Costs and benefits of the Food Fraud Vulnerability Assessment in the Dutch food supply chain

Bindt, Victor

22 February-August 2016

Wageningen University

BEC-Business economics group

Costs and benefits of the Food Fraud Vulnerability Assessment in
the Dutch food supply chain.

Author: Victor Bindt
Registration number: 910823068090
Course code: BEC-80433
Supervisor Wageningen University: Dr. Ir. M.P.M. (Miranda) Meuwissen (Wur)
Supervisor PwC Amsterdam: Dhr. Berendsen

Acknowledgements

Summary

Food fraud is a growing concern due to the significant financial and reputational losses. Furthermore it may damage public health. The amount of reported food fraud incidents increased during the past ten years. The global damage as a result of food fraud is estimated at $30 to $40 billion dollars. Although there are significant financial consequences for the food sector, limited research has been conducted in regard to the losses as a result food fraud and the costs and benefits of food fraud mitigation tools. To increase the knowledge concerning food fraud mitigation tools, the main objective of this study was to investigate the costs and benefits of the Food Fraud Vulnerability Assessment in the Dutch Food supply chain.

The Food Fraud Vulnerability Assessment is a risk mitigation tool, which provides companies their vulnerability profile regarding food fraud. In order to fulfill the main research objective, sub-objectives were developed. First a review has been made of reported cases and losses. Secondly Dutch food companies were characterized regarding their current risk mitigation situation based on the Food Fraud Vulnerability Assessment. At last the perceived costs and benefits of Dutch food companies of implementing the fraud mitigation tools named by the "Food Fraud Vulnerability Assessment". For the literature review besides scientific literature, grey literature has been used. For the characterization of Dutch food companies a cluster analysis is used. This cluster analysis is made, based on the results obtained from the Food Fraud Vulnerability Assessment n=38. At last three interviews were conducted, to assess the perceived costs and benefits. To develop a benchmark for the interviews, potential costs and benefits were retrieved from literature.

Concerning the first research objective reviewing losses of reported food fraud cases, social losses and punishments were mostly reported. With regard to sales drops, drops ranged between 13%-80%, stock prices decreased between 37%-75%. In relation to the price of an adulterated product, the price was 1,5-4 times higher than the genuine product. Also confidence is affected by food fraud, the decrease of trust in industries ranged between 7,25%-63,6%. Based on the cluster analysis three clusters appeared. The largest cluster, 47% seems not to have a strong focus on mitigation strategies named by the Food Fraud Vulnerability Assessment. Yet cluster 2, although it was the smallest (10%), seems to have a focus on most of the fraud mitigation strategies named by the Food Fraud Vulnerability Assessment. The third cluster, 42% seems to have a focus on soft controls (the human related mitigation strategies, such as a whistleblowing policy). Based on the interviews the denominator of the perceived costs and benefits of the fraud mitigation tools named by the Food Fraud Vulnerability Assessment was the process. Regarding the benefits a more smoothed process of verification, auditing and interventions were perceived. Regarding the costs a less flexible process, training costs and verification process were perceived.

Based on this thesis two recommendations can be made for PwC.

1. Food fraud can also affect companies, which have a large resilience regarding food fraud, because this thesis showed that whole industries may get affected as a result of a single fraud incident. Therefore institutions that have influence on a whole industry, can also be an interesting client of PwC in order to build resilience against food fraud among a whole industry.
2. It is important to pay attention to the whole supply chain (both horizontally as vertically), while supporting a single client. This thesis showed how complex recall actions can be and the how complex the inter-correlations of links in the supply are. Moreover it may be meaningful to put extra focus on retailers as clients. The interviews showed that retailers have much power within the supply chain. Furthermore the cluster analysis showed a large cluster (47%), which seems not to focus on fraud mitigation strategies named by the Food Fraud Vulnerability Assessment. Therefore retailers may be important clients, because of their size, power and the amount of potential improvements that can be made within the chain.

List of tables

List of figures

List of abbreviations

EMA- Economical Motivated Adulteration
FDA- Food and Drug Administration
GMA- Grocery Manufacturers Association
NCFPD- National Food Protection and Defence Institute
USP- United States Pharmacopeial Convention
GB- Great-Britain
GFSI-Global Food Safety Initiative
GAO- General Accountability Office
YTD- Year To Date

Table of Contents

.

1   Introduction

1.1   Background

Food fraud is a growing concern due to the significant financial and reputational losses (Moore et al., 2012). The amount of reported food fraud incidents increased during the past ten years. The amount of reported fraud cases grew among other factors due to increasingly complex supply chains (Moore et al., 2012). Food fraud is a combined term, which includes intentional substitution, addition, false or misleading statements about the product or false presentation of the food, food ingredients or food packaging, all this for economical gain (Spink & Moyer, Fraud, Defining the Public Health Threat of Food, 2011). Food fraud may harm public health issues, because food fraud criminals do not always have the resources, knowledge or willingness to carry out a proper public health risk assessment (Moore et al., 2012).

According to RIKILT Wageningen UR (2016) and Schoolderman et al. (2015) the impact of food fraud on the global food industry is estimated at $30 to $40 billion. The top five of globally most reported fraud product groups are herbs and spices, olive oil, fish and fish products, milk and milk products and meat and edible offal (Weesepoel & van Ruth, 2015). Consequences of food fraud can be direct like bankruptcy, recall costs, legal costs or lost revenue. But also indirect such as a damaged brand, lost market share or a smaller market (Henry et al., 2010). Previous literature studies reviewed vulnerable product groups such as Weesepoel and van Ruth (2015). Furthermore Henry et al. (2010) reviewed the impact of food fraud on the US market. Yet there is no review found, which focuses directly on the different losses of fraud on food supply chains.

To mitigate for (potential) losses, food companies may take measures to reduce the chance and impact of a food fraud incident. Standard food safety and food quality assurance systems are generally not developed to detect new adulterants (Everstine et al., 2012). Therefore, in order to be able to detect food fraud, the food sector need more transparent supply chains and cost effective generic testing methods (Everstine et al., 2012). Besides the study of Evertine et al. (2012), there is another study conducted, which investigated costs and benefits of traits in regard to food safety in the food supply chain by Meuwissen et al. (2002). Although the articles found that investigated the needs and costs and benefits of traits regarding food safety, there is no study found yet, which describes the current mitigation measures for fraud in the food supply chain and their costs and benefits.

An example of a tool, which could indicate the vulnerability profile of a food company is the "Food Fraud Vulnerability Assessment", developed by PwC and SSAFE (January 2016). The Food Fraud Vulnerability Assessment is a free online science based tool, based on criminal behaviour and decision-

making studies. The assessment is applicable anywhere in the in the food supply chain. When a company executes the assessment, a profile of the company its potential fraud vulnerability is provided. This profile can be used as a basis for interventions in order to decrease the risk of food fraud (Schoolderman et al., 2015). The scientific basis for this assessment is developed by the Wageningen University, RIKILT Wageningen UR and the VU Amsterdam (RIKILT Wageningen UR, 2016).

1.2   Research problem

As mentioned in section 1.1, the amount of reported food fraud incidents increased the last ten years (Moore et al., 2012). In order to prevent or react on food fraud-, food safety- and food quality- incidents, companies make use of mitigation measures such as tracking and tracing (Meuwissen et al., 2002). In addition to the already available measures, PwC launched in January 2016 the Food Fraud Vulnerability Assessment. This assessment is a free tool for food companies, which helps these companies to identify its vulnerability to food fraud (Schoolderman et al., 2015). In regard to the introduction of this model the main research objective was developed: "Investigating the costs and benefits of the Food Fraud Vulnerability Assessment in the Dutch food supply chain.

1.3   Objectives

The main objective of this study is to investigate the costs and benefits of the "Food Fraud Vulnerability Assessment" in the Dutch food supply chain. To reach this objective the following sub-research objectives were formulated:

a) To review reported cases and losses as a result of food fraud in food supply chains.
b) To characterize Dutch food companies regarding their risk mitigation situation.
c) To assess the perceived costs and benefits of implementing the fraud mitigation tools named by the "Food Fraud Vulnerability Assessment" of Dutch food companies.

In this study only food fraud will be reviewed and assessed in regard to intentional substitution, addition, false or misleading statements about the product or false presentation of the food, food ingredients or food packaging, in order to obtain economical gain. This means that tax-avoidance or smuggle are not taken into account. Furthermore in regard to the food supply chain the following links in the supply chain will be studied farms, processors, distribution centres and traders and retailers. The chains assessed in this study will be the top five of most reported product groups to be known: herbs and spices, olive oil, fish and fish products, milk and milk products and meat and edible offal (Weesepoel & van Ruth, 2015).

1.4   Thesis outline

Chapter two of this thesis gives an overview of the history of attention for food fraud and contains the chosen definition of food fraud for this study. The third

chapter describes the materials and methods in regard to the research objectives. The fourth chapter presents the results of the conducted research in regard to the three objectives. Paragraph 4.1 contains a table in which the investigated cases and the reported losses are combined. Thereafter, paragraph 4.2 provides a characterization of Dutch food companies concerning the Food Fraud Vulnerability Assessment and paragraph 4.3 contains an analysis of the conducted interviews. Chapter 5 contains the discussion, conclusion and ideas for further research.

2 History and definition of Food Fraud

2.1 Attention for food fraud in the past

In this section, the attention for food fraud is investigated by conducting a literature study. First the attention for economical motivated adulteration by the FDA is described. Then food fraud databases and its differences are presented. Thereafter the attention of the Global Food safety Initiative is given and what this means for reputable certificates used in the food sector. At last the scientific attention to food fraud is reviewed.

Although the history of food fraud goes back to the Roman empire, it took government institutions up until the 21th century to develop working definitions for food fraud and economical motivated adulteration (Spink & Moyer, 2011). The FDA developed in 2009 a working definition for a public meeting to raise the awareness of ecomical motivated adulteration of food (Johnson, 2014; Spink & Moyer, 2011). This meeting of the FDA was for non-governmental organisations a reason to develop mitigation measures and a food fraud policy. Examples are the GMA by publishing a consumer report in 2010; or the USP, by introducing the Food Protein Workshop in 2010. In addtion to the public meeting of the FDA, the Government Accountability Office launched a report in relation to seafood fraud in 2009. This report recommend that governmental and non-governmental institutions should collaborate better to fight food fraud (Spink & Moyer, 2011). Yet there are still govenmental institutions which, do not have a clear definition of food fraud. The European Union for example, despite its detailled food safety legislation (Johnson, 2014). Currently the EU uses its food packagaging, labeleing and presentation regulations ("you shall not mislead consumers") to fight food fraud (Johnson, 2014). Nevertheless the requirements for the packaging are not the same for all member states and food fraud is often not detected in the European Union (Johnson, 2014).

As a result of the increasing attention, several institutions initiated databases in which food fraud cases are reported and summarized. An example is the database of The United States Pharmacopeial Convention (United States Pharmacopeial Convention, N.D.). In this database food fraud incidents are reported since 1980. This databank makes distinction between scientific based sources and media based sources (United States Pharmacopeial Convention, N.D.). The objective of this database is to identify problematic food ingredients and detection methods (United States Pharmacopeial Convention, N.D.). Another example of a governmental database is the NCFDP, which tracks the amount of food fraud incidents. In this database EMA incidents since 1980 are reported. Distinctive for this database is the fact that food fraud incidents are reported as a fraud incident on its own (Food Protection and Defence Institute, n.d.). This way food fraud incidents without clear characteristics, such as a date or group of violators could also be registered (Weesepoel & van Ruth, 2015). The USP and the NCFDP databases are both focused on the US. An example of EU originated data base is the RASFF Databank.

This databank is designed in order to repress food and feed safety incidents since 1979. These disclosures are used in order to track and trace the source of the contaminated food and feed (Weesepoel & van Ruth, 2015). The downside of these databases is that these are only developed to regard the amount of fraud/safety incidents. This means that impacts on the food sector are not taken into account (Weesepoel & van Ruth, 2015).

Besides the increased attention for food fraud by the development of the databases, the GFSI (Global Food Safety Initiative) also recognized the importance of fighting food fraud. The acknowledgement by the GFSI is important, because the GFSI specifies the requirements for the recognition of food safety schemes and benchmarks (GFSI, 2016). This benchmark includes leading food safety shemes such as the BRC, FSSC 22000 and IFS (GFSI, n.d.-a). Furthermore the GFSI functions as a forum for food safety experts (GFSI, 2016). Currently the GFSI has 20 members, which are all important stakeholders in the food industry, such as AHOLD, Tesco, Walmart, Mc Donnalds and Nestlé (GFSI, n.d.-b). The cause of the increased attention by the GFSI regarding food fraud, was a publication in 2014 concerning the public health risk of food fraud. This publication was the result of the food fraud think tank. This think tank recommended two elements. First they advised food companies to carry out a food vulnerability assessment. Secondly they advised to set up control measures in order to reduce the risks of these vulnerabilities. The GFSI decided to adopt these two recommendations and incorporated these in the GFSI Guidance Document (GFSI, 2014). This document would eventually be the basis for the 7th version of the Guidance report, launched in March 2016. In this document the GFSI describes how the GFSI runs its benchmarking process among the different food safety certificates and how this process has changed. In this benchmark document the GFSI declared to take food fraud into account in all benchmarked scopes (GFSI, 2016). The standard will now require companies to have a documented food fraud vulnerability assessment (not by definition the assessment of PwC). The standard also requires that a company should document the specified control measures the company has implemented (GFSI, 2016; GFSI, 2014).

In literature the amount of articles available is low. Dr J. Spink published most of the articles found in literature, which combine economy and food fraud. Most of these articles have an exploratory character, such as defining and describing food fraud in different contexts (Spink et al., 2015; Spink et al., 2012; Wheatley & Spink, 2013; Spink & Moyer, 2011; Spink, 2012). Although the little amount of articles, literature acknowledeges the increasing attention for food fraud (Spink & Moyer, 2011).

2.2   Definition of food fraud
There is no undisputed definition of food fraud available. Therefore a review in regard to the available definitions is conducted. The definitions found in this review are given in table 1.

