Perceptions of risks and risk management strategies;

an analysis of Dutch livestock farmers

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Abstract

The risk environment of farmers is changing and new risk management strategies are being introduced. Beal (1996) stated that risk management strategies adopted by farmers will be in accordance with their personal preferences for risk. In this context it would be useful for developers and sellers of new risk management strategies to have insight into farmers' preferences for risk. This paper studies to what extent such preferences are farmer-specific or whether general relationships exist. By means of a large questionnaire survey among 2700 livestock farmers in the Netherlands we gathered data on four groups of variables, i.e. socioeconomic characteristics of the farm, farmers' attitudes towards risk, their perceptions of sources of risk, and their perceptions of risk management strategies. Various techniques of multivariate data analyses have been used to analyse the relationships between these groups of variables. Many significant relationships were found (although not to a great extent for attitudes towards risk). However, we are cautious in recommending that new risk management strategies need to be fully fine-tuned to aspects analysed in this study. Low values of the adjusted R-squared indicate that there are still other (possibly even more personal) aspects that determine the final perception of a farmer of a risk management instrument. In addition, results of this study reflect farmers' *perceptions* of risk management

strategies, which is not necessarily the same as the extent to which they would *actually* use such strategies.

Key words: perception; sources of risk; risk management strategies; attitude towards risk; questionnaire survey; livestock farming; The Netherlands

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1. Introduction

The risk environment of farmers is changing, among others due to increasing market liberalisation and industrialisation of agriculture (Boehlje and Lins, 1998). These changes lead to new risks, and new risk management instruments are being developed (see for example Blank, 1995; Harwood et al., 1996; Goodwin and Ker, 1998; Skees et al., 1998). Beal (1996) stated that risk management strategies adopted by farm managers will be in accordance with their personal preferences for risk. In this context it would be useful for developers and sellers of such new risk management strategies to have insight into these preferences of farmers. This paper studies to what extent such preferences are farmer-specific or whether more general guidelines exist. Data were collected from a sample of livestock farmers in the Netherlands.

Related research has been carried out in the U.S. Patrick et al. (1985) studied livestock farmers in eight U.S. states. Boggess et al. (1985) did the same in Florida and Alabama. Wilson et al. (1988) studied Arizona dairy farmers. Large-scale U.S. cornbelt farmers were studied by Patrick and Musser (1997). Patrick et al. (1985) indicated that perceptions of sources of and responses to risk varied across geographic areas and by farm type. Boggess et al. (1985) and Wilson et al. (1988) found that perceptions varied so much among individuals that a risk classification based on socioeconomic variables was not possible. Wilson et al. (1993) wrote that "results illustrate the highly complex and individualistic nature of risk perceptions and the selection of management tools". Patrick and Musser (1997) concluded

that, besides geographic location and farm type, institutional structures and other factors affecting the operating environment of producers were also likely to influence farmers' perceptions of sources of and responses to risk.

The goal of this paper is to study whether the conclusions of U.S. research also hold for Dutch livestock farmers (or whether indeed more general relationships exist) and, if such relationships are found, to analyse what kind of information is most valuable in explaining farmers' perceptions of risk management strategies: objective information regarding socioeconomic characteristics or subjective information on preferences for risk.

2. Materials

To study farmers' perceptions of various sources of risk and risk management strategies, a questionnaire was developed and sent in October 1997 to 2700 randomly selected livestock producers in the Netherlands. These included cattle, pig and poultry farmers (respectively 1200, 1200 and 300)[1]. Before the questionnaire was mailed to the 2700 farmers, it was extensively pretested in three sessions with 10-15 farmers in each session. After each session, the questions were improved based on the comments and suggestions of the farmers.

The questionnaire survey consisted of four parts, i.e. questions related to 1) socioeconomic characteristics of the farmers, 2) their attitudes towards risks, 3) their perceptions of the importance of various sources of risk, and 4) their perceptions of various strategies to manage risks. Most questions were closed questions, mainly in the form of Likert-type scales ranging from 1 to 5 (Schuman and Presser, 1981; Churchill, 1995). In total, the questionnaire included 121 variables.

[1] The farmers were selected from the lists of addresses from NV Interpolis Tilburg (insurance company) and Misset Publishers.

After screening on completeness, the questionnaires of 737 farmers were available for statistical analyses, i.e. the effective response rate was 27.3 per cent. The eventual number of questionnaires analysed was 612 because only farms with a minimum of 20 NGE were included, and furthermore only farms in which livestock accounts for at least two thirds of the total size of the farm (also measured in NGE). NGE is a Dutch standard of farm size (Agricultural Economics Research Institute and Statistics Netherlands, 1998). 20 NGE equals about one third of a full labor unit. From the livestock farms (classified into pig, cattle, poultry and mixed farms), poultry farms have been left out as well as cattle farms other than dairy farms. A farm was classified as e.g. a cattle farm if at least two-thirds of the total NGEs of the farm was attributable to that livestock category. For further subclassifications the same proportions have been used, i.e. a cattle farm was classified as a dairy farm if at least two-thirds of the NGEs for cattle was accounted for by dairy cows.

