

**THESIS RESEARCH THEMES
FOR MSc FOOD QUALITY
MANAGEMENT STUDY YEAR
2018 – 2019**

RESEARCH THEMES

- I. FOOD QUALITY AND SAFETY MANAGEMENT**
- II. GOVERNING FOOD SAFETY AND SUSTAINABILITY IN FOOD SUPPLY CHAINS**
- III. FOOD AUTHENTICITY AND INTEGRITY**
- IV. QUALITY DESIGN OF FOODS: PRODUCT, PROCESS, AND CHAIN (REDESIGN)**
- V. CONSUMER-PRODUCT INTERACTIONS IN CONSUMER CHAINS**
- VI. PRODUCTION AND CONSUMPTION OF NOVEL PROTEIN FOODS: INSECTS**
- VII. FOOD QUALITY AND LOGISTICS MODELLING [ORL CODE]**

I. Research theme – FOOD QUALITY AND SAFETY MANAGEMENT

Introduction

Nowadays food quality and safety management systems in agribusiness and food industry are complex and dynamic. They are under continuous pressure due to multiple factors such as global trade, competitive markets, increasing public and private safety and quality requirements, consumer trust, emerging hazards, demographic changes, climate change, and etcetera. These pressures increase the need to design, control, improve, and assure production and preparation of healthy, authentic, and palatable food that is safe, and is produced in a sustainable way. In anticipation, agribusiness and food industry put much efforts in designing, maintaining and upgrading their quality management systems (QMS) and food safety management systems (FSMS) based on a wide range of public (legally required) and private (driven by industry) assurance guidelines and standards (like HACCP, BRC, SQF, GLOBAL GAP, ISO22000). Government sets product, process, and system requirements in legal frameworks, which public authorities enforce by inspections using different incentives (ranging from sanctions to support). Private scheme makers design the standards and audit requirements, and certification bodies audit against the private standards and provide certificates as companies comply with the standards.

However, the worldwide reoccurrence of food scandals, foodborne outbreaks and other food safety and integrity issues indicate that a deeper understanding of factors determining the QMS/FSMS performance is still needed. Multiple studies have provided evidence that behaviour of people operating in the QMS/FSMS as well as the context wherein these systems operate are important factors contributing to the systems food safety and quality performance.

The research theme food quality and safety management addresses topics like food safety culture; effectiveness of auditing; food handler compliance behaviour; safety governance and FSMS performance in emerging countries; effectiveness supplier control systems; control systems for particular foods (heritage, organic food), etc.

1. Does national culture has an impact on food companies' food safety culture?

Building on research of MFQ students: Yes

Possibility to combine with internship: Yes

MFQ specialisation: Quality control and assurance; quality management and entrepreneurship

Open to 1 student

First supervisor: Pieterneel Luning / Shingai Nyarugwe (PhD)

Problem description

Food safety is a permanent challenge in the food supply chain up to final preparation and food consumption. Food producers at all levels of the production chain up to food service establishments have the responsibility that proper safety and sanitation practices are followed to ensure the health of their customers. The primary focus of food companies - establishing food safety management systems - is on implementing the required quality assurance guidelines and standards resulting in process monitoring systems, preventive control measures, technological infrastructures (e.g. hygienic equipment design, zoning), and procedures to guide people in executing their safety tasks. However, existing systems have been unable to provide food safety guarantees and recent studies suggest that the food safety culture of an organisation should be analysed as it could have an influence on the food safety performance of organisations.

Existing studies have assessed the food safety culture at company level but the impact of the organisation's context has not been analysed. Organisational and safety culture studies have shown that operating in ways that are congruent with the cultural context can improve an organisation's (safety) performance. Moreover, with globalisation, companies are becoming multinational and this increases the complexity of an organisation's food safety culture as organisations have to take into account the national values of the workers and of the country that the organisation is in. The importance of national culture is well documented in the occupational safety and health fields but the scientific literature on these factors is limited in the field of food safety management. The thesis is part of a PhD project on understanding the influence of food safety culture on hygiene practices in food factories and small food manufactories, and the role of national culture.

The aim of the study is to investigate if differences in national culture and food safety governance are reflected in differences in prevailing food safety culture in food companies. The research activities include testing of a survey based on a previously developed food safety culture framework, on-site visits and in-depth interviews to assess food safety culture of companies in a particular national context. The location/scope of the research (food sector, country, type of food industries) will be demarcated at the start of the project.

References

- Nyarugwe, S.P., Linnemann, A., Nyanga, L.K., Fogliano, V., & Luning, P.A., (2018), Food safety culture assessment using a comprehensive mixed-methods approach: A comparative study in dairy processing organisations in an emerging economy. *Food Control* 84, 186-196. <http://dx.doi.org/10.1016/j.foodcont.2017.07.038>
- Nyarugwe, S.P., Linnemann, A., Hofstede, G J., Fogliano, V. & Luning, P.A. (2016). Determinants for conducting food safety culture research. *Trends in Food Science & Technology*, 56, 77-87.

2. Challenges in food safety communication - does it reflect business' food safety culture?

Building on research of MFQ students: Yes

Possibility to combine with internship: Yes in UK collaboration UCLAN University of Lancaster

MFQ specialisation: Quality control and assurance; quality management and entrepreneurship

Open to 1 student

Supervisors: Pieterneel Luning / Carol Wallace (UCLAN, UK)

Problem description

Food safety culture (FSC) has been identified as an emerging factor in the performance of food safety management systems, which is reflected in the fact that a technical working group of the GFSI (Global Food Safety Initiative) developed a food safety culture document as a guidance document for the food industry.

Food safety culture has been defined by various researchers as the employees' perceptions towards the management system, style and process, communication, sharing of knowledge and information, leadership, accountability, risk perception and work environment.

To study food safety culture, it is important to acknowledge that culture exists at different levels in a food business. At operation, food handlers and their direct operational managers may have another view on food safety compared to middle management (including quality assurance managers) and top management. Food safety culture can differ amongst these different levels, and alignment amongst these levels is crucial.

Several studies discussed that a positive food safety culture should start from top management with a strong food safety vision to align all employees' safe handling practices; introducing notions such as food safety expectations, effective communication strategies, risk-based vs conventional training and engaged leadership are some factors influencing food safety culture. The importance of mentioning food safety in the organisation's vision is related to developing strategic goals and values, which management can pass on to food handlers in order to increase compliance. However, if middle management lack required skills (e.g. communication, leadership) to engage employees into having the same vision, then discrepancies will occur. Particularly if communication is not conducted in a continuous and consistent manner, behaviour and perceptions will not be in line with companies' food safety vision and priorities.

The aim of the MSc study is investigate challenges in food safety communication in relation to food safety, and to get a deeper understanding on how characteristics of food safety communication reflect a companies' food safety culture. The research will build further on previous research and will be defined at the start of the project

3. Understanding how auditors assess food safety culture beyond the checklist

Building on research of MFQ students: Yes

Possibility to combine with internship: Yes, Lincoln University UK/food business

MFQ specialisation: Quality control & assurance; quality & entrepreneurship

Open to 1 student

Supervisors: Pieterneel Luning / Dimitra Mardiyri (PhD)

Problem description

Nowadays, food businesses have to reduce risks inherent to food safety hazards from farm to fork. Legal requirements and industry guidelines have become more demanding and sophisticated, obligating food businesses to establish effective food safety management systems (FSMS). Moreover, different retailers have set their own codes of practice and safety requirements. Many food companies, have frequent audits is, since they need to show compliance with private standards (e.g. IFS, BRC) and other product specific standards (e.g. organic, MSC, RSPO).

However, the World Health Organization's Foodborne Disease Burden Epidemiology Reference Group estimated that there were 582 million cases and 351,000 deaths associated with 22 different foodborne enteric diseases in 2010 (WHO FERG group, 2010). These diseases and deaths usually linked to a breakdown in food safety programs because of improper human behaviour or an inappropriate food safety culture (Griffith, 2010 and Jespersen and Huffman, 2014). The investigation of an E.coli outbreak in South Wales in 2009, resulting in the death of a young boy, showed that the owner of a butchery was using a single vacuum packing line for all products and he was encouraging ill employees to continue working in the establishment. A Salmonella outbreak in the USA in 2008 caused the death of nine people and at least 714 people had food poisoning after consuming contaminated peanuts. The company's management had ignored lab tests showing high level of Salmonella counts and they decided to ship the products to their customers without taking any actions. In both incidents, the effectiveness of audits and the abilities of the auditors to detect those discrepancies were under question.

Existing studies have assessed the food safety culture and its dimensions at a company level. However, there is yet limited research on how to evaluate and measure effectively the influence of these dimensions and their impact on food safety risks. The thesis is part of a PhD project on understanding the role of auditing on food safety culture, examining food safety culture assessment tools currently available, and investigating how auditing can assess food safety culture to increase the final products safety.

The aim of the MFQ study is to investigate how auditors assess food safety culture, which approaches they use, and how that deviates from existing FSC assessment tools as basis for recommendations.

Research questions:

- What tools, schemes, standards are available to address FSC?
- How do auditors evaluate food safety culture, particularly in 2nd party audits

4. To what extent can nudging affect food handlers' compliance to hygiene control measures in poultry processing to avoid *Campylobacter* contamination?

Building on research of MFQ students: Yes

MFQ specialisation: Quality control and assurance

Possibility to combine with internship: To be discussed

Open to 1 student

Supervisors: Pieterneel Luning (FQD), Ewa Pacholewicz & Mariam Koene (Bioveterinary Research, WUR)

Problem description

Campylobacter contamination in fresh poultry products is an ongoing safety challenge for the meat industry. Since the largest amounts in *Campylobacter* have been found at the slaughtering steps, it is expected to be the most vulnerable location in the supply chain. Companies have food safety management systems in place and similar process equipment but substantial differences in the variation in *Campylobacter* counts have been found. Large variation is an indication of a system that is not fully under control, but there is yet not a full understanding of the causes of variation. Causes of differences in hygienic performance might be not only due to poultry properties and equipment design, but also because of variable control behaviour of operators in daily operations. Very few studies investigated the impact of decision-making behaviour in hygiene tasks on the variation in microbial contamination. Furthermore, studies have suggested that variable execution of hygiene (related) tasks of operators in daily operations associated with contamination of processed poultry.

Previous PhD research, investigated factors affecting execution of control tasks, and analysed the effect of variable execution of control tasks on variation in *Campylobacter* contamination. More recently, an MSc thesis study in-depth analysed causes of non-compliance in a slaughterhouse, developed a framework, and explored literature on nudging applications, which seem very limited in the food industry. Nudges can be defined as *changes in the presentation of various choice alternatives in such a way that makes the desired choice easier, automatic or default* (De Ridder, 2014). It is expected that this strategy will contribute to reduction of faecal contamination of carcasses during processing and thus diminish the level of *Campylobacter*.