Table 1 Comparison between different definitions among different institutions

Elements of definition	Institutions						
	FDA[a]	EU[b]	FSA[c]	MSU[d]	USP[e]	NCFPD[f]	GMA[g]
Economical motivated	X	-	X	X	X	X	-
Increase apparent value	X	-	-	-	-	-	-
Misleading consumer	-	X	X	-	X	-	-
Dilution	X	-	-	X	-	X	X
Substitution	X	-	X	X	-	X	X
Addition	X	-	-	X	X	X	-
Misdescription of the food	-	X	X	X	-	X	X
Tampering	-	-	-	X	-	X	-
False labeling	-	X	-	-	-	-	-
False advertising	-	X	-	-	-	-	-
Counterfeit	-	-	-	X	X	-	-
Mispresentation of the ingredients	-	-	-	X	-	X	X
Mispresentation of the packaging	-	X	-	X	-	X	X
False or misleading statements	-	X	-	X	-	X	X
Possible health risk	X	-	X	-	-	-	-
Removal/replacement	-	-	-	X	X	X	X
Use of illicit substances	-	-	-	X	-	X	X

[a](Spink & Moyer, 2011), [b] (European Union, n.d.), [c](FSA, n.d.), [d](Spink & Moyer, 2011), [e](United States Pharmacopeial Convention, n.d.),[f](Spink & Moyer, 2011), [g](Henry et al., 2010)

An important note of table 1 is that it is not necessary that a case includes all elements of a definition. For example, this can be the case for the definition of the MSU: *"Food fraud is a collective term used to encompass the deliberate and intentional substitution, addition, tampering, or mispresentation of food, food ingredients, or food packaging; or false or misleading statements made about a product for economical gain"* (Spink & Moyer, 2001)*.* Table 1 shows for example, that substitution and addition are marked as elements of this definition. This does not mean that addition and substitution need to be included both in a food fraud case. It can still be marked as food fraud within this definition, when addition or substitution is included. Moreover this definition of the MSU is chosen for this study.

The food fraud matrix has been developed by Spink and Moyer (2011) in order to separate food fraud from food quality, food safety and food defence issues. From figure 1 it can be concluded that food fraud always has an economical motivation and food fraud is by definition intentional. However it is

important to notice that this matrix is about the causes and not the effects of food fraud. Although food fraud can result in a public health issue.

Food quality	Food fraud		Motivation Gain: Economic
Food safety	Food defence		Harm Public health, Economic or Terror
Unintentional	Intentional		
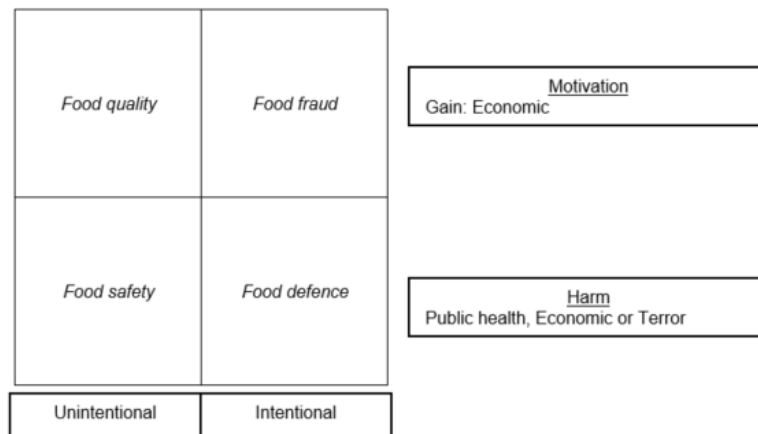
Figure 1 Food fraud matrix (Spink & Moyer, 2011)

When this definition is applied, food fraud can be categorised into different fraud issues. These categories can be found below (Weesepoel & van Ruth, 2015).

- Botanical/cultivar/varietal origin/species
- Product composition: dilution, substitution, replacement of product foreign ingredients/components or constituents
- Product quality: dilution, substitution, replacement of low-quality product-own components or constituents
- Production system
- Geographical origin

The division between issues gives an overview of what happened to the food product. In case of a Botanical/ Cultivar/Varietal origin/Species issue concerning meat, it can be the case that a meat ingredient is (partially) substituted by another piece of meat product. In case of a product composition issue water may be added to the meat. In case of a geographical issue the meat does not originate from the region claimed or to the region to which the meat should belong (such as Parma harm, which actually does not originates from Parma). In production system fraud, a food product may claimed as biological, when it is not (Weesepoel & van Ruth, 2015).

Another important aspect regarding the definition of food fraud is the crime triangle. The crime triangle consist out of: the guardian and hurdle gap, the victim and the fraudster. The guardian and the hurdle are the measures taken to prevent the fraud. The actual gap creates a situation that makes the fraud possible. Yet this does not automatically mean that there is no competent guardian or hurdle, but that the fraud opportunity has revealed a new gap between the opportunity and the hurdle. The victim is the one who is taken advantage of. The victim can be the producer of the food and/or the consumer. The criminal in this case is the one who commits the fraud, this

also includes the persons who decide to commit the fraud. It can also be the case that entire organisations are created to commit the fraudulent actions (Spink, 2013).

3 Materials and methods

3.1 Literature review of food fraud cases and losses

To develop the review of reported cases and losses in food supply chains (research objective a) scientific sources were retrieved from databases made available by the university. Furthermore LexisNexis was used in order to find additional food fraud cases. Regarding the losses of the melamine scandal and horse meat scandal extra information is retrieved from statistical websites, news websites and institutional websites. This choice has been made, because there was little information found in the scientific literature. The method for the scientific literature research is given in sub-paragraph 3.1.1 and the method for the enrichment of the scientific data with grey literature is given in sub-paragraph 3.1.2. The losses retrieved are divided into sub-groups, the definition of these sub-groups are given in sub-paragraph 3.1.3.

3.1.1 Cases and losses retrieved from scientific sources

Terms used in order to find scientific literature are given below. These terms were used in combination with the term "food fraud".

- Losses
- Substitution
- Mispresentation
- Punishment
- Confidence
- Supply chain losses

- Costs
- Economic gain
- Ingredients
- Boycott
- Recall
- Supply chain risks

- Adulteration
- Health issue
- Reputation
- Overpayment
- Counterfeit
- Supplier bankruptcy

- Tampering
- Government intervention

In addition to the terms above, product specific terms were used, to be known the five studied product groups: herbs and spices, olive oil, fish, dairy and meat. An example of a search term is: "meat and food fraud and losses". The databases used were: ABI/Inform complete, ABI/INFORM Dateline, ABI/INFORM Global, ABI/INFROM Trade & Industry, Banking and information source, Elsevier, AGRIS, Taylor & Francis, SpringerLink, Accounting & Tax, Wiley Online Library, DOAJ, Emerald Journals, NARCIS and AGEcon. Furthermore in this study only English articles and books are used published between January 2005 and March 2016, to find recent articles and to frame the research. Table 2 describes the amount of hits and the amount of used articles by combining the named search terms. Of the 6284 hits, there were 16 scientific studies used in order to develop the scientific basis of the review. Articles or books were excluded because of redundancy in two or more databases. Articles were also excluded when the reported case was outside the chosen time frame (January 2005-March 2016). Moreover articles that reported a fraud case in another product group or regarded another topic (testing methods, a broader approach of (food) fraud or supply chain management) were excluded. Furthermore articles were excluded when the content was not specific enough or a loss missed too much context.

Table 2 Hits in scientific databases categorised per product group and by database

	Herbs and spices	Olive oil	Fish	Dairy	Meat	Case specific[a] Melamine	Horse meat	Total
Number of studies after initial search								
ABI/INFORM Dateline	0	1	1	1	2	0	0	5
ABI/INFORM Global	157	201	202	555	476	130	213	2287
ABI/INFORM Trade & Industry	70	88	135	136	92	55	79	655
Banking and information source	0	0	1	1	3	2	0	7
Elsevier	117	101	81	220	174	51	85	968
AGRIS	51	67	128	129	144	26	68	613
Taylor & Francis	106	112	360	356	257	39	121	1351
SpringerLink	67	32	129	129	106	28	75	566
Accounting & Tax	0	8	40	40	5	18	2	113
Wiley online Library	0	5	2	2	2	3	0	14
DOAJ	1	2	3	3	0	1	0	9
Emerald Journals	0	1	25	52	55	27	2	162
NARCIS	4	5	0	0	2	5	5	21
AGEcon	0	1	1	1	0	0	0	3
Total hits	573	624	1109	1625	1318	385	650	6284
Number of studies used	2	-[b]	1	-[b]	-[b]	8	5	16

[a]There was research conducted specifically in regard to the melamine scandal and the horse meat scandal.

[b]There were no cases found in literature, which reported a case in relation to: olive oil, dairy or meat, (not considering the melamine and horse meat scandal).

3.1.2 Enrichment of data with grey literature

In order to enrich the review with additional cases LexisNexis and its combined search method was used (with the major US & Major world news option selected). The time frame used was between January 2005 and March 2016. The product groups searched for were the same as for the scientific cases. The objective was to find additional cases to the scientific cases. The different terms used and the amount of hits are given in table 3. Of the 31 cases found, nine were used in order to enrich the review. The relevance of the case was assessed by looking at new aspects of the cases found, such as a new fraud issue or product group. Media references were excluded when another case received more media attention, because of redundancy with the scientific data or when the media references did not contain enough context or explanation.

Table 3 Hits and selected articles retrieved from LexisNexis

Product group and terms	Terms used	Cases found	Cases selected
Olive oil		10	2
	olive oil fraud		
Herbs and spices		4	2
	herbs and spices fraud		
	herb fraud		
	spice fraud		
	saffron fraud		
	cumin fraud		
Fish		4	1
	fish fraud		
	tuna fraud		
	salmon fraud		
	fish authenticity		
Dairy		6	2
	milk fraud		
	cheese fraud		
	yoghurt fraud		
Meat		7	2
	meat fraud		
Total		31	9

Additional information on the melamine and horse meat case

Grey literature was also used to enrich the melamine case and the horse meat case with additional data regarding the losses. The additional data was retrieved from: institutional websites (such as the website of national food authorities), boerderij.nl, news websites, Statista, the Asia case research centre and the website of Ipsos Mori. Besides the additional data retrieved from websites, two scientific based books were used ("Sorting the Beef from the Bull" and "The Routledge Companion to Ethics, Politics and Organisations"), by making use of the Kobo library and the google books website. The same search terms as in paragraph 3.1.1 were used. Furthermore the same selection criteria were used in order to select the data for usage were adopted as described in paragraph 3.1.1. and 3.1.2

3.1.3 Loss groups and definitions

In order to structure the data found, the losses are divided into different loss groups. Table 4 gives an overview of the chosen loss groups and a description of the definition of the specific loss group.

Table 4 Characterisation and loss groups used with a description of each definition

Character
Name of the issue, product group.
Scale: Country in which fraud is discovered and spread of the case.
Length: Time between date of discovery and recovery of sales
Fraud issue: Issue as described in paragraph 2.2

Loss groups	
Loss group	**Definition**
Social losses and punishments	Health issues, religious issues or idealistic violations. Punishments refers to bankruptcies and punishments, which are imposed by a court.
Third party losses	Measures taken by governments or industry organisations, such as trade organisations as a direct result of the case in concern.
Confidence losses	Decline of confidence in the commodity, food or industry.
Sales losses and overpayment	Decline of sales of the food or commodity or stocks as a direct result of the case in concern.
	Overpayment: Less valuable component for which the original product was adulterated.
Recall costs	Direct recall costs: Media announcements, transportation, warehousing costs, extra labour and destruction costs (Velthuis et al., 2009).
	Indirect recall costs: losses due to market share, costs incurred for brand rehabilitation and crisis response expenses (Velthuis et al., 2009).

3.2   Analysis of the Food Fraud Vulnerability Assessment

In order to group the current risk mitigation situation of Dutch food companies, the output of the highly anonymized Food Fraud Vulnerability Assessment is used, launched by PwC in January. The Food Fraud Vulnerability Assessment was developed by the Wageningen University, VU University Amsterdam, PwC, SSAFE and in consultation with the food industry (Schoolderman et al., 2015). The tool is a questionnaire of 50 questions. These questions are divided into three groups: opportunity questions, motivation questions and control questions. The opportunity questions are regarding the opportunities for fraud. The motivation questions are in relation to the motivations to commit food fraud, and the control questions are related to the control measures taken by the supplier and the company itself. Regarding the control questions there are three different sub-groups. The first sub-group are the internal hard controls, these are the physical control measures. The second sub-group are the soft control measures, these are regarding the intangible control measures, such as a whistleblowing policy. The last sub-group are the supplier controls, these are in relation to the affairs agreed upon in the contract with the supplier and the control measures the supplier implemented.

For the analysis of the results, the results up until April were taken into account. The survey was made available by PwC on the internet and not send to a company in particular, although PwC actively recommended some clients to participate in the survey. The survey is supposed to be filled in by different specialists within food companies, because each question requires specific knowledge. The assumption is made that the survey is actually filled in by the required specialists because, the survey mentions the specialism required for each question. Furthermore the result of the questionnaire will not be useful, when the questions were not filled in veraciously. For companies, which just wanted to have a quick look, there was an excel file available with all questions, therefore it is less likely that these companies took part in the survey just to have a look.

The total response in the Netherlands of the Food Fraud Vulnerability Assessment was 62 (between January and April). The deviation of industries in the Dutch food sector that took part in the survey is given in table 5. This table shows that most participants were food production companies (41). The second largest group were part of the group "other". The description of the group other is given below the table.

Table 5 Summary of respondents into industries

Industries	No. of companies
Production of Food	41
Processing of Ambient Stable Products[a]	3
Food Broker / Agent	3
Other[b]	15
Total	62

[a]Production of food from any source that are stored and sold at ambient temperature including canned foods, biscuits, snacks, oil, drinking water, beverages, pasta, flour, sugar, food grade salt (fssc 22000, 2016)

[b]Other: Animal Conversion, Catering, Farming of Grains & Pulses, Farming of plants, Processing handling of plant product, Processing of Animal and Plant Perishable products (mixed products), Processing of Animal Perishable products, Processing of Plant Perishable products, Production of (bio) Chemicals, Production of Animals, Production of Animals, Production of Beverage, Production of Feed, Production of Fish, Production of Food Packaging, Retail, Storage & Distribution Services and Wholesale.

