CHAPTER 11

THE INSURABILITY OF PRODUCT RECALL IN FOOD SUPPLY CHAINS

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Abstract. Insurers face growing difficulties with insuring food-related risks among others due to an increasing number of product recalls and an increasing amount of claims being pushed back into the chain. This paper focuses on the risk of product recall in dairy supply chains. The paper aims at providing insurers with useful tools for insurance design and claim handling. More specifically, the objectives of this paper are (1) to define product recall, aimed at recognizing recall perils and losses; (2) to identify important precautionary action points and related control measures, for underwriting and class-rating purposes; (3) to develop a risk assessment framework, as a tool for calculating premium levels; and (4) to evaluate third-party verifiability of due diligence, aimed at identifying eligibility for insurance payments. Precautionary action points are prioritized with adaptive conjoint analysis. In the risk assessment framework, case studies are used to quantify the size of losses. Additionally, throughout the paper, expert consultation has been an important source of information. Results show that perils and losses of product recall need to be strictly defined, preferably on a case-by-case basis. Also, case studies show that recall losses easily cumulate as losses are yet between Euro 210,000 and Euro 2,300,000 for only a limited number of recall expenses and contaminated products. Furthermore, in relation to the third-party verifiability of due diligence, difficulties are encountered at the farm level. We conclude that, if risks are properly defined and insurance schemes incorporate adequate due diligence and disclosure incentives for all chain participants, product recall remains an insurable type of risk, even if the number of recalls will further increase.

Keywords: precautionary action points; risk assessment; due diligence; dairy supply chains; compound feed; insurance

INTRODUCTION

Insuring liability and recall risks in food supply chains is getting increasingly complex. On the one hand, risk prevention gets lots of attention, therewith reducing

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the risk of food safety crises and related liability claims (Segerson 1999; Henson and Hooker 2001; Valeeva et al. 2005). On the other hand, the number of recalls is increasing (Teratanavat and Hooker 2004) and traceability systems allow claims to be pushed back into the chain (Meuwissen et al. 2003). At the same time, third-party verifiability of due diligence is getting increasingly important, both for counterattacking liability claims and for proving the unintentional character of a (recall) loss. Also, with the 2005 implementation of the General Food Law (EC/178/2002) adequate performance with respect to traceability and recalls is no longer facultative but legally required.

Due to such changes in the risk environment of food supply chains, insurers face growing difficulties in designing adequate insurance schemes and in calculating proper premium levels. As a consequence, they may opt for higher risk loadings or an increasing number of perils and losses excluded from cover, therewith reducing the insurability of food-related liability and recall risks. A reduced availability of insurance cover is generally not considered beneficial (Arrow 1996). Skees et al. (2001) specifically address the positive incentives of recall insurance for improving the level of food safety.

Of the various food-related risks, this paper focuses on the risk of product recall. Recall risks are fairly straightforward and work well as an illustration for other food-related risks such as liability risks. We aim to provide insurers with a number of useful tools for debating the future feasibility of insuring product recall. More specifically, the objectives of this paper are:

(1) To define product recall, aimed at recognizing perils and losses.
(2) To identify important precautionary action points and related control measures, for underwriting, class rating and specifying proper rules of behaviour.
(3) To assess the risk of product recall, as a tool for calculating premium levels.
(4) To evaluate third-party verifiability of due diligence, aimed at identifying eligibility for insurance payments.

The objectives (1), (2) and (3) are relevant from an *insurance designing* point of view, while objective (4) is a crucial aspect of *claim handling*.

These issues are studied for dairy supply chains in The Netherlands and, more specifically, for the supply chain of fluid pasteurized milk. This chain is characterized by a few large supplying and processing industries and many small dairy farms (CBS and LEI 2005). Throughout the chain a lot of attention is paid to quality control and assurance (Valeeva et al. 2005) and Dutch consumers believe pasteurized milk to be a very safe product (Novoselova et al. 2002). Recently, only a few recalls have taken place, viz., with respect to penicillin (2001 and 2002) and hydrogen peroxide (2002).

