Integrating Economics into Food safety monitoring

Prof.dr H.J. (Ine) van der Fels-Klerx

Inaugural lecture upon taking the position of Special Professor of Food Safety Economics at Wageningen University & Research on 20 October 2022

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Introduction

Esteemed rector magnificus, professors, dear colleagues, family and friends. You can see here a large bridge (Figure 1), the bridge of the Rotterdam harbour, and you may wonder what has this bridge to do with the research and education in Wageningen. In my address, I will explain what the domain of food safety economics is about, and in particular I will focus on food safety monitoring. And you will find out what is the link with this bridge.

Figure 1. Illustration of Harbor bridge of Rotterdam

First of all, you may wonder "why food safety"? In the Netherlands, in Europe, actually in the entire Western world, we are used to having enough food. We choose what we want to eat every day ourselves. There is a very wide variety of products on our market. They have been produced and are imported from all over the world. We take it for granted that we have enough food and that there is a wide choice of food products. On top of that, we also take it for granted that our food is safe; how often do we ask ourselves if the food we are eating is safe? Do we know, or do we even consider our food may contain food safety hazards, like bacteria, chemicals, or the presence of pieces, like carton or glass? These food safety hazards can be present in our food and can affect our health. They can result in more than 200 different diseases, ranging from mild diarrhea - to liver problems - to a severe form of cancer. When there is a food safety incident, and there is a lot of media attention, we are getting worried about food safety. Think about the crisis with E. coli in 2011, or about the horse meat scandal in 2013. But we do not often think about food safety when we buy our food in the supermarket or prepare it at home. For us, safe food, like having enough food and a wide choice, is natural.

This is not the case in low-income countries, where there is a shortage of food for most of the people living there. In areas with a shortage of food, where the harvest of crops often is destroyed by drought, insects, or plant diseases, people will not worry about food safety. All there is to eat is urgently needed. Even a bad crop, for instance, heavily infected with fungi and mycotoxins, will be consumed. In these countries, having safe food is not natural. This has become even more apparent with the Ukraine war, which has dramatic impacts on food security in African countries.

This was also not the case in Europe in the olden days. In the middle ages, in Europe, a lot of people suffered from poisoning after eating bread. The bread was made from rye grain that had been infected with fungi and was contaminated with mycotoxins. The particular fungal species produces mycotoxins – named ergot alkaloids – when it infects the rye grain in the field. Ergot alkaloids are chemicals that are very toxic to human health. If these mycotoxins enter the human body, by the consumption of contaminated food, they can disturb the blood supply to hands and feet. This results in gangrene, which makes you feel like your hands and feet are burned. This was the reason that - in that time - ergot poisoning was named Saint Anthony's Fire. Figure 2 shows a painting from Peter Bruegel, who painted "The Beggars" in 1568. The people on this painting may be survivors of Saint Anthony's fire.

More recently, the biggest food safety incident from the last 25 years clearly was the PCB/ dioxin crisis in Belgium in 1999. During this crisis, animal feed was contaminated with dioxins and PCBs. These are toxic compounds that affect human health[1]. The contamination was caused by the use of fatty ingredients that were contaminated with dioxins, during the production of animal feed. More than 2500 poultry and pig farms in Belgium had used the contaminated feed and were affected[2]. The farms were blocked, animals were killed, and

1 Van Larebeke N, Hens L, Schepens P, Covaci A, Baeyens J, Everaert K, Bernheim JL, Vlietinck R, et al. 2001. The Belgian PCB and dioxin incident of January – June 1999: Exposure data and potential impact on health. Environmental Health Perspectives 109(3): 265–73.

2 Covaci A, Voorspoels S, Schepens P, Jorens P, Blust R, Neels H. 2008. The Belgian PCB/dioxin crisis—8 years later. Environmental Toxicology and Pharmacology 25 (2): 164-170.