The student will be involved in the field trials in close collaboration with Wageningen Bioveterinary Research (Lelystad) and a poultry processing plant. The purpose of the field trials is to evaluate the current hygienic status and the compliance of food handlers with procedures. Observational studies of food handlers as well as microbiological investigations will be carried out. Next, the thesis will contribute to the development of possible nudging based interventions to change food handlers' control behaviour using literature research and expert interviews, and the student will evaluate effects of implemented nudge-based interventions on compliance behaviour and actual *Campylobacter* contamination.

The aim of the MSc study is to validate the framework for other poultry processing factories, and to develop and test nudges to improve compliance behaviour of food handlers.

5. Understanding mechanism of farmer's quality decisions on pesticide choice in China

Building on research of MFQ students: Some research done in the past in other country

Possibility to combine with internship: Yes

MFQ specialisation: Quality control and assurance; quality management and entrepreneurship

Recommended: Chinese language skill is recommended because of the character of the study

Open to 1 student

Supervisors: Pieterneel Luning (FQD) / Yingxue Ren (China)

Problem description

In the last decade, many food safety issues occurred in raw materials supply stage, such as pesticide residues, which not only pose problems for international trade but also damage the health of Chinese consumers. In order to improve food safety, farmers are now increasingly adopting low-toxic or biological pesticides. The adoption of pesticide depended heavily on farmers' quality decision. Both scientific and social researches have studied factors affecting farmers' decision on pesticide choice, e.g. low education background, limited knowledge on pesticide, high cost of biological pesticides. Despite these attempts to find effective ways of preventing pesticide residues, great challenges remain to ensure food safety in China.

Recent researches studied many aspects of quality decisions of farmers in the context of China. Those researches, however, mostly focused on the descriptive statistics of demographic characteristics about farmers, e.g. education background, knowledge about pesticide, etc. Nevertheless, few studies focused on identifying factors affect the quality decision, and understanding the mechanism on how they work.

The thesis is part of a PhD project on understanding the mechanisms behind farmer's quality decisions on food safety management system in the Chinese food sector. This MSc thesis project aims to modify and validate an analytical framework to analyze farmers' quality decision based on The Planned Behavior theory. The research will be carried out in the Chinese context. The thesis is to be combined with an internship; typical research activities include focus group discussion, expert interviews, on site visits, on-site interviews, document analysis.

6. Development of (communication) tools to support farming hygiene practices and improve safety of dairy in dairy supply chains in East Africa

Building on research of MFQ students: Yes

Possibility to combine with internship: Yes

MFQ specialisation: Quality control and assurance; quality management and entrepreneurship

Open to 1 student

Supervisors: Pieterneel Luning and James Ledo (PhD)

Problem description

In East African countries, the demand for safe, nutritional, and palatable dairy products is increasing in response to the rise in food supermarkets, growth of affluent population but also due to increasing foodborne outbreaks. The supply of fresh milk and processed dairy food occurs via the informal or formal channelling system. Currently, the equipment capacity is not fully used, so there is potential for growth. For example, a study in Tanzania indicated that the dairy industry utilises less than 30% of the installed capacity. Nevertheless, the growing demand poses a challenge for the dairy industry to increase capacity and improve processing conditions in order to consistently meet the market, consumer, and legal demands. The dairy sector is indeed confronted with many challenges. Common problems are milk adulteration, spoilage, microbial, and chemical contamination. Current dairy companies, local businesses, governments, and non-governmental organisations, offer technical and infrastructure support to poor actors along the chain to boost their production capacity and improve their livelihood. However, poor and inconsistent quality is still reported for locally manufactured dairy products such as pasteurised milk, ultra-high treated milk, cultured milk, and fresh raw milk. There is therefore need to develop assessment tools to profile the quality and safety of raw milk in selected regions where current intervention models have focused. The overall aim of this PhD project is to understand how business support strategies relate to quality control and dairy quality along dairy supply chains in East Africa, in order to identify critical success factors for improving dairy quality. In previous (PhD and MSc) research, tools have been developed to assess and differentiate farming practices and analyse milk quality and safety, and two field studies have been done in Tanzania. Currently data is under analysis to identify possible relations between practices and dairy quality and safety.

The MSc project will focus on developing interventions to enhance the dairy hygiene and safety practices along the dairy chain for a developing country context by exploring literature on factors influencing effectiveness of intervention strategies, co-analyse field study data (observations of farming hygiene practices), and develop and test communication tools (e.g. short movies, apps, etc.) to improve support hygienic practices along the raw milk supply chain. The MSc student will closely collaborate with the PhD in his 3rd field study in Tanzania

7. Understanding causes, occurrence, and magnitude of postharvest losses and establishing critical quality points in avocado and macadamia supply chains in Zimbabwe

Building on research of MFQ students: No

Possibility to combine with internship: Yes (Zimbabwe); can also be chosen as separate internship

MFQ specialisation: Quality control and assurance; user-oriented food quality

Open to 2 students

Supervisors: Pieterneel Luning; Lesley Macheka

Problem description

Fruits and vegetables are the major horticultural crops grown in Zimbabwe. This sector is the fastest growing industry with an average growth of 32% over the last decade and has the potential to develop a strong global competitive position, thereby providing substantial social and economic benefits to the country SNV (2014). In Zimbabwe, the avocado and macadamia supply chains have attracted huge interest from both farmers and investors. The huge demand for avocados in the European Union (EU) market, which increased by 45% from US\$760 million in 2011 to US\$1,1 billion in 2014, presented an opportunity for Zimbabwean farmers within the fresh produce sector. Zimbabwe's exports of avocado have increased by 400% from US\$177 000 in 2012 to US\$710 000 in 2014 (FAOSAT, 2016), driven mainly by large-scale avocado producers from plantations in the Manicaland Province. Like avocado, Macadamia cultivation in Zimbabwe is increasing yearly due to the high demand for macadamia on the global market. Macadamia is now a lifeline for more than 200 farmers in Manicaland Province, Zimbabwe, where the crop is exported primarily to China and South. In 2010 the price on macadamia was pegged at US\$0.30 cents per/kg; between \$1.50 and \$1.80 in 2015, and US\$3.20 per/kg in 2017 (Macadamia Growers' Association of Zimbabwe, 2017).

However, avocados and macadamia are known to be highly susceptible to postharvest losses (PHL). Losses and waste of avocados are estimated to range between 5 to 25% in developed countries and between 20 to 50% in developing countries (FAO, 2016). In Zimbabwe, the exact amount of PHL in these two supply chains is yet unknown. The complexity of PHL requires insight into the multiple factors causes. There is need for comprehensive studies on causes and magnitude of PHL and establishing critical quality points (CQP) to minimise incidence of PHL in avocado and macadamia supply chains in Zimbabwe. Insights from such studies could enable the designing of dedicated postharvest loss reduction strategies.

The MSc projects aim at identifying CQP's contributing to PHL in avocado and macadamia supply chains in Zimbabwe. A previously developed tool to assess PHL in tomato chains (Macheka et al, 2017, 2018) will be tailored and validated for the two chains.

Initial literature

Macheka, L., Spelt, E., van der Vorst, J. G. A. J., & Luning, P. A. (2017). Exploration of logistics and quality control activities in view of context characteristics and postharvest losses in fresh produce chains: A case study for tomatoes. *Food Control*, 77, 221-234.

Macheka, L., Spelt, E. J. H., Bakker, E.-J., van der Vorst, J. G. A. J., & Luning, P. A. (2018). Identification of determinants of postharvest losses in Zimbabwean tomato supply chains as basis for dedicated interventions. *Food Control*, 87(C), 135-144.

8. Towards risk-based assessment of chemical control measures in a global supply chain context

Building on research of MFQ students: Yes

Possibility to combine with internship: Yes

MFQ specialisation: Quality control and assurance

Open to preferably 2 students

Supervisors: Pieterneel Luning/ Wilma Taverne/Klementina Kirezieva (Cargill)

Problem description

Globalization resulted in increase of awareness of the various risks and vulnerabilities that products are exposed to as they move along the supply chain continuum from design and sourcing to manufacture, transportation, distribution, and final sale. Supply networks are long and complex resulting in higher risks. The risk of the global supply chain must be covered in the Food and Feed Safety Management Systems / Product Safety Systems. In Europe when there is product in the market which is unsafe or not in compliance with the regulatory requirements, there is an obligation to report this to local authorities. When more member states are involved it is reported to the Rapid Alert System for Food and Feed (RASFF). It is a tool that facilitates the cross-border flow of information. However, it is also a tool that influences trust. On the other side it supports risk assessments. A fact is that a high number of Rapid Alerts are related to supply from non-EU countries. So, there is a need for global supply, but there are also challenges for companies in this globalized business environment. Therefore, appropriate control measures must be installed for food and feed ingredients for a global supply chain based on the risk.

The **aim of the study** is to validate a tool for risk-based assessment of chemical control in global feed supply chains. The study includes literature analysis and expert interviews to improve and validate a previous developed tool; testing and applying the tool in case studies in a company context during the **internship at Cargill** (including interviews, on-site visits, observations, document analysis, data analysis), as basis for development of improvement strategies.

One thesis student will focus on the producer of ingredients and transport in the supply chain. The other student will focus the next steps, storage-trade-transport and arrival at Cargill. The topics will be further fine-tuned at the start of the thesis in collaboration with the co-supervisors from Cargill.

9. Understanding determinants of heritage food and its key-risk factors

Building on research of MFQ students: No

Possibility to combine with internship: To be discussed

MFQ specialisations: Quality control and assurance; user-oriented food quality

Open to 1 student

Supervisors: Muhammad Almansouri (PhD); Pieterneel Luning

Problem description

Consumers increasingly demand heritage food, which is food with a special traditional character. Consumers usually perceive such food as high quality and more sustainable, and they fulfil the need of cultural identity. Furthermore, heritage food of any destination plays an important role in the experience of tourists. In the last few decades, tourist's perspective of traveling has changed and the focus is on overall cultural experience instead of just visiting places. However, what exactly determines heritage food? When can food be categorised as heritage food, what are crucial quality attributes, and how to ensure production of heritage food?

Heritage food inherits from community ancestors, usually has a long history of consumption, and is commonly part of the cultural history of any population. Heritage food can be a traditional food that has proven usage in the community market for a period showing transmission between generations. Heritage cuisines are a mix of tangible (e.g. ingredients and cooking accoutrements) and intangible (e.g. tastes, smells, recipes, and eating traditions) elements that contribute to the cultural values and characteristics of places.

Multiple factors could influence the quality attributes of heritage foods such as its authenticity. Authenticity is an important feature of heritage food because it refers to the originality of heritage food. It is usually associated with reality, history, traditions, locality, and culture. Food authenticity is a complex concept and associates with a certain culture in a specific area. For example, the consumption of heritage foods prepared by local people using ingredients and methods typical for the own region, is observed as authentic. Therefore, any changes in local practices, ingredients etc. would hamper authenticity. Moreover, safety is a basic requirement of food particularly in the tourists sector.