The method of analysis chosen to characterize the responses was a cluster analysis (Sarstedt & Mooi, 2014). This method is chosen, because it can make a clear overview of a dataset by segmenting observations into groups with simmilar characteristics (Sarstedt & Mooi, 2014). The questions used for this analysis were questions 32-44 (appendix 1). This decision is made because, these questions are regarding the control measures and therefore directly influenceable by the food company in order to change its reselliance against food fraud. The scale used in the assessment was an ordinal scale ranging from 1-3 (1-not implemented to 3-fully implemented), also an option "not applicable" was available. The software chosen for the analysis was SPSS. Although the data from the Food Fraud Vulnerability Assessment were ordinal, in market analaysis it is common to use ordinal scaled data (in this case 1-3), and make the assumption the distances are equal between 1 and 3 (Sarstedt & Mooi, 2014). When a respondent used the option "not applicable"

for one of the mitigation methods, this respondent was excluded for the cluster analysis. This choice was made, because it is not possible to verify whether the option was really not applicable for the company, or the control measure was not implemented or misinterpreted. Therefore the cluster analysis is based on 38 observations.

For this study there were no colinearity issues, because for each independent variable there was no value above 0,9 found in the colinearity matrix. In order to make an indication of the amount of clusters the hierargical clustering method is used, with Ward's method used as algorithm and squered Euclidean distance as interval measure. Ward's method was chosen, because there were no outliers expected and equally sized clusters (Sartedt & Mooi, 2014). The squared Euclidean distance interval was used, because this is one of the most common methods according to statistical text books, besides the data was standardised and small differences within the oberservation occurred (Finch, 2005; Sartedt & Mooi, 2014). Based on the Dendrogram the choice is made for three clusers (the Dendogram is included in appendix 2). Therafter a K-means cluster analysis is conducted, because observations can be reassigned to another cluster during the clustering process (Sartedt & Mooi, 2014). The post-hoc LSD test was chosen to check the means for significant differences (p value <0.05).

3.3   Elicitation of perceived costs and benefits

The objective of the interviews was to get a general view on the perceived costs and benefits of the Food Fraud Vulnerability Assessment tool. In total there were 38 companies approached for the elicitation of the data, the full list of approached companies and industry organisations are given in appendix 3. Companies and industry organisations were selected for elicitation based on the network form PwC, diversity in product usage and sales and expected interest in implementing the mitigation tools of the Food Fraud Vulnerability Assessment. Within these companies specialists in food quality, safety, risk and procurement were asked to take part in the interviews. For anonymity reasons the companies which took part in the interviews cannot be named. The amount of respondents willing to be interviewed was three, of which two were employed within the same company.

In order to obtain the data semi-structured interviews were used. The interview script is included in appendix 4. In order to make the interview not too exhausting (over 100 questions) the interview was send to the respondents a day before conduction. This way the respondents were able to read the questions in advance. To prevent socially desirable answers anonymity was ensured. Literature concerning potential costs and benefits of the Food Fraud Vulnerability Assessment, has been used in order to develop a benchmark, which is the basis of the interview script. The databases used for this research are the same as for the review described in chapter 3.1. The terms used for this research were: soft internal controls, integrity screening, ethical code, whistle blowing, code of conduct, track and trace and verification food products. These terms were used in combination with the terms: costs

and benefits. An overview of the amount of hits and the amount of used articles is given in table 6.

Table 6 Hits in scientific databases categorised per search term and by database

	Terms used in combination with: "Costs and benefits"							**total**
	Soft internal controls	Integrity screening	Ethical code	Whistle blowing	Code of conduct	Track and trace	Verification food products	
Number of studies after initial search								
ABI/INFORM Dateline	1	-	-	1	4	-	-	6
ABI/INFORM Global	1	-	-	4	6	3	-	14
ABI/INFORM Trade & Industry	3	-	-	1	7	2	-	13
Banking and information source	2	-	1	-	9	-	-	12
Elsevier	-	2	-	-	-	-	1	2
AGRIS	-	1	-	-	-	-	1	2
Taylor & Francis	-	-	1	-	-	-	-	1
SpringerLink	-	-	-	-	-	-	-	-
Accounting & Tax	-	-	-	2	2	1	-	5
Wiley online Library	-	1	1	-	-	-	-	2
DOAJ	-	-	-	-	-	-	-	-
Emerald Journals	-	-	-	-	-	-	-	-
NARCIS	-	2	-	-	-	-	-	2
AGEcon	-	-	-	-	1	-	2	3
Total hits	7	6	3	8	29	6	3	52
Number of studies used	1	-	-	1	1	-	1	4[a]

[a]Besides the articles found above an article by Meuwissen et al., 2003 was used

Of the 52 articles found, four were used in order to develop the interview script. Articles or books were excluded, because the articles were not applicable to the food industry or not detailed enough.

After this literature review, the costs and benefits found were included in the interview script (appendix 4). The central question for this interview was: *"Does the company recognize the following costs and benefits in regard to the following control measures?"*. This question was asked for every cost and benefit item found in the literature study. The scale for answering used was a Likert scale ranging between 1 and 5, in which 3 meant undecided. Because the goal of this sub-objective was to assess the most recognised costs and benefits, the top 3 of costs and benefits were incorporated in the results. Although for some costs and benefits there were equal scores, in this case the four most recognised costs and benefits were used.

4 Results

4.1 Review of reported cases and losses in food supply chains

Table 7 gives an overview of the reported cases and the losses related to each case. The table shows that as a result of food fraud a broad range of losses can occur, there are examples found regarding all product groups investigated and loss groups taken into account. Furthermore the table shows the international scope of the food industry. The melamine scandal makes clear that food fraud can also have food safety risks, this is harshly shown by the six deaths, 60.000 hospitalised and the 240.0000 infants, who became ill (Dani & Deep, 2010). The same case also shows the effect that food fraud can have on sales. Ten days after disclosure the sales of Mengniu and Yili dropped with 80%, the overall drop of sales sector wide ranged between 30%-40% (Dani & Deep, 2010; Lu & Tao, 2009). Furthermore stock prices of companies dropped between 37%-60,25%, between 15 and 24 September. Also the confidence in the Chinese dairy industry decreased drastically. Between 63,65%-45,3% of the Chinese consumers perceived at least one of the main Chinese dairy products (fluid milk, yoghurt, milk powder and ice cream) as unsafe between 16 and 18 September (Qiao et al., 2010). These were just examples of the potential magnitude food fraud can have.

Table 7 Reported cases and losses as a result of food fraud in food supply chains

Case and character	Social losses and punishments	Third party losses	Confidence losses	Sales losses & Overpayment	Recall losses
Melamine scandal dairy 2008 • Scale: Global, started in China[1]; • Length: Dec-2007-still not fully recovered[1,2]; • Fraud issue: PC[B]	• Court imposed death sentences, imprisonment and fines[3], • 240.000 infants affected, 60.000 hospitalized, six confirmed deaths, long term effects not known[5,8] • Bankruptcy of Sanlu Group co, Ltd, debt $160 million[4,11]	• New laws and intensified inspections in dairy chain[2,4] • Chinese dairy boycotted by 30 EU countries[G,2,5,6,7]	• Between 63,6%-45,3% of Chinese consumers perceived at least one of the main Chinese dairy products (fluid milk, yoghurt, milk powder and ice cream) as unsafe between 16-18 September[9]. In November this percentage was between 5,7%-16,3%[9]	• 80% sales drop for Mengniu and Yili, 10 days after disclosure in September[5]. • Overall sales drop Chinese dairy industry 30%-40% around September YTD[10] • Purchase volume of milk decreased to 18,5% of normal sales on 22 September 2008 YTD (37,62 tons)[12] • Yili stock price drop of 37% ($621 million), between 15 -17 September, Mengniu stock price drop of 60,25% ($2,36 billion), on 24 September[H,8] • Chinese dairy consumption dropped with 7,14% (15-14 kg. between 2010-2011)[13] • Overpayment: Cow milk was watered down for less costly water[4]	• Recall: whole Chinese dairy industry and five multinationals[l,2,5] • Estimated recall costs Chinese dairy industry $3 billion, worldwide recall expenses estimated on $18 billion (based on 30 affected brands in more than 60 countries)[4,8] • Recall costs for two largest Chinese dairy producers $470 million (Mengniu $130 and Yili $370)[4]

Table 7 continued

Case and character	Social losses and punishments	Third party losses	Confidence losses	Sales losses & Overpayment	Recall losses
Beef adulterated (horse meat scandal) 2013 • Scale: Europe, started in Ireland[14] • Length: January 2013-NA[14,15] • Fraud issue: BCVS[C]	• Court imposed jail terms and fines[16] • Non edible meat in ended up in supply chain and a sensitive adulterant (pork meat and horse meat)[14, 17, 18] • Bankruptcy of Vleesgroothandel Willy Selten[16]	• Intensified tests in meat chain[15, 19] • CBL launched additional production demands[20]	• 18% of the British consumers declare to have less confidence in food retailers (between 20-22 December 2013)[28] • 17% of British consumers declared that their perception of involved food producers worsened (between 20-22 December 2013)[26] • 53% of British consumers declare to be suspicious of discounted food (between 20-22 December 2013)[27] • 31% of the British consumers declared to have changed their buying behavior (in December 2013)[24] • 26% of British consumers declared to be not confident about food safety in supermarkets (between 22-24 February 2013)[25] • Drops trust score in meat market: GB 1,9 and Ireland 1,6 (between 2012-2014), EU wide trust score dropped 0,5 points from 6,9[30]	• Greencore share price decreased 75% (Greencore was the manufacturer of adulterated Bolognese sauce)[29] • 29,83%-49,73% decline of sales of adulterated hamburger brand, between December 2013-March 2013 at Tesco[21] • Burger King dropped supply contract Silvercrest[23] • Decline of sales in frozen meals 13% in GB (between 21 January-17 February)[21,22] • Overpayment: Beef adulterated with less costly horse meat[17, 34]	• EU reports high costs for tracking and tracing meat due to complex supply chain[33] • Beef products recalled by 22 multinationals[J, 31] • NVWA recalls 50.000 tons of meat in Netherlands (1800 companies involved)[32]

Table 7 continued

Case and character	Social losses and punishments	Third party losses	Confidence losses	Sales losses & Overpayment	Recall losses
Fish mislabeled 2008 • Scale: North-America samples and U.S.[35] • Length: NA • Fraud Issue: PS[D]/PQ[E]	• NA[A]	• NA	• NA	• Overpayment: Red-snapper valued $6,45 per kg, content fish valued at $1,62 per KG[35]	• NA
Oregano adulterated 2009 • Scale: Europe, started in Italy[36] • Length: NA • Fraud issue: BCVS	• NA	• NA	• NA	• Overpayment: Cheaper other botanical sources were used[36]	• NA
Black Pepper adulterated 2004 • Scale: India[37] • Length: NA • Fraud issue: BCVS/PS	• NA	• NA	• NA	• Overpayment: Chili was used to fortify exhausted pepper[37]	• NA
Curcuma adulterated 2004 • Scale: India[38] • Length: NA • Fraud issue: BCVS	• NA	• NA	• NA	• Overpayment: non-culinary curcuma used[38]	• NA
Black pepper adulterated 2008 • Scale: India[40] • Length: NA • Fraud issue: BCVS	• NA	• NA	• NA	• Overpayment: Black pepper adulterated with cheaper Papaya seeds[40]	• NA

Table 7 continued

Case and character	Social losses and punishments	Third party losses	Confidence losses	Sales losses & Overpayment	Recall losses
Chili adulterated 2011					
• Scale: India[39] • Length: NA • Fraud issue: BCVS	• NA	• NA	• NA	• Overpayment: Chili adulterated with less costly Jharber[39]	• NA
Olive oil mislabeled (suspected) 2015					
• Scale: Italy[41] • Length: November 2015-NA[41] • Fraud issue: PS	• Possible fines up to $2000,- per adulterated product[41]	• NA	• Damage consumer trust according to Carlo Rienzi, president of principal consumer association[42] • Damage for Italy as Olive oil producing country according to Rosario Trefiletti president of a consumer organization[42]	• Overpayment: regular olive oil was sold as regular olive oil price difference between extra-virgin and regular is $3,27 per liter[41]	• Prosecutor demanded that concerned brands should be taken off shelves[42]
Olive oil mislabelled (Mama Mia) 2016					
• Scale: Spain, Greece and Italy[43] • Length: February 2016-NA[43] • Fraud issue: GO[F]	• NA	• Italian consortium of Olive oil producers called for tighter controls on Olive oil imports[43]	• NA	• Overpayment: Cheaper olive oil from Greece and Spain sold as Italian extra virgin[43]	• 2000 tons of olive oil, worth $14,1 million[43]
Cumin adulterated 2015					
• Scale: International, started in Great-Britain • Length: January 2015-NA[44, 45] • Fraud issue: BCVS	• Dangerous adulterant was used (nuts), although no reported incidents[44, 45]	• NA	• NA	• Overpayment: Cumin adulterated with less costly nuts[44, 45]	• Ground cumin recalled by three companies[45]

Table 7 continued

Case and character	Social losses and punishments	Third party losses	Confidence losses	Sales losses & Overpayment	Recall losses
Oregano adulterated 2015					
• Scale: U.K.[46] • Length: July 2015-NA[46] • Fraud issue: BCVS	• NA	• NA	• NA	• Overpayment: Oregano was adulterated with less costly other botanical sources[46]	• NA
Milk dairy 2007					
• Scale: U.S.[48] • Length: October-Na[48] • Fraud issue: PS	• Settlement USDA for $7,5 million[48]	• NA	• NA	• Price difference between organic milk and regular milk was 0,75$ per liter[48]	• NA
Parmesan cheese adulterated 2012					
• Scale: U.S.[49] • Length: November 2012-Never recovered[49, 50, 52] • Fraud issue: PS	• Fine of $500.000 fine for Castle cheese Ltd, possible imprisonment and fine for CEO[50,51] • Bankruptcy of Castle cheese Ltd[54]	• NA	• NA	• Overpayment: Parmesan cheese adulterated with wood pulp[52]	• NA
Salmon mislabelled 2013					
• Scale: U.S.[54] • Length: December 2013-NA[54] • Fraud issue: PS	• NA	• NA	• NA	• Overpayment: farmed salmon was labelled as more costly wild salmon[54]	• NA
Lamb meat adulterated 2014					
• Scale: Great-Britain[55] • Length: February 2015-NA[55] • Fraud issue: BCVS	• Sensitive adulterants were used (pork and beef)[55]	• Restaurants pleaded guilty could receive a fine up to $500,-[55]	• NA	• Overpayment: Lamb meat was adulterated with less costly other meats[55]	• NA

Table 7 continued

Case and character	Social losses and punishments	Third party losses	Confidence losses	Sales losses & Overpayment	Recall losses
Halal meat mislabelled 2007					
• Scale: International, started in U.S.[55, 59] • Length: 2007-NA[55] • Fraud issue: PS	• Non-halal conformity slaughtered meat was sold as halal meat[57,58] • Court imposed $60.000 fine and imprisonment[60]	• NA	• NA	• Overpayment: non-halal conformity slaughtered meat was sold as halal meat[60]	• NA

Acronyms: [A]NA=Not available. [B]PC=product composition. [C]BCVS=Botanical/cultivar/varietal origin/species. [D]PS=Production system. [E]PQ=Product quality. [F]GO=Geographical origin

Notes: [G]Boycotts as a direct result of the melamine scandal in 2008: Australia, New Zealand, India, Bangladesh, Bhutan, Brunei, Burundi, Cameroon, Chile, Colombia, Dominican Republic, Gabon, Cote d'Ivore, Ghana, Malaysia, Philippines, Singapore, Indonesia, Maldives, Mali, Mexico, Nepal, Papua new Guinea, Paraguay, South Korea, Taiwan, Suriname, Tanzania, Togo, United Arab Emirates. [H]Damage calculated with average exchange rate 2011. [I]Recall multinationals melamine scandal: Tesco, Cadburys, Heinz, Nestle, Unilever. [J]Recall multinationals in EU horse meat scandal: Tesco, Sainsbury's, ASDA, Waitrose, CO-OP, Lidl, Iceland, Aldi, Morrisons, Whitebread, Compass, Birds Eye, Taco Bell, Makro, Burger Manufacturing Company, Sodexo, King Fry, Hungarian Food Ltd, Nestle, Real and Ikea.