Figure 2. Illustration of Painting "the Beggars"

food products were taken from the market, resulting in empty shells. The total losses for the Belgium economy were close to €2 billion euros. Besides Belgium, other European countries, such as the Netherlands and Germany, were also affected. This incident was part of a series of food safety scandals; it followed several other smaller incidents. As expressed by a Dutch saying, this dioxin incident was *"the drop that made the bucket overflow"*.

It was the trigger for a dramatical change of food safety policy in Europe. In Belgium, this incident lead to the formation of the Belgium Federal Food Safety Agency. At the European level, it led to the formation of EFSA, the European Food Safety Authority, in 2004, and also to the establishment of the General Food Law[3]. Many food safety rules and laws in

3 European Commission, 2002. Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. Official Journal of the European Communities L31, 1.2.2002, p. 1-24.

different countries in Europe until that time were replaced by this overarching food law. One important aspect of the General Food Law is that it makes all companies in the food production chain responsible for the safety of the products at their own company. Another important aspect of the General Food Law is the so-called precautionary principle, implying food can only be placed on the market and sold, when it has been proven to be safe. The General food law was followed by more specific rules, regulations and recommendations to improve food safety in entire Europe.

As a result, nowadays in Europe, we can surely say our food is safe. For more than two decades, food safety has been improved. Without any doubt, our food in Europe has never been so safe as it is today. But this did not come without any sacrifice. We do have strict risk management systems in place, at the government and at the industry. They include, for instance, high food safety standards to protect animal and human health. An example of such standards are the maximum legal limits for the presence of a range of contaminants, like for dioxins and PCBs, heavy metals and mycotoxins in foodstuffs[4]. This means that feed and food products that contain these contaminants in concentrations above these legal limits may not be consumed, and should be taken from the market.

However, recent developments in our environment and in our food system have put food safety in Europe under pressure. They include, for instance, the impacts of climate change, the transition towards a circular economy, the use of alternative proteins, and urbanization. But also others like the increasing prices, and the energy crisis of today. Below, I will outline the impacts of two of these developments in more detail.

The effects of climate change include a higher temperature, more droughts, and more rainfall and – in particular - more heavy rainfall in short periods of time. Everyone remembers the very high rainfalls during a few days in the South of the Netherlands in May 2021. Such climate change effects can lead, for instance, to more fungal infection and mycotoxin contamination of crops, like maize and wheat. Such climate change effects can also lead to high pressure of pests, insects and plant pathogens. Farmers then need to spray more pesticides during the growing of the crops. Or the effects of climate change can lead to more stress of the plants. As a result, the plant then produces certain chemicals to protect itself, for instance, against drought. So, climate change will increase the presence of pesticide residues, mycotoxins and plant toxins in crops. But also other chemical and

4 European Commission, 2006. Commission Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs. Official Journal of the European Union L364, 20.12.2006, p. 5-24.

microbiological hazards, such as viruses and micro-organisms[5], will be seen more often.

A second important development is the transition in Europe towards a circular economy. Such a transition was proposed recently by the European Commission. In its Green Deal, the European Commission described how they want to make our food production more sustainable in the near future[6]. It proposes to re-use side and by-streams of food production, so as to bring these back into the food production system. In this way, our production system will change from linear production chains to circular production loops. But we do not know much about food safety when using by- and side streams and closing loops. Hazards that we know, such as heavy metals, may accumulate in the system, and hazards that we do not know much about may suddenly show up[7].

Given these two and other changes in our environment and stressors of food safety, our food safety is under pressure. So, it needs our continuous attention. Only in this way, we can keep our food safety at the current high level. But we may also consider lowering our food safety standards, when this is needed to adapt to climate change and to move to circular production systems.

