairs where the advice of the auto mechanic is likely to be unquestioned, there are a number of contentious policy areas in which the general public is suspicious of the advice of experts. "Ordinarily, expert consensus governs … so an explanation is needed of why consensus wins so easily in most cases, but in some minority of cases that does not happen" (Margolis 1996:32). This issue has been highlighted of particular interest in the area of nuclear power but is also relevant to quarantine decisions and the setting of the Appropriate Level of Protection for Australia.

Suspicion of science may be a feature of Beck's "risk society" mentioned earlier, where 'risk' is primarily associated with catastrophic events, irrespective of how unlikely (in probabilistic terms) those events might be. Where science and technology once provided safety, they are now seen as the source of risk (Douglas and Wildavsky 1982:10). This suggests that the expert/lay differences explored by Margolis are further coloured by the emerging interpretation of risk and the emergence of a mistrust of scientific experts and other elites (Garvin 2001). Hood describes this shift as follows:

> "The faith of previous generations in the ability of science to provide answers has turned to doubt, partly because scientists themselves are not in agreement, partly because the answers science now gives are much more complex and contingent, and partly because 'they' are always changing their mind" (Hood et al. 2001: 21).

Disagreement among experts can cause confusion in the public mind about the validity of risk assessments (Covello et al. 1984:225), as well as providing a further area of uncertainty in the risk analysis itself (Morgan & Henrion 1990:64).

Sjöberg is much more explicit. Rather than suggesting that it is the *perception* of risk that is influenced by the lack of trust in modernity associated with this type of dread risk, he *defines* risk in terms of this type of neglect: "Risks are typically produced as side effects to some industrial programs. Risks are often produced when dangers are overlooked or underestimated" (Sjöberg 1987). This approach is consistent with that of Ulrich Beck, which suggests a new use of the term risk in the literature that appears to blur the issue of *perception* with attempts to describe levels of risk.

Farmer risk perceptions

If there are substantive differences in the way that different sections of society perceive risk, then it is important to consider how rural communities and farmers perceive risks. Agriculture always involves some degree of risk (Geurin & Geurin 1994), and we face considerable uncertainty particularly in relation to climate change and variability and what impacts these will have on production. Better understanding of farmers' risk perceptions and how those perceptions influence behaviour is an integral component of developing sustainable land and resource use, effective rural policies and programs that are supported and implemented at local and regional scales (Krogmann et al 2001; Shrapnel & Davie 2000; Pannell 2003).

There is a limited amount of research on Australian farmer's perceptions of risk and this deficit needs to be addressed to avoid relying too heavily on European and American studies to generalise to and understand Australian experiences and contexts (Finucane 2000; Clark & Brinkley 2001; Stehlik, Gray & Lawrence 1999). The Australian research on farmer and rural perceptions of risk focuses on varied topics including climate variability and change (Shrapnel & Davie 2000; Clark & White 2002; Dalgleish & White 2001); biotechnology including GMOs (Coakes & Fisher 2000); rural locations in risk contexts (McGee 1998 cited in Finucane 2000: 22); salinity hazards (Haw et al 2000); experiences of drought (Stehlik et al 1999); and capacity to adopt innovation (Cary et al 2002; Pannell 1998, 1999, 2003). This body of work examines a range of factors which influences perceptions of and response to risk including:

- characteristics of individuals (e.g. psychological traits, socio-demographics)
- characteristics of the risk or practice in question
- characteristics of social and environmental contexts (e.g. political conditions, geographical settings, culture) (Wejnert 2000: 297).

Finucane's (2000) substantive report on risk perception reviews research on the influence that rural settings have on perceived risk. Greater independence created by the isolation of rural settings might lead to greater risk tolerance, but sometimes feelings of vulnerability resulting from that isolation can heighten concerns about risks. Finucane's review also found mixed opinions on the degree to which socio-demographic characteristics influence particular risk perceptions.

