

# Combining risk perception and risk attitude: A comprehensive individual risk behaviour model

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## **Abstract**

Although risk management in farming is a well-documented subject in scientific literature, this same literature is usually used only by other scientist and is not aiding individual farmers in their management. Risk perception and risk attitude are well described determinants of risk behaviour but rarely combined in an integrated approach for risk behaviour research. Furthermore in most literature risk attitude is taken as a given stable personality trait on which the optimal behaviour should be based. We argue that risk attitude can be manageable in order to derive optimal risk behaviour. Based on these findings we develop a comprehensive theoretical basic model on farmers risk behaviour. Furthermore a participatory approach involving the stakeholder, the farmer, to build on this model is presented. This presented model has as final purpose of guiding research on establishing risk management tools applicable by farmers.

## **Keywords:**

risk management, risk perception, risk attitude, risk behaviour

## 1. Introduction

### 1.1. Risk

No consensus yet exists on the notion of risk in scientific literature. Different domains of science apply different concepts of risk. These concepts of risk can be grouped according to the epistemological foundation (Zinn 2009). Some authors argue that risk does not exist beyond it being a psychological construct (Sjöberg et al. 2004). Indeed, risk, or uncertainty for that matter, is characterised by lack of information. Risk and uncertainty would not exist if the decision maker have been perfectly informed about the consequences of his choice (Windschitl and Wells 1996). From a realist perspective risk is seen as a real event or real threat and objectively measurable (Zinn 2009). Risk in this view is seen as the multiplication of the probability of the risk event happening and the negative (or positive) consequence of the risk:  $risk = probability * consequence$ . If the factors consequence and probability are uncertain, this is ascribed to a lack of knowledge. Hence, precision may increase with further research on the subject (Zinn 2009). In practice probability and consequence are usually calculated based on past events, therefore new and uncertain risks are often harder to quantify. Even though, from a realist perspective risk is seen as objective and calculable, this approach leaves room for risk being subjectively biased by the personal interpretation of the risk or risk perception. The latter approach will be used in the presented research.

### 1.2. Farming and risk

Today risk considerations are becoming increasingly important in agriculture. First, volatility of both output and input prices is expected to increase due to globalization, liberalisation and increased trade levels (Chavas and Kim 2006; Eakin 2005; Ericksen et al. 2009; European Commission 2001; Sumner 2009) Surprisingly, despite the unanimous agreement on the growing importance of risk and despite a huge body of literature, the practical application in the agricultural domain of this literature is little. Further, even when it is applied, risk management often fails to meet expectations, as businesses fail and opportunities are left untaken. Clearly the mere existence of principles, processes and knowledge is not sufficient to guarantee success. The focus of this paper, relates to the difference between theoretical conceptions of risk and risk behaviour on the one hand, and the conceptions of risk and risk behaviour of individual decision makers on the other. Put simply, individual risk behaviour is, despite a huge body of literature not well understood and unless we are able to improve our understanding of what decision makers *would* do, risk management tools advising decision what they *ought to* do will fail. This observation is not new in itself. However, while we do not think that any expert in agricultural risk management will falsify this idea, it is virtually never considered in the research literature. We want to direct the reader to the seminal paper by Sitkin and Pablo (1992), who, inspired by the very same conclusion, developed a risk behaviour model for company managers. Our research builds on this work and modifies it by focusing on agricultural decision makers and by involving the decision makers in building the model.

Traditionally, methods in risk management practice, such as the subjective expected utility approach, regard risk management as the process of maximizing risk preferences, given the objectively measured or estimated risk. Risk perception is not

considered explicitly, but implicitly it is assumed that whenever risk management strategies are inadequate, this has to do with either the inability of calculate the objective risk, or a biased perception of the objective risk. Risk management tools then function as a way to inform the decision maker on the objective risk, such that risk perception equals the objective risk.

In section 2, we try to bridge the gap between literature and practise by reviewing the determinants of risk and risk behaviour from the literature. In section 3 we present our basic model reconciling these determinants and in section 4 we conclude.