Of the 612 farms included in the analyses, 361 farms (i.e. 59 per cent) were classified as dairy farms, 170 farms (i.e. 28 per cent) as pig farms, and 81 farms (i.e. 13 per cent) as mixed livestock farms. Dairy farms had on average 61 milking cows with an average milk production of 7732 kg milk per cow. Pig farms had on average 262 sows and 787 fattening places. On mixed livestock farms there were on average 41 milking cows, 165 sows, 618 places for fattening pigs, 12,400 layer hens, and 40,600 broilers.

The average size of farms was 109 NGE with 1.7 labour units. The dominant form of ownership on the farms was a partnership between husband and wife. This form occurred on 39 per cent of the farms. Other frequent forms of ownership were sole proprietorship (25 per cent), partnerships between child(ren) and parents (18 per cent), and partnerships between child, husband or wife, and parents (11 per cent). Of all respondents, 33 per cent indicated that they had a successor, 19 per cent had no successor and on 48 per cent of the farms succession was yet uncertain.

The average age of the respondents was 44, the average 1996-gross farm income (in Dutch guilders) 110,000 and the average solvency rate 48 per cent[2]. Related to the level of education, 59 per cent of the respondents indicated to have received a 'medium' level of education; 34 per cent a low level, and 7 per cent a high level.

Some 16 per cent of the respondents indicated they had an off-farm job. For partners (husband/wife) the proportion was 24 per cent. In both cases, the main reasons given for having the off-farm job were an increase of family income and an increase of personal skills.

3. Methods

Figure 1 shows the groups of variables in the questionnaire (i.e. socioeconomic variables, attitudes towards risks, sources of risk, and responses to risk) and the relationships of interest (indicated by the numbers 1 to 3). Also the applied measurement scales have been indicated.

[Figure 1]

Descriptive analyses were carried out to locate outliers and to examine present variability within variables (Churchill, 1995). Then, relationships between variables within a certain group were analysed. For the category of socioeconomic variables, nonlineair principal components analysis (Gifi, 1990) and Pearson correlation coefficients (only for the ordinal and metric variables) were used. For the variables in the groups of 'sources of risk' and 'responses to risk' factor analyses were carried out (Hair et al., 1995). With factor analysis, insight into underlying relationships of variables within a group can be obtained, and the amount of variables can be reduced by identifying new (and uncorrelated) variables (so-called factors).

[2] Questions related to age, income and solvency were in the form of predetermined classes. Averages represent weighed averages.

After the analyses per group, relationships between groups were studied. The relationships of interest were (see also the numbers in figure 1):

1. Socioeconomic variables → risk attitude;
2. Socioeconomic variables and risk attitudes → sources of risk;
3. Socioeconomic variables, risk attitude, and sources of risk → risk management strategies.

Relationship (1) was studied with multiple discriminant analysis. The relationships (2) and (3) with multiple regression (Hair et al., 1995). Logistic regression was used for analysing some binary variables deduced from open questions with respect to risk management strategies. In analysing the relationships 1 to 3 we used stepwise procedures with a significance level of $P \leq 0.05$.

In using the techniques described, we assumed that standard parametric statistical procedures are appropriate for ordinal variables such as the variables in the form of Likert-type scales (see also Wilson et al., 1993; Patrick and Musser, 1997). This assumption was not necessary for applying the nonlineair principal components analysis since this technique is suited for analysing nominal and ordinal variables.

All analyses have been carried out with SPSS for Windows(v6.1.4).

4. Results; analyses per group of variables

To reduce the amount of output in this section, results are only shown for the analyses in which no distinction between farm types has been made.

4.1 Socioeconomic variables

We found relationships between the socioeconomic variables. With nonlineair principal component analysis a (logical) relationship was found between the form of ownership and the availability of a successor. Having a successor on the farm goes together with partnerships in

which both children and parents participate. Having no successor goes together with sole proprietorship and partnerships between brother and sister. On farms on which succession was yet uncertain, partnerships between husband and wife dominate.

Pearson correlation coefficients for the non-metric/ordinal and metric variables (see figure 1) show a significant relationship ($P \leq 0.01$ level) between age and education (correlation of –0.43), size and 1996-gross farm income (+0.28), age and solvency (+0.24), and 1996-gross farm income and solvency (+0.22). Since all relationships found were not very strong, we did not exclude any of the socioeconomic variables from further analyses.

