Risk Management in Milk Production:
A Study in Five European Countries

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Abstract. The EU agricultural policy has recently been characterized by radical changes that increase market volatilities. Especially in the dairy market, fluctuating prices as well as production and political risks lead to high uncertainty for farmers. Based on a comprehensive survey, this paper discusses the risk perception and risk management strategies of dairy farmers in selected European countries. This approach allows a more detailed analysis of the determinants of farmers' risk perceptions and risk management. First, based on the literature, a comprehensive framework was developed for the determinants of farmers' risk perceptions and risk management. This framework guided an empirical study in 2007 in which 236 German dairy farmers were interviewed using a standardized questionnaire. Subsequently, parallel surveys have been conducted in the Netherlands, Ireland, Switzerland and France using case studies and expert interviews on dairy farmers' risk management. The findings provide in-depth insights into the determinants of risk perception and risk management on dairy farms and the way risk management is integrated into the strategic management of those farms. The most important risks that dairy farmers currently perceive are various market risks followed by policy and production risks. Results show that future-oriented dairy farmers operate in a risk-conscious but not risk-averse way and selectively apply risk management strategies.

Keywords: risk management, risk strategy, risk matrix, dairy farming.

1. Introduction

Since the midterm review, the EU agricultural policy has been undergoing radical changes. While in the past the milk market was strongly regulated, in accordance with the 2003 Luxemburg decisions, far-reaching changes have since been carried out, leading to market liberalization. Dairy farmers are now considerably less reliant on EU safety nets. Instead, they find themselves confronted with new dynamics in the milk markets; the recent crisis on the milk market impressively underlines this development. Today, market policy instruments are used far less frequently to support the market. The intervention prices for butter and skim milk powder, for instance, have been reduced, and subsidies for internal consumption in the EU are also under discussion. Although WTO negotiations have come to a halt, further liberalization of the world market is to be expected. In fact, in December 2005, a reduction in export subsidies and tariffs was already assured on the EU political level. If the WTO negotiations fail, experts expect numerous panel decisions, which could lead to an even faster reduction in consumption subsidies and export refunds.

The abovementioned aspects are the reasons why the income of dairy farmers depends more strongly than before on international price developments for agricultural products and on farmers' entrepreneurial spirit. Price and liquidity risks will become increasingly important in dairy farming[22] and will require a careful identification and assessment of changing market conditions as well as improved risk management at the farm level. The current prices for milk and dairy products on the world dairy market challenge dairy farmers even further so that risk management systems are rapidly gaining in importance.

Most previous studies on political changes and the milk quota abolishment are based on sector and general equilibrium models and highlight the economic consequences of political decisions. These studies mainly address changes in milk prices and quantities and in preferred production regions[17,24,42]. On the other hand, the attitudes and perceptions of dairy farmers as well as farmers' risk management strategies have received little attention. How important the behavioural perspective is, however, has repeatedly been demonstrated by the milk quota system. Although experts have frequently forecasted a fall in quota prices and have pointed out the economic necessity of lowering quota prices, many German farmers have still

offered high prices at the milk quota exchanges, thus stabilizing prices at high levels[5,13]. This example shows that the decision behaviour of farmers is not represented correctly in many economic models and that farmers' actual behaviour is often at odds with expert opinions derived from these models.

Against the background of changing political and market conditions, the objective of this paper is to examine the risk perceptions and risk management strategies of dairy farmers in Germany, the Netherlands, Ireland, France and Switzerland and, from a behavioural science perspective, to derive implications for politicians, consultants and extension services as well as farm management.

2 Risks and Risk Management in Agricultural Enterprises

Risk is one of the most frequently used terms in the economic literature and many different definitions and categories are used. This includes, for example, distinctions between corporate risks and personal risks[14,30]. Other classifications differentiate between pure and speculative risk concepts[25] or between objective and subjective risks[30]. In the context of this study, risk is defined as the uncertainty of decision-makers with regard to future events that is reflected in incomplete information and can result in economic losses or deviations from a priori fixed target values[26]. LEHRNER (2002) categorizes agricultural risks into those which can be influenced by farmers (internal risks) and those outside the reach of farmer's influence (external risks) (cf. Figure 1). The sources of internal risks, like production, equipment and financial risks, are located primarily within the farm and, therefore, can often be managed through internal measures, such as improved hygiene or financial management. External risks, which include market and political risks, are rooted in a farm's environment so that the management has little if any control over the incident rates of these risks[7].

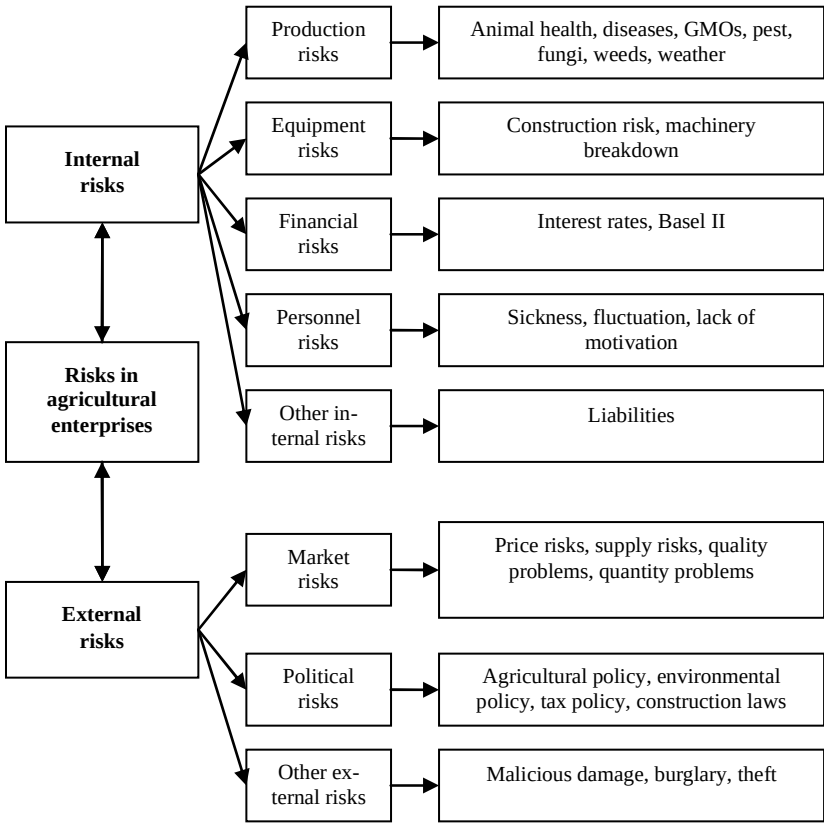


Figure 1. Risks in agricultural enterprises

Source: LEHRNER, 2002.