## **2. Bridging the gap between literature and practise**

A huge body of literature exists that explains the mechanisms by which individuals make choices under uncertain conditions, what we will call risk behaviour in this paper. In this scientific literature on individual risk behaviour different determinants are proposed. Sitkin and Pablo (1992) concluded that all these different determinants are influencing behaviour indirectly via risk perception and risk propensity or risk attitude. However, in current literature risk perception and risk attitude are often seen as individual and sole determinants of behaviour. Hereunder we give a short literature overview of the concepts risk perception and risk attitude and discuss why it should be pertinent to see both risk perception and risk attitude combined in order to explain risk behaviour. Furthermore we will demonstrate that there should be a shift in thinking on risk attitude as a stable personality trait towards a changeable trait that can be optimised for risk management purpose. Next we present some feedback loops that exist once a risk decision was taken. Finally we combine these insights to present a model that offers new opportunities for aiding risk management and therefore bridging the gap between science and practise and the next section.

### ***2.1. Risk perception***

From a realist perspective it is assumed that “real risk” can objectively be measured, individual perceptions of risk however, differs from one person to another. This difference as we will see cannot be explained solely by the imperfect knowledge on the real risk being observed. Moreover individuals have different perceptions of reality because of their different interpretation of reality. For all perceptions of reality the brain is filtering the incoming information and this filtering process is strongly related to social and cultural background and personal history of the individual (Proske and Proske 2008) Furthermore if it is established that different people can perceive the same objective risks differently, than it is only a small step to conceive that an individual person can perceive the same risk differently at different times or under different circumstances. The latter stresses the importance of getting an insight in the way risk is perceived, in order to make any inference about how risky decisions are made. Risk perception is differing from other perception studies while, like stated above, risk can be seen as only existing in once mind. Of course we cannot perceive something that is not out there. Risk perception, therefore, according to Sjöberg (2002), is all about thoughts beliefs and construct. Risk deals with uncertainty and mostly risk is too complicated to objectively calculate Hence people instead tend to use heuristics (rules of thumb) to make an estimation of the risks they are facing (Helgeson et al. 2010). One example of heuristics learns us that small risk are emphasized both in gains and losses (Kahneman and Tversky 1979). In the 1970’s the

idea on risk thinking using heuristics became dominant, partly as a consequence of the work of Tversky and Kahneman (1974) on subjective probability (Sjöberg 2000). They pointed out the difference between objectively calculated risk and the risk that people intuitively feel (Sjöberg 2000; Sjöberg, Moen, and Rundmo 2004). Nowadays there are three major streams on thinking about risk perception: the psychological of which the psychometric paradigm is the major contributor, one that is rooted in cultural theory (Rippl 2002; Sjöberg et al. 2004) and a third often referred to as social amplification of risk.

The Psychometric paradigm is rooted in psychology and decision theory (Rippl 2002). It actually focuses on methods of measuring risk perceptions rather than offering a real scientific paradigm (McDaniels et al. 1995). However, some depictions can be made. An important assumption within the psychometric approach is that risk is seen as a lack of knowledge and does not exist outside human cognition. Therefore, risk cannot be measured independent of our minds and culture (Slovic 1992). The psychometric paradigm has been used in much of the recent literature on risk perception and has repeatedly provided similar factors that are well accounting for the risk perception (Sjöberg, Moen, and Rundmo 2004). The downside of this measurement is that it does not argue why and how individuals differ in their risk perception.

The second major stream in thinking on risk perception is derived from cultural theory. Cultural theory, founded by Douglas and Wildavsky (1982), is taking culture and other social aspects in account in explaining risk perception (Rippl 2002). The perception of risk is seen as determined by the group the individual belongs to and is socially participating in. The amount of risk a person is subscribing to certain hazards can thus be predicted only in the social and cultural context. Therefore risk is based on a socially shared worldview rather than determined individual cognitive process (Oltedal et al. 2004)

The third major stream is the interdisciplinary or social amplification of risk paradigm. The main principle is that risk events interact with psychological, social and cultural factors in a way that may either increase or decrease the perception of risk (Kasperson et al. 1988). It is mostly used in the context of natural hazard and threats to the environment or human health, and describes the way risks are communication through different channels and persons, whereby each channel amplifies or decrease the risk, based on psychological aspects.