4.2 Attitudes towards risk

Respondents could indicate their attitude towards risk on nine statements. Four statements were of a general kind, the other five refered to respondents' willingness to take risk relative to other farmers. Similar statements were used by Patrick and Musser (1997). Table 1 gives the percentage distribution of the respondents' answers in relationship to each statement. According to their answers, respondents were classified as 'more risk averse', 'averse', or 'less risk averse'. The percentages reflecting a less risk-averse attitude are in italic. Categories with the highest frequencies are underlined.

[Table 1]

Table 1 shows that there are three statements for which the majority of the respondents were 'less risk averse': statements 1, 2 and 4. For all the 'willingness to take risk' statements (statements 5 to 9), respondents perceived their own willingness to take risk as equal or less than that of their colleagues.

There was a significant positive correlation ($P \leq 0.01$) among the answers given for statements 3 and 4 (correlation of 0.46) and for the answers given for statements 5 to 9 (correlations ranging from 0.41 to 0.64). Aggregating the responses to statements 5 to 9, 26

per cent of the respondents had the same risk attitude for each of these statements. This implies that (despite the positive correlation among the answers given) the majority of respondents had different attitudes for different areas of risk. Results for statement 5 ('I am willing to take more risks than my colleagues') was used for further analyses.

4.3 Sources of risk

Twenty-two sources of risk were considered. Five of these were conditional on farm type and tenancy of land (risks related to milk yield, milk price, technical results of fattening animals, meat price, and land rent). The second column of table 2 shows the average score for each source of risk while the third column shows the standard deviations of the scores.

[Table 2]

Table 2 shows that, on average, the highest scores were given to risks related to meat price, epidemic animal diseases, and milk price. All these sources of risk had standard deviations of less than 1, indicating a high level of consensus among respondents. The high score for the occurrence of epidemic animal diseases is probably due to the fact that at the time the questionnaire survey was held there was a major outbreak of Classical Swine Fever in the Netherlands affecting many farms for several months (issue of context; Plous, 1993). The high score for milk prices seems to be odd in the current context of guaranteed milk prices.

Sources of risk that received average scores below 3 (indicating that they were generally not perceived as relevant) related to changes in farm capital, ability to redeem loans, division of tasks within farm family, technology, and land rent.

Farmers were also asked to indicate their 'top three' of most important sources of risk. Most frequently mentioned sources of risk in the top three related to epidemic animal diseases, death of the farm operator, and milk price. After excluding dairy farms, the 'top

three' consisted of (again) epidemic animal diseases, but now accompanied by meat price and environmental legislation.

Applying factor analysis on the sources of risk resulted in five factors with eigenvalues greater than 1 and a total variance explained of 55 per cent (which can—in social sciences—be regarded as satisfactory; Hair et al., 1995). A varimax orthogonal rotation was implemented. The variables that were conditional on farm type were not included in the factor analyses, because they have many missing values.

Factor 1 can best be described as the 'health of the farm family' factor because of the high loadings associated with death and disability of the farm operator and the health situation of the farm family. Note the relatively high loading of epidemic animal diseases on this factor.

Factor 2 can be referred to as a 'financial' factor due to high loadings of variables related to value of production rights, interest rates, government support, farm capital, and loans.

Factor 3, called 'legislation', involves large loadings of environmental and animal welfare policy, and changes in the value of production rights. Also elimination of government support scores relatively high on this factor.

Factor 4 is related to 'production', given the high loadings of animal diseases (both epidemic and non-epidemic), production costs, consumer preferences, and technology. The high loading of consumer preferences is likely to reflect farmers' concern about changes in consumer preferences and the result this may have on production techniques used.

Factor 5 reflects 'changes in the farming situation' referring both to changes in the family situation (large loadings of variables related to health of the farm family, family relationships, and division of tasks) and the farm situation (indicated by a relatively high loading of technology).

4.4 Risk management strategies

Respondents' perceptions of strategies to manage risk were also assessed using scales from 1 (not relevant) to 5 (very relevant). Table 3 shows the results.

[Table 3]

Table 3 shows that there was a clear distinction between strategies perceived as very relevant and those perceived as not very relevant. Strategies with high average scores related to producing at lowest possible costs, and the buying of business and personal insurance (in this order). The use of futures and options markets was perceived as the less relevant way to manage risks, followed by off-farm employment and (other) strategies of diversification.

Factor analysis of responses to risk resulted in four factors with eigenvalues greater than 1 and a total variance explained of 55 per cent. Again, a varimax orthogonal rotation was implemented. Based on the concentration of factor loadings, the four factors can be described as 'reduction of price risk', 'insurance', 'diversification', and 'secure income' respectively.