Food safety monitoring

To manage food safety, companies have quality management systems in place, like Hazard Analysis and Critical Control Points, also shorted as HACCP. As part of HACCP and other management systems, companies apply prevention or control measures to improve the safety of their products. For instance, they can use disinfectants during the washing or oranges to control the contamination with bacteria. They also collect samples of their foods and their ingredients, and analyse these for the presence of food safety hazards. The main reason for this monitoring is to check if quality systems in place do work well; it is, for instance, part of the verification and validation steps of HACCP systems. So, by regular sampling and analyses, products are checked if they are safe, and if the systems work well. On top of the systems from the companies, governments in Europe also have measures to

5 Marvin HJP, Kleter GA, Van der Fels-Klerx HJ, Noordam MY, Franz E, Willems DJM, Boxall A. 2013. Proactive systems for early warning of potential impacts of natural disasters on food safety: Climate-change-induced extreme events as case in point. Food Control 34: 444-456.

6 European Commission (2021). European Green Deal: Delivering on our targets. Luxembourg: Publications Office of the European Union, 2021. 26 pp. DOI:10.2775/595210

7 Focker MF, Van Asselt ED, Berendsen BJA, Van de Schans MGM, Van Leeuwen SPJ, Visser SM, Van der Fels-Klerx HJ. 2022 Review of Food Safety Hazards in Circular Food Systems in Europe. *Food Research International* 111505. DOI: 10.1016/j.foodres.2022.111505

manage food safety. In fact, the implementation of food safety regulations, such as the setting of maximum limits for the presence of contaminants in foods, is one of the measures that governments can take. Governments in European countries also need to do official controls. This is needed:

i) to check if the companies meet the minimal requirements,
ii) to check if the food products that are on our market are safe, and
iii) to estimate the occurrence of food safety hazards.

To do so, governmental agencies, like the Netherlands Food and Consumer Product Safety authority (the NVWA) collect samples from a wide range of feed and food products. These samples are sent to an official laboratory, Wageningen Food Safety Research (WFSR), for analyses for the presence of a range of chemicals and pathogens. For instance, the Dutch government has a National Plan Animal Feed in place, in which between 2000-2500 samples per year are collected from a wide range of feed products. These samples are sent to WFSR, where they are analysed in the lab with up to 5000 different chemical analyses per year.

But there is a problem with food safety monitoring. As mentioned, there are many different food safety hazards, and many different feed and food products. It is clear that not all products, and not all food safety hazards can be checked; the list of possible combinations of food products and food safety hazards is simply too large. Also, there are many stages and companies in the food production chain that can be checked. So clearly, not all stages, not all products and not all hazards can be checked. So, choices have to made.

One way to do so, is to use risk based monitoring. In the last five years, European regulations state that the official control, so the control by the governments, needs to be done more and more in a risk based way[8]. This means that sampling and testing is focused on those products and those food safety hazards that have the highest risk to animal and human health. Not only governments more and more apply risk based monitoring, but also companies and sector organisations do so. A related way of doing so, is to apply cost-effective monitoring. This means that the sampling and analyses is done in such a way that the impact of the monitoring is highest, given the available resources, like time, money, and manpower.
Risk based and cost-effective monitoring have more impact, on animal health, human health, and the economy. Till today, research has been done on setting up methods for risk

8 European Commission (2017). Regulation (EU) 2017/625 of the European Parliament and of the Council of 15 March 2017 on official controls and other official activities performed to ensure the application of food and feed law, rules on animal health and welfare, plant health and plant protection products, amending Regulations ..... Official Journal of the European Union L95, 7.4.2017, p. 1–142.

based monitoring, e.g. by Van Asselt et al. (2021)[9]. But, not much research has been done yet on setting up cost-effective monitoring programmes for food safety.

In this Chair, I will focus on the design of cost-effective monitoring plans for food safety. I will do this by combining two research fields; the field of Business Economics and the field of Food Safety. These two fields are brought together, they are bridged, to form the domain of Food Safety Economics, as illustrated by Figure 3. With cost-effective monitoring, the question is how resources and food safety monitoring strategies can be weighted. It will make decisions on food safety monitoring more transparent, objective, and science based. In the end, risk managers in industry and government make decisions on food safety monitoring every day. This Chair will help them in making these decisions.