We learn from all three major streams of risk perception that perceived risk is not only an imperfect transfer of knowledge that can be improved by providing information. We do recognise that, especially dealing with risk, the knowledge transfer as aspect of perception is relevant. After all risk by definition deals with uncertainties and therefore incomplete knowledge. However, incorporating the social and cultural determinants of risk perception will lead to a more comprehensive view of perceived risk and so to a better understanding of individual's risk management.

## ***2.2. Risk attitude***

Different persons have different attitudes towards risk which causes them to deal differently regardless of their individual perception, i.e., risk behaviour is partly influenced by risk attitude. Two distinctive attitudes towards risk are usually recognized: risk seeking and risk aversion. These attitudes lie on a continuous scale on which an

extreme risk seeker is willing to accept any risk even for a marginal increase in return, while a risk averse person will not accept whatever risk no matter what increase in return. However, the terms risk aversion and risk seeking might be confusing while it seems to apply to some sort of stable personality trait applicable to any risk no matter the context. In the recent literature on risk attitude the major approaches are derived from methods coming from the Expected Utility theory (Pennings and Garcia 2001).

The major model for investigating risk preference (or attitude) is the theory of Expected Utility (EU). Based on a series of previous choices of events all with different probabilities and utility the utility function is formed describing the relation between probability and expected utility. From the utility function the risk attitude is derived by dividing the second derivative over the first:  $-u''(x)/u'(x)$ . This measurement of risk attitude is then seen as a stable personality trait, which applies to all future risk behaviour. This simple method of EU assumes the decision maker to be rational and the risk to be a choice between alternatives (Pennings and Garcia 2001). As such Risk attitudes in the EU framework simply describe choice patterns (Dyer and Sarin 1982)

Relative risk attitude, formulated by Dyer and Sarin (1982) separates marginal values  $v(x)$  and uncertainty values  $u(x)$ . Because both could have an impact on the final behaviour for a rational decision maker, separating them would result in risk attitude solely based on the uncertainty factor. Once again this is often seen as a stable personality trait and taken as given in order to determine optimal risk behaviour.

Perceived risk attitude is explaining the instability of risk attitude measured from risk behaviour as differences in the perception of the risks, therefore not explicitly keeping risk perception in mind (Weber and Milliman 1997).

As appears from the above, risk attitude is often seen as being a stable personally trait, i.e., no matter what the context, the risk and consequences involved the same attitude will apply. Risk attitude in this way is measured by confronting the subject with some choices concerning risks with a different uncertainty and return and from this a risk attitude is derived. Optimal behaviour given any newly presented risk is then formed taken into account the supposedly stable personal risk attitude. This way of explaining and interpreting risk behaviour has different objections with regards to aiding risk management in practise.

First risk attitude is proven to be context specific (Pennings and Garcia 2001). This means that in different circumstances or faced with different risks individuals will show different risk attitudes. To be more precise risk attitude is, besides other context, influenced by risk perception. Indeed, it is impossible to take into account aspects of the risk that are not perceived. Therefore differences in risk taking behaviour between persons and even for an individual regarding a risk in different context, do not always reflect differences in risk attitude but might be induced by a differences in risk perception.

Second it might be that optimal behaviour should not take into account a personal risk attitude, but optimal behaviour should establish a risk attitude. The difference here although seemingly subtle is rather significant. If risk attitude is seen as observed risk behaviour and the observed behaviour is inadequate behaviour to manage the risk (for example caused by some hard constraints like the financial situation of the entity, whether farm household or company), it should be possible to influence the farmers' risk attitude. That this is possible and even wanted in some situations is already described by