Sources: [1](Dong & Zhemin, 2015). [2](Custance et al., 2011). [3](Cucchiella & Gastaldi, 2006). [4](Xiu & Klein, 2010). [5](Dani & Deep, 2010). [6](Economic times, 2008). [7](Reuters, 2008). [8](Evershed & Temple, 2016). [9](Qiao, et al., 2010). [10](Lu & Tao, 2009). [11](Lyu, 2013). [12](Qian et al., 2011). [13](Boerderij, 2011). [14](FSA, n.d.). [15](EU, n.d.). [16](Higgins & Ellis, 2015). [17](Boyaci et al., 2014). [18](Hsieh & Ofori, 2019). [19](Stoyke et al., 2013). [20](Boerderij, 2014). [21](Yamoah & Yawson, 2014). [22](Neville, 2013). [23](Irish Times, 2013). [24](Ipsos Mori, 2014). [25](Statista, 2013a). [26](Statista, 2013b). [27](Statista, 2013c). [28](Statista, 2013d). [29](Financial Times, 2013). [30](EU Comission, 2014a). [31](BBC, 2013). [32](NVWA, 2013). [33](EU commission, 2014b). [34](Guardian, 2013). [35](Wong & Hanner, 2008). [36](Marieschi et al., 2009). [37](Pavathy et al., 2014). [38](Sasikumar et al., 2005). [39](Dhanya et al., 2009). [40](Dhanya et al., 2011). [41](Poulter, 2015a). [42](Squires, 2015). [43](Squires, 2016). [44](Turner, 2015). [45](FSA, 2015). [46](Poulter, 2015b). [47](Progressive grocer, 2007). [48](Martin, 2007). [49](Uria, 2016). [50](Department of Justice, 2016). [51](Gajanan, 2016). [52](FDA, 2013). [53](U.S. Bankruptcy court, 2016). [54](Mclean, 2007). [55](Mackay, 2014). [56](Poulter, 2014). [57](Associated press, 2014). [58](Legal monitor, 2014). [59](Express Tribune, 2015). [60](Franzman, 2016).

Besides the melamine scandal, 16 other cases were reviewed. Within the product group herbs and spices seven cases were reviewed. The relative large amount of reported cases may be as expected, due to the fact that herbs and spices are the most reported product group according to Weesepoel & van Ruth, (2015). A similarity between the herbs and spices cases is that in all herbs and spices cases reviewed, botanical sources were used as adulterants. Remarkable is the fact that in six cases an adulterant was used to cut the yield, and in one case in order to strengthen the spice (Parvathy, 2005). In this sample in particular chili was used to fortify exhausted black pepper. Furthermore there seems to be no connection between the countries or place in the supply chain of discovery of the cases. Some cases were discovered in emerging countries, while others were discovered in first world countries. Also one case was discovered at a wholesaler, while others were discovered in retail (Marieschi et al., 2009; Turner, 2015; Poulter 2015a).

Regarding olive oil two cases were found, this was rather surprising, because the relative share within this literature study is small, while olive oil is the second most reported product group (Weesepoel & van Ruth, 2015). The similarity between these cases is large, both cases were discovered in Italy, and both cases were recently reported (2015 and 2016).

In relation to fish also two cases were reviewed. The similarity between the cases is the fact that the samples were not adulterated, but mislabelled. Yet this is not surprising, because adulterating a whole fish is hard. Despite this similarity, there are differences between the cases. Some fish were mislabelled in order to be able to sell the fish, because the actual fish caught was an endangered species (Wong & Hanner, 2008). And other fish were mislabelled to increase profit margins. Some of these fish were mislabelled for a more expensive species, while for others the species were correctly labelled, but the method of production was incorrect (farmed salmon for wild salmon) (Wong & Hanner, 2008; Mclean, 2015)

Concerning dairy, two cases were reviewed, besides the earlier described melamine scandal. The similarity between these two cases is the relative high price of the genuine product; Parmesan cheese and organic milk (Progressive grocer, 2007; Poulter 2015). Surprising is the fact that regarding the Parmesan cheese case is the fact that this is the only case in which a non-edible adulterant was used (wood-pulp), besides the melamine scandal and to the horse meat scandal to a certain extend.

In regard to the product group meat, four cases were investigated. The similarity between these cases is that religion and idealistic views were often violated, compared to the other product groups. Also remarkable is the fact that all these cases were reported in first world countries. Yet these similarities may be as expected, because religions have often rules regarding meat, and the consumption of meat is the highest in developed countries (Machovina et al., 2015).

Concluding table 7 shows that as a result of food fraud a broad range of losses can occur. Furthermore the melamine scandal and the horse meat scandal have the most reported losses of the investigated cases. Of the investigated reported losses the sales & overpayment losses occurred the most, followed by the social losses and punishments. Furthermore the table shows that food fraud involves companies of various sizes and both the first world as emerging markets. The melamine scandal and the horse meat scandal both have most reported losses of the investigated cases. Although not all losses were quantifiable, multiple drops in sales, confidence and stock prices are reported as a direct result of food fraud. Moreover some companies may go bankrupt as a result of food fraud. Besides drops in sales and bankruptcies consumers and customers may get affected in all fraud cases due to overpayment. In some cases the adulterant was not even edible. This reinforces the statement of Moore et al. (2012) that people who commit food fraud do not always have the knowledge in regard to toxicological or hygienic risks. Furthermore the table shows that food fraud cases are represented in all five product groups and all cases could be linked to the different fraud issues as described in the definition. Moreover the table also shows that a whole industry can get affected as a result of a food fraud case. This is shown by the melamine scandal in which to whole Chinese dairy industry was influenced, and is still not recovered.

An important remark for the table is the fact that there are also benefits found in literature as a result of food fraud. As a result of the melamine scandal the sales of non-Chinese dairy companies increased (Xiu & Klein, 2010). Furthermore literature that is not directly focused on food fraud states that some products may have benefit from illicit sales. There are studies available that state that sales of counterfeit products increase the brand awareness of the genuine brand (Thorsen & Staake, 2008). Furthermore these studies show that illicit products do not automatically cause direct substitution of the genuine product (Thorsen & Staake, 2008). Moreover researchers do not know how widespread the problem of food fraud is (Johnson, 2014). Therefore if food fraud would be solved, products may get relatively more expensive, so people may only be able to buy a smaller amount of genuine products.

4.2 Characterisation Dutch food companies regarding their risk mitigation situation

First an analysis of the survey itself is given in sub-paragraph 4.2.1. Then the characterisation in made based on a cluster analysis in sub-paragraph 4.2.2

4.2.1 Results of the Food Fraud survey

As mentioned in the materials and methods chapter, the survey is conducted anonymously. Although an overall result was available, which gave an overview in which sector a company belonged to, it was unfortunately not possible to check for each individual response in which industry the response belonged to. How the responses were divided into different industries is given in table 8

Table 8 Mitigation tools named by the Food Fraud Vulnerability Assessment in order to increase resilience towards food fraud for food companies

Mitigation tool	n	Percentage level of implementation		
		Low	Medium	High
Fraud monitoring system raw materials	57	50	43	5
Verification of fraud monitoring system raw materials	51	39	41	19
Fraud monitoring system final products	54	59	27	12
Verification of fraud monitoring system final products	52	36	28	34
Information system own company	57	24	29	45
Tracking and tracing own company	59	16	42	40
Integrity screening own employees	58	53	22	24
Ethical code of conduct own company	57	24	45	29
Whistle blowing own company	58	50	32	17
Contractual requirements suppliers	59	15	54	30
Fraud control system supplier	55	52	38	9
Mass balance control supplier	46	21	45	32
Tracking and tracing system supplier	54	24	51	23

Table 8 shows that there is differentiation between the fraud mitigation measures regarding the level of implementation. The highest percentage is a low level of implementation for the variable "Fraud monitoring system final products", with 59% (n=54). The lowest percentage is for the high level of implementation of the variable "Fraud monitoring system raw materials" with 5% (n=57).

4.2.2 Analysis of the level of implementation of fraud mitigation tools named Food Fraud Vulnerability Assessment

By making use of the dendrogram (appendix 2) of the hierarchical cluster analysis, the choice has been made for three clusters. These clusters were obtained by using the k-means clustering method. After the clusters were retrieved a one-way Anova test was conducted with post-hoc LSD. The results of the cluster analysis and the LSD are combined in table 9.

Table 9 Mitigation variables, clusters and significance rates of differences in means

		Cluster			
Cluster		**1**	**2**	**3**	
Size of cluster	n	16	4	18	
	percentage	42	10	47	
Variable name					**sig**
Fraud monitoring system raw materials		1,5	<u>2.5</u>	1,5	0,004[S**]
Verification of fraud monitoring system raw materials		2	<u>2,5</u>	<u>1,278</u>	<0,001[S**]
Fraud monitoring system final products		1,563	<u>3</u>	<u>1,333</u>	<0,001[S**]
Verification of fraud monitoring system final products		2,438	<u>2,750</u>	<u>1,389</u>	<0.001[S**]
Information system own company		2,313	2,750	1,944	0,109
Tracking and tracing own company		2,438	<u>3</u>	<u>1,889</u>	0,002[S**]
Integrity screening own employees		2,125	2,5	1,389	0,005
Ethical code of conduct own company		<u>2,625</u>	2	<u>1,778</u>	0,001[S**]
Whistle blowing own company		<u>2,313</u>	1,750	<u>1,278</u>	<0,001[S**]
Contractual requirements suppliers		2,5	2,5	2	0,053
Fraud control system supplier		1,813	<u>2,25</u>	<u>1,333</u>	0,023[S**]
Mass balance control supplier		2,313	<u>3</u>	<u>1,889</u>	0,006[S**]
Tracking and tracing system supplier		2	2,750	1,944	0,074

Note: [s**] Means a significant mitigation strategy variable for sig 0,05 significance of differences in means

The "[S**]" marked significance rates represent variables with significant differentiation between the cluster means. The underlined numbers represent the two extreme values between the different clusters. Cluster 1 (n=16) and 3 (n=18) are the largest clusters by representing 42% and 47% of all valid observations. Cluster 2 and 3 differ most from each other, therefore cluster 1 is between clusters 2 and 3, but slightly closer to cluster 3. Cluster 2 has implemented most of the mitigation measures, and cluster 2 the least.

Cluster 1 seems to focus on the internal soft controls of the Food Fraud Vulnerability Assessment (the human side of the company), and seems to have less focus on Fraud monitoring systems of raw materials. Given the fact that cluster 1 has a focus on the mitigation tools "ethical code of conduct of

own company" and "whistle blowing policy" to this cluster is referred to as the "the soft control focused".

Cluster 3 is the second largest group, cluster 3 seems to have the least focus on control measures of all clusters. All control variables for cluster 3 are significantly less implemented, except for the control measurement "fraud monitoring system raw materials". Therefore the assumption is made that food fraud is not a real agenda point for this cluster. So to cluster is referred to as "the unfocused".

Cluster 2 is the smallest cluster. All control variables for cluster 2 are significantly most implemented, except for the variables "ethical code of conduct own company" and "whistle blowing own company". Yet it is assumed that food fraud is an attention point of these companies. The fact that there is not the strongest focus on "whistle blowing" and "ethical codes of conduct" can be due to the fact that there is, no or not a lot of personnel in these companies. Furthermore these controls may be perceived as unnecessary, because there may be another factor which provides a level of social control, such as within a family business. Based on these assumptions and the cluster analysis this cluster is referred to as "The integral focused".

4.3   Elicitation of perceived costs and benefits

As stated in the materials and methods there is made use of semi-structured interviews. The total response of these interviews was three. The entire interview script is given in appendix 4. The interview was concerning the three mitigation groups named by the Food Fraud Vulnerability Assessment to be known: internal hard controls, internal soft controls and direct supplier controls. For each mitigation group there were three different categories discussed with the interviewee concerning potential perceived costs and benefits to be known: extra costs, cost reduction and extra revenue. Before the interview script could be developed a literature study has been conducted, regarding the potential costs and benefits of the mitigation strategies of the assessment. The result of this literature study is given in table 10. Of these costs and benefits, cost reduction benefits are most found in literature. The denominator of the cost reduction benefits seem to be a more structured process. This may be the result of clear agreements concerning the product and process. Therefore the flexibility of the process may decrease at the same time, due to stricter procedures. Furthermore the category "other" was used for benefits that could neither be assigned to cost reduction nor extra revenue.