Systematic risk management allows farmers to identify, quantify, control and monitor risks and potential losses[41]. Risk management strategies are implemented to identify risks in an organization and to respond to those risks in an appropriate way[27]. The risk management process consists of four consecutive steps:

identification, assessment, management and control of risks[19,44]. The identification and assessment of risks are also called risk analysis and provide the basis for the subsequent implementation of risk management measures[28]. Risk identification seeks mainly to describe the potential risks a farm faces. Risk analysis focuses on the quantification of the incident rates of risks and possible damage[9]. In the literature, very different qualitative and quantitative instruments for identifying and assessing risks are discussed, for instance, checklists, risk maps, simulations[27], balance sheets and profit-or-loss statements[1] and methods based on value-at-risk or extreme-value theory[8,29]. Often a constant flow of information is considered to be one of the most important instruments of agricultural risk analysis, particularly when farms are being confronted with increasing external risks, like political and market risks[16]. In the risk management phase following the risk analysis, strategies and measures are chosen for coping with the risks that have been identified and assessed. The aim of implementing risk management instruments is not to minimize the risks a farm faces but to optimize its opportunity-risk profile while taking into account farm objectives and strategies[9,27]. The available instruments can be clustered into four groups; their combination represents a farm's individual risk management strategy mix[6]:

Risk avoidance includes measures that reduce a farm's exposure to internal or external risks. Avoidance of a risk often requires stopping certain entrepreneurial activities. Abandoning dairy production, for instance, allows a farm to avoid risks associated with milk production[9]; at the same time, however, it means that the farm loses the (income) opportunities associated with milk production. Therefore, risk avoidance is a risk management strategy that can only be applied selectively.

The *risk reduction* strategy consists of measures that reduce incident rates, or potential damages or losses. This category includes such diverse measures as the use of technical aids, such as fire alarm systems, and the diversification of farm activities in order to improve the mixture of risks a farm is exposed to[9.23]. Since risk reduction does not imply a complete stoppage of any economic activities, this strategy can be used in a much more flexible way than the risk avoidance strategy.

Measures that reduce the incident rates of risks cope primarily with internal risks and, thus, are usually part of the daily farm management activities. Thus, their nature is predominantly an operative one. For example, the production risks assoociated with animal production can be reduced through compliance with hygiene and quarantine rules, good housing conditions, appropriate feeding management and regular animal health checks by a veterinarian[15].

Measures that reduce potential damages or losses often have a more strategic character, for instance, risk spreading through diversification. Generally speaking, guaranteeing strategic flexibility is of central relevance with regard to risk reduction[40]. This strategy can be implemented by such means as hiring subcontractors instead of investing in one's own machinery. Horizontal cooperation between farmers is also being discussed as a potential means of reducing risk[10]. Last but not least, entering niche markets with higher price stability can also help to reduce a farm's risks.

With the help of a *risk transfer* strategy, the consequences of risk incidences are transferred to other—in many cases professional—risk-taking institutions. Typical instruments are fire insurance, crop insurance[4], weather derivatives[2,29] and the use of commodity futures exchanges[35]. Current agricultural economic research strongly emphasises advanced risk transfer strategies such as the use of weather derivatives. Nevertheless, in day-to-day farm management, much simpler instruments, like hail, fire, legal protection and occupational disability insurance, still dominate. More complex instruments, such as multiple risk insurance or weather derivatives, are still in their infancy and. although insurance companies have started to offer some of these products, have yet to be broadly implemented by farmers. Another strand of research addresses growing risks on the input side. Adjustment clauses for land-leasing and crop-sharing contracts, for instance, share the yield and price risks in arable farming between leaseholders and landowners[20,39]. Risks can also be transferred to buyers by such methods as long-term contracts with price guarantees; however, this alternative is still somewhat unpopular among many farmers in Western countries[34].

The *risk acceptance* strategy is preferred where risks have not been identified or where other strategies are technically impossible. However, this measure can also be used deliberately in order to avert cost-intensive risk avoidance, reduction or transfer strategies[3]. Empirical research shows that the determinants of risk acceptance are manifold and heterogeneous[32].

Risk control is the final phase of the risk management process. Its aim is to figure out whether the risk management strategies implemented have been successful and the desired degree of security has been

reached. Furthermore, risk control allows the strengths and weaknesses of risk management systems to be assessed, new requirements to be identified, and the cost-benefit ratio of specific measures to be improved[12].

The risk management process outlined so far assumes a highly rational decision-making process in which information is gathered and processed systematically. Nevertheless, empirical studies show that individual as well as organisational decision-making processes are characterized by various anomalies that represent deviations from strictly rational decision making[18,36]. Farmers' actual risk perception and risk management strategies have seldom been examined from this perspective. Instead, most research still assumes rational decision-making behaviour in the field of farm risk management. This study addresses this shortcoming in agricultural economic research and contributes to a better understanding of farmers' decision-making behaviour in the field of risk management.