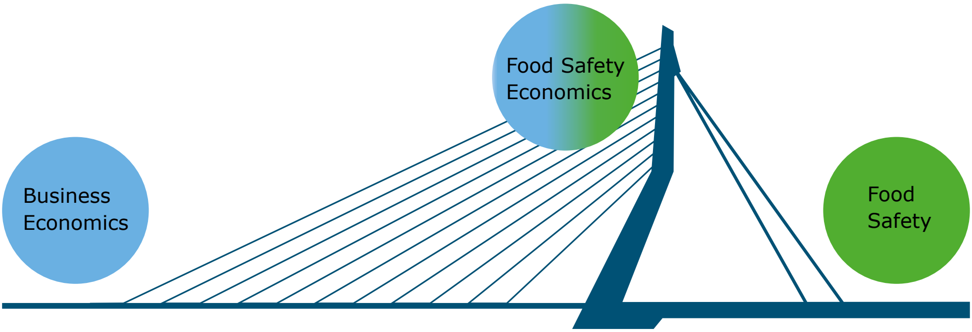

Figure 3. Combining the fields of Business Economics and Food Safety to form the domain of Food Safety Economics

Cost-effective monitoring

The set-up of cost-effective monitoring plans for food safety needs three different steps:

a First, we need to know WHAT to monitor, thus we need to know which food products should be sampled, and what food safety hazards should be analysed.

b Second, we need to know WHERE to monitor, so we need to identify the most critical steps and companies in the chain.

c Third, we need to know HOW to monitor, thus we need to know the number of samples to collect, how many samples to combine in a pooled sample, and which analytical method to use.

These three steps are further outlined below.

9 Van Asselt ED, Hoffmans Y, Hoek – van den Hil E, Van der Fels-Klerx HJ. 2021. Methods to perform risk-based inspections of food companies. *Journal of Food Science* 86(12): 5078-5086. DOI: 10.1111/1750-3841.15978

What to monitor

In the first step, the products that will be sampled and the food safety hazards that will be tested need to be selected. The question is how to do this. This will depend on the aim of the monitoring programme. When the aim is risk based monitoring, the most risky food products and the most risky hazards need to be tested. There are different ways to select these products and hazards: it can be done with using historical monitoring data, with using expert judgement and with predictive modelling. Often, a combination of these three methods is used. As an example of a risk model, the RiskFeed model uses historical data, expert opinion, and modelling[10]. The RiskFeed model results into a ranking of feed ingredients that are most risky for human and animal health concerning the presence of a given contaminant in the ingredients. In Figure 4 the risk ranking of feed ingredients related to the presence of aflatoxins in these ingredients is presented. Aflatoxins are a group of mycotoxins that can cause cancer in animals and humans.

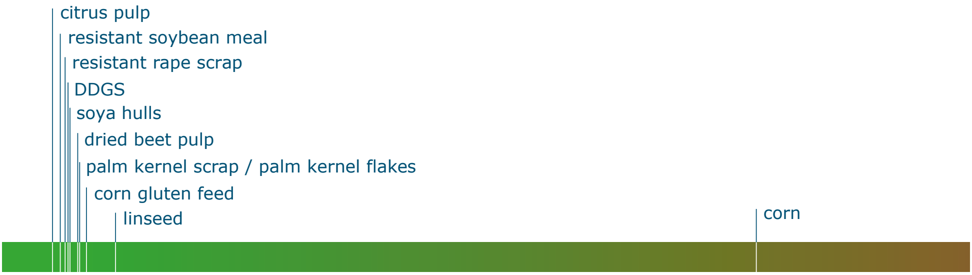

Figure 4. Ranking of feed ingredients for risk related to animal and human health due to the presence of aflatoxin B1 in animal feed ingredients in the Netherlands, as example output of the RiskFeed model.

As can be seen from Figure 4, the risk related to the use of maize is highest, followed by linseed and corngluten feed. The RiskFeed model has been developed at WFSR, and it is updated every year with the latest information. It is used by the NVWA as one of the inputs for setting up the yearly National Plan Animal Feed. For this plan, the NVWA needs to decide which feed products to sample, and which chemicals to analyse in these samples.