The aim of study is to gain insight in determinants of heritage food by exploring definitions and concepts of heritage food and connected concepts (like food ethics, traditional food, etc.), by identifying major quality attributes of food heritage, and key-risk factors that can hamper the quality of heritage food. The research will consist of literature analysis, developing an initial conceptual framework, and in-depth interviews with academics and professionals (like chief cooks), and possibly designing a survey.

The type of heritage food, country of origin etc. will be further defined upon the start of the thesis project.

10. Why do food companies (not) choose for halal certification and if they do how do they choose the certification body ?

Building on research of MFQ students: No

Possibility to combine with internship: No

MFQ specialisation: Quality control and assurance

Open to 1 student

First supervisor: Ralf Hartemink

Problem description

Halal is a religious issue, which is a very important part of the quality attributes for Muslim consumers. Halal certification and halal quality labels are important for Muslim consumers in their food choices.

Halal food is a booming industry worldwide, including in Western Europe. Many common food products on for example the Dutch market are halal (or kosher) certified, but this cannot be seen on the domestic labels. Only for export to relevant Muslim countries the label will be added.

On the other hand, there are in the Netherlands alone, nearly 10 different halal certification bodies, which do not agree on the halal standards to be used. This is a typical problem in Western Europe, as the Muslim population originates from many different countries and thus comprises many different Islamic schools.

The thesis should include an overview on the differences in halal certification, the role and background of the different halal certification bodies in the Netherlands, and will include a survey among the Dutch industry on their policy on halal certification for both the domestic as the export market.

It is not necessary to have a Muslim background for this thesis.

11. Local Food: regulations, labels and safety

Building on research of MFQ students: No

Possibility to combine with internship: No

MFQ specialisation: Quality control and assurance

Open to 1 student

First supervisor: Ralf Hartemink

Problem description

In many countries, there is an increasing trend among consumers towards more locally produced food. This is also the case in the Netherlands.

Local food is often produced on a very small scale on farms or by small companies. Often it is a 'hobby', which has grown into a small company. Most producers do not have a proper background either as a cook or as a food scientist. Nevertheless, they all have to deal with the current regulations on safety (HACCP), labelling (nutritional value, allergies...) and more.

As a quality attribute often a sign or symbol like Locally produces in ... appears. However, what do these quality signs actually mean? Moreover, what are the organizations behind these signs?

The thesis will deal in the theoretical part on the trend of locally produced foods and the regulations for such foods, as well as with the organisations and quality signs. It will also include a survey among local food producers on how they deal with these issues and how they can be helped.

Because the thesis will include a survey among (small) producers, working knowledge of Dutch is recommended as not all small producers may be fluent in English.

12. Food safety early warning model based on Machine learning approaches: Meat supply chain as a case

Building on research of MFQ students: New topic

Recommended courses: Mathematical modelling, optimization, machine learning or an equivalent course.

Possibility to combine with internship: No

MFQ specialisation: Quality control and assurance

Open to 1 student

First supervisor: Dr. Yamine Bouzembrak

Second supervisors: Dr. ir. Ayalew Kassahun, Dr. Cagatay Catal

Problem description

In the last decade, multiple food safety incidents occurred in the EU food market such as the horse meat incident and Fipronil in eggs incident, which were mainly because of the increasing complexity of the food supply chains and the wide variety of food safety hazards that can contaminate food. The recurring occurrence of unexpected food safety incidents demonstrates the need for the early identification of these hazards. The aim of this study is to develop a Meat food safety early warning model based on machine learning methods, such as neural networks, to predict in an early stage food safety hazards (see Figure). The developed model will be applied to food safety monitoring data.

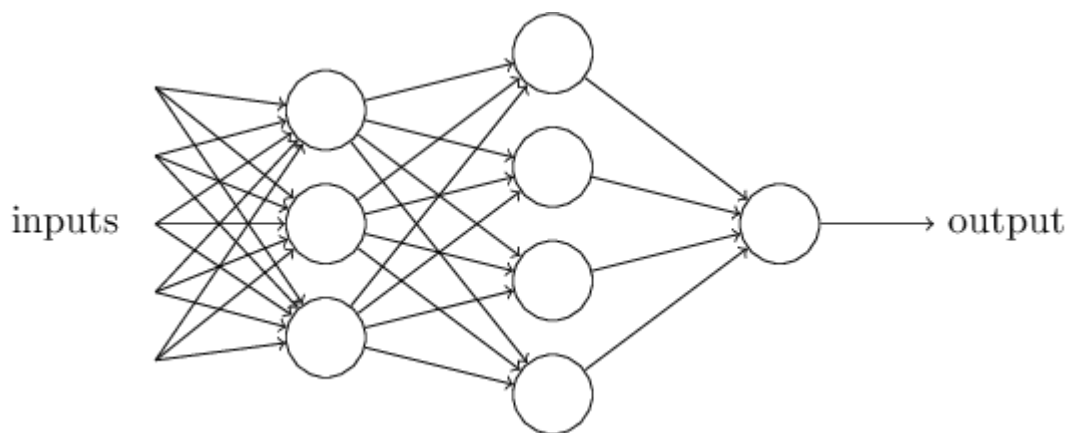


Figure : An example of the architecture of a neural network

In this research project, the student will:

- (1) Conduct a literature survey of the topic to obtain an understanding of possible modelling approaches and formulations;
- (2) Collect and process the meat food safety monitoring data: Dutch national food safety monitoring data and open source food safety databases will be used.
- (3) Develop a food safety early warning model using machine-learning techniques.

13. Identification of critical quality points for food companies and supply chains

Building on research of MFQ students: Yes

Possibility to combine with internship: No

MFQ specialisation: Quality control and assurance; quality and food logistics

Open to 2 students

First supervisor: Elsbeth Spelt

Problem description

Food companies strive for high quality food day-by-day. Integrated supply chains, sophisticated control measures, quality controlled logistics (QCL), and novel measurement techniques facilitate food companies in realizing high quality food. Each of these measurements addresses a single aspect in realizing food quality and lacks an integrated, preferably techno-managerial, point of view.

The Quality Analysis Critical Control Points (QACCP) method involves the integrated techno-managerial analysis of Critical Quality Points (CQP's) affecting food quality. A CQP is a point in the food production process that is critical regarding the prevention or elimination of quality loss, which in turn may lead to food products unacceptable for the customer. Previous research (e.g., Ali, 2012) highlighted the benefits of using this method for the food industry. These benefits are the reduction of food quality losses and minimization of variation in the quality of the produced food.

However, the complete integrated analysis for food companies and supply chains on CQP's is, to date, lacking. Such an analysis is necessary to support food companies in evaluating their Quality Management Systems (QMS) regarding controlling and assuring the quality of their produced food.

Research question

Four thesis projects on the application of the QACCP method are currently running. These projects address the overall research question of: *'Which CQP's can be identified to control and assure food quality in companies and supply chains?'*

Research approach

The research approach originates in the QACCP method including multiple steps. Each step requires precision and a full dedication in analysing the literature and the current practice to identify the CQP's.

Four different projects

Project 1: to identify CQP's for a chosen food product on company level.

Project 2: to identify CQP's for a chosen food product on supply chain level.

Project 3: to identify CQP's for the tomato chain to integrate QACCP and QCL.

Project 4: to analyse current practice of QMS on CQP's for a chosen food product.

14. Advanced training needs among food companies to enhance the auditing performance

Building on research of MFQ students: Yes

Possibility to combine with internship: To be discussed

MFQ specialisation: Quality assurance and control

Open to 1 student (preferably a Dutch student)

Supervisors: Elsbeth Spelt, Pieterneel Luning and Cor Groenvelde

Problem description

Food companies do internal and supplier auditing on a regular basis as part of their food safety management system. These audits are an essential tool to review if food safety related processes are conforming requirements and are effectively implemented and provide input for continuous improvement of the food safety management system. To ensure the internal and supplier audit processes are effective and add value mainly depends on the competencies and skills of the internal auditors.

Quality managers and other selected employees are conducting these internal audits. These so-called, internal auditors are usually internal trained or receive a one or two day training on doing internal audits by one of the external consultancy companies in the Netherlands. However, there is a lack in the providing of more advanced training in auditing competence and skills for these internal auditors. Especially with the increase of various kinds of standards, the continuously changing requirements of public and private standards, the current elaboration of requirements to food fraud, food defence and food safety culture issues, it is hypothesized in the present thesis research that food companies will benefit from the providing of an advanced auditing training for their internal auditors.

Therefore, the current thesis research will conduct a needs assessment among food companies in the Netherlands on these advanced auditing training needs. For this purpose, an overview of available needs assessment tools will be made to select the most appropriate one for this present research. Secondly, an overview of the currently internal audit trainings and their learning outcomes in the Netherlands will be made. Third, a dedicated questionnaire for the needs assessment will be developed based upon the selected needs assessment tool and latest scientific understanding on the first and second-party audits. Fourth, food companies in the Netherlands will be approached to conduct the needs assessment. Lastly, the synthesis of all findings will lead to an advice on the design of an advanced training for internal auditors responsible for first and second-party audits in food companies in the Netherlands. For this advice, the enhancement of auditing performance of food companies should be taken into account.

15. How to improve food quality through supply chain collaborations?

Building on research of MFQ students: No

Possibility to combine with internship: To be discussed

MFQ specialisation: Quality control and assurance

Open to 1 student

Supervisors: Annemarie Groot Kormelinck (Phd), Geoffrey Hagelaar

'26 French babies sick. French food safety inspectors missed salmonella at baby milk factor.,'
(January 2018, Le Monde).

'2.5 million chicken slaughtered because of Fipronil contamination of eggs in the Netherlands.'
(September 2017, de Volkskrant).

These quotes are only two examples of food safety and quality scandals that reached the international newspapers during the past six months. Each food scandal has enormous consequences. Consumers might suffer from health issues, and lose their trust in a certain product or supply chain. Farmers, food manufacturers and other chain actors lose their income, might receive a fine, and suffer from reputation damage.

The scandals demonstrate that ensuring high quality and safety of food products is very important in supply chains. So the question for you to answer in this thesis is:

How can coordination among supply chain actors assure food quality and safety?

Food quality is the outcome of activities and agreements among all actors in a supply chain, from producer to consumer. Food quality is also influenced by (inter)national quality standards for a supply chain. Changing attention for quality of food products impact the way supply chains are organized from producer to consumer. You will take a management and economic approach to investigate how collaborations among different actors in supply chains can be improved for quality and safety guarantees.

You are free to choose a supply chain case study from your own country or a country of your interest.