MATERIALS AND METHODS

In relation to the first objective, i.e., a checklist for recognizing potential perils leading to a product recall and their related losses, a review was made of relevant internet pages (European Food Safety Authority, Dutch Food Safety Authority),

insurance programmes (also through internet) and the General Food Law (EC/178/2002).

With regard to the second objective, a list of important precautionary action points and related control measures for underwriting purposes, we studied three chain participants, viz., feed companies, dairy farms and dairy industries, and two food safety perils: chemical hazards and microbiological hazards. More specifically, the chemical hazards include antibiotics and dioxin and the microbiological hazards refer to *Salmonella*, *E. coli*, *S. aureus* and *M. paratuberculosis*. The specification was done after literature research (Cullor 1995a; Collins 1997; Cullor 1997; Gould et al. 2000; Mathews et al. 2001) and consultation with representatives from the dairy industry, research organizations and regulatory authorities. Relevant precautionary action points and related control measures were selected based on a review of the scientific literature (among others Cullor 1995b; Sischo et al. 1997; Veling et al. 2002), current regulations, and individual consultations with experts from the various chain participants considered. In order to prioritize the identified action points, two workshops were organized in October 2002. A total of 22 respondents participated in these workshops. These were four experts from feed companies, thirteen of dairy farms and five of dairy industries. During the workshops respondents had to fill in computerized questionnaires, following the adaptive conjoint analysis (ACA) technique. A more extensive description of these workshops and materials and methods used is given by Valeeva et al. (2005).

In relation to the third objective, i.e., a framework for risk assessment and rating, we focus on the loss part of product recall in dairy supply chains; the *probability* of these losses occurring is not considered. Losses are assessed through: (1) estimating the size of relevant batches in dairy supply chains, and related processing times; (2) calculating the lost value of destroyed products and the costs of handling and notifications; and (3) assessing four case studies varying in point of contamination and allocation. Besides the three chain participants considered previously, this part of the study includes retail and consumers as well. Batch sizes, processing times and recall expenses were verified by farm and industry experts.

For the fourth objective, assessing third-party verifiability of due diligence as an instrument for evaluating the eligibility for insurance payments, we focused on the top-five action points resulting from the ACA workshops. This implies a total number of 30 precautionary action points and their related control measures. The third-party verifiability of the control measures was assessed on a three-point scale, i.e. ‘fully verifiable’, ‘partly verifiable’ or ‘not verifiable at all’, and checked with a lead auditor of an accredited certification body regularly auditing food supply chains. At this stage two mid-points, i.e. ‘fully/partly verifiable’ and ‘not/partly verifiable’ were deemed necessary to adequately reflect third-party verifiability circumstances at the farm level.

IDENTIFYING PERILS AND LOSSES

Insurers generally insure named perils and losses or, in case of ‘all-risks insurance’ there are usually a number of perils and losses specifically excluded. In relation to

the perils leading to a recall, existing insurance schemes often cover 'product recall due to contamination'. This is clearly a food safety issue. However, the 'non-compliance with food safety requirements', as stated in the General Food Law (EC/178/2002, article 19) obviously includes more aspects than only contamination: "if a food business operator considers or has reason to believe that a food which it has imported, produced, processed, manufactured or distributed is *not in compliance with the food safety requirements*, it shall immediately initiate producers to withdraw the food in question from the market where the food has left the immediate control of that initial food business operator and inform the competent authorities thereof (..)".

Besides hazards leading to 'public health at risk', Table 1 lists a number of other food safety aspects that can lead to product recall, such as 'not fit for human consumption', referring to, i.a., spoilage of products and 'faulty claim on label'. An example of the latter is 'fit for diabetics', while due to some mistake the product is actually not fit for this group of consumers. In addition, besides food safety reasons, there can be other motivations for product recall as well, such as non-compliance with aspects of quality or image.