Nowadays, machine learning is used a lot in risk modelling. As an example, machine learning has been used to estimate the probability that food products are contaminated with dioxins[11].

10 Van der Fels-Klerx HJ, Adamse P, Punt A, Van Asselt ED. 2018. Data analyses and modelling for risk based monitoring of mycotoxins in animal feed. Toxins 10(2): 54.

11 Wang Z, Van der Fels-Klerx HJ, Oude Lansink AGJM. 2021. Modeling cost-effective monitoring schemes for food safety contaminants: case study for dioxins in the dairy supply chain. *Food Research International* 141: 110110. DOI: 10.1016/j.foodres.2021.110110.

People are exposed to dioxins via the consumption of food, and mainly the food that comes from animals, such as pork meat, milk, and eggs. Wang and co-authors used a dataset from the official control in the Netherlands to develop a model that predicts the chance that each of eight different food products from animal origin contains too much dioxins, so in a concentration above the respective legal limit. Results showed that this chance was highest for sheep meat and for eggs, and lower for the other six food products. These estimations were then used in an economic model that used linear programming to minimize the monitoring costs for the eight different animal derived food products, while still having a certain predefined minimal monitoring performance. This monitoring performance was expressed as the probability to detect non-compliant samples, so samples with concentrations above legal limits. The second constraint of the economic model was that also the dioxin background concentration in the eight food products could be estimated with the sampling plan. Based on these constraints and other input, an optimal monitoring scheme for dioxins was designed, consisting of the number of samples to collect from each of the eight food products per year.

Results showed that with the optimal monitoring plan 58 samples of pig meat are needed each year. In reality, in 2018, 98 samples of pig meat had been taken, so 40 samples can be saved. For sheep, the optimal number of samples was 9, whereas in reality 12 samples had been taken in 2018. Every year 274 samples are needed for the eight food products in total. In reality, every year 365 samples are collected. So, in total, about 90 samples can be saved, while the monitoring plan still has the same effectiveness. The total costs that can be saved in this way are about 10.000 euro. The savings can be obtained by shifting the monitoring from products with a lower chance of being contaminated to products with a higher chance, and also by collecting the samples in different seasons of the year.

Where to monitor

The second step of designing monitoring plans is to identify the best step in the production chain to do the sampling, and maybe even the particular companies to check.

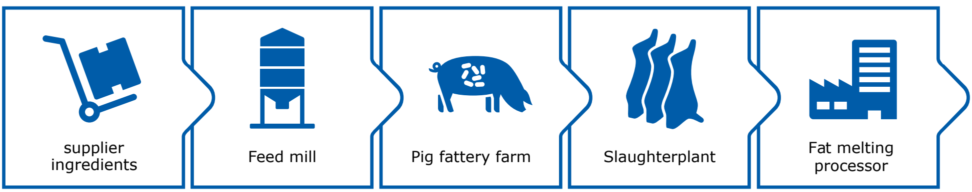

Figure 5. Simplified pork supply chain

Figure 5 shows a simplified pork supply chain with five different stages, from the supply of feed ingredients, to feed production, farms with pigs, the slaughterhouse, and the fat melting facility. A choice needs to be made, where in the chain to collect samples for food safety monitoring. As an example, Lascano et al. (2014)[12] focused on the cost-effectiveness of detecting dioxins in the pork chain. Contamination in the animal food production chains often starts with the use of contaminated feed, like in the large Belgium crisis in 1999, mentioned before. Lascano and co-authors looked at the best step in the chain to collect samples, and calculated the number of samples that should be collected in each step. They included four possible control points in the chain: feed ingredients, the feed mill, the slaughterhouse, and the fat melting facility. Dioxin contamination was assumed to occur via an oil ingredient that was used for the production of feed for the pigs. Simulation modelling was then used to estimate the presence of dioxins in each step of the chain. Results were used as input to an economic model that minimizes the monitoring costs to detect the dioxin contamination. Results showed that monitoring at the beginning of the chain, in this case at the feed mill, was best. Table 1 shows the results for a baseline scenario and for four alternative scenarios, indicated with s1, s2, s3 and s4. The scenarios vary in the assumed initial dioxin contamination and in the pre-set monitoring effectiveness. In each scenario, most of the samples are collected from the feed ingredients and the feed mill, and less samples are collected from the later stages of the chain, which are the slaughterhouse and the fat melting facility. Actually, in reality, most of the samples are collected from the fat melting facility. So, this model advises to focus more on the beginning of the chain than on the end of the chain.