3 Methodology and Sample

Data on farmers' risk perception and risk management strategies have been collected in comprehensive face-to-face interviews with farm managers using a standardised questionnaire. The latter contains ten-point scales (1 to 10) that allow evaluation of farmers' risk perception and assessment. The risks included in the questionnaire were discussed with farm consultants, dairy experts from extension services, farmers, scientists and members of farmers associations. The survey uses five-point Likert-scales to measure the attitudes of the dairy farmers interviewed. These scales are coded from -2 ("I fully disagree.") to +2 ("I fully agree."). Socio-demographic data and information on farm operations are asked for at the beginning and end of the questionnaire.

Interviews with 236 dairy farmers in Germany, case studies on dairy farms in France (14), Ireland (13), the Netherlands (15) and Switzerland (12) and semi-structured interviews with dairy consultants in each country took place between June and September 2007. The survey focused on comparatively large agricultural enterprises. That implies that only full-time farmers operating farms with at least 50 dairy cows and about 100 ha of farmland were interviewed. Of the interviews, 83 % took place in the German federal states of Lower Saxony, Hesse and the Rhineland-Palatinate, which can all be considered major milk-producing areas in Germany. Due to the selection of respondents, the share of large dairy farms is higher in the sample than in German agriculture in general and, therefore, allows statements mostly about larger, future-oriented dairy farms. Due to the small sample sizes in the other European countries included in the study, the case studies provide snapshots. None of the empirical studies can claim representativeness. The focus on larger farms is due to fast structural changes in dairy farming, which will result in larger average herd sizes in the future. Table 1 gives a comprehensive overview about the farm structure in the countries surveyed.

Table 1: Farm structures in the sample

	Germany	Nether-lands	Ireland	France	Switzerland
Number of farms (n)	236	15	13	14	12
Average size of land (ha)	150	66	120	110	27
Share of grassland (%)	37	83	67	36	78
Share of ownership (%)	47	68	25	27	54
Average number of dairy cows per farm	87	105	140	50	38
Average milk yield per cow per year (kg)	8,915	8,386	6,600	9,000	7,189

The farms surveyed in Germany keep on average 87 dairy cows, while the overall German average is 38 cows per farm. The size of land managed on the farms surveyed (149.6 ha) is also larger than the German average (42.7 ha). Of the respondents, 13.8 % manage more than 200 hectares and 15.2 % manage

between 100 and 150 hectares. The annual milk yield per cow—a central figure for the production efficiency of dairy farms—is 8,915 kg per year; this is again far above the German average (6,849 kg per year and cow in 2006)[1]. Most of the farms surveyed are farmer-owned individual enterprises (74 %). Of the farms included in the study, 23.4 % are managed as non-trading partnerships, 1.7 % as limited liability companies and 0.9 % as limited partnerships; 6.3 % of the farmers have an annual profit of less than €20,000 59.7 % earn between €20,000 and €60,000 per year and 16.3 % of the farmers have an annual profit of more than €80,000.

While 95.7 % of the interviewees are male, 4.3 % are female,. The average age is almost 41 years. The respondents are the main decision-makers on their farms: 83.3 % are owner-managers, 15.5 % successors and 0.9 % managers of dairy enterprises employed by the owner(s). The level of education is also high in the sample: 12.4 % have completed a university degree in agriculture, 47.0 % have completed a higher apprenticeship in agriculture, 20.5 % are agrarian management experts (two-year technical college) and 13.2 % have attended a technical college for one year. Only 4.7 % did not absolve any higher school after finishing their basic agricultural apprenticeships, and 13.2 % of the farmers interviewed have no agricultural education at all.

4 Results

The following results reflect the risk perceptions of the dairy farmers surveyed. The results are subjective assessments. As such, they can differ from expert opinions and are not necessarily the result of in-depth management calculations; they can also represent feelings or assumptions. Therefore, they provide insights into farmers' perceptions and subjective evaluation as well as their decision criteria and decision behaviour.

4.1 Risk Perception and Risk Assessment in Germany

4.1.1 Willingness to Take Risks and Importance of Various Risks

With regard to farmers' willingness to take risks, the results are mixed and, at first sight, seem contradictory. On the one hand, the mean values of two statements that express risk-averse attitudes ("I prefer to be on the safe side in milk production rather than take a risk" and "I avoid risky decisions in dairy production") signal some agreement on the side of the respondents ($\mu = 0.34$; $\sigma = 0.836$ and $\mu = 0.33$; $\sigma = 0.824$). On the other hand, most farmers agree with the statement "I accept risks in order to reach my farm objectives" ($\mu = 0.67$; $\sigma = 0.691$), while only 1.3 % of the farmers disagree with it. Obviously dairy farmers are aware of the fact that operating a farm always includes some risks and that these risks have to be accepted. Cross-tabulations show that 41.5 % of the farmers are willing to take risks, whereas 25.2 % are markedly risk-averse. The other farmers answer either indifferently (14.1 %) or inconsistently (19.2 %). The latter can be explained by reference to differences in risk behaviour in different farm operations (for instance, dairy production and arable farming) or with behavioural uncertainties.

The relative importance of the three risk groups—political, market and production risks—was measured with the help of a constant sum scale. The interviewees were asked to attach a total of 100 points or percentage to the different risk groups in accordance with their relative importance for farm operations. In the end, the three risk groups obtained almost the same weight. Market risks received on average 35.8 %, political risks 33.2 % and production risks 31.1 %.