Table 1. *Perils and losses of product recall*

Perils	Scope of losses	Types of losses
Non-compliance with respect to: ▪ *food-safety* requirements, i.a.: - public health at risk - not fit for human consumption - non-compliance with legislation - faulty claim on label ▪ *Quality* issues ▪ Aspects of *image*	▪ *Customer* level: - non-conforming product(s) or batch(es) - suspected product(s) or batch(es) ▪ *Further along the chain*: - non-conforming product(s) or batch(es) - suspected product(s) or batch(es)	▪ *Producer* recall expenses, such as: - decreased value of products - product handling - notifications to customers or end users - relocation of the product - business interruption - rehabilitation expenses ▪ *Customer* recall expenses, such as: - business interruption - increased cost of production - empty shelves ▪ Recall expenses and liability claims *further along the chain*

In relation to the scope of losses, it is obvious to recall *non-conforming* products at customer and consumer level. However, also *suspected* products or batches are generally recalled or destroyed. For any insurance scheme covering losses from 'suspected' batches, it is crucial to define carefully what is meant by this term. For instance, if a dairy farm uses various sorts of compound feed and one appears to be contaminated, does this always mean that all raw milk needs to be destroyed? Also, if a dairy industry recalls a specific batch of consumer milk, does retail always agree with recalling only this specific 'best before' date or do they also return other batches or even other products from the company? And if so, does the insurer

provide cover for this? With respect to the types of losses, Table 1 lists a number of recall expenses, both for producers and customers. For instance, producer recall expenses include the decreased value of the recalled products (values not necessarily reduce to zero as other usages may be possible), costs of handling and notifications, costs of relocating the product, and losses of business interruption and brand rehabilitation. At the customer level there may also be losses of business interruption (e.g., dairy farmers not being able to deliver milk because of some feed contamination), increased cost of production (such as dairy farms facing higher culling rates due to contaminated feed) or retailers being confronted with empty shelves. Similar costs may occur further along the chain, possibly leading to liability claims.

Clearly, although product recall seems to be a straightforward type of risk, it is crucial to define strictly the perils and (scope and types of) losses covered. The wide variety of perils and losses may induce insurers not to generalize 'product recall' across chain participants and supply chains but to define these issues on a case-by-case basis.

IMPORTANT PRECAUTIONARY ACTION POINTS FOR UNDERWRITING

From the review and expert consultation, we identified 82 precautionary action points for the chemical and microbiological hazards considered. More specifically, from these action points, 6 were relevant for chemical hazards, 41 for microbiological hazards and 35 for both. For chemical hazards, more than 50% of the identified action points are at the feed level, whereas 32% and 17% relate to the dairy farm and dairy industry, respectively. For microbiological hazards, the number of action points per chain participant is more equally distributed, but with a focus (40%) on farm level.

For compound feed production, precautionary action points and related control measures refer to purchase, transport and storage of compound feed ingredients and the identification and traceability of both feed and its ingredients. Also there are action points relating to the design of production facilities at the feed plant and the production practices and hygiene conditions for compound feed production and transport. In relation to the dairy farm, precautionary action points include a wide variety of aspects, viz., the purchase and production of feed, the grazing of pastures, cattle movement and its traceability, herd health and treatment, dairy-cattle housing, calving and feeding of calves, water management, and general hygiene conditions at the farm. For dairy industries precautionary action points identified refer to, i.a., transport of raw milk to the processing factory, the design of production facilities at the dairy plant, production practices and hygiene conditions for raw-milk processing, and the delivery of pasteurized milk to the sale unit.

Table 2 lists the prioritized action points from the workshops. The table shows top-five action points per chain participant and hazard. Relative importance is derived from respondents' utilities for action points and related control measures, and expressed as percentages (Valeeva et al. 2005). Numbers illustrate that none of

***Table 2**. Important precautionary action points along the supply chain of fluid pasteurized milk, their relative importance, and third-party verifiability of related control measures*