Lascano and co-authors (2014) also showed that when the monitoring results for dioxins are shared between the different stages of the chain (scenario: chain vs base), the total number of samples can be reduced. This compared to the situation in which each company in the chain performs its own monitoring and does not share the outcomes with other companies. So, sharing of monitoring results can lead to a great reduction of the costs. Of course, this needs trust between the companies, and also agreements need to be made.

How to monitor

As the third step, at the indicated point in the chain, samples are collected and analysed for the presence of food safety hazards. Decisions need to be made on three aspects:

i) the number of individual samples to collect,
ii) the number of samples to pool into one combined sample,
iii) the analytical method to use.

12 Lascano-Alcoser VH, Mourits MCM, Van der Fels-Klerx HJ, Heres L, Velthuis AGJ, Hoogeboom LAP, Oude Lansink AGJM. 2014. Cost-effective allocation of resources for monitoring dioxins along the pork production chain. Food Research International 62: 618-627.

Table 1. Total number of samples and related monitoring costs to detect dioxins in the pork supply chain, at different control points and under different scenarios.

	Number of samples collected (# / week)				Total Monitoring Costs (€ thousand/year)			
	Chain stage[1]				Chain stage			
Scenario[2]	FI	FP	SH	FM	FI	FP	SH	FM
Base	29	9	11	1	42.2	31.1	55.0	111.6
S1	79	9	11	-	100.7	86.4	111.2	-
S2	19	9	11	1	28.1	24.7	39.9	111.6
S3	25	7	9	1	37.3	22.1	45.0	111.6
S4	37	11	14	1	51.9	33.1	65.6	111.6
Chain[3]	3	7	-	-	10.8	19.6	-	-

1 FI: feed ingredients; FP: feed production; SH: slaughterhouse; FM fat melting facility; 2 Base and s1-s4: base scenario and four alternative scenarios for presence of dioxins and monitoring effectiveness; 3 Chain approach instead of individual stages (base scenario)

For analyses of food safety hazards, different analytical methods are available, varying (amongst others) in their costs, performance and easiness in handling. On the one hand, we have the instrumental methods that need to be used in the laboratory. They are very sensitive but also take time and are relatively expensive. And on the other hand, there are the cheaper methods, like dipsticks, which are easy to use on the site but also have lower performance. Samples can be analysed one by one, or several samples can be combined into a pooled sample that is then analysed.