Shrapnel & Davie (2000) state that consideration of personality traits is needed to complement the rural sociological approaches to understanding how people relate to their environments and how likely they are to change their practices. They posit that landholders most able to respond strategically to the

stress that risk factors, such as the uncertain influence of climate on production, have personalities most conducive to coping with isolation, stress and the particular challenges of rural life.

Stehlik et al (1999) examined Australian farm families' experiences with the drought of 1994-95 and also considered some of the emotional responses to drought, as well as demographic, social and policy factors. They found gender differences responses, priorities for business considerations over environmental viability, sacrifices of social time for farm work, and high levels of mistrust and scepticism regarding specialist advice on and government responses to drought.

Coakes and Fisher (2000) found that several factors influenced farmers' widespread concern about the use of GMOs in agriculture. These factors included:

- how well people understood the issue and how they perceived the trustworthiness of available information;
- the voluntariness of the process;
- how memorable related events have been;
- the degree to which people felt they had some control; and
- their moral stances on use of such technology.

Similarly, Finucane's (2000) review of risk perceptions of GMOs revealed high degrees of uncertainty among farmers about whether the risks of GMOs outweigh the benefits, and added that these concerns are likely to be based on unknown and dread risk dimensions which inform perceived risks of other technologies.

Beliefs, knowledge and values are an important theme in the research on perceived risks from climate change. An American study found that farmers were more likely to perceive the risk of climate change and adapt their practices if they believed that global warming was a reality (Weber 1997). Connor et al (1999) suggests that in addition to believing that climate change would happen and have bad consequences, recognising the *causes* of global warming was an additional and independent predictor of behaviour.

Other Australian research is finding that because farmers' were having difficulties interpreting and applying the probabilistic information, there has been low uptake of the plethora of resources to improve understanding about key climate drivers, drought risk and the range of effective response options (Clark and White 2002; Dalgleish & White 2001). The Climate Variability in Agriculture Program (CVAP) aims to improve climate risk communication with farmers by seeking ways to help farmers to use probabilistic information on seasonal climate variability in their risk assessments.

Farmers and the risk of innovation

Another related area of research shedding light on farmers' risk perception is adoption of innovation. Geurin & Geurin's (1994) undertook a comprehensive review of mostly Australian studies of adoption of innovation. In this context, 'innovation' is defined as an idea, practice, or object perceived as 'new'. The inherent riskiness of agriculture becomes even more pronounced when a new technology or practice is being considered. Consequently, how farmers perceive the risk of new technology or practice will be an important factor in understanding the adoption process (Geurin & Geurin 1994).

This dynamic is especially interesting and relevant given the overall finding that farmers are generally 'risk averse'. That is, because most people typically place greater weight on potential negative – as opposed to positive – outcomes of risk, farmers in particular are prepared to sacrifice some income to avoid some risk or uncertainty (Ghadim & Pannell 2003; Marra et al 2003; Ghadim & Pannell 1999; Cary et al 2002; Dalgleish & White 2001).

A range of situational factors and knowledge, beliefs and attitudes influence the perceived risk of innovation. Guerin & Guerin's (1994) review of adoption found that farmers were less likely to take up innovation when they did not understand the nature of the risk and its associated circumstances; could not easily compare new alternatives with old practices; had a diminished sense of personal control over agricultural production; and had bad past experiences. As farmers are seeking to reduce the risk of adopting innovation, new practices are taken up more quickly when they can be readily observed, trailed, are less complex (Cary et al 2002: viii); are perceived to be profitable, appropriate, consistent with existing goals and can be integrated easily integrated into existing practices (Barr & Cary 1992 cited in Guerin & Guerin 1994:).

Like Coakes & Fisher (2000), Wejnert (2002) states that an individual's familiarity with a particular innovation influences how an individual will perceive the risk of that innovation. Since people are more cautious when it comes to novelty, the rate of adoption tends to increase as novelty decreases. People who are more self-confident are less likely to wait and see how others have gone before taking up the innovative practice (Wejnert 2002; Dalgleish & White 2001).