Precautionary action points	Relative importance (%)[1]	Third-party verifiability[2]
Feed company – chemical hazards (k=21; n=4)		
Procedures and instructions for compound feed production	6.84	Fully
Quality assurance system of feed ingredient manufacturers	6.74	Fully
Adequate cleaning and disinfection of production equipment and premises	5.97	Fully
Finished compound-feed identification and traceability	5.81	Fully
Feed ingredients identification and traceability	5.71	Fully
(Total importance of top-five precautionary action points)	*31.07*	
Feed company – microbiological hazards (k=23; n=4)		
Feed ingredient identification and traceability	9.08	Fully
Quality assurance system of feed ingredient manufacturers	6.03	Fully
Adequate cleaning and disinfection of compound-feed transport vehicles	5.37	Fully
Adequate conditions of feed ingredients storage and intake	5.34	Fully
Quality assurance system of feed ingredient carriers	5.09	Fully
(Total importance of top-five precautionary action points)	*30.91*	
Dairy farm - chemical hazards (k=13; n=12)[3]		
Identification of treated cows in milking parlour	11.22	Fully
Quality assurance system of compound-feed manufacturers	10.50	Partly
Action in case of doubt about the withdrawal period	9.10	Fully/Partly
Origin of forage	8.32	Partly
Best farm practices	7.79	Partly
(Total importance of top-five precautionary action points)	*46.93*	
Dairy farm – microbiological hazards (k=30; n=13)		
Manure supply source	4.40	Partly
Action in salmonellosis and *M. paratuberculosis* cases	4.35	Fully
Acquisition of cattle	4.27	Fully
Udder cleaning before milking	4.16	Not/Partly
Calves feeding before weaning	4.11	Not/Partly
(Total importance of top-five precautionary action points)	*21.29*	
Dairy industry – chemical hazards (k=7; n=5)		
Sourcing raw milk	19.27	Fully
Delivered raw-milk identification and traceability	18.63	Fully
Procedures and instructions for raw-milk processing	14.30	Fully
Finished-product identification and traceability	12.89	Fully
Water used for production purposes	12.64	Fully
(Total importance of top-five precautionary action points)	*77.73*	
Dairy industry – micro-biological hazards (k=23; n=5)		
Finished product identification and traceability	5.97	Fully
Location of sealing equipment	5.96	Fully
Maintenance of the equipment and leakage prevention	5.62	Fully
Adequate cleaning and disinfection of raw-milk collection vehicles	5.21	Fully
Sourcing raw milk	5.09	Fully
(Total importance of top-five precautionary action points)	*27.85*	

[1]For each chain participant and group of hazards, there were *k* action points and *n* respondents. Per *k* action points, importance figures add up to 100%.

[2]Assuming no fraud.

[3]One respondent was removed from the analysis due to a mistake made in the validation profiles.

the top-fives embraces more than 50% of total importance, which equals 100% for each chain participant and group of hazards. (An exception to this is the top-five for chemical hazards at dairy-industry level, which embrace 77.7%, but this is due to the low number of action points, i.e. 7.). These numbers illustrate that many of the 82 precautionary action points are perceived as important in preventing against chemical and microbiological hazards.

Our findings, i.e. a long list of relevant precautionary action points for only two perils, imply that specifying rules of behaviour and classifying the insured based on a number of separate precautionary action points may not be feasible. Instead, insurers might consider 'packages' of measures such as already existing quality assurance schemes demanding defined protocols for a large number of a company's processes.

A RISK ASSESSMENT FRAMEWORK FOR CALCULATING PREMIUM RATES

For a number of dairy supply-chain stages and processes, Table 3 shows the estimated size of batches and related processing times, as well as the calculated lost values of destroyed products and the costs of handling and notifications.