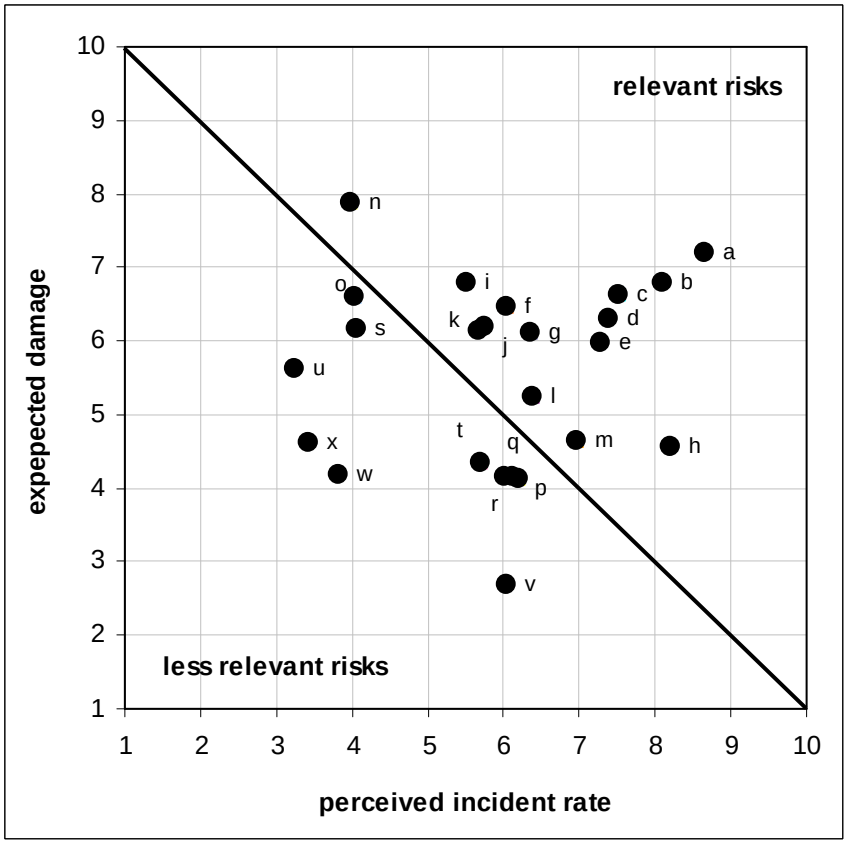
4.1.2 Risk Assessment

Risk assessments take into account the incident rates and the damage or loss potentials of the relevant risks. In the questionnaire these two aspects were addressed separately for each risk. In order to acquire a better overview and ranking of the potential risks in dairy farming, the expectation values were calculated by multiplying the incident rates and the damage potentials of the risks.

[1] Since the main focus of the study was on Germany, only the German survey results are published here. For other national averages please see EUROSTAT.

Figure 2 summarizes farmers' risk perceptions and assessment in a risk map. The incident rates are shown on the abscissa (1 = "very unlikely" to 10 = "very likely") and the potential damages or losses on the ordinate (1 = "no consequences at all" to 10 = "threatening my existence"). The two-dimensional diagram shows the different risks taking into account farmers' average perceptions of the incident rates and damage potentials of risk. The risk map sheds some light on the relevance of various risks from the farmers' perspective and how these risks should be managed. Risks with a high incident rate but low possible damage, for instance, have to be managed differently from risks with low incident rates but high loss potential.

The diagram once again confirms that the most important risks for German dairy farmers are (a) increasing feed prices, (b) increasing land lease prices and (c) reduced land availability. These risks are characterized by quite high incident rates as well as potential damage.



a: Increasing feed prices, **b:** Increasing land rents, **c**: Reduced land availability, **d:** Increasing legal requirements, **e**: Increasing fluctuations of milk prices, **f**: Unscheduled reduction in direct payments, **g**: Tighter cross-compliance regulations, **h:** Political decision for a phase-out of the milk quota system, **i**: Reduced equity capital growth rate, **j**: Loss of labour units, **k**: Animal diseases, **l**: Increasing climate changes, **m:** Further liberalization of EU milk market policies, **n:** Sharp milk price decreases, **o:** Insolvency of my dairy, **p:** Further thinning of milk production in my region, **q:** Increasing quality requirements, **r**: Further thinning of dairies, **s:** Quality scandal with milk and dairy products, **t**: Loss of influence of my dairy, **u:** Worsening image of dairy farming, **v:** Decrease in quota prices, **w**: Reduced acceptance of dairy farming, **x**: Increasing problems to find a new buyer for my milk, **y**: Introduction of exit or adjustment subsidies.

Figure 2: Risk map dairy farming in Germany

Market Risks

With regard to market risks, price risks on input markets have first priority for the farmers surveyed. Increasing feed prices are attributed a very high probability and a high loss potential. Therefore,

increasing feed prices are perceived as the single most important risk by dairy farmers (expectation value: 62.35). Other very important risks are increasing land lease prices (54.92) and reduced land availability (49.78).

Farmers who are sceptical about biogas production attach a comparatively high loss potential to the rising prices of feed and land. This is supported by correlations between, on the one hand, the statement "As a dairy farmer, I have no chance against the bioenergy boom" and, on the other hand, the perceived damage potential of increasing feed prices ($r = 0.293$ ***), increasing land leasing prices ($r = 0.290$ ***) and a reduced availability of land ($r = 0.235$ ***). This strong focus on factor prices is obviously influenced by the price trends on the world agricultural markets during the survey period and land scarcities resulting from the discussion on and public support of bioenergies. Farm size and other aspects of farm structure do not influence farmers' perception of the most important risks.

Political Risks

Political risks are ranked second. This category includes a tighter legal framework for dairy production and increasing documentation and control requirements (including cross-compliance regulations). Obviously, farmers strongly fear an increase in the bureaucratic burden on their farm businesses. Dairy farmers who consider the damage potential of increasing cross compliance requirements to be high also feel significantly more restricted by the European agricultural policy (correlation with the statement "The agricultural policy restricts me more and more" is $r = 0.224$ ***).

Furthermore, many dairy farmers consider an unscheduled reduction in direct payments probable and assess the financial consequences of such a measure as being quite severe. I)t is assumed that further reductions in or caps on direct payments will be introduced. Altogether, 46.6 % of the farmers are aware of their dependence on agricultural policy ($\mu = 0.47$; $\sigma = 0.89$).

The dairy farmers regard a possible phase-out of the milk quota system as very likely but do not expect important negative consequences for their farms. The expectation value (incident rate multiplied by loss potential) is lower than the value for a potential reduction in direct payments. Larger dairy farmers assess the risk of the milk quota system being phased out lower than do smaller dairy farmers (correlation with the number of dairy cows: $r = 0.196$ **).