On the factor 'insurance' high loadings of commercial (business and personal) insurance are accompanied by high loadings of 'on-farm insurance': producing at lowest possible costs and applying strict hygienic rules. Factor 3, diversification, seems to reflect diversification 'away from the current farm business', given the high negative loadings of variables related to the current farm business (i.e. producing at lowest possible costs and spatial diversification). The argument for naming factor 4 'secure income' comes from the high loading of off-farm employment and the fact that the main reason indicated for off-farm employment was 'increase of family income'. Also for this factor, loadings suggest that it refers to a secure income 'from outside the current farm business', given the high negative loading for the on-farm strategy of applying hygienic rules.

Farmers can respond to risks by applying strategies as mentioned in table 3. However, they can also bear a number of risks themselves. In an open-ended question, 330 respondents

indicated which risks they perceived as ‘bearable’. The first risk mentioned was taken into account in the analyses. Results showed that weather and price related risks were regarded as bearable risks by respectively 24 and 21 per cent of these respondents. Non-epidemic diseases, low technical results of livestock, and low crop yields were considered as bearable by respectively 12, 7 and 7 per cent.

Respondents could also list risks for which they would like to buy insurance. This question was answered by 398 respondents. Again, only the first risk listed was included in the analyses. Outcomes showed that the risks of epidemic diseases, prices, personal disability, and legislation were mentioned by respectively 23, 14, 10, and 10 per cent of the respondents.

5. Results; relationships between groups of variables

In this section, results are presented for analyses for all livestock farms as well as by farm type.

5.1 Explaining attitudes towards risk

All socioeconomic variables except for the nominal ones were included in the analyses. Table 4 shows the discriminating variables, the risk groups that are discriminated, and the group that had a significantly higher (or lower) value for each variable.

[Table 4]

Table 4 shows that farm characteristics (not farmer characteristics) distinguish between different risk attitudes. Taking into account all livestock farms, the variable ‘farm size’ discriminated between more risk-averse farmers on the one hand and (less) risk-averse farmers on the other. The more risk-averse farmers have significantly larger farms. For dairy farms about the same conclusion can be drawn.

For pig farms, gross farm income and solvency are the discriminating variables. More risk-averse pig farmers have significantly higher incomes than (less) risk-averse colleagues. Solvency distinguishes the middle group ('risk averse') from the extremes ('more risk averse' and 'less risk averse'): pig farmers in the middle group have a significantly higher solvency. For mixed farms, solvency also distinguishes the middel group from the extremes, but now the middle group has a significantly lower solvency.

5.2 Explaining perceptions of sources of risk

Multiple regressions were carried out for each of the five factors identified in the factor analysis and for the sources of risk conditional on farm type (see table 2). Dependent variables consisted of normalised factor scores and the direct scores given by the respondents respectively. The independent variables consisted of the socioeconomic variables and the attitude towards risk. Nominal variables (farm type, ownership, the availability of a successor, and the attitude towards risk) were included as dummy variables. Table 5 shows the results. In general, the adjusted R-squared was relatively low (see third column in table). For only three of the conditional sources of risk, significant relationships were found.

[Table 5]

For the risk factor 'health of the farm family' (first row of table 5), we did not find any significant differences between the various types of farms. We did find significant relationships for age and hours off-farm work (a direct and inverse relationship respectively). Considering farm types separately, it appears that each farm type has its own socioeconomic variables that are significant in explaining the perception of the importance of the health of the farm family.

Financial risks (second part of table 5) are perceived as less important by pig farmers than by dairy and mixed farmers. Other socioeconomic variables that were significant were mainly

economic parameters (gross farm income and solvency). Both parameters have an inverse relationship with the perceived importance of financial risks.

Factor 3, legislation, is perceived the least important by dairy farmers. Within the group of dairy farmers, the availability of a successor is significant in explaining the perception of risks related to legislation. Farmers with a successor perceive risks related to legislation as more important than farmers without a successor. For pig farms we found a direct relationship with solvency. For mixed farms it can be concluded that farmers with smaller farms perceive risks related to legislation as more important than their colleagues with larger farms.

The risk factor 'production' is perceived the most important by pig farmers. Level of education appears to be important in explaining differences in perceived importance.

The extent to which farmers are concerned about changes in the farming situation appears to relate to the form of ownership, the degree of solvency, and—for mixed farms—the size of the farm. Farmers with a form of ownership are more concerned about changes in their farming situation than farmers with sole proprietorship. For solvency and size we found an inverse relationship.

For risks related to the milk price, significant relationships were found for dairy farmers. Significant variables (i.e. solvency and availability of successor) are similar to those found to be significant for the factors 'financial risks' and 'legislation'. These are exactly the factors that relate to the uncertainty around milk prices.

For technical results of fattening animals, the inverse relationship with the availability of a successor seems to reflect that farmers with a successor pay more attention to the performance (and inherently the future perspectives) of their farm.