Batches are not specified for all production processes since for our case studies we assume a contamination, or cross-contamination, only to occur in a few stages and processes: through feed ingredients (leading to multiple 4-ton processing batches to be contaminated), the storage of feed at farm level (in silos of on average 14 tons), the storage of raw milk at farm level (in tanks of on average 5 tons), the collection of milk (in trucks of on average 20 tons) and the storage of milk at industry level (in tanks of on average 150 tons). *Average* values of batches and related processing times are used for tracking products forward along the chain. For instance, if a contamination of raw milk at the farm level is notified 2 hours after delivery, we assume that the milk is still in the collection vehicle, not yet in the storage tanks of the dairy industry. Also, in case of tracking the number of farms having received contaminated compound feed this number is based on the amount of feed produced and the average storage capacity of feed at the farm level. *Maximum* batch sizes and processing times listed in Table 3 are used for tracing products back into the chain to identify all suspected product. For instance, if a dairy farm encounters problems with compound feed, the feed supplier's production of the past 336 hours (14 days) becomes suspected. In relation to the product values specified, it is assumed that recalled products must be destroyed. Costs per kg of milk increase from Euro 0.31 per kilo at the farm level to Euro 0.69 at retail level. Notification costs only include media-announcement costs once products reach consumer level.

Table 3*. Framework for risk assessment*

Chain stages, processes and related products	Batch (1000 kg)[1]	Related time (hours)[1]	Recall expenses		
			Product[2] (Euro/kg)	Handling[3] (Euro/kg)	Notification[4]
Feed company					
Processing (feed)	4	8 (4; 24)	0.15	0.25	-
Transport (feed)	*	2 (1; 4)	0.20	0.25	-
Dairy farm					
Storage (feed)	14 (8; 24)	168 (2; 336)	0.20	0.30	-
Storage (raw milk)	5 (3; 7)	36 (1; 72)	0.31	0.15	-
Dairy industry					
Collection (raw milk)	20 (10; 33)	3 (1; 6)	0.32	0.15	-
Storage (raw milk)	150 (100; 400)	10 (1; 24)	0.34	0.15	-
Processing (processed milk)	*	1.5 (1; 2)	0.46	0.15	-
Packaging (processed milk)	*	1.5 (1; 2)	0.54	0.18	-
Transport (processed milk)	*	3 (1; 5)	0.59	0.18	-
Retail					
Storage (processed milk)	*	8 (1; 12)	0.61	0.20	-
Pickup (processed milk)	*	4 (1; 12)	0.66	0.20	75,000[5]
Retail (processed milk)	*	12 (2; 72)	0.69	0.20	75,000[5]

[1]Average value, minimum and maximum between brackets.
[2]Products are destroyed, i.e., salvage value of zero.
[3]Only transportation costs (local) and costs of destruction (full costs, no additional revenues).
[4]Only media costs; as soon as products reach the consumer level, recalls must be announced in the media.
[5]Worst case, i.e. three front-page announcements in major newspapers.
[*]These (much smaller) batches are not specified in this paper.

Table 4 presents a short description of the case studies. The second column of the table shows related products (feed, raw milk, processed milk) and, if clear, an indication of whether these products are at the customer level or further along the chain. The third column includes estimated recall expenses. Case studies refer to (1) 400 tons of contaminated compound feed; (2) 5 tons of contaminated raw milk; (3) 150 tons of contaminated processed milk; and (4) 1 can of contaminated milk at retail level for which the source of contamination cannot be readily detected. Cases (1) to (3) refer to tracking products forward along the chain. They are varied with respect to the promptness of the product recall. Case (4) refers to a situation of both tracking and tracing.