The farmers surveyed are not worried about the potential consequences of a further liberalization of EU milk market policies, whereas the probability of such a development is considered quite high. The favourable market trends for dairy farmers in the year 2007 seem to have influenced this judgement. Larger farms have more positive attitudes towards further market liberalization. Nevertheless, 44 % of the farmers surveyed feel strongly dependent on the milk market.

Similar to many market analysts, dairy farmers expect increasing fluctuation in milk prices, however, they do not expect milk prices to decrease. Out of 25 risks mentioned in the questionnaire, the probability of decreasing product prices is ranked only 22nd. A low standard deviation ($\sigma = 2.037$) shows that the farmers tend to agree in this respect. Farmers, however, who are better informed and invest more in professional advice and training, assess the probability of sharp price reductions in future to be significantly higher. Recent market developments have clearly demonstrated the risk of sharply declining milk prices. Whereas farmers do not expect negative consequences from growing price fluctuations, remarkably lower milk prices are considered the risk with the highest loss potential. All in all, dairy farmers seem to assume markets will fluctuate more and more, but, at the same time, they tend to expect milk prices to remain high overall.

The decreasing ability of a farm to accumulate equity capital is considered an important risk. This is not surprising since the increasing capital requirements of growing farms and changing credit rating processes in the banking sector mean that having a dependable supply of equity capital is gaining in importance. Furthermore, equity capital is a safeguard against liquidity risks in times of low milk prices.

The farmers surveyed consider the structures of the German milk market as relatively stable. They expect a decreasing number of dairy companies but, however, do not see difficulties in selling their milk. A reason for this evaluation could be that the farmers consider their own dairies to be in a secure and stable position. Nevertheless, a high standard deviation ($\sigma = 3.078$) indicates that farmers do not agree with regard to the problems that may stem from further structural changes in milk processing.

Increasing quality requirements for delivered milk are regarded as quite probable, but they are not viewed as a challenging problem. On the contrary, farmers attribute a high loss potential to possible quality

scandals but consider them quite unlikely. Similarly, the majority of the dairy farmers do not anticipate the image of dairy farming to worsen in the wider population, although potential damage of such a development is regarded as quite significant. On the other hand, a local lack of acceptance of dairy farming, such as residents' complaining about new cowsheds, is not perceived as an important risk.

Production Risks

Besides market and political risks, production risks represent another important group of agricultural risks. Altogether, a loss of workers (family or employees) due, for instance, to accident or illness is considered the most important production risk with comparatively severe consequences for the farms. Farms with a higher number of hired employees can more easily compensate for such problems and, therefore, tend to perceive this risk as less important.

Despite the rapid spread of bluetongue disease and other incidents, such as the foot-and-mouth epidemic in the United Kingdom in 2001, incident rates ($\mu = 5.66$) and potential damage ($\mu = 6.14$) from animal diseases are perceived as only relatively modest. Similarly, quality scandals with milk and dairy products (due, for instance, to food safety incidents or the use of GMO feed) are not considered very likely. Obviously influenced by the currently strong media presence of the topic, farmers assume a higher incident rate of possible climate changes ($\mu = 6.38$). However, they judge the damage to their individual farms that would be caused by climate changes to be rather low.

4.1.3 Risk Management Strategies

After surveying farmers' risk perceptions, the implementation of generic risk management strategies—risk acceptance, risk reduction, risk transfer and risk avoidance—was analyzed (see Table 2).

The empirical study revealed that farmers strongly rely on *risk acceptance* strategies. These include a wide spectrum of measures that allow farmers to cope with higher market pressures and intensified competition between dairy farms; significant among these measures are productivity increases (83.3 %), cost reductions (80.7 %) and growth of the dairy business (71.1 %). Of the farmers interviewed, 60.5% wish to continue specialize in dairy farming. Despite the probable end of the milk quota system, 47.0 % of the dairy farmers still wish to buy milk quota in order to fuel their growth strategies.

With regard to *risk reduction*, cooperatively organized purchases of input factors, which reduce price risks associated with such purchases, are favourites among farmers (83.3 %). The picture is more mixed with regard to sales cooperatives ($\mu = 0.26$). Whereas 42.9 % of the farmers can imagine entering this form of horizontal cooperation, another 24.7 % strongly reject this option. Production cooperatives are also assessed very differently. A large group of dairy farmers want to strengthen these cooperatives in order to meet future challenges, whereas many other farmers strongly reject the idea of giving up their entrepreneurial freedom.

Diversification and activities in less price-sensitive niche markets are also risk reduction strategies. Generally speaking, diversification is of minor importance for large dairy farmers. Only 17.6 % can imagine starting up new farm businesses, whereas 44.6 % do not wish to diversify their farm activities. Answers are more mixed with regard to market niches, such as organic dairy production. Although 54.5 % of the dairy farmers are not interested in this type of production, a high standard deviation indicates that at least some farmers have a different opinion.

Risk transfer strategies mainly rely on insurance. Nearly all farmers have some kind of insurance against the most important risks; among these are fire insurance (100 %), business liability insurance (99.6 %), occupational disability insurance (88.3 %), legal protection insurance (78.1 %), building insurance against storm (69.2 %), environmental liability insurance (64.1 %), crop insurance (64.0 %), hail insurance (56.3 %) and business interruption insurance (27.8 %). Despite a high insurance quota, many farmers do not want to transfer all risks through insurance due to the high costs entailed. Nevertheless, farmers who already have covered many risks with insurance are more likely to sign additional insurance contracts (correlation $r = 0.298$ ***).

Long-term contracts with suppliers including price guarantees are another form of risk transfer. Of the dairy farmers who completed the questionnaire, 31.2 % are willing to accept long-term contracts with their dairies. Others prefer shorter, more flexible contracts (36.8 %). Nearly one-third of the interviewees are indifferent. Due to the possible phase-out of the milk quota system, the existing forms of contracts between dairy farmers and processors will have to undergo some adaptations[43].