For this relevant topic, you will combine insights from your case study and from theoretical literature to formulate an answer on the following questions:

- What are (inter)national quality standards for a certain supply chain (for example EU food safety legislation, national retail standards)?
- What are the type of quality agreements made among different supply chain actors? How are these agreements formalized and controlled (coordinated)?
- Do (inter)national quality standards impact the type of quality agreements among supply chain actors?
- Which policy and practical recommendations can be given for supply chain actors and quality control organizations to improve their quality coordination?

II. Research theme - GOVERNING FOOD SAFETY AND SUSTAINABILITY IN FOOD SUPPLY CHAINS

Introduction

In food policy, we can witness a shift in governance. From a regulatory, top down mode of governing, the responsibility is increasingly transferred to companies. Nowadays in Europe, companies have to account fully for their policies and actions in the field of food safety and sustainability. Government by means of the national Authorities do not anymore inspect the shop floor but inspect the quality systems of companies in order to assess whether or not a company is abiding by the goals of the food safety policy. Such a change in mode of governance affects the focus, organisation, and capabilities of the government but also that of companies. What are the consequences of such a change for the inspection by government officials, both technological and administrative? How can we assess that a governmental inspection at a distance of the shop floor, renders a reliable image of the more or less complex processes in the company and between companies in the food chain and ultimately of the food safety of the product.

From a more global perspective, one can notice big differences in enforcement philosophies (facilitative versus systematic), - strategies (state versus market driven), and – practices (e.g. standards, sanctions, audits, information support etc.).

The **overall objectives** include the understanding of how (differences in) enforcement philosophies, strategies, and practices affect the governing of food safety and sustainability in (international) food supply chains. Understanding of how companies (industrial to small and medium enterprises) translate QA requirements into their systems. Designing tools to support companies in assessing how they perform in the sustainability dimensions.

16. Developments in private food safety requirements in Chinese food industries

Building on research of MFQ students: Yes

Possibility to combine with internship: Yes

Recommended: Chinese language skill is recommended because of the character of the case study

MFQ specialisation: Quality control and assurance; quality management and entrepreneurship

Open to 1 student

Supervisors: Geoffrey Hagelaar/ Pieterneel Luning/ Yingxue Ren (PhD)

Problem description

In the last decade, many food safety issues occurred in China. Several food safety hazards are abusive additive use, metal contamination, presence of mycotoxins, and chemical residues. In order to regain consumer trust, food manufacturers are now increasingly adopting food safety requirements both from public and private. Since the public food safety requirements are insufficient to deal with current situation, increasing private food safety requirements come to stage, such as Hazard Analysis Critical Control Point (HACCP), ISO 22000, FSSC 22000, to improve food safety.

In general, private food safety requirements can be clustered into two kinds. One is food safety requirements on food products, e.g. Organic Food, Green Food. Another one is those on food production system, HACCP, ISO22000. They contribute to food safety via different ways. Food companies adopt private food safety requirements (on system) to establish their company specific Food Safety Management Systems (FSMS). The FSMS is part of the quality management system aimed at controlling and assuring microbiological, chemical and physical food safety. FSMS performance, however, does not only depend on the level of control and assurance activities but also depends on the systems' context riskiness. As part of *food safety governance system*, *private food safety requirements* play important role in FSMS's context.

Although private food safety requirements are not mandatory in China, the development of private food safety requirements heavily depend on food safety governance. For instance, to promote and encourage the adoption of HACCP system in food companies (Jin et al., 2016; Jin et al., 2008), many local governments provide subsidy policies for those companies to support their adoption (Bai, Ma, Gong, et al., 2007). How do private food safety requirements interact with public food safety requirements and how do food companies perceive the interacts? These are important research questions. The thesis is part of a PhD project on understanding the mechanisms behind food safety governance and FSMS performance in the Chinese food sector.

This **MSc thesis project** aims to explore the interact between public and private food safety requirements and the impact of the interact put on FSMS in the view of food safety governance. The thesis is to be combined with an internship; typical research activities include focus group discussion, expert interviews, on site visits, on-site interviews, document analysis.

17. Developing FSM-systems in a multi-stakeholder environment

Building on research of MFQ students: Yes

Possibility to combine with internship: Yes

Recommended courses: MST

MFQ specialisation: Quality control and assurance; quality management and entrepreneurship

Open to 1-2 students

Supervisor: Geoffrey Hagelaar

Problem description

Food Safety Management-systems are designed on the bases of quality and safety goals. All the control activities are directed at reducing risks concerning food safety and reducing variety in quality output. The choices for the goals to be achieved on strategic level and on an operational level and the measures to be taken are ultimately made by a company. However, these decisions are taken in an environment in which different stakeholders from differing perspectives pose quality assurance requirements to that company. When dealing with an international supply chain requirements to food quality and safety can be far apart. Or in a company in which resources are scarce and competitive choices need to be made between requirements from stakeholders; which requirements are ranked as priorities and what is the underlying argumentation for that. The quality and food safety output on which the demands are focussed can be labelled as a wicked problem i.e. a problem with multi-dimensions and possibly conflicting aspects. To be able to implement requirements possibly new knowledge, new equipment, new investments are needed. Within the companies, choices need to be made in which the technological infrastructure and the organizational capabilities need to be aligned in order to reach the goals.

In this research, a certain product group will be focussed upon. For the company processing this product and the demands on their FSMS (1) stakeholders will be identified, (2) the perception of the stakeholders of certain aspects of food quality and safety will be analysed, (3) the influence of these requirements of different stakeholders will be analysed from a technological and managerial angle.

18. Tailoring FQM-systems to small and medium sized companies

Building on research of MFQ students: Yes

Possibility to combine with internship: Yes

Recommended courses: MST

MFQ specialisation: Quality control and assurance; quality management and entrepreneurship

Open to 1-2 students

Supervisor: Geoffrey Hagelaar

Problem description

Food quality management systems have a tendency to be designed and to develop into a conglomerate of rules, norms and measurements, including training, tasks and responsibilities throughout the organisation and related to a managerial and technological infrastructure. Specialised knowledge is needed to develop and implement systems. Specific measurement instruments, databases, communication channels are needed to operate the systems. From this point of view one can assume that food quality management-systems are developed for the bigger companies which have the capacity to deal with all these presumed managerial and technological conditions. However, the majority of companies is not a big company, but is a small or medium sized enterprise (SME). Those kinds of companies are in a certain sense the mirror image of bigger companies. The organisation is rather informal, not that much specialisation of employees, different functions are intertwined including quality and the director-owner is leading from a strategic level on the shop floor, the operations. Informality and flexibility (employees know a lot about everything) are both a weakness (towards executing systems) and a strength (for developing their business).

In this setting a FQM-system needs to be implemented as required by stakeholders as consumers, buying companies, (international) governments. So then SMEs need to find a way to develop and implement a system which complies with stakeholders requirements and meet their scarce resources. Ultimately, the goal for big companies as well as for small and medium sized companies, is to produce products with a certain level of quality and safety. However, small and medium sized companies, because of their limited resources and more informal organizational structure, will cope with this task in a different manner. The thesis goal is to deepen the insight in how SMEs cope with the organisational and technical requirements presumed by a FQM-system within their constrained setting. A second objective is to give recommendations on the implementation of FQM-systems in small and medium sized companies.

19. Developing a diagnostic to assess food sustainability to support the governance of sustainability

Building on research of MFQ students: Yes

Possibility to combine with internship: Yes

Recommended courses: MST

MFQ specialisation: Quality control and assurance; quality management and entrepreneurship

Open to 1-2 students

Supervisor: Geoffrey Hagelaar

Problem description

Labelling and (third party) certification reflects a shift of public governance to private governance. Certification provides assurance to stakeholders about the production process and the product itself. The rise of private governance in the form of certification is in line with the globalization of the food supply chain. This has a consequence that an increasing amount of food is produced in other countries than it is consumed. The purchase of food stuffs is evidently done from suppliers who function under different regulatory regimes on food safety and food quality. Moreover, the speed in which new demands on food quality and food safety are introduced puts a strain on governmental agencies. Governmental agencies tend to lack behind the newest developments in production practices. This holds true not only for food quality but also for sustainability.

The effect of this trend is that not only governmental organizations, like the global WTO, is standard setting but also internationally operating retail organizations see themselves as standard setting organizations. For supermarkets, standard setting is not only targeted at governing the stakeholders in the supply chain to ultimately selling the product with the intended food safety and quality attributes. The standard is developing into a strategic issue as well with which new markets can be developed and penetrated. Sustainability seen as a food attribute is one of the characteristics of food stuffs which becomes increasingly important as a strategic attribute as well.

Because of the previously mentioned trend of the increasing usage of certification by retail organizations, the number of sustainability certification rises. With this increasing number of certificates, the overview of consumers or of representing consumer organizations becomes blurred. Every certificate seems to develop their own line of attention, which ends up in different sustainability issues taken into account by specific certificates.

From a consumer perspective, we want to address this variety of sustainability certificates by examining a basis for comparing sustainability certificates. The master thesis focusses on the identification of critical decision points on measures taken in production and processing from the perspective of sustainability and assessing the impact of those decisions on the sustainability of the product. On the basis of the developed assessment instrument different sustainability labels can be compared and get an overview on the sustainability certificates.

From a producer perspective we want to focus on the implementation of certificates to identify where in the producer's practice the implementation leads to a confrontation between regular production practices and certificates' requirements and the impact of this on the quality and quantity of the produce.

III. Research theme - FOOD AUTHENTICITY AND INTEGRITY

Introduction

Food fraud is a form of criminal behaviour, no matter the definition of crime. The consequences of food fraud are devastating. Food companies and their reputation are damaged, stories go viral, whole supply chains are painted with the same brush, consumer confidence erodes, markets collapse, and management and/or employees are fired, prosecuted, and locked up.

The series of food fraud incidents – melamine, horse meat, organic eggs, cardboard stuffed dumplings – is demonstrating that the vulnerability of food fraud incidents reaches to every dinner table in the world nowadays. Food fraud is a major concern not only for consumers, but also for producers and distributors. There is some popular belief that food fraud is mostly an external threat caused by organized crime groups seeking to permeate the food supply chain. Although politically convenient, in reality it is more often a problem within the food system itself and committed by legitimate food supply chain actors who make the most of criminal opportunities that arise.

Food adulteration has been practiced forever, but has become more sophisticated in the recent past. These illicit activities result in considerable monetary losses worldwide and eroded consumer confidence.

Fraud is the result of the interaction between motivated offenders, and the opportunities presented by victims and by those entrusted with controlling risks. Vulnerability are due to openings for undesirable events resulting from weaknesses or flaws related to the system. The criminogenic incentives can differ for the various tiers in production and distribution chains though. An assessment of the factors affecting this vulnerability is, therefore, the first step towards fraud prevention and mitigation. Food fraud vulnerability is defined by three key elements: opportunities, motivations, and control measures.