In interviews with farmers in Western Australia's wheat belt, Pannell (1998) found those farmers' attitudes to and perceptions of risk and uncertainty of grain legumes combined with other socio-economic characteristics to influence adoption decisions. A crucial element in the success of development and adoption of new species of grain legumes were the growers' perceptions of the riskiness of the crop. Pannell (1999; 2003) found that farmers approach radical innovations with some scepticism, uncertainty, prejudices and preconceptions given their prior negative experiences with trailing innovations, and they may be especially wary of systems that are very different from their own farm and may perceive promoters of that system do not understand farming realities.

Vanclay (1992) and Pannell (2003) also found a variety of social, economic, cultural, perceptual and situational reasons for why farmers' failure to take up solutions to land degradation at the pace which would be preferred by land managers and policy makers. Pannell (2003) noted uncertainty as a neglected factor in adoption, not just of techniques for improved productivity, but for greater sustainability. He stated that problems of uncertainty have a more profound effect on decision processes, but are harder to measure. Vanclay (1992) noted that while some farmers do see their local area at risk, they may not necessarily see the same risk for their own properties given some misconceptions of land degradation that are propagated by the media, extensions services and other institutions. That is, the early warning signs are not heeded given the over-emphasis on extreme conditions.

Picking up on this theme, Haw et al (2000) also looked at farmers' non-responsiveness to land degradation. They use a hazards research framework to shed light on responses to salinity risk and note that acute, high energy short events draw more attention than chronic hazards which are more insidious, pervasive, low energy and of longer duration. This approach is especially relevant given that farming depends on a natural resource base which is regularly affected by chronic hazards such as salinity, drought, erosion, climate variability (Haw et al 2000: 157). Similar to Vanclay (2000), Haw et al (2000) found people were more responsive to regional/district scale problems than they were for their own properties, because the 'constant' progressive nature of insidious hazards are often considered less important in farm-level decision-making than other issues. Consequently, this judgement would necessarily compromise the effectiveness of farmers' responses to the hazard relative to more acute events (Haw et al 2000: 166).

It is valuable and worthwhile to understand broad trends in perceived risks across societal groups such as farmers and rural communities. It has been well established that risk is socially constructed and therefore individual and group responses to risk will always vary and be subject to change by societal culture. Consequently, we need to be careful about making overly broad generalisations, which might overlook the variable and dynamic nature of perceived risk and implement continual monitoring of attitudes on several scales to address the shortage of Australian research (Finucane 2000; Geurin & Geurin; Wejnert 2000). A necessary challenge will be to facilitate adequate coordination across

research communities to fill these research gaps. Moreover, sufficiently flexible government policies and programs are needed to respond to the variable and dynamic nature of perceived risks.

Trust and risk perception

Implications for policy makers – risk communication

While there is a shortage of Australian research on perceived risk, there is a substantive body of international work, which argues that we need to rethink the way we communicate with the public about various technological, health, and environmental risks. This work covers a spectrum of topics that range from addressing the content and style of information transfer to redefining the entire process of who we 'communicate' with, how and for what reasons.

Older models of risk communication tend to define the public as an essentially naïve audience and recommend a one way process where increasing amounts of technical and scientific information are disseminated to the public in an effort raise literacy levels, to counteract 'irrational' opinions and to build support for various policies and programs in the face of concern and/or opposition (Peters et al 1997; Gutteling & Kuttschreuter 2002: 36; Sly 2000; Slovic 1999). These models of risk communication are referred to as a 'technical' approach (Rowan 1994 cited in Gutteling & Kuttschreuter 2002: 36) or 'deficit' models (Parliamentary Office of Technology 2001: 4). They are based on several assumptions considered faulty and erroneous for the following reasons:

- By assuming that the public uses the same style of analytical thought as 'experts', rationalistic communication strategies enhance public doubts by communicating about small probabilities while neglecting the potentially severe consequences which are of great concern to 'lay people'(Gutteling & Kuttschreuter 2002: 36).
- Risks are not apolitical – communicating with the public about risk is about fundamental questions, including individuals' values concerning risk decision-making processes, and the fairness of allocating risks and benefits across society. When risk communication is about using power to persuade people to accept certain points of view, the reactivity of the audience is increased – they can become more fearful, oppositional and/or lose trust (Kasperson 1986; Rowan 1994 cited in Gutteling & Kuttschreuter 2002: 36; Renn et al cited in Beckwith et al 1999: 4).
- Insufficient acknowledgement of 'rival rationalities' (differences in perceived realities between laypeople and experts) jeopardizes risk dialogues between these groups. Experts working from technical orientations are likely to produce information judged too complex, irrelevant or uninteresting by laypeople, who may be distrusting of experts or scientific expertise given questions about how well the public interest is being served (Margolis 1996: Gutteling & Kuttschreuter 2002: 37).

The technical or deficit approach has been predominant since the early 1980s when risk management was seen primarily as an activity of government and industry experts. In addition, as systems grew in complexity and making socially acceptable risk decisions became more problematic given rising public opposition, there was a concerted push for resolution through risk communication and risk 'experts' were expected to undertake much of the 'communicating' (Gutteling & Kuttschreuter 2002; Slovic 1999).

By the late 1990s newer models of risk communication were emerging (Petts & Leach 2000). This trend has primarily been in response to risk management becoming increasingly politicised and contentious (Slovic 1999). There is now a growing body of research, which challenges the older paradigm of risk communication and advocates for more democratic approaches.

Slovic (1999: 689) notes that these new perspectives:

- focus more on the inherent complexity of the concept of 'risk', as well as the inadequacies of viewing risk assessment as a purely scientific enterprise;
- recognise that risk and risk assessment are socially-constructed: science and technical judgements are blended with important political, social, cultural and political factors; and
- appreciate that the way in which risk is defined and by whom is central to how assessment, management and communication are undertaken.

This research is also producing evidence that the older approaches to risk assessment and communication may be exacerbating some of the problems in risk situations (Beckwith et al 1999; Randall 2002; Parliamentary Office of Technology 2001; Slovic 1999). For example, one suggested lesson from the British government's response to the BSE crisis was that its preference for a 'sedative' approach to communicating with the public rather than being more open about what was known and unknown, created "greater damage to commercial interests and trigger[ed] virtually unmanageable levels of public distrust"(Randall 2002). In these kind of situations actors fail to recognise that 'rival rationalities' and loss of trust are not only fundamental to the success or failure of risk communication, but become increasingly relevant the more politically controversial a risk situation may be (Gutteling & Kuttschreuter 2002: 46; Margolis 1996). In the face of an untrusting audience, using more science (and risk assessment) is believed to feed public concerns, because evidence for a lack of risk often carries little weight with the public , so trying to address risk controversies primarily with more science is in fact likely to exacerbate conflict (Slovic 1999: 699).

In the face of these challenges, increasing attention is being paid to trust in public institutions and science and technology and how greater understanding of trust issues can improve risk management and communication. A number of studies cite declining levels of trust in public institutions and science and technology (Randall 2002; Petts & Leach 2000; Trettin & Musham 2000; Parl office; Slovic 1999). Trust is thought to be one of the most important influences on how people perceive risk and respond to risk communications (Petts & Leach 2000: 6; Spangler 1984; Finucane 2000: 4; Siegrist & Cvetovich 2000). 'Trust' in this context can be defined as a person's expectation that other individuals and institutions in a social relationship can be relied on in ways that are competent, caring and predictable (Beckwith et al 1999: 54). Public trust may rest more on a faith in the capacity of the authorities to cope with the risk rather than remove it completely (Starr 1984). In other words, people are happy for tigers to remain on display in zoos as they trust zoo managers to keep the tiger securely caged (see box).