Table 10 Potential costs and benefits found as a result of literature review regarding potential costs and benefits of the fraud mitigation tools named by the Food Fraud Vulnerability Assessment

Potential costs
Extra costs

- Capital investments
- Development costs
- Training costs
- Verification and validation of systems
- Record keeping
- Operational processes
- Storage of production materials and documentation
- Audits
- Flexibility process
- Transformation process

Potential benefits		
Cost reduction	**Extra revenue**	**Other**

Cost reduction	Extra revenue	Other
- Production costs - Pre-empting certification standards - Pre-empting governmental rules - Risk and liability - Due diligence defence - Licence procedures - Control of production process - Product waste - Reduced defects - Customer complaints - Need for quality audits by customers - Audit process - Efficiency allocation of resources - Effectiveness resource management - Disease control and residue monitoring - Disease levels - Detect source of defect final product or infected products - Compensation payments - Price premiums - Transaction costs - Labour-management relation - Productivity employees - Breakdown of departmental silos - Rate of employee change - Adequate intervention - Creation of team culture - Protection of natural and social environment	- Maintaining or expanding market size - Access to market - National and international acceptance - Build a good market position - Competitive advantage - Consumer/customer confidence - Consumer assurance - Transparency - Employee motivation - Transformation in attitude employees - Customer/consumer loyalty and satisfaction	- Access to finance - Access to liability insurance

Sources: Dhanya, 2014; Gellynck & Verbeke, 2001; Luning et al., 2008, Manning, 2013; Meuwissen et al., 2003; Payne et al., 1999; Psomas, 2013; Skees et al., 2001; Tanner, 2000.

Table 11 gives an overview of the most recognised perceived costs and benefits. As mentioned in paragraph 3.3 the scale used ran from 1-5 of, which 1 meant not-recognised/perceived at all, 5 very recognisable/likely, and 3 meant undecided. This way the three most recognised costs and benefits could be given. For costs and benefits with an equal score, all costs or benefits with an equal score were mentioned in the table. The numbers between brackets represent the total score of a potential cost or benefit given by the respondents.

Table 11 Overview of perceived costs and benefits of the Food Fraud Vulnerability Assessment

Mitigation strategy	Most recognised cost or benefit[a]		
	Extra-costs	**Cost reduction**	**Extra revenue**
Internal hard	Verification and validation systems (15)[b]	Certification process (15)	Customer/consumer confidence (14)
	Flexibility process (15)	Customer/consumer complaints (14)	Transparency (12)
	Transformation process (15)	Adequate intervention (14)	Employee motivation (12)
Internal soft	Flexibility process (14)	Need for quality audits by customers (11)	Consumer/customer confidence (14)
	Verification and validation systems (14)	Compensation payments (13)	Maintaining expanding market size (11)
	Training costs (14)	Adequate intervention (13)	Competitive advantage (11)
		Certification process (13)	Transparency (11)
			Customer loyalty and satisfaction (11)
Direct supplier	Development costs (14)	Certification process (13)	Transparency (12)
	Training costs (14)	Adequate intervention (14)	Consumer/customer confidence (14)
	Validation and verification process(15)	Need for quality audits by customers (14)	Competitive advantage (12)
	Flexibility process (15)	Customer complaints (13)	

[a]Regarding the category "other", only two potential benefits were assessed: access to finance and access to liability insurance. The scores for the three mitigation strategies ranged between 11-12

[b]Numbers between brackets present the total score given by the respondents of the potential benefit or cost

Table 11 shows that validation and verification of the process, flexibility and training costs were the most recognised extra costs. In relation to the cost reduction the most perceived benefits were the certification process, adequate intervention, customer/consumer complaints and need for quality audits by customers. Regarding the extra revenues customer/consumer confidence, transparency and competitive advantage were most perceived and recognised. The respondents mention the fact that Dutch companies just started with implementing fraud mitigation techniques. Yet one of the respondents admitted that the reputation risk is large. The respondents also indicate that their supplier management has been changed. High risk suppliers were excluded from business, as a result the opportunity costs may increase. Nevertheless, besides the costs of implementing the

mitigation techniques the companies expect to have a competitive advantage in the future compared to other companies, which do not see importance to mitigate the food fraud risk. Another interesting aspect is the fact that all three respondents speak about the increased team culture as a result of the awareness of food fraud. All respondents mentioned for example that procurement and food quality management departments collaborate more. At last the power of retailers was marked as high, due to their position within the supply chain and their size.

5   Discussion and conclusions

In this section the discussion and conclusion of this study are described, followed by the suggestions for further research.

5.1   Discussion

The objective of reviewing reported cases and losses was to make an overview of all potential losses linked to food fraud. The deviation of articles was not as expected. Such as like the cases regarding olive oil, only two cases were found. This may be due to two reasons, first, because the low impact on society. Secondly Moore et al., 2012 stated that food fraud is a relatively new topic. For this study also grey literature has been used in order to enrich the scientific literature. The reliability of the grey literature was increased, by taking the amount of hits on LexisNexis into account, this way articles could be compared with each other. The result of this study can be used as an outline of the variety of impact food fraud can have.

The second research objective was to characterize the current risk mitigation situation of Dutch food companies. This characterisation was based on the results of the Food Fraud Vulnerability Assessment. Although the assessment was conducted internationally, it was possible to single out the assessments of Dutch food companies. The largest cluster of the characterisation was referred to as the "unfocused", this may also be an indication of the novelty of the topic food fraud within food companies, as described in literature (Moore et al., 2012). Yet the limitation for this characterization was the fact that there were a little valid respondents for this study to represent the whole Dutch food supply chain. Furthermore there were no comparable studies available, so it was not possible to verify the reliability of the characterization. The initial response was 62. In order to keep the results comparable over the dataset, responses using the option "not applicable" were excluded. The remaining amount of valid respondents was 38. The reason why companies used the option "not applicable", might be due to two reasons. First the option "not applicable" may have been used, because the respondent did not know if, or on what level, a mitigation strategy was implemented. Secondly the mitigation strategy may not be feasible or relevant for the company. Most of the respondents were companies in the field of food production (41 respondents), the second largest group were companies in the category "other" (15 respondents). Therefore this characterisation is mostly related to food production companies. The results of the characterisation can be used as a benchmark for future study. Yet the result of future studies can deviate from this characterization, because the attention for food fraud prevention is expected to increase. Also the characterisation may be different in real life, because respondents did not put the required effort in the assessment. At last the assessment can be biased by the fact that companies which participated are somehow already interested in increasing their resilience regarding food fraud.

At last the perceived costs and benefits of implementing the fraud mitigation tools named by the Food Fraud Vulnerability Assessment were assessed. It was hard to find respondents for the interviews, possibly because of the sensitivity of the topic. The result of 38 approached companies were three interviews. To create a benchmark of the potential perceived costs and benefits scientific literature was used. To be able to assess this benchmark interviews were chosen over questionnaires. The advantage of interviews is that additional questions can be asked or concepts can be explained. The interviews seem to have similarities with a study published by Meuwissen et al., (2003). This publication was regarding traceability and certification in meat supply chains. This paper showed similar potential costs and benefits for traceability systems and certification schemes. Yet the interviews only give a general idea of the perceived costs and benefits. So the results are not a reliable representation of the perceived costs and benefits of the Food Fraud Vulnerability Assessment in the Dutch food sector. The output of the interviews can be used for future research, such as improvement of the interview script or as a basis for a questionnaire.

5.2   Conclusions

The objective of this study was to investigate the costs and benefits of the Food Fraud Vulnerability Assessment in Dutch food supply chains. In order to achieve this research objective three sub-objectives were formulated. Although the limitations discussed in the previous paragraph, the three sub-objectives were achieved and answered. Overall this study shows that food fraud can have a significant impact on all kind of companies, also companies which did not commit food fraud actively themselves. Also fraud cases may occur in every stage of the supply chain. Furthermore not only companies can get affected, but also consumers regarding their health and trust in their food. Moreover this study shows that food fraud is a new topic in the Dutch food supply chain, literature regarding the international market already stated this. At last the thesis shows that there may not only be costs concerning the implementation of fraud mitigation tools, but also potential benefits.

Based on a literature review it can be concluded that sales, drops ranged between 13%-80%, stock prices decreased between 37%-75%. In relation to the price of an adulterated product, the price was 1,5-4 times higher than the genuine product. Also confidence is affected by food fraud. Decreases in trust in industries ranged between 7,25%-63,6%. Concerning the amount of multi-nationals involved in recalls, the amount of multi-nationals ranged between 5 and 22.

As a result of a characterization of Dutch food companies, three clusters appeared. Cluster 1 (42% of the responses), is referred to as "soft control focused", because this cluster seems to focus on the soft controls and less on internal hard controls. Cluster 2 (10% of the responses), is referred to as "the integral focused", because this cluster seems to focus on almost all mitigation tools. Cluster 3 (47% of the responses), is referred to as "the unfocused", because this cluster seems not to have a focus on any of the mitigation tools.

Thirdly the interviews showed that in relation to the extra costs of the mitigation tools validation and verification of the process, flexibility and training costs were most recognised and perceived. Regarding the cost reduction the perceived benefits were the certification process, adequate intervention and customer/consumer complaints and the need for quality audits by customers. Concerning the perceived benefits of the tools customer/consumer confidence, transparency, and a competitive advantage were most indicated.

5.3   Future research

- As mentioned in the discussion chapter this study can have an ongoing character regarding the literature review and the results of the Food Fraud Vulnerability Assessment. Due to the still increasing amount of food fraud cases and the increasing attention for food fraud, the amount of reported cases and losses may increase also in scientific literature. Furthermore the amount of results of the Food Fraud Vulnerability Assessment is also increasing, this way it is possible to conduct another cluster analysis to see whether something changed due to increasing attention for food fraud. If the study is being continued comparisons between timeframes can be made. Also concerning the increasing amount of respondents of the Food Fraud Vulnerability Assessment, a comparison among countries may be made. Yet difficulties in this comparison are the comparability between countries. Some production stages are by definition in low wage countries. Therefore the risk of food fraud may be automatically high for some countries. Still this comparison may be made between similar countries, such as Germany and the Netherlands. This comparison may be useful, because of the international character of the food supply chain and to see what effective fraud mitigation policies are. Furthermore concerning the perceived costs and benefits more research can be conducted. This can be done by conducting a survey among Dutch food companies. This way quantitative analyses can be made of the perceived costs and benefits among different sectors in the Dutch food supply chain. The benefit of this study is that an explanation can be found why certain mitigation strategies are preferred, assuming that costs are the most important constraint concerning the implementation of mitigation strategies.

- Also future research may be done by conducting a risk simulation in @Risk, this way a more quantifiable overview of the risk and the mitigating influence of the tools may be provided. However in order to conduct this type of research a probability distribution of the risk of becoming a victim of food fraud and the costs of implementing mitigation tools should be taken into account. This research can help companies with the decision process regarding the implementation of fraud mitigation tools. Yet this kind of study would be very complex, due to factors that are hard to quantify, such as reputation losses.

5 References

Associated Press. (2014, December 5). US halal food companies, execs charged with fraud. *Associated Press State & Local.* Retrieved March 2016

Boyaci, I.H., Temiz, T.H., Uysal, S.R., Veligoglu, H.M., Yadegari, R.J., Rshkan, M.M. (2014). A Novel method for dicrimination of beef and horsemeat using Raman spectroscopy. *Food Chemistry, 148*(1), 37-41.

Bron, J. (2011, October 25). Chinese zuivel herstelt van melamine-crisis. *Boerderij vandaag*, . 4.

Cucchiella, F., Gastaldi, M. (2006). Risk management in supply chain: a real option approach. *Journal of Manufacturing Technology Management, 17*(6), 700-720.

Custance, P., Walley, K., Jiang, D. (2012). Crisis brand management in emerging markets. *Marketing Intelligence & Planning, 30*(1), 18-32.

Dani, S., Deep, A. (2010). Fragile food supply chains: Reacting to risks. *International journal of Logistics: Research and applications, 13*(5), 395-410.

Department of Justice. (2016, February 26). *justice.gov.* Retrieved March 2016, from https://www.justice.gov/opa/pr/court-accepts-pleas-adulterated-and-misbranded-cheese-cases

Dhamija, S. (2014). Whistleblower Policy- Time to Make it Mandatory. *Global Business Review, 15*(4), 833-846.

Dhanya, K., Syankumar, S., Siju, S., Sasikumar, B. (2009). Development and Application of SCAR Marker for the Detection of Papaya Seed Adulteration in Traded Black Pepper Powder. *Food Biotechnology, 23*(2), pp. 97-106.

Dhanya, K., Syankumar, S., Saskikumar, B. (2011). SCAR markers for adulterant detection in ground chili. *British Food Journal, 113*(5), 656-668.

Dong, X., Zhemin, L. (2015). Food safety issues in China: a case study of the dairy sector. *Journal of the Science of Food and Agriculture, 96*(12), pp. 346-352.

Economic Times. (2008, September 29). UAE bans Chinese dairy products. *Economic Times.* Retrieved March 20 , 2016

Ellefson, W. Z. (2013). Defining Food Fraud. In J. Spink, & W. Z. Ellefson (Ed.), *Improving Import Safety* (pp. 196-216). Hoboken, New Jersey, USA: John Wiley & Sons, Inc.

EU commission. (n.d.). *ec.europa.eu.* Retrieved April 1, 2016, from http://ec.europa.eu/food/food/horsemeat/

European Union. (2014). *Consumer Markets Scoreboard.* Publications Office of the European Union. Retrieved March 2016, from http://ec.europa.eu/consumers/consumer_evidence/consumer_scoreboards/10_edition/docs/consumer_market_brochure_141027_en.pdf

Evershed, R., Temple, N. (2016). *Sorting the Beef from the Bull The Science of Food Fraud Forensics.* New York: Bloomsbury.

Everstine. K., Spink, J., Kennedy, S. (2012). Economically Motivated Adulterated (EMA) of Food. *Journal of Food protection, 76*(4), 723-735.

FDA. (2013, July 11). *fda.gov*. Retrieved March 2016, from http://www.fda.gov/iceci/enforcementactions/warningletters/2013/ucm363201.html

Finch, H. (2005). Comparinson of Distance Measures in Cluster Analysis with Dichotomous Data. *Journal of Data Science*(3), 85-100.