Overall objectives

The main objectives are to (a) elucidate key risk factors contributing to food fraud vulnerability, and (b) to discern differences between nodes/tiers and actors of the same tier in order to understand how and where vulnerability arises and how these risks can be mitigated. This will help to manage food fraud risks across the chain or sector.

20. Fraud prevention in the catering and food service industry

Building on research of MFQ students: Partially

Recommended courses: Food Fraud & Mitigation (FQD-36306)

Possibility to combine with internship: No

MFQ specialisation: Quality control and assurance; quality management and entrepreneurship

Open to 1 student

First supervisor: Saskia van Ruth

Problem description

The food service sector comprises companies that are engaged in production, processing, trading, and marketing of food-away-from-home. These companies provide food products for snacks and meals in e.g., hotels, restaurants, café's, schools, prisons, hospitals, airplanes, and petrol stations. Where people spent less time on cooking and eat more at restaurants, the food-away-from-home expenditure increased in the last. This gives the food service sector of major importance in the food supply chain network.

When looking into food fraud, mostly retailed foods are considered. However, the foods consumed by consumers through the food service industry is just as important, and probably more complex. The food service sector can be characterised by a large number of different products and a complicated supply chain. Between producer and the food service company, the chain can pass several countries, traders, processors and distributors in a random order. Furthermore, a food service company can act as a processor itself and can deliver its products directly to the consumer (restaurant) or indirectly via a customer (catering in a school). The complexity of the supply chain and the large number of products involved, adds to a high vulnerability for food fraud issues.

An, in Wageningen developed theoretical concept of food fraud, has been further elaborated into a food fraud vulnerability self-assessment tool in collaboration with SSAFE (<http://www.ssafefood.org/our-projects/>; <http://www.pwc.nl/en/agrifood/ssafe-food-fraud-tool.html>). This tool has been adjusted to suit in particular food industry and retail. It appeared however somewhat complex for the food service industry because of their enormous number of ingredients, food products, as well as suppliers. Therefore, an adapted food fraud vulnerability assessment was developed for the food service sector in the last two years and applied in four companies.

In the current project, the fraud vulnerability of different actor groups (e.g. canteen services, small café's, airline catering businesses, and top restaurants) will be examined for a limited number of products. Key risk factors will be determined and actor groups compared in order to discover vulnerable points.

21. Addressing food fraud in developing countries

Building on research of MFQ students: Yes

Recommended courses: FQD-36306 would be beneficial

Possibility to combine with internship: No (but there is a possibility)

MFQ specialisation: Quality control and assurance; quality management and entrepreneurship

Open to 1 student

First supervisor: Sara Erasmus

Problem description

With the expansion of the global market and the increase in agri-food trade, issues such as food security are addressed while the economic growth of the countries involved are also increased. However, due to the current challenging economic times the prevalence of food fraud is increasing. Food fraud is particularly evident in complex food supply chain networks, where the detectability is low and the traceability of the food ingredients is limited. In developing countries, there is often a lack of regulations and enforcement, together with the prevalence of a dominant informal market – increasing the risk of food fraud when ingredients are sourced from these countries. Therefore, a crucial question is: *Are developing countries the biggest developing threat to the food supply chain?* If so, what can be done to address this issue?

Food fraud comes in various forms from adulteration, substitution, mislabelling to artificial enhancement etc. However, the main driver to commit food fraud is economic gain. Hence, with an increase in demand for certain products, i.e. sustainable and premium foods, the vulnerability to fraud also increases. In addition, serious food safety issues or public health threats can also arise depending on the nature of the fraud. Consequently, the Global Food Safety Initiative (GFSI) has included new food fraud prevention and mitigation measures in its Guidance Document for food safety standards (i.e. BRC, FSSC 22000 and SQF). Yet, for many small and medium-sized food businesses this level of assurance does not come cheap. Even more so in developing countries. Fortunately, this should not be a limitation to prevent food fraud as a free tool has been developed by SSAFE (<http://www.ssafe-food.org/our-projects/>; <http://www.pwc.nl/en/agrifood/ssafe-food-fraud-tool.html>) to help any food business to identify how they may be vulnerable to fraudulent activities and prepare mitigation plans. The tool can also be used to determine the vulnerability of an ingredient, product or that of the entire company.

The aim of the thesis is to use the SSAFE tool to systematically assess, examine and understand the vulnerability to fraud of various actors (perspectives) in the production chain of food ingredients/products of developing countries and discern critical points that needs to be addressed to help mitigate food fraud. The project will provide insights in the specific places in the import/export chain vulnerable to fraud, and differences in vulnerability between different actors at a particular point in the chain.

The project will help to fight food fraud by assisting companies to have a documented fraud vulnerability assessment procedure in place and implement measures to mitigate against the identified vulnerabilities. Ultimately, endorsing global **fraud-free trade**.

22. EVOO supply chain vulnerability assessment in the oil based food manufacture sector

Building on research of MFQ students: Partially

Recommended courses: FQD-36306 Food Fraud and Mitigation

Possibility to combine with internship: No

MFQ specialisation: Quality control and assurance; quality management and entrepreneurship

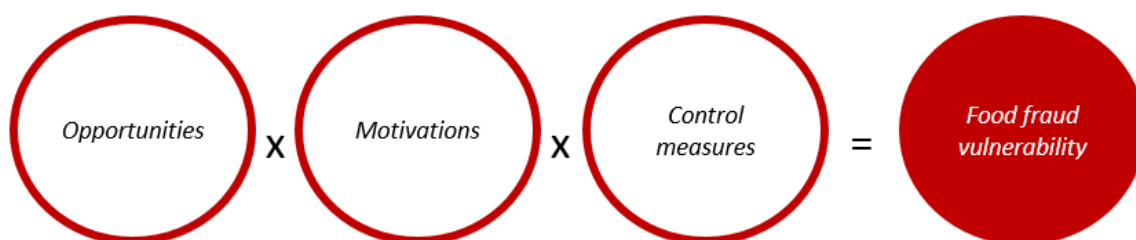
Open to 1 student

First supervisor: Jing Yan (PhD) (jing.yan@wur.nl)

Problem description

With the increasing globalization, elevating market competition, and growth in supply chain steps, food fraud in the food supply chain is becoming an emerging topic of concern. Product reliability, consumer trust, food safety, and economic effects are facets of impact as a result of food fraud. Due to the premium quality and associated high price of extra virgin olive oil (EVOO), historical cases of extra virgin olive oil fraud have been discovered all over the world, but especially in the main production countries (Greece, Italy, Spain, Portugal). Generally, the olive oil fraud issues include mislabelling, blending EVOO with other types vegetable oils and adding chemicals in other types vegetable oils to sell as pure EVOO. In order to solve those problems, researchers have explored a lot of laboratory techniques (relying on the chemical and physical characteristics of olive oils) to identify the EVOO authentication. Although detection helps to limit impact of a fraud case, it is of limited value in view of prevention. A systematic assessment of the vulnerability to fraud in the EVOO supply chain, however, will provide insights with regard to fraud risks and the most vulnerable points in the supply chain. A commonly used tool is the SSAFE food fraud vulnerability self-assessment tool, the science of which was developed in Wageningen (<http://www.ssafe-food.org/our-projects/>; <http://www.pwc.nl/en/agrifood/ssafe-food-fraud-tool.html>). In the past fraud vulnerability of primarily oil producers and retailers have been studied. However, no attention has been paid yet to the vulnerability of food manufacturers that use olive oil as raw material.

The aim of the current study is to examine and understand fraud vulnerability, key risk factors and critical points in the EVOO supply chain for the food manufacture actor group in order to map fraud vulnerability and suggest mitigation measures. Interviews with food manufacturers producing various kinds of foods and their olive oil suppliers will be an important part of this study.



23. The differences of food fraud vulnerability in the banana chain

Building on research of MFQ students: Yes, partly

Recommended courses: Food Fraud and Mitigation

Possibility to combine with internship: No

MFQ specialisation: Quality control and assurance; quality management and entrepreneurship

Open to 1 student

First supervisor: Zhijun Wang (PhD)

Second supervisor: Saskia van Ruth

Problem description

In recent years, many food fraud scandals have surfaced, thereby also making food fraud one of the main topics in the field of food safety. As reported by several academic institutions, organic food, vegetable oils, and spices and herbs are some of the foods that have the highest risk of fraud in food chains partly due to their higher market value. Therefore, the authenticity of these products has received great attention from media and consumers. However, more food fraud is concealed and hidden for the general public.

Fruits are becoming more vulnerable to crime with the development of economic globalization and the world food trade. Imported tropical fruits are particularly targeted in import countries because of their premium prices and longer food chains. Globally, bananas are one of the most consumed agricultural crops. Consequently, there is a strong growth in the banana market with worldwide production reaching up to 113 million tonnes in 2016. The fresh bananas are sold through retailers and the processed banana products are processed and subsequently sold. For the retailers and factories, the fraud vulnerability changes as well. The processed products of bananas such as banana powder, fritters, starch and other extracts from bananas are raw materials for food industry and health care cosmetics. The authenticity of processed of bananas is more hidden than for fresh bananas.

Currently, bananas are cultivated in tropical and subtropical regions, while being consumed all around the world. Although the process of market globalization has created substantial opportunities, some of these opportunities are unfortunately also associated with food fraud risks. Interestingly, some import countries are also export country in banana chains. The food fraud situation and vulnerability in these countries are different in comparison with pure import countries. In a previous student project, the possibilities for fraud in the banana supply chain were analysed for fresh bananas.

The aim of this study is to:

- (a) Carry out a literature study to map supply chain and data on banana production and processing, as well as import and export of South American and European countries.
- (b) Examine the fraud vulnerability of companies in the banana supply chain that process fresh bananas to a variety of end products using the SSAFE food fraud vulnerability assessment tool.

IV. Research theme - QUALITY DESIGN OF FOODS: PRODUCT, PROCESS, ORGANIZATIONS AND CHAIN (REDESIGN)

Introduction

In this research theme, the design of healthy foods is approached in a holistic way from the nutritional, technological, and managerial point of view to find out the more suitable strategies to create value at the different points of each food chain. All aspects that should be considered to achieve quality in developing food products, in developing food process designs, and in developing food chain design will be considered. Quality design is very important for companies in agribusiness and food industry to remain competitive. Similarly, the adoption of quality design approach into the food chains deals with incorporation of critical chain aspects, for instance, trustful customer-buyer relationships determining optimal food quality.

Overall objectives

The overall objective of research is to find out critical quality points in developing new food products, in developing new food process designs, and in new food chain designs to establish an optimal food quality that helps companies in remaining competitive. Food healthiness is one of the main driver in the creation and marketing of new food products. Different strategies can be pursued to design healthy foods such as the adoption of new ingredients having potential health benefits or the implementation of production processes to optimize the formation of desired compounds and to reduce the formation of those potentially harmful. Also, foods targeted at specific categories can be designed: children, pregnant women, elderly, sportsman, students population. As well as foods intended for the prevention of specific pathological conditions: foods for weight management, osteoporosis, gut health, mental performance and so on.