Keeping the tiger caged
(The importance of public trust in institutions)

"Almost every big city has a zoo, and in any popular zoo there is usually a tiger. It would be intriguing to make a public risk assessment of the consequences of the tiger escaping from the zoo. Perhaps we might crudely estimate that there is a probability of one in a thousand per day (or once in 3 years) of the tiger escaping and killing a nearby resident; or if we do a more sophisticated analysis, we may estimate the probability is one in a hundred thousand per day (once in 300 years) of such an occurrence. Regardless of probability, such an event can occur. What are the options to protect the public? There are basically three - - political, technical, and managerial. A political solution is to order the elimination of all tigers from zoos. A technical solution is to declaw and defang the tiger. A managerial solution is to cage the tiger securely and alert zookeepers to keep the access gates closed. How has the public chosen among these three?

The public acceptability of zoos is obviously not influenced by risk assessments. Even though we know that wild animals occasionally escape from zoos, the public certainly considers them safe and acceptable enough to visit them with their children frequently. What is obviously acceptable to the public is the assurance by the zookeeper that the tiger is securely caged." (Starr 1984, p64)

Trust is also thought to be fragile – it is easily broken, but it is considerably harder to rebuild, and in some cases cannot be rebuilt (Slovic 1999: 697). The fragile nature of trust can create real difficulties in risk management and communication. Sometimes, the level of mistrust in political establishments is so profound that risk communication can be counterproductive, particularly where it becomes dangerous to perpetuate unrealistic goals, such as in the case of Nuclear waste sites (Slovic 1993; Fox & Irwin 1998). Langford cites the British public's response to the BSE crisis as an example of a loss of trust accompanied by considerable outrage, changing "not only attitudes and opinions, but something deeper to do with our accepted or taken-for-granted view of our world." (2002: 103). Trettin & Musham (2000) question whether actually having 'trust' as a primary goal for risk communication is realistic, if it means that the public willingly abdicates all its responsibilities and fully trusts agencies and corporations to recognise and protect public interests. They believe that is more worthwhile and appropriate to build the public's capacity for critical thinking and provide sufficient information and processes to ensure citizens have an adequate voice in decision-making.

Despite these varied positions on trust, there is widespread support for a more fully engaged public in risk decision-making, which is widely reflected in contemporary approaches to risk communication [and other areas of public policy]. In these frameworks, 'communication' takes on a broader meaning and:

- is an integral component of risk assessment and management strategies and processes;
- has clear short term and long term goals (Finucane 2000; Parliamentary Office of Technology 2001: 7);
- includes, but is not limited to, increasing public knowledge and should also seek to stimulate interest in risk issues, involve citizens in decisions, obtain information from them, acknowledge and respect their beliefs and opinions and establish interactive dialogues and partnerships (Trettin & Musham 2000: 416; Petts & Leach 2000; Finucane 2000; Parliamentary Office of Technology 2001);
- includes activities involving the public, which can take many forms but should be clearly structured with decision frameworks that focus on values, meaningful technical information, tradeoffs and insights (McDaniels et al 1999);
- seeks to accommodate diversity in communities (Marsh 2001) given the influence of gender, race, political worldviews , affiliation, emotional affect, and trust on risk judgements (Slovic 1999: 692; Finucane 2000);
- avoids hierarchical categories that designate 'experts' as 'rational' and therefore more knowledgeable and wise, while 'laypersons' are considered to rely on perceptions that are subjective, emotional and foolish (Slovic 1999: 690; Rowe & Writght 2001); and
- recognise the value of different "knowledge cultures" (local, specialised, strategic, holistic) and the need for them to be better integrated to ensure effective and equitable decision-making in complex policy contexts like risk (Brown et al 2001).

The benefits of applying these principles are being increasingly recognised in the United Kingdom where risk policy has been plagued by the complexities and controversies associated with BSE. The advantages of greater engagement of the public tends to depolarise debates by bringing interested parties on all sides out of their entrenched positions and creating opportunities for more reasoned debate (Parliamentary Office of Technology 2001:4).