Food Protection and Defence Institute. (n.d.). Retrieved April 29 , 2016, from foodfraudresources.com: http://www.foodfraudresources.com/

Franzman, D. (2016, February 25). *kcrg.com*. Retrieved March 2016, from http://www.kcrg.com/content/news/Midamar-Founder-Sentenced-to-2-Years-in-Prison-in-Halal-Meat-Case-370133021.html

FSA. (2015, January 31). *Bart Ground Cumin recalled.* Retrieved March 2016, from http://www.food.gov.uk/news-updates/news/2015/13512/bart-ground-cumin-recalled

FSA. (n.d.). *Timeline on horse meat issue.* Retrieved March 14, 2016, from webarchive.nationalarchives.goc.uk: http://webarchive.nationalarchives.gov.uk/20150624093026/http://www.food.gov.uk/enforcement/monitoring/horse-meat/timeline-horsemeat

fssc22000. (2016). Retrieved July 2016, from http://www.fssc22000.com/documents/news-items/07082014-use-of-iso-220032013-food-chain-categories.xml

Gajanan, M. (2016, February 17). *theguardian.com*. Retrieved March 2016, from http://www.theguardian.com/lifeandstyle/2016/feb/17/parmesan-cheese-store-bought-wood-pulp

Gellynck, X., Verbeke, W. (2001). Consumer Perception of Traceability in the Meat Chain. *Agrawirtschaft, 50*(6), 368-374.

GFSI. (2014). *GFSI Position On Mitigating The Public Health Risk Of Food Fraud.* Silver Spring: GFSI. Retrieved April 28, 2016, from http://www.mygfsi.com/files/Technical_Documents/Food_Fraud_Position_Paper.pdf

GFSI. (2016). *GFSI Benchmarking Requirements.* Silver Spring: GFSI. Retrieved April 28 , 2016, from http://www.mygfsi.com/images/mygfsi/gfsifiles/technical-documents/Design_Guidance_Document_Intro.pdf

GFSI. (n.d.-b). *My GFSI: GFSI Board composition.* Retrieved May 4, 2016, from http://www.mygfsi.com/news-resources/news/471-amazon-tesco-auchan-and-dole-join-the-gfsi-board.html

GFSI. (n.d.-a). *My GFSI: Recognised schemes.* Retrieved May 4, 2016, from http://www.mygfsi.com/schemes-certification/recognised-schemes.html

Gleeson, G. (2013, January 24). *irishtimes.com*. Retrieved March 2016, from http://www.irishtimes.com/news/burger-king-drops-silvercrest-as-supplier-1.965264

Henry, C., Morehouse, J. E., Freienstein, C., Cardoso, L. (2010). *Consumer Product Fraud: Deterrence and Detection.* Retrieved Februari 2016, from http://www.gmaonline.org/downloads/research-and-reports/consumerproductfraud.pdf

Higgins, M., Ellis, N. (2015). "Who said we're flogging a dead horse. In A. R. Pullen (Ed.), *The Routledge Companion to Ethics, Politics and Organizations* (pp. 249-264). New York : Taylor & Francis Group. Retrieved March 14, 2016

Horst, M. (2014, June). CBL gaat extra eisen aan producenten stellen. *Boerderij*. Retrieved March 2016, from http://www.boerderij.nl/Registreren-of-inloggen/?returnurl=%2fHome%2fNieuws%2f2014%2f6%2fCBL-extra-eisen-aan-producenten-1545408W%2f

Hsieh, Y.H.P., Ofori, J.A. (2014). Detection of Horse Meat Contamination in Raw and Heat-Processed Meat Products. *Journal of Agricultural and Food Chemistry, 62*(52), 12536-12544.

Ipsos MORI. (2014, January 11). *ipsos-mori.com*. Retrieved March 2016, from https://www.ipsos-mori.com/researchpublications/researcharchive/3327/Horsemeat-in-the-food-supply-one-year-on.aspx

Johnson, R. (2014). *Food Fraud and "Economically Motivated Adulteration"of Food and Food Ingredients.* Washington: Congressional Research Service.

Legal Monitor. (2014, December 17). Certified Halal Food Supplier Misleads Muslims, Charged Fraud Due to False Marketing. *Legal Monitor Worldwide*. Retrieved March 2016

Lu, J., Tao, Z. (2009). *Sanlu's Melamine-Tainted Milk Crisis In China.* Hong Kong: Asia Case Research Centre. Retrieved March 2016, from https://yellowrabbittales.files.wordpress.com/2014/01/china-baby-milk-case-study.pdf

Lucas, L. F. (2013, April). *ft.com*. Retrieved March 2016, from http://www.ft.com/intl/cms/s/0/de13d3de-97d0-11e2-97e0-00144feabdc0.html#axzz4AQjan8Ww

Luning, P.A., Bango, L., Kussaga, J., Rovira, J., Marcelis, W.J. (2008). Comprehensive analysis and differentiated assessment of food safety control systems: a diagnostic instrument. *Trends in Food science & Technology, 19*(10), 522-534.

Lyu, J.C. (2012). A comparative study of crisis communication strategies between Mainland China and Taiwan: The melamine-tainted milk powder crisis in the Chinese context. *Public Relations Review, 38*(5), 779-791.

Machovina, B., Feeley, K., Ripple, W.J. (2015). Biodiversity conservation: The key is reducing meat consumption. *Science of the Total Environment, 536*(1), 419-431.

Mackay, E. (2014, April 25). Which? uncovers meat fraud. *Meat Trades Journal*, 1. Retrieved March 2016

Manning, L. (2013). development of a food safety verification risk model. *British Food Journal, 115*(4), 575-589.

Martin, A. (2007, August 30). *nytimes.com*. Retrieved from http://www.nytimes.com/2007/08/30/business/30dairy.html

Mclean, R. (2015, October 29). *cnnmoney.com*. Retrieved from http://money.cnn.com/2015/10/29/news/salmon-mislabeled-oceana-report/

Meuwissen, M.P.M., Velthuis, A.G.J., Hogeveen, H., Huirne, R.B.M. (2002). New approaches to food safety economics. In Velthuis A.G.J., Unnevehr L.J. , Hogeveen H., & Huirne R.B.M., *Technical and economic considerations about traceability and certification in livestock*

production chains (pp. 41-54). Wageningen: Wageningen Academic Publishers.

Meuwissen, M.P.M., Velthuis, A.G.J., Hogeveen, H., Huirne, R.B.M. (2003). Traceability and Certification in Meat Supply Chains. *Journal of Agribusiness, 21*(2), 167-181.

Moore, J.C., Spink, J., Lipp, M. (2012). Development and Application of a Database of Food Ingredient Fraud and Economically Motivated Adulteration from 1980 to 2010. *Journal of Food Science*(4), 108-127.

Neville, S. (2013). *Frozen burger sales plunge 43% after horsemeat scandal.* Retrieved March 2016 , from guardian.co.uk: http://www.guardian.co.uk/uk/2013/feb/26/frozen-burger-sales-fall-horsemeat-scandal

Payne, M., Bruhn, C.M., Reed, B., Scearce, A., O'Donnel, J. (1999). On-Farm Quality Assurance Programs: A Survey of Producer and Industry Leader Opinions. *Our Industry Today, 82*(10), 2224-2230.

Poulter, S. (2014, April 16). *dailymail.co.uk*. Retrieved March 2016, from http://www.dailymail.co.uk/news/article-2606513/FSA-huge-food-fraud-using-substitute-meat.html

Poulter, S. (2015, July 23b). *dailymail.co.uk*. Retrieved March 2016, from http://www.dailymail.co.uk/news/article-3171492/Oregano-bulked-cheaper-leaves-Quarter-packets-supermarkets-contain-ingredients-including-olive-myrtle-leaves.html

Poulter, S. (2015a). Top Italian brands are under investigation for passing off ordinary olive oil as 'extra-virgin' after disastrous harvest. *Daily Mail*. Retrieved March 2016

Progressive Grocer. (2007, October 18). *progressivegrocer.com*. Retrieved from http://www.progressivegrocer.com/aurora-dairy-contests-charges-organic-fraud?sort_order=DESC

Psomas, E., Vouzas, F., Kafetzopoulos, D. (2014). Quality management benefits through the "soft" and "hard" aspect of TQM in food companies. *The TQM Journal, 26*(5), 431-444.

Qian, G., Guo, X., Guo, J., Wu, J. (2011). China's dairy crisis: impacts causes and policy implications for a sustainable dairy industry. *International Journal of Sustainable Development & World Ecology, 18*(5), 434-441.

Qiao, G., Guo, T., Klein, K.K. (2010). Melamine in Chinese milk products and consumer confidence. *55*(2), 190-195.

Reuters. (2008, September 23). Tanzania suspends milk imports from China. *Reuters*. Retrieved March 21, 2016

RIKILT Wageningen UR. (2016 January). *Tool om kwetsbaarheid voor voedselfraude in te schatten*. Retrieved Februari 11, 2016, from https://www.wageningenur.nl: https://www.wageningenur.nl/nl/nieuws/Tool-om-kwetsbaarheid-voor-voedselfraude-in-te-schatten-.html

Sarstedt, M., Mooi, E. (2014). A concise Guide to Market Research. In M. M. Sarstedt. Berlin: Springer.

Sasikumar, B., Syamkumar, S., Remya, R., Zachariah, J. (2007). PCR Based Detection of Adulteration in the Market Samples of Turmeric Powder. *18*(3), 299-306.

Schoolderman, H., Nillesen, O., Lissaur, Q., Armitage, C. (2015, December 15). *Food fraud vulnerability assessment Think like a criminal to fight food fraud.* Retrieved January 22, 2015, from PwC.nl: file:///Users/victorbindt/Downloads/618939-food-fraud-vul.pdf

Skees, J., Botts, A., Zeuli, K.A. (2001). The potential for recall insurance to improve food safety. *International Food and Agribusiness Management Review, 4*(1), 99-111.

Spink, J. (2012). Defining Food Fraud and the Chemistry of Crime. In W. Z. Ellefson, *Improving Food Safety* (pp. 195-216). Hoboken, NJ, USA: John Wiley & Sons, Inc.

Spink, J., Moore, J.C. (2011). *Backgrounder: Defining the public Health Threat of Food Fraud.* East Lancing: Michigan state University. Retrieved May 4, 2016

Spink, J., Moyer, D.C., Park, H., Wu, Y., Fersht, V., Hong, M., Peak, S.Y., Edelev, D. (2015). Introducing Food Fraud including translation and interpretation. *Food Chemnestry, 189(1)*, 102-107.

Spink, J., Moyer, D.C. (2013). Defining the types of counterfeiters counterfeiting, and offender organizations. *Crime Science, 8*(2), 1-10.

Spink, J., & Moyer, D. (2011). Fraud, Defining the Public Health Threat of Food. *Journal of Food Science* (9), 157-163.

Squires, N. (2015). Italian companies investigated for passing off ordinary olive oil as extra-virgin; The investigation, the latest scandal to hit Italy's lucrative food and drink sector, involves seven well-known producers. *The Telegraph.* Retrieved March 2016

Squires, N. (2016). Mama Mia- olive oil firms accused of fraud. *Irish Independent.* Retrieved March 2016

Statista. (2013, December c). *statista.com.* Retrieved March 2016, from http://www.statista.com/statistics/295088/attitude-towards-discounted-food-since-the-horsemeat-scandal-in-great-britain/

Statista. (2013, December d). *statista.com.* Retrieved from http://www.statista.com/statistics/295088/attitude-towards-discounted-food-since-the-horsemeat-scandal-in-great-britain/

Statista. (2013, February a). *Statista.com.* Retrieved March 2016, from http://www.statista.com/statistics/293610/supermarket-food-safety-consumer-confidence-in-great-britain/

Statista. (2013, December b). *Statista.com.* Retrieved March 2016, from http://www.statista.com/statistics/293790/consumer-confidence-in-food-producers-retailers-involved-in-horsemeat-scandal-in-great-britain/

Stoyke, M., Hammann, F., Radeck, W., Gowik, P. (2013). Tasks of the NRLs with respect to crisis managment: contribution of the EURL/NRL at the BVL as exemplified by the horse meat scandal. *Journal of Consumer Protection and Food Safety, 8*(1), 91-100.

Tanner, B. (2000). Independent assessment by third-party certification bodies. *Food Control, 11*(5), 415-417.

The Express Tribune. (2015, September 11). US companies guilty of conspiring to export misbranded halal products to Muslims countries. *The Express Tribune.* Retrieved from: http://tribune.com.pk/story/954884/us-companies-guilty-of-conspiring-to-export-misbranded-halal-products-to-muslim-countries/

The Guardian. (2013, February 15). Retrieved April 12, 2016, from
        http://www.theguardian.com/uk/graphic/2013/feb/15/horsemeat-
        scandal-food-safety1

Thorsen, S., Fleish, E. (2008). *Countering Counterfeit Trade.* Berlin: Springer.

Turner, C. (2015, February 14). *telegraph.co.uk*. Retrieved from
        http://www.telegraph.co.uk/foodanddrink/foodanddrinknews/11413486/
        Stay-away-from-curry-FSA-warns-amid-undeclared-nuts-scare.html

U.S. Bankruptcy court. (2016, May 30). *Judge Deller's Calendar*. Retrieved
        March 2016, from http://199.107.21.26/cal/schedjad.pdf

United States Pharmacopeial Convention. (n.d.). Retrieved April 29 , 2016,
        from usp.org: http://www.foodfraud.org/node

Uria, D. (2016, February 27). *upi.com*. Retrieved from
        http://www.upi.com/Top_News/US/2016/02/27/Cheese-companies-
        executive-plead-guilty-to-mislabeling-products/5501456595285/

Velthuis, A.G.J., Meuwissen, M.P.M., Huirne, R.B.M. (2009). Distribution of
        Direct Recall Costs Along. *Agribusiness, 25*(4), 466-479.

Weesepoel, Y., van Ruth, S. (2015). *Inventarisatie van voedselfraude:
        mondiaal kwetsbare productgroepen en ontwikkeling van analytische
        methoden in Europees onderzoek.* Wageningen: RIKILT Wageningen,
        report number: 2015.014.

Wheatley, V.M., Spink, J., (2013). Defining the Public Health Threat of Dietary
        Supplement Fraud. *Comprehensive Reviews in Food Science and
        Food Safety, 12*(6),F 599-613.

Xiu, C., Klein, K.K. (2010, May 4). Melamine in milk products in China:
        Examining the factors that led to deliberate use of the contaminant.
        Food policy, 35(5), 463-470.

Yamoah, F.A., Yawson, D.E. (2014). Assessing Supermarket Food Shopper
        Reaction to Horsemeat Scandal in the UK. *International Review of
        Managment and Marketing, 4*(2), 98-107.