Hillson and Webster (2007). Furthermore Underwood and Ingram (2010) describe a classification of different risk attitudes that became evident during their research. Instead of the classic division in risk seeking and risk aversion, four different groups of risk attitude profiles can be identified: managers, maximizers, conservators and pragmatists. Maximizers are considered to seek for risks, letting the possible gain outweigh the possible negative consequences of any given risk, conservators are described to be quite the opposite trying to avoid any risks no matter the possible profits, risk managers are thought to carefully select between risk as to maximize profit and at the same time minimize losses, while pragmatist finally are indifferent of the risk and instead behave in such a way to leave the most options open. Furthermore four different risk environments can be distinguished, each can follow the other in time and place: Boom times defined by little risk and high profit, recession characterised by high risk low profit, uncertain times risks and profits are uncertain, and moderate times both risk and profits are moderate. Finally, Underwood and Ingham (2010) argue that in any given situation the risk attitude should be consequently adapted, in boom times a maximizers attitude will be optimal, in recession the preferred risk attitude is conservator, uncertain times call for pragmatist considering each risk separately keeping options open and only in moderate times a management risk attitude will be optimal. This research once more shows the need to actively change risk attitude in order to adapt to optimal risk behaviour and therefore the necessity to consider risk attitude for aiding individual risk management purpose.

We also suggest that farm managers should take into account their risk bearing capacity, besides the health of the overall economy, as suggested by Underwood and Ingham (2010). Indeed, as most producer entities in agriculture are farm households, the farm manager, managing business risk, is also the financier, managing financial risk. A farm's risk bearing capacity is defined as the financial survivability in times of adverse business income. We suggest that adequate risk management should take into account the farm's risk bearing capacity, potentially via adopting more or less conservative risk attitudes.

### ***2.3. Combining risk perception and risk attitude***

From the previous we learned that both risk attitude and risk perception determine risk behaviour, and both serve as target for risk management practise. Furthermore there is an interaction between risk perception and risk attitude, as risk perception is a determinant for risk specific risk attitude. Hence, for individual risk management aiding purpose it is essential to distinguish between perception and attitude. If the farmers risk perception caused inadequate risk behaviour or inadequate risk management, more information about the real risk should be given together as influencing the social and cultural factors influencing risk perception. However, when a non adapted risk attitude of the farmer is causing the inadequate behaviour, targeting of emotional responses should be the focus (Weber and Milliman 1997)

### ***2.4. Feedbacks***

An example of the importance of differing between risk perception and risk attitude while considering risk behaviour comes from Weber and Milliman (1997). They investigated the changing risk behaviour of gamblers on a day at the horse races. They observed a behavioural change of subjects that were losing in the course of the day.

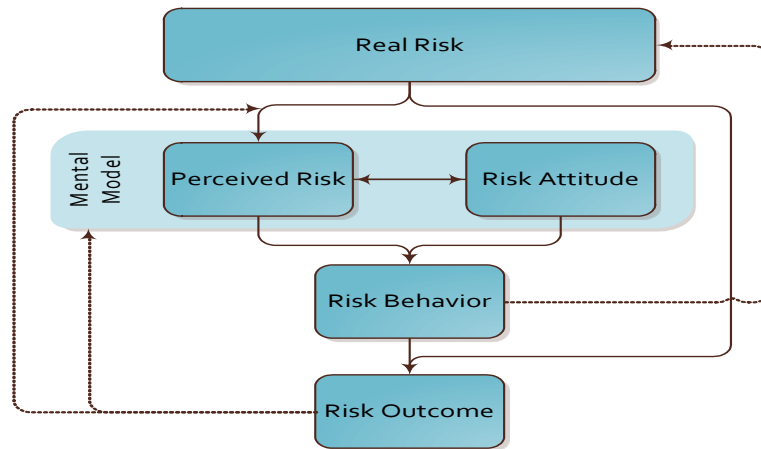
Those people tended to bet on long shots (horses with less expected chance to win) at the end of the day. Weber and Milliman (1997) found that this changing behaviour was caused by a change in risk perception, a realisation of the fact that the supposedly winning horses weren't in fact winning. In fact it were the long shots that gave them the better chance of cashing some prize money. This shows that there is a feedback from risk outcome, here defined as the consequence of the risk given the risk behaviour, to the information transfer from real risk to perceived risk. Indeed, the gamblers were perceiving the risk of the long shot horses different as during the day it were those horses that were winning. Another important feedback loop in individual risk behaviour is risk management itself. While undertaking any form of risk management the real risk will be adapted to a new real risk, hence a feedback from risk behaviour to real risk exists. Finally a feedback loop exist from the risk outcome to the factors indirectly influencing risk behaviour via risk perception and risk attitude. If during the course of the racing day we keep on losing our bets, we might change our strategy or risk attitude caused by some emotional factors in order to compensate for our losses. This involves a change in our Mental Model causing a change in our risk behaviour via a changing risk perception or a changing risk attitude. The Mental Model is explained in the next paragraph