The benefits of public participation in risk assessment and management are strongly endorsed, but are not necessarily seen as a panacea. McDaniels et al (1999) asserts that risk management choices are complex and involve difficult choices, and the most that can be hoped for is that those participating gain more insight and can therefore provide better-informed recommendations (McDaniels et al 1999). Slovic also cautions against seeing public participation as some easy, guaranteed 'cure all' for all risk assessment and management woes, but is less equivocal in his support for greater levels of public participation:

> The limitations of risk science, the importance and difficulty of maintaining trust and the complex, socio-political nature of risk point to need for a new approach – one that introduces public participation into both risk assessment and risk decision-making in order to make the decision process more democratic, improve the relevance and quality of technical analysis, and increase the legitimacy and public acceptance of the resulting decisions (Slovic 1999: 689)

Explaining risk

An important component of creating opportunities for more inclusive and deliberative risk dialogues with the public is the transfer of sound and accessible information. In light of the findings of psychologists and other social scientists about the ways in which the general public perceives risk, policy makers are faced with a substantial challenge in explaining risk and risk assessment procedures.

The first challenge is that, in spite of its advantages as a measure of risk, probability presents particular problems as a means of explaining risk. There is general agreement in the literature that the lay public does not relate easily to the concept of probability (Nisbett et al. 1982:111; Covello et al. 1984:226; Teuber 1990:237). Individuals are less responsive to probabilistic information "especially when the probabilities are small and the risks are unfamiliar" (Covello and Johnson 1987: xi). If probabilities are over or under-estimated, it can result in scepticism about the formal information presented on those probabilities (Merkhofer 1987:20). Margolis notes that "risks that are statistically microscopic can prompt very substantial visceral perceptions of risk, while much larger risks are perceived as negligible" (Margolis 1996:82). As discussed above, there is also a tendency to reduce probabilistic information to a binary status, outcomes are probable or improbable, certain or uncertain (MacCrimmon and Wehrung 1986; Garvin 2001).

HRT and Breast Cancer
(Communicating risk)

A recent example of the different impact generated by the presentation of risk statistics is the debate over a report in July 2002 into the increased breast cancer risk associated with hormone replacement therapy (Gittins 2002).

The US National Institutes of Health media release referred to the finding that there was a 26 per cent increase in breast cancer risk for patients on particular types of hormone replacement therapy (National Institutes of Health 2002). This statistic was picked up in the mainstream media and caused a large degree of public concern. Examination of the original article on which this news release was based reveals that while the increase in *relative* risk was indeed 26 per cent, the increase in *absolute* risk was from 30 to 38 in 10,000 person-years (Women's Health Initiative Investigators 2002). The latter is probably a more meaningful statistic to the individual concerned with their own health.

If probabilities are to be used, the nature of their presentation can also be influential in how the material is received. Slovic suggests that

> The precise manner in which risks are expressed can have a major impact on perceptions and behaviour. For example, an action increasing one's annual chances of death from 1 in 10,000 to 1.3 in 10,000 would probably be seen as much more risky if it were described as producing a 30% increase in annual mortality risk" (Slovic et al. 1982:478)

If probabilities are not an appropriate way to convey risk assessment information, alternatives need to be found. Slovic argues that "Creating effective information programs [about risk] may be quite difficult. Doing an adequate job means finding cogent ways of presenting complex, technical material that is often clouded by uncertainty" (Slovic et al. 1982:478). In a similar vein, Nisbett cautions against excessively "dry" data which may not be effective in communicating information to the non-scientific community " (Nisbett et al. 1982:115). However, it is important that presenting "dry" data in "emotionally interesting ways" (Nisbett et al. 1982:115) does not result in the sort of headline-grabbing, and arguably misleading, presentation of information which resulted in the HRT-Breast cancer scare (see box). Avoiding technical and legalistic language can also enhance communication

as such language can give the "impression that officials are being unresponsive and evasive"(Covello et al. 1984: 225).