Overall objectives

- To design healthy foods looking at the different point of the production chain from raw materials to consumer satisfaction. Developing formulation and processing strategies for designing foods tailored for different health benefits
- To find out critical quality points in developing new food products, in developing new food process designs, and in new food chain designs to establish an optimal food quality that helps companies in remaining competitive.

24. Success of new food products

Building on research of MFQ students: Yes

Possibility to combine with internship: No

MFQ specialisation: User-oriented quality; quality management and entrepreneurship

Open to 2-3 students

First supervisor: Andrijana Horvat (post-doc); Pieterneel Luning

Problem description

High failure rates of new products have been an ongoing topic in the scientific and industry domains. Scientific literature shows high and stable rates of new product failure in the period from 1965 to 2010 (Castellion and Markham, 2013). One of the highest failure rates of new products has been recorded in the food industry. Product life cycle (PLC)

management is one way of following the success of a product once it has been developed and launched on the market (see figure 1). Almost every product reaches the decline phase of its life cycle (Weinstein, 2002). Since new products are responsible for company's growth and profit (Fuller, 2005), it is important to constantly develop new food products and to keep existing products successful by avoiding the decline phase. Keeping new products successful is challenging, since there is not a single new product development (NPD) and PLC management strategy that would guarantee product's success.

Moreover, there is no clear definition of what a successful or a failed product is. While some people consider that products that reached the market, and were discontinued shortly after, are failures, others also take into account products that failed to perform already during NPD and never reached any market.

Since the topic of new food product success can be explored from multiple angles, more than one thesis topic is possible, for example:

- 1) The student's task could be to study what makes a product failure or success, throughout product's life (NPD and PLC), to validate the literature findings with food industry professional, and to learn how food industry professional define product failure or success.
- 2) The student's task could be to study the (mis)alignment between NPD and PLC success strategies recommended in the scientific literature, and currently employed practices in the food industry. This could be done for a specific product category or for new food products in general.
- 3) Students are also welcome to suggest their own research ideas, which should be in line with studying the success of new food products throughout various phases of product's life.

The research will include literature analysis, followed by data collection, for example, by designing a survey or conducting interviews.

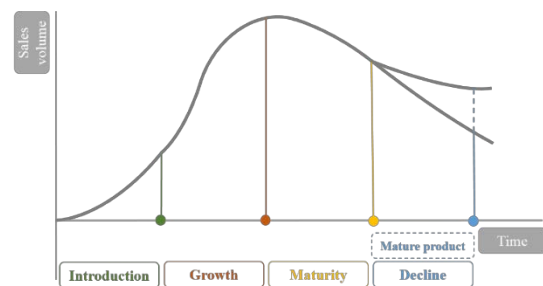


Figure 1: Typical behaviour of product's performance in product life-cycle phases (introduction, growth, maturity, decline), expressed as sales volume over time (adapted from Weinstein (2002)).

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25. Investigating conditions for learning and innovation in food companies

Building on research of MFQ students: Yes

Possibility to combine with internship: Yes

MFQ specialisation: Quality management and entrepreneurship

Open to 1 student

First supervisor: Maria Annosi (maria.annosi@wur.nl)

Problem description

Understanding food as a set of practices that are embedded in a historical, globally distributed system has been one of the main theoretical lenses developed over the past decades (Ericksen, 2008; Rosin et al., 2013). In the food quality management approach the systems perspective is taken into account by integrating relations between food, people and the organizational forms of governance within the food sector. In a competitive business environment, where innovation and agility are seen as being vital for a firm's competitive advantage, the management of the system is even more challenged and access to information and organizational learning have become progressively more central in order for a firm to survive. Additionally food organizing has remained partial or even accidental, despite the tremendous resources, calculations, energy, creativity and goodwill that are involved in the various processes related to food.

In the food sector, new organizational forms, relying on teams, have also been introduced, implying a shift in the power that has not yet received proper attention by organizational scholars (Easterby-Smith et al. 1998). Moreover the literature on organizational learning is inconclusive on the role of intentionality in learning, especially in the context deserving a higher level of autonomy to their organizational actors. Interesting for the food sector is to research how teams deal with the complexity of the food production and processing system and especially in an innovative setting in which access to information and organizational learning becomes more important. With the present call, we want to draw attention to food as an important setting for organizing, as well as to the roles, conditions and consequences of food organizing in diverse form of governance. Zooming in on food and its particularities is a way to access, reveal, and enhance the understanding of food system complexities.

We aim to explore the self-regulative dynamics of food organizations by identifying and analysing the key mechanisms involved in the self-regulated learning activities of single actors inside the team and in the organization. This is the basis for identifying relevant organizational regulation actions, relevant for improving learning and innovation at both the team and organizational levels. Therefore, recognizing the strategic importance of organizational learning and innovation as a means of providing a sustainable competitive advantage (DeGeus, 1988; Stata, 1989), we propose the following research question: Which are the processes and mechanisms involved in the regulation of learning and innovation activities occurring at the level of individuals, teams, and organization in food sector?

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26. Organizational culture and the adoption of new practices: Empirical evidences from food companies

Building on research of MFQ students: Yes

Possibility to combine with internship: Yes

MFQ specialisation: Quality management and entrepreneurship

Open to 1 student

First supervisor: Maria Annosi (maria.annosi@wur.nl)

Problem description

Globalization has forced managers to use manufacturing capabilities in countries with different cultures than their own. Some quality problems in China have raised the concern among managers operating in food sector and researchers as to how to assure product quality from Asian facilities (see Chao & Leow, 2008; Teagarden & Hinrichs, 2009). Either by management choice or through supply contracts, Quality management (QM) practices are implemented but are not always effective at increasing product quality. QM practices assume certain cultural traits to exist in a workforce, that if lacking will impact effectiveness. Research on the implementation of quality management (QM) practices indicates that organizations tend to adapt these practices to their culture as they implement them (Baird, Hu, & Reeve, 2011; Prajogo & McDermott, 2005; Zu, Robbins, & Fredendall, 2010) and that cultural misfit partly explains the results of the process (Naor, Goldstein, Linderman, & Schroeder, 2008).

Similarly, a comparative study of public sector organizations forced to adopt private sector managerial practices showed that, if coerced, organizations tend to respond ceremonially by adapting the new practices or by preserving loose coupling between these practices and the rest of the organizations (Lozeau et al., 2002). More in general, the commitment and use of QM are highly influenced by cultural values and context-specific effects (Chiang and Birtch, 2007; Lozeau et al., 2002; Zhao et al., 2004). These findings are consistent with research that showed that employees are likely to resist the implementation of practices that are inconsistent with their cultural values (Kirkman & Shapiro, 2001). Collectively, these studies document and explain the reluctance of organization members to adopt and implement new practices faithfully and extensively when these practices conflict with their cultural values. However, they say little about how members resolve the tensions that arise when new practices are coercively implemented in an organization.

This leads to the research question that motivated this study: When organization members are coerced to implement a practice with low cultural fit, how is the new practice adapted, and how is organizational culture affected by the coerced implementation?

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27. Food quality issue in the new food chain: the Spirulina case

Building on research of MFQ students: No

Possibility to combine with internship: Yes

MFQ specialisation: All

First supervisor: Vincenzo Fogliano

Problem description

To fulfil the dietary needs of the increasing world population more protein-rich food is required. Among the various alternatives of protein sources, microalgae is one of the most promising alternatives. They are carbon negative, do not compete for arable land, and can grow on semi-saline water all factors, which make microalgae cultivation very sustainable. Moreover, they are rich in proteins of very good nutritional quality so they can be easily integrate human nutrition without problem of consumer acceptance as it happen for instance with insect.

Among the various microalgae species available on the market, spirulina (*Arthrospira platensis*) is probably, the most widely adopted because of several cultivation and nutritional advantages. The quality and consequently the market price of spirulina is very different with a range from 10 to 100 Euro per Kg dry matter. This depends on many different factors, which are not systematically identified.

Proposed approach

An integrated techno-managerial point of view can be reached by using the QACCP tool. QACCP is the Quality Analysis Critical Control Points, which refers to the integrated analysis of critical points in food supply chains affecting the food quality as perceived by final customers.

In this work, the QACCP approach will be used on the microalgae production chain exploring in depth the case of the spirulina production, transformation, and commercialization.

V. Research theme - CONSUMER-PRODUCT INTERACTIONS IN CONSUMER CHAINS

Introduction

In the production and supply chain, the quality of food products is controlled to keep it at an optimal level. However after the product is purchased by the consumer, it has to be stored and prepared before actual consumption takes place. In this last part of the chain the quality can deteriorate due to product handling processes by the consumer. Hardly any research is done on consumer handling and practices at home with food products. In order to gain more insight into these behaviours, consumer research in daily life situations is needed to understand practices and motives behind these practices. The methods used will be in home observations and interviewing of consumers. With lab analysis the influence of the consumer behaviour on the final, consumed quality can be assessed. When the final steps in the chain are taken into account during product design, possible quality loss can be prevented by anticipating on the behaviour of the consumer. The aim of the projects will be to generate knowledge that can be used to improve product design and/or to inform consumers about more appropriate food handling.

Overall objectives

- Understanding consumer behaviour (and their motives) related to food storage /food preparation and the effect on food quality and food waste
- Understanding consumer behaviour (and their motives) related to optimal use of appliances for food preparation
- Understanding consumer preferences and motivations for food choice

28. *Think global, act local*: Increasing consumers' familiarity and choice towards ethnic foods

Building on research of MFQ students: No

Recommended courses: Product Properties and Consumer Wishes (FQD-31806)

Possibility to combine with internship: No

MFQ specialisation: User-oriented food quality

Open to 3 students

First supervisor: Lucía Frez Muñoz

Problem description

Food choice is a task that needs to be undertaken by individuals on a daily basis. In this respect, the understanding of the key drivers involved in consumers food choice is paramount to improve/develop new products that will successfully reflect their needs and requirements. An interesting personal factor involved in this process is product familiarity. It has been linked to several product-related experiences such as knowledge, product availability, consumption frequency, and typicality. A higher familiarity with the product is linked to a higher understanding of its attributes, which is translated to more informed product evaluations.

Globalisation has elicited the positioning of ethnic foods in markets all around the world allowing a higher diversification. Spring rolls, sushi, tacos, lasagne, among others, are widely known and consumed around the globe, in other words, consumers are familiar to these products. However, many other ethnic foods do not share the same popularity. For this reason, **the aim of this research** is to determine consumers' familiarity and perceived quality towards ethnic foods in 17 countries in order to develop an 'Ethnic Foods globalisation Index'. Students from the countries listed below are highly appreciated.