Most respondents do not wish to completely *avoid risks*; 87.7 % of them cannot imagine giving up dairy farming, and 77.3 % do not wish to stop investing in milk production. Of course, the sample characteristics—most respondents have large, future-oriented farms—contribute to these results.

Correlations between willingness to take risks and preferred risk management strategies are clearest with regard to growth and exit strategies. Risk-averse farmers tend, to a significantly higher extent, towards quitting dairy farming. Moreover, they are less likely to fully specialize their farm business or to hire additional workers.

Table 2: Risk management strategies

Risk management strategies	**Mean**[1] (root mean square deviation)	**Acceptance**[2] (in %)	**Rejection**[3] (in %)
Risk acceptance strategies			
[4]... increase growth in output of milk production.	1.22 (0.771)	83.3	2.1
[4]... decrease costs of milk production.	1.08 (0.847)	80.7	5.2
[4]... expand milk production.	0.87 (1.069)	71.1	12.5
[4]... specialize in dairy cattle husbandry.	0.67 (1.070)	60.5	14.6
Risk reduction strategies			
I will contract with other milk producers to collaboratively buy resources (feed, technology).	0.47 (0.933)	51.1	12.4
I will cooperate with other milk producers to market the milk collectively.	0.26 (1.081)	42.9	24.7
[4]... cooperate with other farmers.	0.06 (1.061)	32.6	29.6
[4]... have new enterprises on my farm.	-0.28 (0.967)	17.6	44.6
If there is an opportunity for me, I will enter a market niche (e.g., cheese specialties, priority milk etc.)	-0.48 (1.132)	21.1	57.3
Risk transfer strategies			
[4]... obtain insurance.	0.11 (0.880)	28.2	19.2
I will focus on long-term delivery agreements with my dairy.	-0.10 (1.098)	31.2	36.8
Risk avoidance strategies			
I will not invest in dairy cattle husbandry anymore.	-1.01 (1.071)	12.4	77.3
[4]... stop dairy cattle husbandry.	-1.36 (0.882)	4.3	87.7
In the future I will run my farm as a part-time business.	-1.51 (0.730)	2.1	95.3

[1] Spectrum from -2 "I fully disagree" to +2 = "I fully agree"
[2] "I fully agree" and "I agree"
[3] "I fully disagree" and "I disagree"
[4] "In the future I will ....."

There are also significant correlations with the number of dairy cows. Larger farms more frequently wish to enlarge their dairy production. Smaller farms can more frequently imagine continuing dairy production as a part-time farm. Therefore, investments in the dairy business are less important for smaller farmers. As a result, it is the farm enterprises that are already large that wish to grow even further.

Systematic relationships between risk assessment and risk management strategies can be observed in at least some cases. Farmers who expect input factor scarcities to increase or milk prices to fluctuate strongly tend to prefer short-term delivery contracts with their dairies in order to maintain higher marketing flexibility (r = -0.132*). Price increases for fodder and unstable milk prices are met primarily by improved performance in milk production (r = 0.145 *, r = 0.163 *).

Farmers who fear they will lose influence on their dairy tend to form milk producer associations (r = 0.145 *). The exit strategies of dairy farmers correlate significantly with the fear that dairies will thin out (r = 0.217 ***). Farmers who assume that equity growth rates will decline in future are more willing to form purchasing cooperatives with other dairy farmers (r = 0.154 *) but reject long-term contracts with their dairies (r = -0.198 **).

However, several *a priori* expected relationships between risk assessment and risk management strategies did not pass the empirical tests. For instance, the perceived risk of increasing factor prices has no influence on farmers' willingness to collaboratively purchase fodder. Furthermore, there is no relationship between their assessment of market risks and the way farmers design their relationships with their dairies. Similarly, farmers who fear the number of sales possibilities or dairies in their region will decline do not strengthen their efforts to find long-term sales opportunities. On the contrary, these farmers prefer flexible, short-term contracts with their dairies (r = -0.146 *).

All in all, the correlation between risk assessment and risk management strategies is rather low, and risk management strategies are only used in the face of certain risks. This may, in some cases, indicate a lack of suitable risk management strategies. In other cases, however, it may indicate that farmers lack know-how in the emerging field of agricultural risk management or that they underestimate the relevance of some risks. These indications may also explain why some strategies have not implemented on German dairy farms.

4.2 Risks and Risk Management in a European Comparison

Additional case study evidence was obtained to compare the risk perceptions and risk management strategies of German dairy farmers with the perceptions and strategies of dairy farmers in other European countries. The importance of the various risk categories (policy, market and production risks) was analyzed using a continuous scale. Respondents were asked to allocate a total of 100 percentage points to the various risks with regard to their own farms. Looking at risk perception, farmers in France, Ireland and the Netherlands assess policy and production risks highest. By contrast, Swiss farmers attribute higher importance to production risks than to policy or market risks.