***Table 4**. Case studies risk assessment*[1]

Description	Products[2]	Recall expenses (1,000 Euro)[3]
1. *400 tons of contaminated feed*[4]		
1a. Recall is announced 1 day after delivery. Tracking the feed leads to 30 dairy farms. These farms still have 98% of the feed in their silos and none of the farms has delivered milk yet. All stored milk is destroyed.	Feed[a] Raw Milk[a]	200 35 *235 (total)*
***1b*.** Recall is announced 3 days after delivery. 80% of the feed is still in farm silos. 15 farms have not yet delivered any milk. All stored milk is destroyed. The other 15 farms have already delivered milk to various dairy companies. This involves 4 milk collection vehicles and 2 storage tanks, 1 of which has been processed until packaging and 1 until retail. All this milk is recalled and destroyed as well.	Feed[a] Raw milk[a] Processed milk[b]	160 32 315 *507 (total)*
2. *5 tons of contaminated raw milk*		
***2a*.** Contamination is detected just after delivery. The milk is still in the collection vehicle.	Raw milk	*9.5 (total)*
***2b*.** Contamination is detected after 3 days. The milk was delivered 2 days ago. All the milk went into 1 collection vehicle and 1 storage tank, and is now at retail level. Dairy industry recalls the whole batch. Retail agrees with recalling a single batch and does not remove other batches or products from the shelves.	Processed milk[b]	*210 (total)*
3. *150 tons of contaminated processed milk*		
***3a*.** Contamination is detected just after delivery. The milk is not yet stored in retail.	Processed milk	*135 (total)*
***3b*.** Contamination is detected after 3 days. 50% of the milk is still at retail level; the other 50% has already been sold. Consumers are notified to return purchased cans.	Processed milk[a/b]	*210 (total)*
4. *A retailer finds a can of contaminated milk, produced 2 days ago. The source of contamination cannot be readily detected.*		
2 storage tanks of the related dairy company become suspected. All this milk is at retail level and needs to be recalled. In addition, 60 dairy farms become suspected including their delivered and stored milk of the last 3 days. Stored milk (20%) is destroyed. Delivered milk (80%) is tracked to 6 storage tanks, 50% of which have been processed until packaging and 50% until retail. All this milk is recalled as well, which requires a second media announcement. Also, 2 feed companies become suspected, including their feed production of the past 14 days, implying further (announcements of) recalls of feed and milk. 50% of the related milk has already been consumed; 40% is still at farm level; 10% causes raw-milk destruction and processed milk recalls (compare 1b).	Processed milk[a] Raw milk Processed milk[a] Feed Raw milk[a] Processed milk[b]	340 26 800 800 32 315 *2,313 (total)*

[1]Based on (average) batch, time and cost parameters of Table 3.
[2]Superscript characters refer to the scope of losses (if clear): 'a' relates to products at *customer* level, 'b' to products *further along the chain*.
[3]Value of destroyed products and costs of handling and notification.
[4]Equals compound feed production of average cattle feed factory *per day* (100,000 per year).

Cases studies illustrate that even non-compliance of single batches, or even a single product, can lead to considerable losses. Also, it is illustrated that late recalls

lead to higher losses than early recalls (1b-1a, 2b-2a, 3b-3a). In addition, the fourth case shows that recall losses can easily cumulate. Cases also demonstrate the importance of strictly defining perils and losses of a product recall, as discussed earlier in this paper. For instance, in case 1b, largest losses occur 'further along the chain' – not at customer level. Also, even in situations 2a and 2b neither of the losses is at customer level. In the fourth case, in which the source of contamination is not readily detected, defining the scope of losses is even more difficult. Note that with case 2a, a product recall insurance strictly covering recalls at customer level could yet give the wrong incentives, i.e. to postpone the product recall until the milk is stored in dairy industry storage tanks. As such, the framework and case studies presented provide a useful basis for a structured analysis of recall losses, as a basic element for insurers to estimate adequate premium levels.

THIRD-PARTY VERIFIABILITY OF DUE DILIGENCE

Insurance payments generally cover 'accidental and unintentional losses' (Rejda 1992). In order to verify that the insured followed 'proper rules of behaviour', it is useful for insurers to being able to check the insured's due diligence. Terms are clarified by the following example (derived from Blanchfield (1992) and Schothorst and Jongeneel (1992)): In order to avoid the risk of crossing red traffic lights, a *precautionary action point* relates to the brakes. A relevant *control measure* would be 'brakes in working order'. Then, *due diligence* consists of regular checking that the brakes are indeed in satisfactory condition. This due diligence would be *verifiable* by a third party if (1) the checking is validated to give good insight into the working of the brakes, and (2) the results were registered.

Due diligence thus relates to the proper application of an adequate control measure, and third-party verifiability refers to being able to demonstrate objectively that this proper application is ensured.