### **2.5. Mental Model**

So far we have not considered in detail how and why risk perception and attitude are differing between individuals and within an individual for different context. Indeed, we mentioned cultural and social factors but causal links have not been assumed. We assume that other determinants of risk behaviour, effect risk behaviour indirectly via risk perception and risk attitude by influencing an individual's Mental Model. Research on Mental Models explaining behaviour is already extensive (e.g. Aertsens et al. 2009; Helgeson et al. 2010; Kolkman et al. 2005; Schlüter 2009; Wauters et al. 2010; Zhu and Timmermans 2010). From this research combined with the research performed by Sitkin and Pablo (1992) who also assume indirect relation of determinants of risk behaviour via risk perception and attitude, we can identify possible indirect determinants that play a role in the process of decision making influencing risk perception and attitude, like: culture, personality, perceived behavioural control, habits and motivation.

### **3. The individual risk behaviour model**

Based on the reviewed literature and given the lack of integrating the different aspects concerning individuals risk behaviour, we constructed an integrated individual risk behaviour model (figure 1) similar to the model by Sitkin and Pablo (1992). New aspects in our model are the feedback loops from risk behaviour to real risk and from risk outcome to the Mental Model and the link between real risk and risk perception. Although those links are proposed (e.g. Weber and Milliman 1997) they were are not considered in risk management practise and are not yet explicitly mentioned in causal models. Our model is shortly discussed hereafter and then illustrated with an example.



*Figure 1: The basic individual risk behaviour model*

### ***3.1. The individual risk behaviour model explained***

We learned from the major approaches of risk perception that risks perception is influenced by more than just an objective estimation of uncertainties. These factors influencing risk perception combined can be represented in a black box Mental Model. Risk perception on its turn is a very important determinant for risk attitude. We see risk attitude as being context specific and manageable, hence a different risk attitude can lead to a different behaviour. Furthermore the risk attitude is rooted in the same Mental Model as risk perception providing the context for the risk attitude. Also we saw that it is pertinent that perception and attitude are taken into account together influencing the risk behaviour. Indeed, a change in either attitude or perception influences behaviour. Behaviour targeting diminishing of the risk (risk management) is modifying the real risk and hence influencing the outcome of the risk event. Finally the risk outcome is changing the Mental Model influencing future risk attitude and risk perception by and by providing newly learned information on the risk it is further closing the gap between risk and perceived risk.

### ***3.2. An example***

In order to clarify the individual risk behaviour model presented above, we will illustrate the different parts of the scheme with an example of yield risk through drought.

#### **3.2.1. Climate change, drought and yield risk**

One of the most significant expected consequences of climate change are changes in the frequencies of extreme events, like drought and flood. Both the frequency and intensity of floods and droughts are expected to increase locally. In fact various studies provide evidence that this expected pattern is already being realized in Europe. And in the past ten years droughts in Europe have intensified (Lehner et al. 2006). Increased drought occurrence and intensity could very well form a threat to crop yields, especially for the less drought resistance crops such as strawberries. Therefore farmers face an intensified yield risk when planning to plant those crops, compared to, for instance, wheat.



### **3.2.2. Perception of the risk**

Without any assistance in risk management, the farmer might not fully realize the potential consequences of drought on the yield for his crops, or he might not have adapted to the increased probability of drought caused by the changing climate. Both examples mentioned are a consequence of imperfect knowledge about the yield risk involved. In the model, this is reflected in the arrow connecting the real risk to risk perception. Because the risk is too complicated and deals with too much uncertainty to grasp, the farmer will make use of heuristics to form a perception on the risk. These heuristics, based on his previous experience, personality, beliefs, culture and other, lie hidden in the model in the black box called Mental Model. The farmer might be very sceptical and not believe in climate change and in increased chances of drought at all. Maybe he heard many years that drought could ruin yield but in his case never suffered severe losses. All these factors decrease the subjective (farmer's perception) of probability of yield loss given the objectively predictable probability.