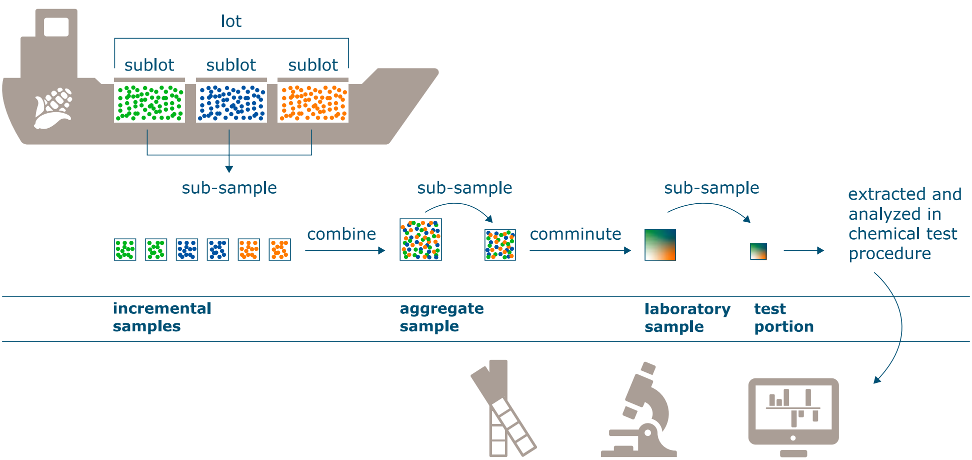

Figure 6. Illustration of sampling a large ship load

As an example, Figure 6 shows a large boat that is filled with grains. The boat enters the Rotterdam harbour. The grain needs to be tested, as an example, for the presence of mycotoxins by an inspector. The question here is: how many samples to collect, how many to pool, and what analytical method to use. The grain is stored in three different compartments of the boat, and each compartment is filled with a sublot of the grain. One or more samples can be taken from each sublot. In the example (Figure 6), two samples are taken from each of the three sublots, totalling 6 individual samples. These six samples are combined into one pooled sample. From this large pooled sample, a part is taken which is homogenized and mixed. Then, a test portion is taken from the homogenized sample, for use in the analyses. For the analyses, different analytical methods can be used, such as LC-MS/MS, ELISA or dipsticks. So, here one needs to decide how many samples to collect from each compartment of the boat; how many samples to combine in one pooled sample; and what analytical method to use.

As an example, Focker and co-authors[13] focused on this problem of optimizing the monitoring of mycotoxins in a large batch of grain. The problem with mycotoxins, such as aflatoxins, is that they can be distributed very scattered in a batch. So, if there is a mycotoxin contamination in the grain, it is often very local, which makes it is difficult to detect. Focker et al. (2019) used an economic model to set up a cost-effective sampling and analytical plan for detection of mycotoxins in one batch of grain. They compared three different strategies for sampling and analyses. In the first one, individual samples are collected, and a certain number of these samples are combined into one aggregate sample. From the aggregated sample, a certain number of test portions is taken, which are analysed in the laboratory with an instrumental method. The second strategy is similar to the first one, except that the test portions are not analysed with an instrumental method but with ELISA, which is more easy to perform but also has a lower performance than instrumental methods. In the third option, the individual samples are not pooled but, instead, they are all analysed one-by-one on the site, so in the harbour, using a dipstick method. For each of these three strategies, the number of samples are calculated, at different available budgets, for each of the number of individual samples, the number of samples to pool, and the number of test portions to analyse.

Figure 7 presents the results, expressed as the performance of the three different sampling and analytical strategies, at different available budgets, for detection and analyses of the mycotoxin aflatoxin B1 in one batch of maize (Figure 7, right panel) and for deoxynivalenol

13 Focker M, Van der Fels-Klerx HJ, Oude Lansink AGJM. 2019. Cost-Effective Sampling and Analysis for Mycotoxins in a Cereal Batch. Risk Analysis 39 (4): 926-939.

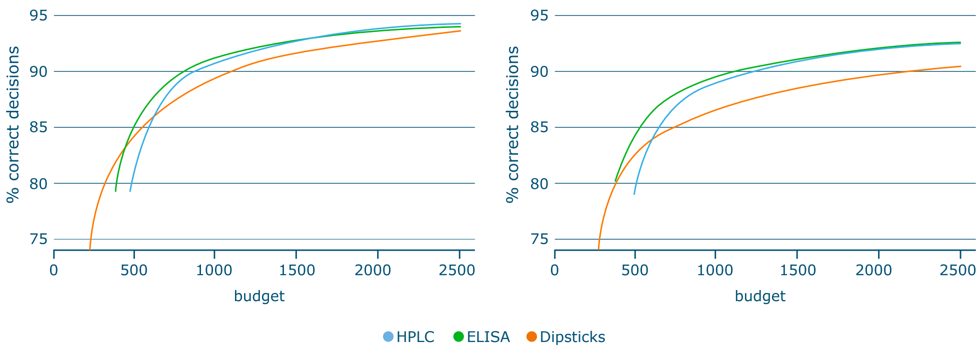

Figure 7. The performance (% correct decisions) for detection of aflatoxin B1 in one maize batch (limit of 4 µg/kg, panel right) and of deoxynivalenol in one wheat batch (limit of 1250 µg/kg, panel left) with three different sampling and analytical plans (Focker et al., 2019).