The precautionary actions points (Table 2) and their related control measures were validated in literature and through expert evaluations. We now focus on the ability to provide objective evidence of ensuring their proper application. Assuming that there is no fraud, Table 2 (last column) shows that most control measures can be fully verified by a third party, especially those at the feed and dairy industry level. However, at the farm level, not all control measures are fully verifiable. For instance, with respect to 'best farm practices', it is fully verifiable whether there is adequate cleaning equipment, sufficient disinfectants and an adequate level of training of the farmer and his employees, but it is not verifiable whether disinfectants are properly used and people always work according to hygiene rules. For these reasons, 'best farm practices' were assessed to be only partly verifiable. Also, the origins of forage and compound feed were assessed as partly verifiable; although auditors can check accounts of goods purchased, it is not verifiable whether they represent all of the present goods. The same applies to the manure supplied to a farm.

A fully verifiable measure at dairy farms includes, i.a., the 'identification of treated cows in the milking parlour'. To verify whether farmers identify treated

cows in the milking parlour in order to discard the milk of these cows, auditors can check the prescriptions of veterinarians. The same applies for the 'action in salmonellosis and *M. paratuberculosis* cases'. Also, 'acquisition of cattle' is a fully verifiable action point since there is a well-functioning identification and registration system. The 'action in case of doubt about the withdrawal period' is only fully verifiable if farmers consistently carry out tests on their milk; not if they just extend the withdrawal period with a few days.

A farm-level top-five precautionary action point which was assessed as 'not/partly' verifiable is the 'udder cleaning before milking'. Continuous monitoring of the control measures related to this action point, e.g., 'wet cleaning' or 'cleaning with dry towel – one towel per cow' is not reasonable (in case of traditional milking systems). Also, even unannounced hygiene audits would not lead to full verifiability as 'udder cleaning before milking' concerns a typical handling which can easily be changed into desired behaviour during an audit. The same issues apply to the 'calves feeding before weaning': do calves always get milk from a non-suspected cow or are they fed with milk from some arbitrary cow?

At feed and dairy industry level many of the issues are more formalized and therefore better verifiable by third parties. For instance, identification and traceability can be verified through records and coding, adequate cleaning is regularly checked upon and sourcing of ingredients can be checked not only through accounts of goods purchased but through entire input/output balances as well.

In conclusion, for feed and dairy industries all of the top-five precautionary action points and related control measures are fully verifiable by a third party. However, at the farm level processes are less intensively monitored, and, therefore, difficulties occur with respect to the third-party verifiability of farmers' due diligence.

CONCLUSIONS

Some insurers provide cover for product recall, others do not (anymore). In this paper we started out by stating that changes in the risk environment of food supply chains lead to insurers facing designing and premium rating problems with food-related products such as recall insurance. Through our four objectives we disentangled these problems for recall insurance schemes in dairy supply chains into four issues: (1) a proper definition of perils and losses of product recall; (2) an identification of important precautionary action points for underwriting, class rating and specifying 'proper rules of behaviour'; (3) a framework for risk assessment and rating; and (4) an assessment of third-party verifiability of due diligence for identifying the insured's eligibility for indemnification. From the analyses we conclude that:

- Perils and losses of product recall need to be strictly defined, preferably on a case-by-case basis in order to prevent pitfalls of ambiguity and to keep incentives for risk prevention straight.
- Underwriting, class rating and rules of behaviour should, if possible, be linked to already existing quality assurance programmes as there are probably too many

relevant precautionary action points and related control measures for insurers to assess.

- Recall losses easily accumulate as we already identify losses between Euro 210,000 and Euro 2,300,000 for contamination problems in single batches and products, and considering only a few recall expenses.
- Third-party verifiability of due diligence is somewhat problematic at the farm level, mainly because of less intensive monitoring systems. Since this issue is not easy to solve, i.a. because of the relatively small scale of most farms, insurers will have to look for other tools providing 'due-diligence incentives' to farmers, such as deductibles and co-payments.

Although our analyses focused on dairy supply chains, we believe these issues to be applicable to other food supply chains as well. Overall, we conclude that, if risks are properly defined and insurance schemes incorporate adequate incentives for due diligence and rapid disclosure, product recall is an insurable type of risk, even if the number of recalls will further increase in the coming years.

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