### **3.2.3. The risk attitude**

The farmer's risk attitude is, as described above, context specific. In the first place, this context is defined by the risk involved, or more precisely the risk that the farmer perceives. Indeed, the farmer's attitude will not depend on information about the risk that the farmer did not perceive. For different types of risk the farmer might be more or less willing to either accept the risk or try to manage the risk. In the second place, the context depends on the farmer's Mental Model: is the risk perceived to be manageable or is the risk out of one's locus of control, are there any previous experiences with the risk, what and how much is there at stake? Let us consider the case that the farmer is willing to put the stakes at the table and willing to take a risk. In this case, the farmer is probably willing to plant the high-value-high-risk strawberries. If a severe drought stays out, and the yield of the strawberries is high it will deliver a high income to the farmer, however, strawberries are very prone to drought and in severe drought a large proportion of the yield can be lost.

Thus the farmer's risk attitude is severely dependent on the type of risk, yield risk, and on other aspects such as his risk perception, personality, general attitude towards risk and many other factors which we can only guess at the moment. The message here is that we believe that the nature of a farmer's risk attitude might be more risk seeking than on other conditions.

### **3.2.4. Behaviour and risk management**

The farmer is risk taking concerning his yield risk, furthermore he does not perceive the yield risk to be very threatening, maybe because he perceives the chance of having a drought this year as smaller than objectively forecasted. Therefore the farmer is willing to plant the high-value-high-risk strawberries. On top of that, the farmer does not install any kind of risk management instrument such as yield insurance, crop diversification and irrigation. So the dashed arrow that connects risk behaviour to real risk (representing risk management) in this particular case is not applicable.

### **3.2.5. An adjusted Mental Model as a consequence of the disappointing yield**

Given that the farmer didn't take any precaution for a possible drought, the strawberry yield will be at risk of being worthless for a major part because of drought. Let's assume that a severe drought occurred and a large proportion of the strawberry yield is lost. As the farmer did not take any management action to either prevent it (irrigation, diversification) and neither took any management options to cope with the loss (insurances), the farmer will suffer a smaller income. This consequence might affect the farmer's Mental Model, the experience he had will define a new context for the risk attitude he will have for similar choices. Furthermore the farmer's experience will make him better understand the objective risk he is facing, this is represented by the line going from outcome to the arrow between real and perceived risk.

### ***3.3. Risk management practice***

Given this example, it is clear that traditional risk management practice – aiding the farmer in calculating the real risk in order to, via an improved risk perception, induce appropriate risk behaviour – may not provide satisfactory results. Indeed, the farmer's risk perception is probably influenced by more than just information on the probability and consequence of drought. Further, even if the farmer's risk perception better resembles the actual risk, he might be to risk seeking, and still grow strawberries, while he would be better off growing wheat. In that respect, Kimura et al. (2010) observed that adopting yield insurance induced a crowding out effect of other, maybe equally efficient risk management strategies. This observation may be due to the fact that farmers, perceiving the risk of yield failure as not so apparent due to the insurance, adopt a more risk seeking attitude profile.

## ***4. Conclusions***

We saw that a gap between literature and practise originates in the incomplete way of studying behavioural decision making under uncertainty. First we learned that risk attitude is wrongly seen as a stable personality trait that should be taken into account for coming to an optimal solution. Rather risk attitude should be managed to change in order to come to optimal behaviour. Second we saw that risk attitude and perception should be combined to derive risk behaviour, like proposed in the model of Sitkin and Pablo (1992). We took this model and added feedback loops to come to a basic model that offers more potential for risk management aiding purpose.

We like to conclude saying that our model is not pretending to be comprehensive, rather as with all models, maps and schemes it is a simplification of reality and only applicable for certain purposes. It omits, as stated above, many factors that indirectly control risk behaviour. However, the presented model can, by distinguishing between perception and attitude, be guiding management aiding purposes and help bridging the gap between science and practice.

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