6 Appendices

Appendix 1 Selected questions Food Fraud Vulnerability Assessment

Question number #	Question	**Assumption**	Answer option 1	Answer option 2	Answer option 3
Appendix 1					
32	How would you rate your company's <u>raw material</u> monitoring control systems' ability to detect fraud?	Detectability of adulterated and/or suspicious raw materials is enhanced when companies have a structured incoming material control system that includes: an evidence-based sampling plan for fraud detection; accurate and specific fraud detection methods; specific fraud monitoring procedures; and systematic record-keeping and documentation as an integral part of their FSMS	• Sampling plan only for safety and quality analyses but not for fraud check	• No systematic ad-hoc sampling for fraud analysis	• Systematic, evidence-based (using both historical and scientific data) sampling plan for fraud-related analyses
			• No methods for fraud detection in place; external fraud analysis only in case of inspection demands/fraud issues	• General screening (quick) methods in place but no (external) confirmatory fraud testing	• Specific fraud screening methods and systematic use of fit-for-purpose confirmatory techniques (in house or in collaboration with accredited laboratories)
			• No procedures for fraud monitoring tasks	• General procedure for sampling and screening for monitoring of ingredient/raw material fraud issues	• Customized procedures for fraud monitoring and handling of non-conformities
			• No record keeping on adulterated or suspicious raw materials, and no documentation of fraud procedures	• Record-keeping in case of deviations; limited documentation on fraud monitoring procedures/systems	• Systematic record keeping and detailed documentation of fraud monitoring procedures & systems
33	Are the fraud monitoring tasks of your <u>raw material</u> control system verified in your company?	Systematic verification of fraud monitoring tasks at incoming material control, i.e. based on document & record analysis, observations, and actual testing by an autonomous controller enhances	• No verification of fraud monitoring tasks at incoming material control	• Ad-hoc and or announced verification of fraud monitoring tasks; mainly based on analysis of records and check of presence of procedures (e.g. as part of auditing)	• Systematic and comprehensive verification (document & record analysis, observations, and actual testing), unannounced and performed by autonomous controller of fraud monitoring tasks

| Question number #	Question	**Assumption**	Answer option 1	Answer option 2	Answer option 3
		discovery of non-compliance practices is enhanced and assures adequate performance of the fraud monitoring tasks		• Ad-hoc reporting of verification outcomes; mainly in case of deviations	• Systematic documentation of verification activities and outcomes
34	How would you describe the fraud related parts of your <u>final product</u> monitoring control system of your company?	A structured monitoring system for fraud detection in final products with an evidence based sampling plan for fraud detection, accurate and specific fraud detection methods, and fraud specific procedures and systematic record-keeping and documentation as integral part of their FSMS enhances detectability of internal fraudulent practices	• Sampling plan only for safety and quality analyses but not for authenticity check	• No systematic, ad-hoc sampling for fraud analysis	• Systematic, evidence-based (using both historical and scientific data) sampling plan for fraud-related analyses
			• No methods for fraud detection in place; external authenticity analysis only in case of inspection demands/fraud issues	• General screening (quick) methods in place but no or ad-hoc (external) confirmatory fraud testing	• Specific fraud screening methods and systematic use of fit-for-purpose confirmatory techniques (in house or in collaboration with accredited laboratory)
			• No procedures for fraud monitoring tasks	• General procedure for sampling and screening for ad-hoc monitoring of products for fraud issues	• Customized procedures for fraud monitoring and handling of non-conformities
			• No record keeping on adulterated or suspicious raw materials and no documentation of fraud procedures	• Mainly record-keeping in case of deviations; limited documentation on fraud monitoring procedures/system	• Systematic-record keeping and detailed documentation of fraud monitoring procedures & fraud monitoring system design
35	Are the fraud monitoring tasks of your <u>final product</u> control system verified in your company?	Systematic verification of compliance to final product monitoring tasks (sampling, laboratory analysis, corrective actions, record-keeping & documentation) based on	• No verification of actual compliance to monitoring tasks at final product control	• Ad hoc and/or announced verification of compliance to monitoring tasks mainly based on analysis of records and check of presence of procedures (e.g. as part of auditing)	• Systematic, comprehensive (document & record analysis, observations, and actual verification testing) and unannounced verification by autonomous controller

Question number #	Question	**Assumption**	Answer option 1	Answer option 2	Answer option 3
		document & record analysis, observations, and actual testing by an autonomous controller (no conflicting interest) enhances discovery of systematic deviations		• Ad-hoc reporting of verification outcomes; mainly in case of deviations	• Systematic documentation of verification activities and outcomes
36	How extensive is the information system for <u>internal</u> control of mass balance flows in your company?	Systematically collected, accurate information on mass balance flows of all raw materials, ingredients, and final products throughout the company (including internal suppliers) and systematically analysis of the integral dataset, enhances discovery of flaws in mass balances, and provides evidence of fraud control (assurance)	• Basic administrative system with limited information or no specific information on mass balances of incoming materials and final products	• Process monitoring information system with accurate information on mass balances of mainly bulk ingredients	• Established and comprehensive (accurate mass balance data, of all crucial ingredients, materials, & final product flows) process monitoring information system dedicated for control of mass balance flows
			• Data only analysed in case of inspection requirements	• No integral analysis of mass flow data throughout the company (including internal suppliers)	• Structured record keeping of mass flow information and systematic analysis of integral data of whole company (including internal suppliers)
37	How extensive is the tracking & tracing system of your company?	An integrated tracking and tracing system including clearly defined traceability resource units, collection of accurate and fraud-relevant information from direct supplier up to direct customer (one up - one down), and a robust data capturing and data retrieval system, enhances tracing and tracking of	• Traceability system without clearly defined traceability resource units or units cannot be exactly defined (e.g. because of continuous flow).	• System with clearly defined traceability resource units; Collection of accurate information but not specifically addressing fraud issues, only information on company level	• System with clearly defined traceability resource units (product level; collection of accurate information including fraud-relevant issues from direct supplier up to direct customer
			• Uncertainty about accuracy of information, and limited/no fraud relevant information	• Computer-based data capturing & retrieval system but not systematically controlled (restricted possibilities for fraud)	• Advanced automated and systematically controlled robust data capturing and data retrieval system (fraud proof)

Question number #	Question	**Assumption**	Answer option 1	Answer option 2	Answer option 3
		suspicious products/batches, and limits (safety, economic, brand) damage in case of fraud	• Data capturing and retrieval system is not fraud proof		
38	Is integrity screening of employees common procedure in your company?	Application of acknowledged integrity screening methods for employment of personnel enhances identification of future employees prone to unethical behaviour	• No integrity screening of employees	• Use of established integrity screening methods for employees at key positions	• Use of established integrity screening methods is standard for employment of all personnel
39	Is there an ethical code of conduct or guideline in place and embedded in your company?	A transparent and specific ethical code of conduct or guidelines that is widely communicated and well embedded in management activities enhances prevention of unethical behaviour	• No written code of ethical conduct or guideline exist	• General written code of ethical conduct or guidelines is available, but awareness amongst all personnel is limited, and or code is not explicitly embedded in management activities	• Detailed written code of ethical conduct or guideline is available and well embedded; awareness amongst all personnel is stimulated (e.g. posters, communication) and demonstrated in management activities
40	Is there a whistle blowing system (system for reporting assumed fraudulent activities) in place in your company?	A well-designed and implemented whistle blowing system, including an independent officer and protection system for whistle blowing, enhances discovery of fraudulent activities	• No whistle blowing system exists	• Whistle blowing system is available, but no clear protection system for the whistle blower is in place, and reporting of fraudulent activity goes to supervisor (no independent officer)	• Whistle blowing system is well-established and well-known among personnel, fraudulent practices can be reported to an independent officer, and anonymity of the whistle blower is strictly protected
41	Do contractual requirements with your <u>direct suppliers</u> include elements that limit opportunities for fraud?	Established, comprehensive contractual requirements explicitly addressing fraud prevention enhance the prevention of fraudulent	• Contractual requirements for direct suppliers are mainly set on logistic parameters: cost, amount and availability	• Contractual requirements are established together with direct supplier(s) for both logistic and safety & quality parameters	• Comprehensive contractual requirements established in close collaboration with direct supplier(s) addressing logistics, safety

Question number #	Question	**Assumption**	Answer option 1	Answer option 2	Answer option 3
		practices			and quality, but also requirements on adoption of ethical code/guidelines, and adoption of similar technical fraud control measures
42	What features the fraud control system of your <u>direct supplier</u>(s)? *NOTE: As an alternative to answering this question yourself, direct suppliers can fill out the tool themselves with respect to the control measures as defined by the company*	Suppliers with well-designed and systematically audited Food Safety Management Systems that include dedicated fraud control measures enhances detectability of fraudulent products supplied to your company	• Direct supplier(s) don't have a FSMS or the FSMS is limited (not audited externally, no fraud measures in place)	• Direct supplier(s) has a well-established FSMS in place that is regularly audited by a 3rd party and uses basic fraud screening methods	• Direct supplier(s) has a well-established FSMS in place that is regularly audited by a 3rd party and systematically uses fraud screening methods and confirmatory tests to identify suspicious materials
43	How extensive is the information system for control of mass balance flows of your <u>direct supplier</u>(s)?	An advanced information system to control mass balance flows in the supplying company enhances discovery of problems in their mass balances and provide evidence of fraud control (assurance) to your company	• A basic administrative system exists with limited/no specific information on mass balance flows of incoming materials and final products	• A process monitoring information system exists with accurate information on mass balance flows of bulk ingredients only	• An established and comprehensive process monitoring information system exists dedicated to the control of mass balance flows (accurate mass balance data, of all crucial ingredients, materials, & final product flows)
	NOTE: This question can be only asked directly of the supplier(s)		• Data only analysed in case of inspection requirements	• No integral analysis of mass data flow across the company (including internal suppliers)	• Structured record keeping of mass data flow and systematic analysis of integral data across the company (including internal suppliers)

Appendix 1					
Question number #	Question	**Assumption**	Answer option 1	Answer option 2	Answer option 3
44	How extensive is the traceability system of your <u>direct supplier(s)</u>?	Suppliers with well-designed and audited traceability systems that systematically communicate accurate and fraud-relevant information to your company, enhances traceability of suspicious products/batches and limits damage in case of fraud	• Direct supplier(s) have a basic traceability system because of legal requirements but it not designed according to best practice nor audited by a 3rd party	• Direct supplier(s) have a traceability system in place for safety issues that is based on a recognized standard and audited by a 3rd party	• Direct supplier(s) have a traceability system for safety issues based on a certified QA scheme(s) and based on contractual requirements as set and audited (2nd part) by your company; systematic, accurate and fraud relevant information exchange to your company
	NOTE: As an alternative to answering this question yourself, direct suppliers can fill out the tool themselves with respect to the tracking & tracing system as defined by the company		• Direct supplier(s) have a simple data capturing and retrieval system and there is no communication about deviations	• Direct supplier(s) have a simple digital data capturing and retrieval system, and information about suspicious materials is communicated ad hoc	• Direct supplier(s) have advanced digital robust data capturing system; fraud proof

Appendix 2 Dendrogram hierarchical cluster analysis

Dendrogram using Ward Linkage
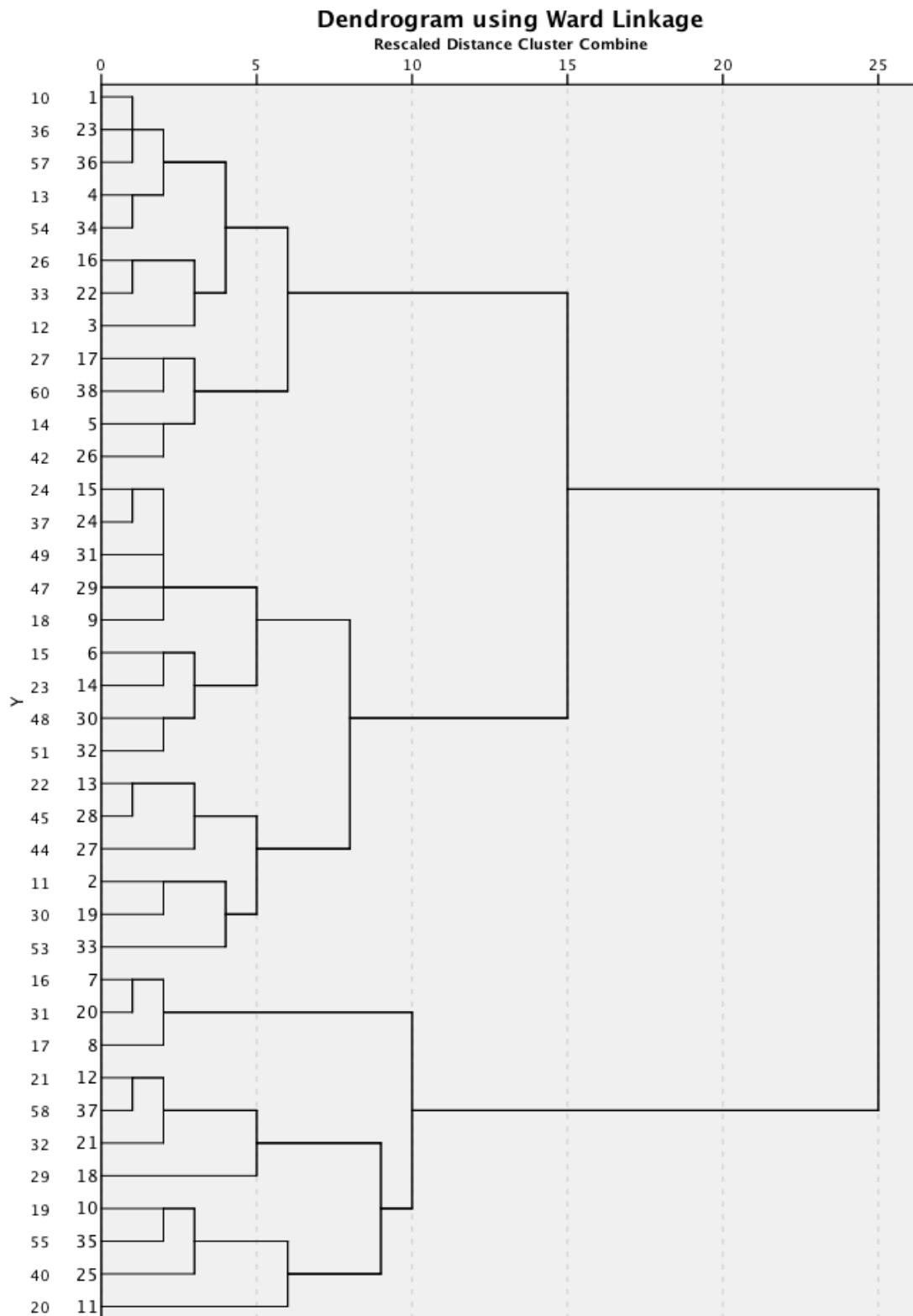
Appendix 3 companies approached to assess perceived costs and benefits of implementing the fraud mitigation tools

Number	Company / Organisation	Location
1	Danone	Spain
2	Allied Mils	Australia
3	Group of Butchers	Netherlands
4	Kerry foods	Ireland
5	Friesland Campina	Netherlands
6	Heinz	Netherlands
7	Unilever	Netherlands
8	Mars	Netherlands
9	Nestle	Netherlands
10	Mondelez	Netherlands
11	Pepsico	Netherlands
12	Cargill	Netherlands
13	ADM	Netherlands
14	Kellog's	Netherlands
15	NZV	Netherlands
16	VERNOF	Netherlands
17	VNV	Netherlands
18	NZO	Netherlands
19	COV	Netherlands
20	AAK	Netherlands
21	IOI groep	Netherlands
22	Sime darby Unimils	Netherlands
23	Wilmar	Netherlands
24	AHOLD	Netherlands
25	Lidl Stiftung & Co. KG	Netherlands
26	Aldi	Netherlands
27	Jumbo groep	Netherlands
28	Super Unie	Netherlands
29	Silvo	Netherlands
30	Verstegen	Netherlands
31	Pro Fish	Netherlands
32	IGLO	Netherlands
33	Mc cain	Netherlands
34	Nutricia Kuyk	Netherlands
35	Nutricia Zoetermeer	Netherlands
36	Wessanen	Netherlands
37	Group of Butchers	Netherlands
38	Remia	Netherlands

Appendix 4 Interview script

Date:
Time:

The interview script
Italic text is only spoken out loud if asked
Objective: To assess the perceived costs and benefits of implementing the mitigation tool entitled Food Fraud Vulnerability Assessment in your business.