in one batch of wheat (Figure 7, left panel). As can be seen from Figure 7, the monitoring plans that use dipsticks have lower performance as compared to the other two monitoring plans. But, this type of analyses can already be used with lowest budgets. The plans that use instrumental methods or ELISA, have quite a similar performance. With lower amount of resources, the plans that use ELISA perform better than the ones that used an instrumental method. The underlying reason is that – with the same budget– more samples can be collected and tested with the cheaper analytical method. The more samples do provide more information on the contamination, even though the performance of the analytical method is lower. Note that the dipstick and ELISA methods cannot be used for official control by governments since the official control needs to follow the procedures for sampling and analyses as prescribed by the European Commission. But this method can be used by companies in the grain supply chain, such as grain traders and feed millers.

With these three examples, I have illustrated the different steps that are needed to set up cost-effective monitoring plans for food safety. I have also shown how economics can help in each of these three steps.

Cooperation within WUR and abroad

The field of Food Safety Economics is a new field of interest that fits very well in domain of Wageningen University and Research. The Chair is placed at the Business Economics group of the University. It fits well with the current three research themes of this group. These are: 1) Sustainable food, 2) Economic performance and risks, and 3) Healthy animals, plants, and food. This Chair strengthens the cooperation between Wageningen Food Safety

Research and the Business Economics Group. It will also strengthen the cooperation between each of these two, with other groups and institutes at the Campus.

And there is cooperation beyond Wageningen and beyond the Netherlands. I hope to contribute to improving food safety in other areas of the world, especially in Asia and Africa. For instance, in China, there was a large melamine scandal in baby food in 2008. We still see the impacts of this crisis on the other side of the world: if you go to the local drugstore you are not allowed to buy more than two packages of baby food. Since the melamine scandal, the Chinese government is setting up new food safety laboratories and food safety monitoring programmes. I supervise several PhD students from Asia, who work on these topics. Their results can help in the decisions on food safety monitoring that have to be made. I also supervise a PhD student from Ethiopia. He works on managing the mycotoxin problem in stable crops, in maize, and sorghum, in his home country. In Africa, they are working on setting up a Food Safety Strategy and an African Food Safety Union. This indicates that there is more and more attention for food safety here, and this Chair can help.

Education

Related to this Chair is the MSc course Food Safety Economics, which is a Master course of the Business Economics group. Students from the Master programme Food Safety and Food Quality Management, but also from other masters, can follow the course. Results from the examples that I mentioned, and from other studies, are used as to make the course materials. Our ambition with this course is to inspire the students to approach food safety problems not only from a technical view but also from a wider view and with an open mind.

As I come to the end of my inaugural address, I can conclude that the multi-disciplinary field of food safety economics is only at its start. There is a wide variety of theories and methods that are used in economics. But they have not been applied much to food safety. I believe that widening the field of food safety with business economics can really improve the safety of our food. With the proposed research and teaching, I will contribute to this, and make the choices for food safety management better underpinned with science, and improve their objectivity and transparency. In this way, I hope to contribute to safe food in the world, now and in the future.

Ladies and gentlemen, thank you for your attention. Ik heb gezegd.

Prof.dr H.J. (Ine) van der Fels-Klerx

The multi-disciplinary field of Food Safety Economics is formed by integrating the domains of Business Economics and Food Safety. Food safety economics can help making the decisions for food safety management, such as food safety monitoring, more transparent, objective and science based. Widening the field of food safety management with business economics will, in this way, improve the safety of our food.

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