Changes in land rent is the only source of risk for which the perceived importance is partly explained by risk attitude (at least for mixed farms): the more risk-averse farmers perceive

changes in land rent as less important. This may relate to the fact that the more risk-averse farmers on mixed farms had higher degrees of solvency (see table 4).

5.3 Explaining perceptions of risk management strategies

To explain farmers' perceptions of risk management strategies a multiple regression was estimated for each of the four factors identified with factor analysis (see table 3). Computed factor scores for the risk management strategies were used as the dependent variables. The independent variables consisted of the socioeconomic variables, the attitude towards risk, and the factor scores for sources of risk (nominal variables as dummies). For analyses by farm type, the relevance scores given to sources of risk conditional on farm types were also included. Table 6 shows the results.

[Table 6]

Reduction of price risk is perceived the most important by mixed livestock farmers. A striking explaining variable in the context of price risks is the risk factor related to the health of the farm family. However, going back to 'health of the farm family' in table 5, it becomes clear that this relationship may be due to the inverse relationship between 'the health factor' and off-farm work: with off-farm work the reduction of price risk may become less important.

The perceived importance of insurance as a risk management strategy has a direct relationship with the risk factors related to legislation, production, finance, and technical results. We found an inverse relationship with age.

Managing risks by diversification was perceived the most important by pig farmers. Within the group of pig farmers, perception of risks related to legislation is the explaining variable.

Dairy farmers perceived a secure income as more important than pig and mixed farmers. Important explaining factors with a direct relationship are hours off-farm work and (again) changes in the farming situation.

Section 4.4 listed a number of risks that were perceived as bearable. Logistic regressions (Hair et al., 1995) were carried out to study what type of farmers regarded the specified risks as bearable. Regressions were estimated for weather and price risks. The same was done for two of the risks for which respondents indicated that insurance was appreciated, i.e. epidemic disease risks and price risks. Table 7 shows the categories of independent variables considered, the specific variables that were significant, and a measure for the goodness-of-fit of the model (i.e. the percentage correctly classified).

[Table 7]

Table 7 shows that on average weather risks were more likely to be considered bearable by dairy and mixed farmers as opposed to pig farmers. Price risks were more likely to be considered bearable by pig and mixed farmers as opposed to dairy farmers. The attitude of pig farmers with respect to weather risks and of dairy farmers with respect to price risks may be due to unfamiliarity with the type of risk: pig farmers generally do not have much land (and/or are not to a large extent depending on crop results) and dairy farmers do not face any price risks (due to guaranteed milk prices). The inverse relationships for perceived importance of a secure income and price risk reduction are obvious.

Insurance for epidemic diseases is appreciated more by pig farmers than by dairy and mixed farmers, and furthermore mainly by farmers who want to focus on their current business (inverse relation with diversification as a risk management strategy). Insurance for price risks is appreciated more by dairy farmers than by pig and mixed farmers. This is in line with dairy farmers not regarding price risks as bearable. Also, the direct relationship for ‘secure income’ adds to this, since a secure income was perceived as more relevant by dairy farmers than by pig and mixed farmers (see table 6).

6. Discussion and conclusions

In this paper we analysed whether significant relationships could be found between socioeconomic characteristics, attitudes towards risk, perceptions of sources of risk and perceptions of risk management strategies.

Many significant relationships were found. However, the conclusion from U.S. research (i.e. perceptions of risk management strategies are highly farmer-specific and it is difficult to deduce more widely applicable relationships) can not be rejected, because of low adjusted R^2. This indicates that there are other (more farmer-specific?) variables that are important in determining a farmer's perception of a risk management strategy. Still, a number of general guidelines appear from the research, such as pig farmers' willingness to cover epidemic disease risk, pig farmers' appreciation for diversification (away from the pig business and inspired by uncertainties in legislation), and dairy farmers' fear for price risks.

The second research question was which of the variables included in the study were most valuable in explaining farmers' perceptions of risk management strategies: objective information regarding socioeconomic characteristics or subjective information on preferences for risk (measured as farmers' attitudes towards risks and their perceptions of sources of risk).

From the study it can be concluded that only information on preferences would not be sufficient; socioeconomic parameters provide much of the information. Variables reflecting attitude towards risks (ranging from more risk averse to less risk averse) were hardly of any explanatory value. This likely relates to our findings that respondents had different risk attitudes for different areas of risk.

Although the study has provided useful insights into farmers' perceptions of sources of risk and risk management strategies, and similar research seems to be helpful for developers and salesmen of new risk management strategies, it has to be noted that results of such research are highly influenced by their context (as was likely to be the case for the current research that

was carried out during a major outbreak of Classical Swine Fever in the Netherlands). Furthermore, results reflect farmers' *perceptions* of risk management strategies, which is not necessarily the same as the extent to which they would *actually* use such strategies.