Countries being studied in this research

America	Europe	Asia	Africa	Oceania
U.S.A.	The Netherlands	China	Egypt	Australia
Mexico	Italy	India	Benin	
Brazil	Sweden	Indonesia	Kenya	
	Hungary/Poland	Japan/Turkey	Zimbabwe	

Research questions

1. Which countries are more/less globalised in terms of familiarity—availability, knowledge, preparation, and consumption—towards ethnic foods?
2. How do perceptions and choice of available ethnic foods differ in countries having different familiarity levels?

Proposed approach

Students will work with the total food quality model and its relation to product familiarity towards (ethnic) foods in a cross-cultural study, together with the influence of globalisation, generational cohorts, gender differences, among others.

Quantitative (questionnaires, analysis of ethnic foods in different countries, etc.) and qualitative (focus groups, in-depth interviews, etc.) research methods will be used to answer the research questions.

29. Value conflicts in food choice: the case of mothers with young children during snacking moments

Building on research of MFQ students: Yes

Possibility to combine with internship: To be discussed

MFQ specialisations: User-oriented food quality

Open to 1 student

Supervisors: Bea Steenbekkers, Femke Brouwer-Damen (PhD) (femke.brouwer-damen@wur.nl)

Problem description

Eating snacks at different moments during the day is clearly a common practice. Also among (young) children snacking is highly prevalent. Because mothers in particular are the main responsible person for the food provided to their children, it is relevant to look at the circumstances surrounding food choice of mothers for their young children. Food choice is influenced by many factors and their interactions, which makes it complex and dynamic. Because of the complexity and dynamics of food choice processes, they are hard to understand and difficult to predict. Especially for younger children, food is provided mostly at home, which makes the home environment highly relevant for studying food choice of mums for their young kids. Focussing on the snacking moments is relevant because there is evidence that children's dietary behaviour and even being overweighted track into adulthood. Especially the choice considerations and value conflicts related to these considerations during food choice are of interest in this research.

The thesis is part of a PhD project about understanding the dynamics of value conflicts and choice considerations in food choice during snacking moments. The target group is "mothers with young children, aged 2-7 years".

The thesis will be on the topic of values and value conflicts of mothers with young children. Research techniques could be either quantitative as well as qualitative, the exact direction of the topic will be defined in September in collaboration with the student.

30. Elucidate consumers food wasting behaviour and motives in different household settings.

Building on research of MFQ students: Yes

Possibility to combine with internship: To be discussed

MFQ specialisations: User-oriented food quality

Open to 2 students

Supervisors: Dieuwerke Bolhuis (Dieuwerke.Bolhuis@wur.nl) /Bea Steenbekkers Bea / Pieterneel Luning

Problem description

About 25% of all food supplied is wasted from farm to fork. Consumer households generate about 50% of the total food waste [1]. Food waste increases with decreasing household size, thus single households waste most per capita. Our recent qualitative research focused on meal preparation and food waste in single households. Some individuals were very motivated to prevent food waste whereas others were clearly less motivated, which was in line with their actual wasting behavior.. Factors that stimulate disposal were mostly consequences of busy or unpredictable lifestyles, lack of creativity in cooking/handling left-overs, negative attitude to left-overs, competing priorities (like cooking a tasty meal with many different ingredients), or struggling with portioning. These factors do not necessarily lead to food waste in individuals that were very motivated to prevent food waste.

We are now interested how differences in individual motivations deal with stimulating factors of food waste in multi-person households. Single-households have an better overview of what and how much food to prepare because they only deal with themselves. Whereas in families cooking (more than) enough for the children could be a competing priority to prevent food waste. The aim of this project is to investigate the most important stimulating factors for food waste in two-person households and families, and how individual differences in motivation to prevent food waste handle these stimulating factors.

Qualitative research will be used to address the research aim. Insight in wasting practices and motivations to prevent food waste will be addressed by dairies followed by in-depth interviews.

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VI. Research theme - PRODUCTION AND CONSUMPTION OF NOVEL PROTEIN FOODS: INSECTS

Introduction

In view of the ever increasing world population the demand for protein will increase over the next decades, and new protein sources are searched for. Insects have been proposed as one of the potential future protein sources of protein. Although insect consumption is new in the western world, world-wide over 1900 insect species are consumed and appreciated for their taste.

Several reasons exist for considering insects as a promising alternative source of animal protein in this part of the world. First, the production of insects is highly sustainable in comparison to production of cattle, pork, and poultry. Farming insects is characterised by higher food conversion efficiencies, lower environmental impact, and higher potential to be grown on waste streams. Sustainability is expected to be an increasingly important aspect for consumers when choosing foods and evaluating food quality, although also nutritional and sensory aspects are among the aspects of major importance. The research is focussed on generating knowledge on how to use insects in a tailored way as an alternative source of protein for human consumption, direct or indirect through the feed chain.

Overall objectives

Overall objectives with a view on defining pathways towards insect-based food consumption - are:

- Consumer acceptance in relation to processing and sensory quality (MFT/MFQ)
- Processing of whole insects in order extract proteins, fats in relation to functional aspects of the fractions obtained (MFT topics)

31. Assessing the potential for large scale production of insects: a chain perspective

Building on research of MFQ students: Yes

Possibility to combine with internship: No

MFQ specialisation: Quality control and assurance; quality management and entrepreneurship

Open to 1 student

First supervisor: Catriona Lakemond

Problem description

The increasingly growing population puts great pressure for sustainable food production. Environmental and ethical concerns of the intensive traditional livestock production to feed the world population have been pointing out for the need to develop production for alternative supply of animal protein. Insects are a potential alternative because they are nutritious, easily reared requiring minimum space and can help limitation of the environmental footprint. However, to have a significant impact on the environment, the production of insects needs to be on a large scale and barriers such as consumer acceptance and requirements for the production and commercialization of these products need to be addressed.

Previous research shows that the main bottlenecks for the expansion of large-scale production of insects as human food are the lack of close collaboration between partners, the relationship with customers/consumers, and the lack of appropriate technical knowledge in insect rearing and processing. Multiple efforts throughout the insects supply chain must be made to allow for availability of insect on a large-scale basis, especially aspects related to consumer orientation, chain collaboration and expansion of the current knowledge in insect production. The research will focus on potential successful strategies to build in these aspects to a larger extend in design of the entire insect chain using the PPP Lab scaling tool.

32. Design of insect supply chains in developing countries

Building on research of MFQ students: Yes

Possibility to combine with internship: No

MFQ specialisation: Quality control and assurance; quality management and entrepreneurship

Open to 1 student

First supervisor: Catriona Lakemond

Problem description

The world's growing population and food securities challenges have necessitated the need for using sustainable natural resources. Consumption of insects is a traditional practice since time immemorial in most African, Asian and South American countries. However, the potential contribution of edible insects to food security in these countries is under threat. Adoption of western food habits, especially in urban areas, has caused a decline in the consumption of edible insects as was clear from a case study done in Zimbabwe. The low insect consumption level in urban areas due to restricted availability limits the actual contribution to food security. Further insect consumption is limited due to seasonal availability, since the insects are often harvested from the wild in developing countries. This justifies the need to improve edible insects availability in all seasons, especially in urban areas through developing reliable value chains, insect farming and processing. The research will focus on potential successful strategies to design such insect supply chains. Aspects that will be taken along in the research are consumer orientation, (technical) knowledge with respect to insect harvesting and processing, insect farming and collaboration between potential partners in such a chain. We will make use of the PPPlab scaling tool.

VII. Research theme- FOOD QUALITY AND LOGISTICS MODELLING

Introduction

Logistics in food supply chains is a key factor in controlling quantity and quality, and more recently also sustainability. Traditionally, logistics is mainly focused on quantity, cost, and location, quality controlled logistics aims for a concurrent analysis of logistic- and food quality parameters to support the design of effective and efficient food supply chains resulting in satisfied customers, less waste and more sustainable supply chains. The focus of this research theme is on the evaluation of opportunities and bottlenecks of this concept in which logistics flows are controlled (steered) using quality data and sustainability data. How can we optimize the product availability in the different market segments and optimise product quality and sustainability using quality prediction models and logistic models.

Overall research objectives

- include understanding the impact of context characteristics on the effectiveness of combined logistics and quality control,
- identifying and modelling strategies to improve sustainability of food supply chains.

33. Modelling Sustainable, Healthy, Affordable and Preferable (SHARP) diets

Building on research of MFQ students: Yes

Possibility to combine with internship: As minor thesis

Recommended courses: In case the student likes to do a model assignment - next to the literature study, knowledge on modelling from courses as decisions science I and operations research and logistics is highly recommended.

MFQ specialisation: Quality and food logistics

Open to 1 student

Supervisors: Argyris Kanellopoulos

Problem description

The increasing need for food and nutrition security for all kinds of consumer groups, and the increasing demand for healthy and sustainable food production challenges actors in food supply chains. There is an increasing demand to redefine “optimal diets” and redesign the structure and management of agri-food supply chains. In this project, we aim to identify Sustainable, Healthy, Affordable, Reliable and Preferable (SHARP) diets and to evaluate the consequences of these SHARP diets on the structure of current agri-food supply chains.

To achieve these goals we develop mathematical decision support models, which combine requirements regarding performance indicators and generate diets that meet specific requirement that are feasible within various socio-economic and biophysical environments. To develop such decision support tools advanced insights in the concept of sustainability, healthiness, and preference of current and future food products are required. There is a need for students to review the current literature on these topics and develop the basic analytical model.

Students can focus on different elements of the SHARP diet model. Relevant questions are: how to make a model that generates a “proper” meal?; What do consumers “prefer” to eat?; How to define what is a proper and what is a preferable diet?; How to define the similarity between different food items so that a consumer has a certain degree of freedom of choice (e.g. rice instead of potatoes)?; How to predict customer’s future dietary choices? To address these questions, student can review and explore existing techniques while there are plenty of possibilities for very interesting modelling assignments.

34. Graph theory approach to trace-back contamination in a food supply chain: Meat supply chain as an example

Building on research of MFQ students: New topic

Possibility to combine with internship: No

MFQ specialisation: Quality and food logistics

Open to 1 student

First supervisor: Dr. Hans Marvin

Second supervisors: Dr. ir. Ayalew Kassahun, Dr. Cagatay Catal

Problem description

The food industry is becoming more customer-oriented and needs faster response times to deal with food scandals and incidents. To cope with these challenge, authorities and companies are already using existing risk assessments and risk-based priority setting tools without taking into account the flow, size of actors, and the interactions in the supply chain.

The aim of this study is to design and analyse the meat supply chain network in the Netherlands in order to quantify the importance of each actor within the supply chain network, especially in relation to food safety. The developed network (see figure) will be used in incident/outbreak investigations to support trace back and forward analysis and to limit the contamination size along the supply chain.