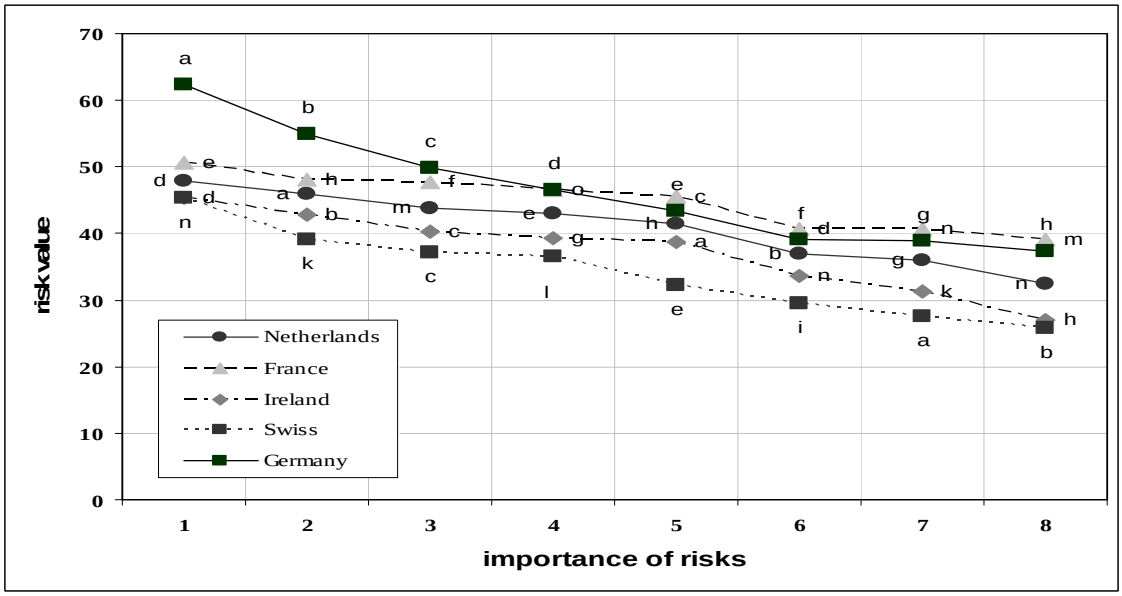
Risk matrices for the other countries participating in the empirical study were analyzed in a similar way to Germany (cf. Figure 2). Figure 3 compares the eight most important risks as perceived by dairy farmers in those countries. The ordinate shows the risk value. This value was calculated by multiplying the incident rates of risks (coded: 1 = "very unlikely" to 10 ="very likely") and the respective loss potentials (coded: 1 = "no effect" to 10 = "may cause loss of existence"). In the questionnaire, these two points were addressed separately.

Looking at the highest ranked risks, especially political risks, it shows that dairy farmers in France, Ireland, Germany and the Netherlands mainly fear a higher degree of (environmental) regulation (d) and increasing cross-compliance regulation (g). Farmers in Germany and France also expect subsidies to decrease (f). Dairy farmers across Europe also agree when classifying as potential risks further liberalization of the EU milk market (m) and the end of the milk quota system in the next few years (h).

With regard to market risks, farmers in most countries expect more volatile milk prices (e) in the future. Only Irish dairy farmers do not expect increasing price fluctuations. Even though most farmers expect higher price fluctuations in the future, they disagree with regard to the extent of potential losses. French dairy farmers expect high losses, whereas farmers in the other European countries assess the potential impact as somewhat less threatening. Rather than price fluctuations, a strong price decrease (n) is perceived as having the most negative consequences for dairy farms. In this context, farmers in France, Ireland and Switzerland worry about the possible impact of bankruptcies among dairies, even though they do not consider this very likely.

The assessment of production risks varies a lot between the countries analyzed. All dairy farmers expect increasing feed costs (a), increasing land rents (b) and a reduced availability of land and assess these as

the greatest risks. In Switzerland, farmers also expect a high impact from livestock diseases and climate change. In the other countries, these risks received lower risk values.



a: Increasing feed prices, **b:** Increasing land rents, **c**: Reduced land availability, **d:** Increasing legal requirements, **e**: Increasing fluctuation in milk prices, **f**: Unscheduled reduction in direct payments, **g**: Tighter cross-compliance regulations, **h:** Political decision to phase out the milk quota system, **i**: Reduced equity capital growth rate, **k**: Animal diseases, **l**: Increasing climate changes, **m:** Further liberalization of EU milk market policies, **n:** Sharp milk price decreases, **o:** Insolvency of my dairy.

Figure 3: Risk assessment in five European countries

Overall, it is obvious that German dairy farmers assess the increasing costs for feedstuff and increasing land rents as far more threatening than do dairy farmers in other European countries. This may result from the very strong political support for bioenergy production in Germany. As a consequence, farmers face strong competition mainly from subsidized biogas plants. The situation is different in other countries, where the support for agricultural biogas production is not as high as in Germany. This also results in a more sceptical assessment of bioenergy production in Germany than in the other countries.

Risk Management Strategies

With regard to risk management strategies, competitive farm structures are gaining in importance for the dairy farmers participating in our empirical study. In this context, increasing specialization and the growth of dairy operations are the most important strategies in most countries, with the exception of France. A strong focus on core businesses usually results in farmers acquiring further knowledge and making economies of scale, both of which lead to lower production costs. French and Irish dairy farmers in particular still consider the extensification of dairy production a way to further reduce production costs, whereas farmers in Germany, the Netherlands and Switzerland do not see the benefits of this strategy. Diversification is regarded as a good strategy for sharing risks between different markets but, all in all, it is not a strategy that will likely be implemented by the dairy farmers interviewed.

In France, farmers strongly focus on cooperative arrangements with other farmers in order to hedge risks and to realize economic and social goals. This is mainly due to strict quota trading regulations and limitations on buying land in France[21]. Similar to single farms with growth strategies, co-operatives can realize economies of scale and increase their productivity in order to be less dependent on market and policy developments. At the same time, the workloads of family members can be reduced[33].

In order to acquire higher prices for their milk, Swiss dairy farmers do not cooperate in producing but in marketing their milk. French farmers sign long-term contracts with dairies in order to realize higher milk prices (see also EDF Report 2008[11]).

All in all, our results show that—with only minor exceptions, such as Switzerland—dairy farmers throughout Europe value risks in very similar ways. Furthermore, risk management strategies are also quite similar, and hardly any differences between German and other European dairy farmers can be observed.

5 Conclusions and Implications

Since the midterm review, EU agricultural policy has been characterized by remarkable changes. The reduced use of market support instruments on the milk market is the most important reason why dairy farmers will be more strongly exposed to market risks in future and will have to adapt their strategies to the new uncertainties resulting from this development. Against this background, it was the aim of this study to analyze the risk perceptions and risk management strategies of dairy farmers in five European countries from a behavioural science perspective. The results allow dairy farmers, consultants and extension services as well as politicians to optimize their contributions to risk management in dairy farming.