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Table 1 Statements on risk and the percentage distribution of respondents over categories (1 = I don't agree, 5 = I agree)[1)]

	1/2 (%)	3 (%)	4/5 (%)
1. I need to take risks to achieve success[2)]	20	26	*54*
2. I am more concerned about facing a loss than about foregoing a profit	*35*	33	32
3. I am cautious about new ideas	*31*	34	35
4. Before applying new farming practices, they first need to be proofed at other farms	*36*	29	35
5. I am willing to take more risks than other farmers	34	40	*26*
6. Specified to production	30	47	*23*
7. Specified to marketing	44	40	*16*
8. Specified to financial issues	35	35	*30*
9. Specified to farming in general	29	39	*32*

1) Statements 1 to 4 are general statements; statements 5 to 9 relate to a respondent's willingness to take risk relative to other farmers

2) The category regarded as 'less risk averse' is in italics; the category with the highest frequency is underlined

Table 2 Average scores (1 = not relevant, 5 = very relevant), standard deviation, and varimax rotated factor loadings for sources of risk

	Average	sd	Factor[1)]				
Source of risk	(n= 612)		1	2	3	4	5
Meat price[2)]	4.41	0.86	----	----	----	----	----
Epidemic animal diseases	4.41	0.89	0.31	0.07	0.12	0.55	-0.08
Milk price[2)]	4.36	0.95	----	----	----	----	----
Death of farm operator	4.15	1.14	0.82	0.09	0.06	0.04	0.09
Technical results fattening animals[2)]	4.13	0.98	----	----	----	----	----
Health situation of farm family	3.91	1.03	0.69	0.11	0.17	0.03	0.36
Environmental policy	3.86	1.03	0.14	0.09	0.78	0.18	-0.02
Disability/health of farm operator[3)]	3.69	1.15	0.75	0.14	0.06	0.12	0.07
Family relations (e.g. divorce)	3.64	1.35	0.32	0.08	0.06	0.01	0.75
Animal welfare policy	3.57	1.12	0.13	0.01	0.75	0.29	0.09
Consumer preferences	3.47	1.08	-0.03	0.08	0.22	0.43	-0.01
Value of production rights	3.47	1.25	-0.01	0.44	0.64	-0.02	0.09
Changes in interest rates	3.44	1.18	0.13	0.80	0.01	0.07	0.04
Production costs	3.33	1.04	0.10	0.28	0.05	0.61	0.01
Milk yield[2)]	3.28	1.14	----	----	----	----	----
Elimination of government support	3.14	1.23	0.18	0.45	0.31	0.16	-0.02
Animal diseases (non-epidemic)	3.07	1.05	0.03	0.04	0.06	0.73	0.10
Changes in farm capital (land, machinery)	2.64	1.14	0.08	0.57	0.27	0.11	0.13
Ability to redeem loans	2.60	1.34	0.06	0.67	0.01	0.25	0.17
Division of tasks within farm family	2.52	1.08	0.10	0.13	0.00	0.04	0.83
Technology	2.24	1.06	-0.19	0.20	0.23	0.42	0.33
Land rent[2)]	2.06	1.27	----	----	----	----	----
Per cent of total variance explained	----	----	12.10	11.95	11.20	10.66	9.26

1) Factors 1 to 5 are health of farm family, financial situation, legislation, production, change in farming situation respectively. Loadings of ≥ 0.25 have been underlined

2) Sources of risk conditional on farm type and tenancy of land

3) Including farm workers

Table 3 Average scores (1 = not relevant, 5 = very relevant), standard deviation, and varimax rotated factor loadings for risk management strategies

	Average	sd	Factor[1)]			
Risk management strategy	(n=612)		1	2	3	4
Producing at lowest possible costs	4.67	0.59	0.11	0.40	-0.30	-0.17
Buying business insurance	4.33	0.89	0.00	0.81	0.03	0.14
Buying personal insurance	4.06	1.10	-0.05	0.77	-0.02	0.06
Applying strict hygiene rules	3.96	0.99	0.16	0.48	0.12	-0.42
Increase solvency ratio	3.45	1.19	0.08	0.36	0.09	0.40
Price contracts for farm outputs	2.58	1.49	0.86	0.07	0.12	0.04
Price contracts for farm inputs	2.53	1.44	0.88	0.08	0.02	-0.04
Spatial diversification	2.17	1.35	0.19	0.00	-0.78	-0.21
Off-farm investment	2.12	1.22	-0.20	0.03	0.61	0.27
Enterprise diversification	2.05	1.29	0.21	-0.01	0.68	0.17
Off-farm employment	1.98	1.24	0.11	0.04	0.14	0.72
Futures and options market	1.58	0.96	0.53	-0.07	0.05	0.40
Per cent of total variance explained	----	----	16.56	14.93	13.31	10.12

1) Factors 1 to 5 are reduction of price risk, insurance, diversification, and secure income respectively. Loadings of ≥ 0.25 have been underlined