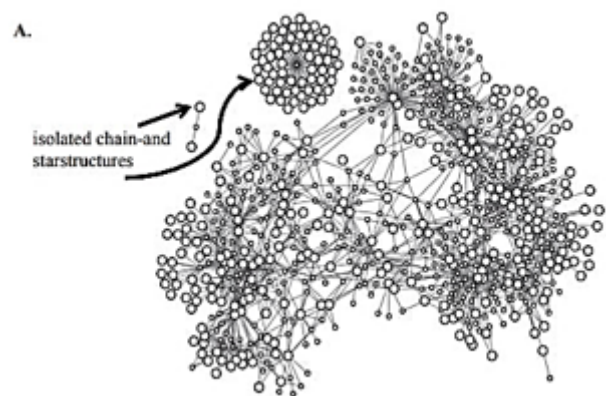


Figure: An example of a German milk supply chain network in 2004 (Pinior *et al.* 2012)

In this research project, the student will:

- (1) Conduct a literature survey of the topic to obtain an understanding of possible modelling approaches and formulations;
- (2) Develop a model of the meat supply chain network of the Netherlands by collecting information about the actors involved, the trade volume between the actors, the geographic locations, the connections between the actors, and by applying a comparable approach followed by Pinior *et al.* (see figure); and
- (3) Develop a related graph model (graph theory) to conduct network analysis, study the relationships between the supply chain actors, and minimize the size of any contamination.

35. Integrating quality decay in logistics models: Modelling and application (potential for multiple applications)

Building on research of MFQ students: No

Recommended courses: DS1, FLM, experience and affinity with optimization modelling (e.g. in FICO Xpress software)

Possibility to combine with internship: No

MFQ specialisation: Quality and food logistics

Open to 2 students

First supervisor: Dr. Renzo Akkerman

Problem description

In many problems related to food logistics management, changing product quality is a key consideration. From farm to fork, food products experience different conditions with regards to temperature, relative humidity, etc. All of these aspects influence intrinsic quality parameters of the food products. These quality aspects do however influence managerial decision problems, from the strategic design of logistics networks to the operational planning of distribution activities.

In decision support tools based on quantitative operations management approaches, quality deterioration is often simplified to keep the mathematical models easy to handle. In earlier research, applications of such approaches are reported and a conceptual model for inclusion of quality deterioration in supply chain planning models was developed. A possible thesis project would aim to validate, refine, or extend this framework using selected food products and/or selected planning problems.

Students are expected to apply mathematical modelling techniques, and should have affinity and experience with this type of research.

36. The role of product quality in food waste valorization in the circular economy

Building on research of MFQ students: No

Recommended courses: FLM, ASCM, and affinity for sustainability issues in supply chains

Possibility to combine with internship: No

MFQ specialisation: Quality and food logistics

Open to 2 students

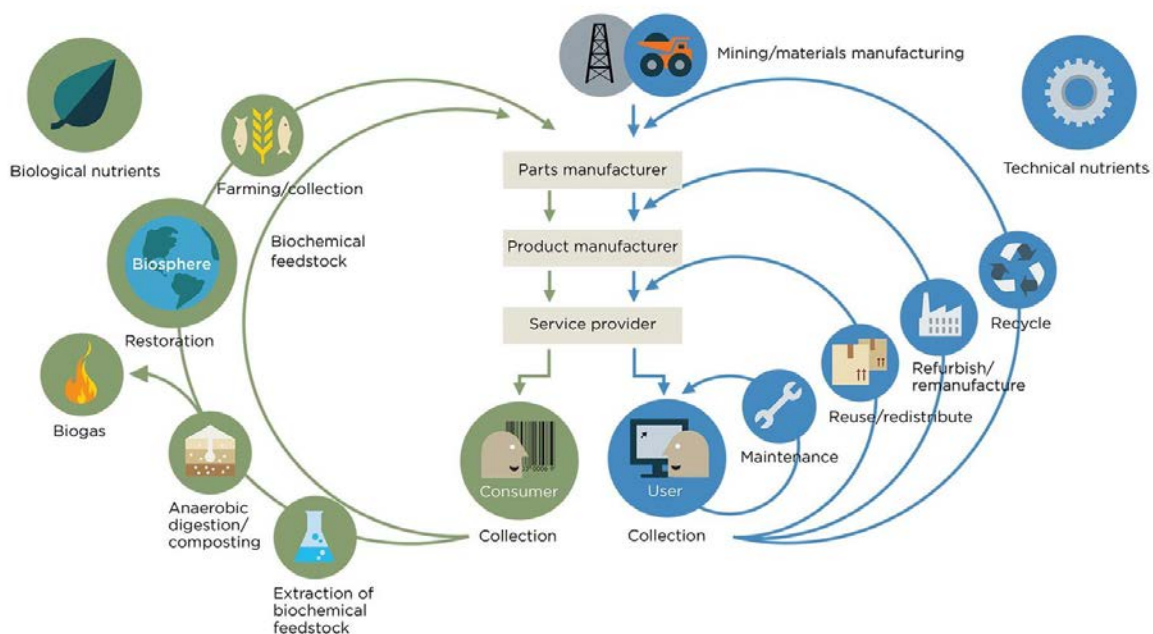
First supervisor: Dr. Renzo Akkerman, possibly together with A. Beames

Problem description

In the current transition to a (more) circular economy, a distinction is normally made between the circularity of “biological nutrients” and “technological nutrients” (See figure below). Within the circularity of biological material, valorization of food waste is an important ongoing discussion, and ranges from reuse as an ingredient in food or feed products to the use in biomass in energy production.

Reusing and valorizing food waste is an important consideration for most food companies, but different valorization options also demand different food qualities (where quality could relate to both intrinsic and extrinsic aspects of food quality).

A possible thesis project would aim to provide an overview of challenges and opportunities of valorizing food waste, with an emphasis on the related quality requirements. If a suitable case study can be identified, a thesis project could also develop and/or analyze case-specific quality-controlled logistics strategies.



(Illustration by Ellen MacArther Foundation)

37. Quality-integrated logistics using intelligent containers: integrating the quality management in the logistics processes

Building on research of MFQ students: Yes

Recommended courses: DS2/ ASCM /ORL

Possibility to combine with internship: No

MFQ specialisation: Quality and food logistics

Open to 1 student

First supervisor: Dr. Behzad Behdani

Problem description

In the past decades, logistics has gone through significant changes due to globalization, increased competition, high customer expectations, increasing operational costs and stricter environment management. These shifts inevitably stimulate the rise of complex modern supply chains, continuously challenging all relevant industries. Particularly in the context of the food sector, the additional key aims (i.e. food quality improvement and food waste reduction) put extra burdens on the SCM. Besides, the design and management of food supply chain are also complicated by its unique characteristics. In many cases, the processes for quality management are detached from logistics processes. For example, in a case of a fruit supply chain like banana, after harvesting and packaging, we load the bananas in a container or reefer ships that transport the product to the destination country. After the sea transportation process, Pallets of packaged bananas are transported from sea to land, and loaded into ‘forced-ripening’ centres before they are transported to the retailers and final consumers. However, instead of this separate transportation and quality management process, we can achieve the required quality during the transportation process using intelligent containers. In an intelligent container, we use Controlled Atmosphere technology to increase the shelf life of fruits and vegetables in a global supply chain. It is also useful to actively control the in-transit quality of products in different stages of a chain. By continuous monitoring and adjusting the atmospheric situation of fresh cargo, we can turn reefer containers into an atmospheric conducive for fruits ripening (or an in-transit ripening chamber). Therefore, we can regulate the expected quality of products in different stages of the chain and minimize the operational cost – by minimising the storage or avoiding unnecessary transport. In other words, we can integrate the “Quality Control” and “Logistics” functions for agri-food supply chains and achieve a “Quality-driven Logistics” for fresh products.

The aim of this master project is performing the economic and sustainability analysis of two different configurations of an agri-food chains; a first chain in which the quality management process is following the transportation stage, and a second case in which the expected quality of products is regulated and achieved using an intelligent reefer.

38. The value of horizontal collaboration in agri-food transport

Building on research of MFQ students: Yes

Recommended courses: DS2/ ASCM /ORL (affinity with ED/Matlab/Python/another simulation/optimization environment is welcomed)

Possibility to combine with internship: No

MFQ specialisation: Quality and food logistics

Open to 1 student

First supervisor: Dr. Behzad Behdani

Problem description

Nowadays, food supply chain faces greater challenges due to significant shifts in logistics (such as increasing operational costs) and unique FSC characteristics. Food companies can no longer manage these difficulties individually or solely rely on logistics service providers. Collaboration is one feasible solution. Horizontal Logistics Collaboration (HLC) is about the logistics collaboration between two or more companies operate at the same level of supply chain and conduct a comparable logistics function, receiving growing interests due to its potential benefits. However, many initiatives failed because of the complexity of HLC operation and management in FSC. Therefore, practitioners need a theoretical guideline for gaining insights into critical factors for achieving feasible HLC.

The main research question here is:

How can Horizontal Logistics Collaboration be motivated and operated in the Food Supply Chain (FSC) while taking unique FSC characteristics into consideration?

To answer this research question, the goal is developing and performing simulation studies to analyse the conditions in which horizontal collaboration in agri-food chain can be materialized.

39. Short sea shipping, rail or trucking: what is the best modality for inter-continental food transport?

Building on research of MFQ students: Yes

Recommended courses: DS2/ FLM /ORL

Possibility to combine with internship: No

MFQ specialisation: Quality and food logistics

Open to 1 student

First supervisor: Dr. Behzad Behdani

Problem description

One important decision in an agri-food supply chain is the choice of transportation modality. The choice of modality will influence the operational costs, the product quality and the sustainability of an agri-food chain.

In this project, we aim at performing a multi-criteria multi-actor system analysis to understand: 1) what different actors in the chain would prefer as the best modality and which performance measures are important for them; 2) what is the appropriate modality in terms of these performance measures.

We may possibly perform a multi-criteria decision analysis using AHP method.

40. Reduce food waste and improve SC/retailer performance (2 Msc thesis projects)

Building on research of MFQ students: Yes

Recommended courses: DS2/ ASCM

(affinity with ED/Matlab/Python/another simulation/optimization environment is welcomed)

Possibility to combine with internship: No

MFQ specialisation: Quality and food logistics

Open to 2 students

First supervisor: Dr. Rene Haijema

Problem description

Retailers like supermarkets keep large assortments and tend to overstock the retailer shelves to meet the uncertain demand by consumers. As a result of frequent replenishment, products with different use-by dates are displayed simultaneously, and consumers tend to select the products with the longest remaining shelf life. This strategy of both retailers and consumers causes food waste.

Around this topic two Msc thesis projects can be defined that focus on a quantitative assessment of a solution that may improve SC/retailer performance.

A solution could be a technological solution (e.g., improved packaging, dynamic shelf life), or managerial (e.g., a change of the order delivery schedule, change in order quantity, apply discounting/dynamic pricing), or a combination.