Introduction (10 min)
-Master thesis supervised by WUR and PwC
-Sustainability and Responsible Governance department
-Research objectives:

>1) To review reported cases and losses as a result of food fraud in food supply chains.
>2) To group current risk mitigation situation of Dutch food companies
>3) To assess the perceived costs and benefits of the implementation of the mitigation tool named by the Food Fraud Vulnerability Assessment

-This interview is in regard to objective 3
-Answer in company perspective *if trade organisation from sector perspective*
-Anonymous

Introduction questions (5 min)
What place in the supply chain does your company or organisation have?

Farm / Processor / Distributor / Trader / Retailer

Other:

What is your function within the company?

Are there challenges for the company / sector in regard to food fraud, if yes, what are these?
Multiple answers may be chosen

No / Mitigate risk / Implementing controls / Certification / Traceability / Insurance / Assurance /

Legislation / Supplier selection and assessment / Monitoring / Risk assessment /

Risk communication / Risk Management

Other:

What is your function / expertise? *Multiple answers may be chosen*

Procurement / Production process / Safety related / Quality related / Public relations / Finance

/ Sustainability / Trading / Business development / Sales / Marketing / Supply chain

Other:

Introduction to main part of interview (5 min)
-3 distinctive kinds of mitigation measures:

1) Internal hard controls
2) Internal soft controls
3) Direct supplier controls

-Internal hard controls:

1) Tracking and tracing
2) Fraud monitoring system raw materials
3) Verification of fraud monitoring system raw materials
4) Fraud monitoring system final products
5) Verification of fraud monitoring system final products
6) Information system own company

-*Characterisation Tracking and tracing:* An integrated tracking and tracing system including clearly defined traceability resource units, collection of accurate and fraud-relevant information from direct supplier up to direct customer (one up - one down), and a robust data capturing and data retrieval system, enhances tracing and tracking of suspicious products/batches, and limits (safety, economic, brand) damage in case of fraud

-*Characterisation Fraud monitoring system raw materials*: Detectability of adulterated and/or suspicious raw materials is enhanced when companies have a structured incoming material control system that includes: an evidence-based sampling plan for fraud detection; accurate and specific fraud detection methods; specific fraud monitoring procedures; and systematic record-keeping and documentation as an integral part of their FSMS

- Characterisation of fraud monitoring system raw materials: Systematic verification of fraud monitoring tasks at incoming material control, i.e. based on document & record analysis, observations, and actual testing by an autonomous controller enhances discovery of non-compliance practices is enhanced and assures adequate performance of the fraud monitoring tasks

-*Characterisation Fraud monitoring system final products:* A structured monitoring system for fraud detection in final products with an evidence based sampling plan for fraud detection, accurate and specific fraud detection methods, and fraud specific procedures and systematic record-keeping and documentation as integral part of their FSMS enhances detectability of internal fraudulent practices

-*Characterisation Information system own company:* Systematically collected, accurate information on mass balance flows of all raw materials, ingredients, and final products throughout the company (including internal suppliers) and systematically analysis of the integral dataset, enhances discovery of flaws in mass balances, and provides evidence of fraud control (assurance)

-Internal soft controls:

1) Integrity screening own employees
2) Ethical code of conduct own company
3) Whistle blowing own company

-*Characterisation integrity screening own employees:* Application of acknowledged integrity screening methods for employment of personnel enhances identification of future employees prone to unethical behaviour

-*Characterisation ethical code of conduct own company:* A transparent and specific ethical code of conduct or guidelines that is widely communicated and well embedded in management activities enhances prevention of unethical behaviour

X

-*Characterisation whistle blowing own company:* A well-designed and implemented whistle blowing system, including an independent officer and protection system for whistle blowing, enhances discovery of fraudulent activities

-Direct supplier controls:

1) Contractual requirements suppliers
2) Fraud control system supplier
3) Tracking and tracing system supplier

-*Characterisation of contractual requirements suppliers*: Established, comprehensive contractual requirements explicitly addressing fraud prevention enhance the prevention of fraudulent practices

-*Characterisation of Fraud control system supplier:* Suppliers with well-designed and systematically audited Food Safety Management Systems that include dedicated fraud control measures enhances detectability of fraudulent products supplied to your company

-*Characterisation tracking and tracing system supplier*: Suppliers with well-designed and audited traceability systems that systematically communicate accurate and fraud-relevant information to your company, enhances traceability of suspicious products/batches and limits damage in case of fraud

Main part interview (30 min)

Question: Does the company or organisation recognize the following costs and benefits in regard to the following control measures? *(1 is not at all recognisable, 5 is very recognisable, 3 is undecided)*

Internal hard controls named by the Food Fraud Vulnerability Assessment

Extra costs

1.	Capital investments	1	2	3	4	5
2.	Development costs	1	2	3	4	5
3.	Training costs	1	2	3	4	5
4.	Verification and validation of systems	1	2	3	4	5
5.	Record keeping	1	2	3	4	5
6.	Operational processes	1	2	3	4	5
7.	Storage of production materials and documentation	1	2	3	4	5
8.	Audits	1	2	3	4	5
9.	Flexibility process	1	2	3	4	5
10.	Transformation process	1	2	3	4	5

Cost reduction

11.	Production costs	1	2	3	4	5
12.	Pre-empting certification standards	1	2	3	4	5
13.	Pre-empting governmental rules	1	2	3	4	5
14.	Risk and liability Due diligence defence	1	2	3	4	5
15.	Licence procedures	1	2	3	4	5
16.	Control of production process	1	2	3	4	5

17. Product waste	1	2	3	4	5
Reduced defects					
18. Customer complaints	1	2	3	4	5
19. Need for quality audits by customers	1	2	3	4	5
20. Audit process	1	2	3	4	5
21. Efficiency allocation of resources	1	2	3	4	5
Effectiveness resource management					
22. Disease control and residue monitoring	1	2	3	4	5
Disease levels					
Detect source of defect final product or infected products					
23. Compensation payments	1	2	3	4	5
24. Price premiums	1	2	3	4	5
Transaction costs					
25. Labour-management relation	1	2	3	4	5
26. Productivity employees	1	2	3	4	5
27. Breakdown of departmental silos	1	2	3	4	5
28. Rate of employee change	1	2	3	4	5
29. Adequate intervention	1	2	3	4	5
30. Creation of team culture	1	2	3	4	5
31. Protection of natural and social environment	1	2	3	4	5

Extra revenue

32. Maintaining or expanding market size	1	2	3	4	5
Access to market					
National and international acceptance					
Build a good market position					
33. Competitive advantage	1	2	3	4	5
34. Consumer/customer confidence	1	2	3	4	5
Consumer assurance					
35. Transparency	1	2	3	4	5
36. Employee motivation	1	2	3	4	5
Transformation in attitude employees					
37. Customer/consumer loyalty and satisfaction	1	2	3	4	5

Other

38. Access to finance	1	2	3	4	5
39. Access to liability insurance	1	2	3	4	5

Do you expect any further costs, in regard to internal hard controls, which are not named?

_____

_____

_____

_____

_____

Do you expect any further benefits, in regard to internal hard controls, which are not named?

_____

_____

_____

_____

_____

_____

_____

What are the 3 most recognised costs and benefits named in regard to internal hard controls?

_____

_____

_____

_____

_____

_____

_____

Internal soft controls named by the Food Fraud Vulnerability Assessment

<u>Extra costs</u>

40. Capital investments	1	2	3	4	5
41. Development costs	1	2	3	4	5
42. Training costs	1	2	3	4	5
43. Verification and validation of systems	1	2	3	4	5
44. Record keeping	1	2	3	4	5
45. Operational processes	1	2	3	4	5
46. Storage of production materials and documentation	1	2	3	4	5
47. Audits	1	2	3	4	5
48. Flexibility process	1	2	3	4	5
49. Transformation process	1	2	3	4	5

<u>Cost reduction</u>

50. Production costs	1	2	3	4	5
51. Pre-empting certification standards	1	2	3	4	5
52. Pre-empting governmental rules	1	2	3	4	5
53. Risk and liability Due diligence defence	1	2	3	4	5
54. Licence procedures	1	2	3	4	5
55. Control of production process	1	2	3	4	5
56. Product waste Reduced defects	1	2	3	4	5

57. Customer complaints	1	2	3	4	5
58. Need for quality audits by customers	1	2	3	4	5
59. Audit process	1	2	3	4	5
60. Efficiency allocation of resources Effectiveness resource management	1	2	3	4	5

61. Disease control and residue monitoring
    Disease levels
    Detect source of defect final product or infected products
	1	2	3	4	5

62. Compensation payments	1	2	3	4	5
63. Price premiums Transaction costs	1	2	3	4	5
64. Labour-management relation	1	2	3	4	5
65. Productivity employees	1	2	3	4	5
66. Breakdown of departmental silos	1	2	3	4	5
67. Rate of employee change	1	2	3	4	5
68. Adequate intervention	1	2	3	4	5
69. Creation of team culture	1	2	3	4	5
70. Protection of natural and social environment	1	2	3	4	5

Extra revenue

71. Maintaining or expanding market size
 	
    Access to market
    National and international acceptance
    Build a good market position
	1	2	3	4	5

72. Competitive advantage	1	2	3	4	5
73. Consumer/customer confidence Consumer assurance	1	2	3	4	5
74. Transparency	1	2	3	4	5
75. Employee motivation Transformation in attitude employees	1	2	3	4	5
76. Customer loyalty and satisfaction	1	2	3	4	5

Other

77. Access to finance	1	2	3	4	5
78. Access to liability insurance	1	2	3	4	5

Do you expect any further costs, in regard to internal soft controls, which are not named?

_____

_____

_____

_____

_____

_____

_____

Do you expect any further benefits, in regard to internal soft controls, which are not named?

_____

_____

_____

_____

_____

_____

_____

What are the 3 most recognised costs and benefits named in regard to internal soft controls?

_____

_____

_____

_____

_____

_____

Direct supplier controls named by the Food Fraud Vulnerability Assessment

<u>Extra costs</u>

79. Capital investments	1	2	3	4	5
80. Development costs	1	2	3	4	5
81. Training costs	1	2	3	4	5
82. Verification and validation of systems	1	2	3	4	5
83. Record keeping	1	2	3	4	5
84. Operational processes	1	2	3	4	5
85. Storage of production materials and documentation	1	2	3	4	5
86. Audits	1	2	3	4	5
87. Flexibility process	1	2	3	4	5
88. Transformation process	1	2	3	4	5

<u>Cost reduction</u>

89. Production costs	1	2	3	4	5
90. Pre-empting certification standards	1	2	3	4	5
91. Pre-empting governmental rules	1	2	3	4	5
92. Risk and liability Due diligence defence	1	2	3	4	5
93. Licence procedures	1	2	3	4	5
94. Control of production process	1	2	3	4	5
95. Product waste Reduced defects	1	2	3	4	5
96. Customer complaints	1	2	3	4	5
97. Need for quality audits by customers	1	2	3	4	5

98. Audit process	1	2	3	4	5
99. Efficiency allocation of resources Effectiveness resource management	1	2	3	4	5

100. Disease control and residue monitoring
    Disease levels
    Detect source of defect final product or infected products
	1	2	3	4	5

101. Compensation payments	1	2	3	4	5
102. Price premiums Transaction costs	1	2	3	4	5
103. Labour-management relation	1	2	3	4	5
104. Productivity employees	1	2	3	4	5
105. Breakdown of departmental silos	1	2	3	4	5
106. Rate of employee change	1	2	3	4	5
107. Adequate intervention	1	2	3	4	5
108. Creation of team culture	1	2	3	4	5
109. Protection of natural and social environment	1	2	3	4	5

Extra revenue

110. Maintaining or expanding market size
 	
    Access to market
    National and international acceptance
    Build a good market position
	1	2	3	4	5

111. Competitive advantage	1	2	3	4	5
112. Consumer/customer confidence Consumer assurance	1	2	3	4	5
113. Transparency	1	2	3	4	5
114. Employee motivation Transformation in attitude employees	1	2	3	4	5
115. Customer loyalty and satisfaction	1	2	3	4	5

Other

116. Access to finance	1	2	3	4	5
117. Access to liability insurance	1	2	3	4	5

Do you expect any further costs, in regard to direct supplier controls, which are not named?

_____

_____

_____

_____

_____

_____

Do you expect any further benefits, in regard to direct supplier controls, which are not named?

_____

_____

_____

_____

_____

_____

_____

What are the 3 most important costs and what are the 3 most recognized benefits?

_____

_____

_____

_____

_____

_____

Completion interview (5 min)

Would you like to receive the results of the thesis, if yes in what format and what address?

_____

_____

_____

_____

_____

_____

_____

_____