Presenting information in cost-benefit terms needs to be done with caution as it implicitly balances values. As Caplan has argued, "Cost-benefit analysis is only ever likely to polarize disputes about risk. Where opposing factions place high values on their own threatened interests and low values on the opposition's potential losses, taking a numerical average of these numbers will settle nothing" (Caplan 2000:110).

It is also important that the degree of certainty associates with the risk assessment is not overstated (Morgan and Henrion 1990:1). Dealing with uncertainty is at the heart of risk management. Paté-Cornell makes an important distinction between two types of uncertainty: epistemic and aleatory. In other words, uncertainty arises from lack of fundamental knowledge about the issues, and from randomness within the sample for which the probability of an event is known (Paté-Cornell 2002). The risk management process must encompass both types of uncertainties, the first of which clearly involves judgment (MacCrimmon and Wehrung 1986; Ansell and Wharton 1992). This is where expert opinion becomes important (Morgan and Henrion 1990:102; Paté-Cornell 2002) and the element of subjectivity inevitably raises moral and ethical issues (Ansell and Wharton 1992:204) – and scope for criticism of government risk management approaches if the subjective element of the decision is open to dispute.

Concepts such as the Appropriate Level of Protection can mislead as the general public sees the level of protection selected as representing the safe level of dose/exposure etc. Margolis argues that "the risk chosen as the standard is seen as a bright line, dividing safe from unsafe" (Margolis 1996:154). This type of "error" in interpreting appropriate risk is compounded by the tendency to seek zero risk. Slovic argues that

> outcomes that are merely probable are under weighted in comparison with outcomes that are obtained with certainty. As a result, protective action that reduces the probability of harm from, say, .01 to zero, will be valued more highly than an action reducing the probability of the same harm from .02 to .01 (Slovic et al. 1982:480)

Institutional and policy-making implications

It may be fruitful to consider various institutional capabilities for designing and implementing more savvy communications and public participation programs, which are determined by factors such as agency cultures, motivation, and skill and training needs. Johnson (1999) found that those responsible for risk communication face a plethora of practical and ethical challenges for which they often have neither the formal training nor the role that would enable them to do so more effectively. Similarly, in a study of the role of scientists in *public debate* – something inherent in risk contexts – it was found that the attitudes and capabilities of those doing the communicating are just as important as those of audience (MORI 2000). Many of the scientists surveyed felt it was their duty to communicate their research and its social and ethical findings and implications. However, they also felt constrained by their lack of communications training and the limited time they had for communication, and were less confident when it came to communicating about the social and ethical implications of their work (MORI 2000).

Marsh (2001: 7) cites a need for re-skilling in agencies, which would enable more complex analyses of communities; shrewder strategies for engaging diverse communities and mediating between competing interests; more advanced skills and techniques for incorporating diverse aspirations into policies and programs (e.g. negotiation/conflict resolution and management). Similarly, Finucane's

(2000: 33) comprehensive research on improving quarantine risk communication identified the need for "achieving significant attitudinal and behavioural change both in the delivery of the Import Risk Analysis service and in the communities to which that service is provided." The report acknowledges the challenges of maintaining on-going dialogues with the public and recommends a number of short to long term strategies for improving public participation in the import risk analysis process, which include building Biosecurity Australia's community engagement capacity through cultural change and formal training programs (Finucane 2000: 34).

In the United Kingdom, many institutions are adopting more interactive and constructive dialogues with the public, and their degree of success is related to whether:

- Clear objectives for engaging in dialogue with the public have been set;
- It can be established that the exercise is fair, matches methods to particular purposes and situations, is well-timed, and uses principles of inclusivity to select participants with wide-ranging interests;
- The quality of the processes can be assessed and outcomes can be examined; and
- Sufficient training and resources have been allocated bearing in mind the full economic and political costs of *not* doing so (Parliamentary Office of Science and Technology 2001).