Table 4 Results of discriminant analysis between more risk-averse, risk-averse, and less risk-averse farmers [1)]

Farms in analysis	n	Discriminating variable	More risk averse	Risk averse	Less risk averse
All livestock farms	498	Farm size	b[2)]	a	a
Dairy farms	305	Farm size	b	b	a
Pig farms	131	Gross farm income	b	a	a
	131	Solvency	a	b	a
Mixed farms	62	Solvency	b	a	b

1) A significance level of $P \leq 0.05$ was taken into consideration

2) A 'b' indicates that farmers in the specific risk category have larger farms, higher incomes, and higher degrees of solvency than the farmers in 'a'

Table 5 Perception of sources of risk based on socioeconomic characteristics and attitude towards risk[1)]

Source of risk	Farms in analysis	adj. R^2	Farm type[2)]	Other socioeconomic variables	Attitude towards risk[3)]
Health farm family	all farms	0.03	----	age (+)[4)], hrs. off-farm work (-)	----
	dairy	0.05		size (-), hrs. off-farm work (-)	----
	pig	0.09		ownership (+)[5)], age (+)	----
	mixed	0.13		successor (-)[6)]	----
Financial risks	all farms	0.21	pig < dairy[7)], pig < mixed	solvency (-), gr. farm income (-), size (+)	----
	dairy	0.19		solvency (-)	----
	pig	0.19		solvency (-), gr. farm income (-)	----
	mixed	0.12		gr. farm income (-)	----
Legislation	all farms	0.07	pig > dairy, mixed > dairy	successor (+), solvency (+)	----
	dairy	0.01		successor (+)	----
	pig	0.06		solvency (+)	----
	mixed	0.07		size (-)	----
Production	all farms	0.05	pig > dairy, pig > mixed	education (+)	----
	dairy	0.02		education (+)	----
	pig	0.06		education (+)	----
	mixed	0.07		size (+)	----
Change in farm. sit.	all farms	0.04	----	ownership (+), solvency (-)	----
	dairy	0.07		ownership (+), solvency (-)	----
	pig	0.06		solvency (-)	----
	mixed	0.08		size (-)	----
Milk price	dairy	0.05		solvency (-), successor (+)	----
Technical results	mixed	0.06		successor (-)	----
Land rent	dairy	0.02		gr. farm income (-)	----
	pig	0.06		ownership (-)	----
	mixed	0.15		gr. farm income (-)	more r-av. < r-av.

1. Results from stepwise regression with $P \leq 0.05$
2. Represented by two dummy variables with—in principle—dairy farms as the comparison group. Models were also estimated with pig and mixed farms as the comparison group. If this led to new insights these are included in this column as well (with the adjusted R^2 in brackets—if different from basis model)
3. Represented by two dummy variables; one comparing less risk-averse farmers with risk-averse farmers, the other comparing more risk-averse farmers with risk-averse farmers
4. The '+' and '-' signs indicate a direct and inverse relationship respectively
5. Measured as a dummy variable with 0 indicating no partnership and 1 indicating a form of partnership
6. Measured as a dummy variable with 0 indicating that there is no successor available and 1 indicating that there is a successor available or that this is yet unknown
7. The '>' and '<' signs indicate that the group mentioned first perceived the specific source of risk respectively as more or less important than the group mentioned second

Table 6 Perception of risk management strategies based on socioeconomic characteristics, attitude towards risk, and perception of sources of risks[1)]

Risk man. strategy	Farms in analysis	Adj. R^2	Farm type[2)]	Other socio-economic variables	Attitude tow. risk[3)]	Sources of risk[4)]
Red. price risk	all farms	0.12	mixed > dairy[5)], mixed > pig	solvency (-)[6)], ownership (+)[7)]	----	health (-)
	dairy	0.26		solvency (-)	more r-av. < r-av.	change (+), land rent (+), milk yield (+)
	pig	0.10		ownership (+)	----	----
	mixed	0.30		education (-)	----	----
Insurance	all farms	0.06	----	----	----	legislation (+), production (+)
	dairy	0.06		age (-)	----	financial (+)
	pig	0.07		----	----	techn. res. (+)
	mixed	----		----	----	----
Diversification	all farms	0.11	pig > dairy, pig > mixed	age (-)	----	change (+)
	dairy	0.10		education (+)	----	change (+)
	pig	0.12		----	----	legislation (+)
	mixed	----		----	----	----
Secure income	all farms	0.17	pig < dairy, mixed < dairy	hrs. off-farm work (+), size (-), education (+)	----	change (+)
	dairy	0.19		hrs. off-farm work (+), education (+)	----	change (+)
	pig	0.24		size (-), gr. farm income (-)	----	change (+)
	mixed	----		----	----	----