Empirical results show that dairy farmers are conscious of risks but are not extremely risk-averse. Since every farm business necessarily requires the acceptance of some risks, farmers are ready to make risky decisions when it seems necessary. Therefore, farmers have already implemented a basic risk management system on their farms. Nevertheless, in the next few years, the development of more comprehensive, continuous and integrated risk management concepts will have a high priority for dairy farmers. This is due not only to increasing volatilities on milk markets, which may also mean long periods of very low prices, but also to increasing debt rates and liquidity problems among dairy farmers with growth strategies and non-family hired labour. Improved risk management may include closer cooperation between traders, processors, insurance companies, banks, consultants and research institutions. Recently launched new products, like multiple risk insurance, show that important developments have started from the perspective of a more systematic agricultural risk management.

Through such an integrated risk management system, farmers should first try to acquire an overview of all internal and external risks and potential damage their farms are exposed to. Next, farmers should conduct what might be termed a “health-risk check” for their farms: all risks should be analyzed and weighted in order to find the best risk management strategy for each farm. Currently very low milk prices show the obvious necessity of strict liquidity management as part of a farm’s risk management approach. Farm consultants and extension services play a crucial role in implementing farm-specific integrated risk management systems. Since farmers often do not have the necessary know-how or lack sufficient time, advisors have to provide the required services in the field of risk management. When implementing risk management concepts, they have to pay attention to the security level desired by the individual farmer and the cost-benefit ratios of alternative measures. Like financial statement analysis, risk management should be understood as a process to be carried out at least once a year in every agricultural enterprise. Since the balance sheet and the profit-or-loss statement can be important instruments of agricultural risk management[1], it seems useful to closely coordinate the analysis of the farm’s financial situation, the controlling of its risks and the design of the risk management approach.

Farmers can cope with market and price risks through transactions at the commodity futures exchange, horizontal cooperation, long-term contracts with processors or financial measures like excess liquidity. Farmers also have several alternative ways of managing production risks, which are—with the exception of animal diseases—largely controllable through internal measures. Nevertheless, improvements are still possible. One crucial improvement could be the implementation of measures that safeguard farms against milk price risks. There have already been initial attempts. The German milk industry association, for instance, currently checks whether futures contracts for milk can be traded at commodity futures exchanges. Such measures are becoming more and more important because investment decisions and the long-term competitiveness of dairy farming strongly depend on the medium and long-term development of milk prices.

It would improve the acceptance and use of advanced risk management instruments such as commodity futures exchanges and multiple risk insurance to provide farmers with more training in these measures, which are not always well understood. Examples from other commodities (for instance, slaughter pigs) show that farmers do not very often use this means of hedging price risks[36]. One explanation could be that futures markets are too complicated and that most farmers are not acquainted with these markets.

More information and training could be provided by consulting and extension services, processors, insurance companies and farmer associations. Furthermore, a good marketing strategy could help popularize the use of such instruments.

Since the price risks of input factors such as fodder and arable land have gained great importance for dairy farmers, it would be a valuable risk management concept if governments refrained from granting above-average financial support for certain market segments, such as the bioenergy sector, as this practice creates market distortions and exposes dairy farmers to high political and market risks.

Production risks do not receive much attention from dairy farmers with the exception of Swiss farmers. It is the joint task of politicians, public administrations and farmers to secure the currently high level of animal health and disease management in European dairy farming. Farmers, processors, industry associations and political decision-makers could contribute to advanced risk management by installing an insurance system that protects farmers against bankruptcy in case of animal diseases. Avian influenza and bluetongue disease have reminded many experts of the possibility of new diseases, especially given the conditions of global warming and the increasing globalization of markets.

Individual dairy farmers can hardly influence political risks. This may explain why many farmers perceive increasing legal requirements and cross-compliance regulations as highly relevant risks. We also know from other areas, such as drug use (for instance, smoking) or food safety (BSE, GMOs etc.), that the controllability of a risk strongly influences people's risk perceptions[31,38]. This raises the question of how the reliability and calculability of administrative controls can be improved in order to avoid farmers perceiving these measures as uncontrollable external risk. Replacing control-oriented measures through goal and motivation-oriented measures might be a possible solution.

Currently high political risks require great attention from farmers and distract managerial capacities of the farms' core businesses. Quick and reliable political decisions about the future of the milk quota system would considerably reduce political risks as perceived by farmers and would allow them to focus on improving their production processes, efficiency and competitiveness. Therefore, there is a great need for early and reliable decisions on the future of the milk quota system and other political regulation of the milk market.

Next to policy risk, it is mainly those risks that had a strong media presence during the survey period that are highly perceived by dairy farmers. Farmers focus, for instance, on competition for land between bioenergy and fodder production. On the other hand, other important risks, such as the increasing volatility of milk prices, were seen as rather low risks during the survey period. Furthermore, the perception of disease risks is surprisingly low. This underestimation of what are, in fact, important risks indicates important decision anomalies which could have a strong impact on the future of dairy farms. Therefore, it is very important that advisers and banks introduce additional risk checks and other measures, for instance, only granting loans if the liquidity situation of the farm is sufficient even in times of lower milk prices.

The results show that risk perceptions and assessments and risk management strategies do not differ much among the countries surveyed except where strong national policy interventions on markets can be observed (for instance, bioenergy support in Germany or quota trade restrictions in France).

All in all, the behaviourist approach applied in this paper has provided new insights into farmers' decision-making behaviour. Due to the selection of the sample, data on incident rates and estimated damages can be considered good indicators for the opinion of future-oriented dairy farmers in Europe. Therefore, this study complements more traditional rational choice-based approaches that rely on stricter assumptions regarding human decision-making behaviour. A combination of both perspectives seems a promising way to improve our understanding of how risk management instruments should be designed (normative approach) and how farm managers actually perceive risks and apply these instruments (descriptive approach).

All in all, it is striking that the dairy farmers surveyed are characterized by a quite strong optimism and great confidence in existing safety nets and risk management strategies. Against this background, there is a need for further research in order to explain this possibly "unrealistic optimism" and "overconfidence" in some areas and to better understand farmers' decision making behaviour. It could also be interesting to repeat a similar study under the influence of the currently much lower milk prices.

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