Conclusions

Risk & modern society

Risk and risk perception are important concepts for rural policy and research. While risk might be a term used widely across society, its meaning varies and remains somewhat contested. Over the last two decades, research has found that 'risk' is often now associated with 'bad risk'. The shift away from the original technical probabilistic meanings of the term has significant implications for risk assessment, management and communication processes.

We have sought to reduce risk in society by increasing certainty in decision-making. This preferred course of action has not been without its consequences. Allocating probabilities to both desirable and undesirable outcomes has been a common method, despite vigorous debates about our ability to calculate the probability of a single (or multiple) event(s). While there are considerable theoretical and technical limitations to using probability as a predictive risk management tool, we have also seen there are substantive social implications for continuing to base our assessments and responses strictly along these lines.

Risk perceptions

The socially constructed nature of risk mandates an understanding of risk perceptions. There are often mismatches between perceived risk and measurable probabilities of risk. This discrepancy suggests that other factors are clearly important in clarifying how people understand and respond to risk.

For example, the characteristics of risk are a significant influence on perceived risk – different types of risk generate different reactions (e.g. voluntary activities are not considered as 'risky' as involuntary activities, new risks viewed differently from familiar hazards). The psychological dynamics of decision-making are important as well. Formed opinions can be difficult to change, particularly when people feel they have knowledge about an issue. When people see benefits from an activity, they may be more receptive to the risks. People are more inclined to judge an event more probable if they can readily recall an occurrence of it or something similar. And hazards that have potentially severe consequences on people's lives, even if the statistical likelihood of their occurrence is 'insignificant', attract considerable attention.

It is important to recognise that all people, irrespective of their role in society, employ speculative frameworks to make sense of the world and selective judgement in their responses to risk. These so-called 'non rational' factors are not necessarily incorrect. However, there are likely to be significant differences in these understandings and responses, and such divergences are critical to understanding how best to manage and communicate about risk. One of the more significant differences discussed recently is that between 'the public' and 'experts'. The public tends to be more concerned about:

- the unknown effects of risky activities;
- significantly negative consequences, irrespective of the 'low probability';
- what the 'experts' do NOT know; and
- why they cannot agree.

Given the limited amount of research, it is not yet clear whether farmers and rural communities have significantly different perceptions of risk than other parts of society. There are still mixed opinions about how socio-demographic factors influence risk perceptions, but it is generally agreed that farmers tend to be risk averse. And their perceptions to risk will be influenced by a range of situational factors and knowledge, beliefs and attitudes. These perceptions will also influence the likelihood of farmers' up-take of production-enhancing or conservation innovations, given that adapting to new practices has some inherent risks. Therefore, success of a range of agricultural and natural resource management policies and programs that are designed to increase productivity and sustainability is clearly dependent on understanding how farmers' (and rural communities) perceive risk and how those perceptions vary among individuals, groups and communities.

Risk dialogues

In numerous policy areas, particularly for those portfolios which rely heavily on scientific and technical expertise and risk assessment and management tools, increasing the time and resources devoted to improving dialogues with the public may be especially pertinent. Declining trust in institutions responsible for science and technology has been well documented. Where there is not sufficient recognition of the differences between the ways 'expert' and 'laypeople' perceive risk, 'expertise' itself may invite public suspicion. Where science and technology have once provided reassurances to society, they may now be seen as *creating risk*. These trends have inspired new research, which revisits older models of risk communication. This work has determined that these approaches have probably outlived much of their usefulness for modern day risk contexts and may have even contributed to some of the contemporary societal conflicts over risk, which challenge policy makers and the public alike. The newer models of risk communication essentially reconstrue notions of risk and risk perception by:

- emphasising the socially-constructed nature of risk;
- valuing different forms of knowledge; and
- advocating for greater levels of public participation in risk assessment and management.

Most advocates of these models recognise the significant challenges in facilitating more and inclusive dialogues with the public and recommend a range of capacity building strategies targeted at both the broader community, as well as the policy and scientific communities.

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