1. Results from stepwise regression with $P \leq 0.05$
2. Represented by two dummy variables with—in principle—dairy farms as the comparison group. Models were also estimated with pig and mixed farms as the comparison group. If this led to new insights these are included in this column as well (with the adjusted R^2 in brackets—if different from basis model)
3. Represented by two dummy variables; one comparing less risk-averse farmers with risk-averse farmers, the other comparing more risk-averse farmers with risk-averse farmers
4. Sources of risk as defined by factor analysis. In the analyses per farm type also sources conditional on farm types (for dairy farms: milk price, milk yield, and land rent; for pig farms: meat prices, technical results of fattening animals, and land rent; for mixed farms: all previous variables)
5. The '>' and '<' signs indicate that the group mentioned first perceived the specific source of risk respectively as more or less important than the group mentioned second
6. The '+' and '-' signs indicate a direct and inverse relationship respectively
7. Measured as a dummy variable with 0 indicating no partnership and 1 indicating a form of partnership

Table 7 Perception of bearable risks and risks for which insurance is appreciated based on knowledge of socioeconomic characteristics, attitude towards risk, perception of sources of risks and of risk management strategies

Independent variables	Bearable risks[1]		Insurance appreciated[2]	
	Weather risks (n = 166)	Price risks (n = 166)	Epidemic dis. risks (n = 193)	Price risks (n = 193)
Farm type[3]	pig < dairy, pig < mixed (74%)	pig > dairy, mixed > dairy	pig > dairy, pig > mixed	dairy > pig, dairy > mixed
Other socioec. var.	ownership (+)[4]	hrs. off-farm work (+)	successor (-)[5]	size (+), ownership (-)
Attitude towards risk	----	----	----	more r-av. > r-av.
Sources of risk[6]	----	----	----	----
Risk man. strat.[6]	Secure income (-)	Price red. (-)	Diversification (-)	Secure income (+)
Percentage correctly classified	77%	80%	80%	84%

1. Measured as a binary variable with 1 indicating that the risk was mentioned as 'bearable', and 0 indicating that the risk was not mentioned in this way
2. Measured as a binary variable with 1 indicating that the risk was mentioned as a risk for which insurance was appreciated, and 0 indicating that the risk was not mentioned in this way
3. Represented by two dummy variables with—in principle—dairy farms as the comparison group. Models were also estimated with pig and mixed farms as the comparison group. If this led to new insights these are included in this column as well (with the adjusted R^2 in brackets—if different from basis model)
4. Measured as a dummy variable with 0 indicating no partnership and 1 indicating a form of partnership
5. Measured as a dummy variable with 0 indicating that there is no successor and 1 indicating that there is a successor or that this is yet unknown
6. Factors identified by factor analysis

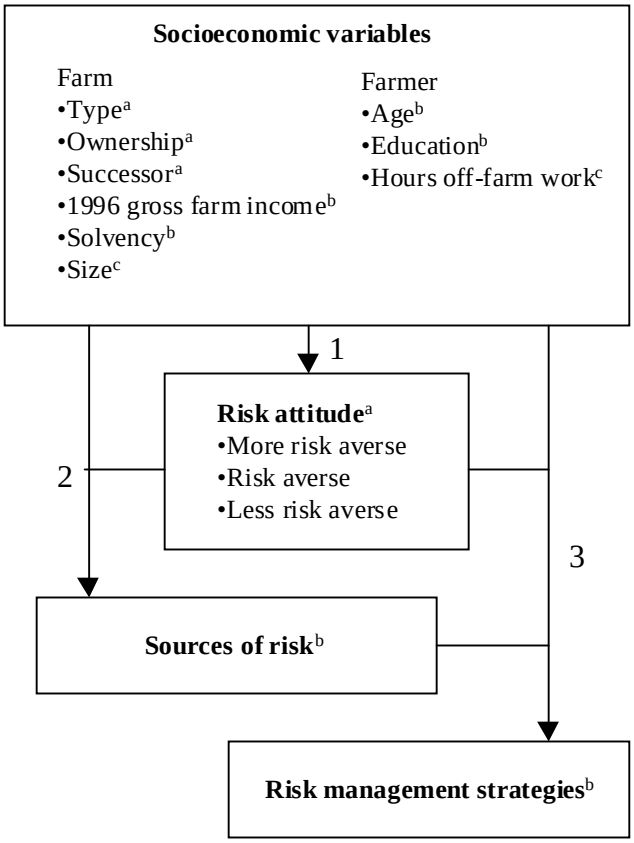

Figure 1 Schematic overview of analyses (i.e. explanation of 1 = attitudes towards risk; 2 = perceptions of sources of risk; and 3 = perceptions of risk management strategies)

a. Non-metric variable / nominal scale

b. Non-metric variable / ordinal scale

c. Metric variable