**FP6 - 518451**

**ΣChain**

# Developing a Stakeholders' Guide on the vulnerability of food and feed chains to dangerous agents and substances

**STREP**

**Food Quality and Safety**

***Final Activity Report***

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# 1 Project objectives and major achievements

## 1.0 Publishable executive summary of the project

### Publishable executive summary of the project

Food chains are the collective links of production (including raw material production), processing and distribution of food. These chains are becoming more and more complex networks in a dynamic and global environment. Food is a basic need and its safety is of great importance to consumers. People expect the food they eat to be safe and suitable for consumption. Food borne illnesses are at best unpleasant, and at worst, fatal. The implementation of comprehensive food quality and safety assurance systems enhances consumers' confidence and the sustainability of the EU food industry, while also minimising food spoilage.
The three-year EU Framework funded research project, *Sigma Chain* (∑*Chain*), with eleven partners, including one non-EU partner- viz. ITAL (Brazil), developed a methodology to identify, assess and address vulnerabilities in the food chain. In general, vulnerabilities can be divided into two principal categories: (1) contamination by a dangerous substance, whether chemical, microbiological, or physical; and (2) loss of information regarding the product on its journey through the chain. A novel stepwise procedure was adopted that guides practitioners through the process in a systematic way, within applicable regulatory frameworks and existing practices. Vulnerability identification and assessment, according to the ∑*Chain* approach, can be used to investigate the whole food chain or specific parts of it, in order to minimize risks or optimize production and processing.

∑*Chain* developed a Stakeholders' Guide which is a practical manual detailing how to identify and address vulnerabilities for specific food products or food chains – copies are available free of charge from www.sigmachain.eu. The Stakeholders' Guide addresses chain vulnerabilities problem through the following stages:

1. Map the specific food (and feed) chain in some detail to allow a systematic review of the information to be collected: Information to be collected includes possible contaminants, their occurrence, best manufacturing practice, relevant legislation, and more. Access to good sources of data is key to the process. Addressing the lack of data, particularly for many chemical contaminants, is a key recommendation of the project that needs further concerted action at a pan-European level.

2. Identify vulnerable links in the chain: The main focus should be on entry points of contamination and points in the chain where information can be lost.

3. Rank the vulnerability: The ∑*Chain* project developed a new risk ranking approach to rank potential contaminants and the subsequent assessment of the potential vulnerabilities is based on a novel application of **Failure Mode and Effects Analysis** to food chains.

The methodology developed within the ∑*Chain* project to identify and address vulnerabilities in the food chain was validated in a practical manner by its application to four major case studies for water, poultry, farmed salmon and milk powder, carried out by the project partners. For practitioners of food safety, the Stakeholders' Guide represents a valuable tool to identify and address vulnerabilities for specific food products or food chains.

## Partners involved

1. University College Dublin (UCD), Ireland. Status: university. Areas of expertise: project management; Biosystems and food engineering, including traceability, food safety, risk assessment. Role in EChain: project co-ordination and leader of Workpackages (WP) 3 & 5. Contributes to other WPs.

2. Max Rubner-Institut (MRI) Standort, Kulmbach (Meat) (Institute for Chemistry & Physics), Germany. Status: government research centre. Areas of expertise: species identification, GMOs, contaminants, lipids, residues. Role in ΣChain: leader of WP2 and contributes to other WPs.

3. TNO, Netherlands. Status: organisation for Applied Scientific Research, comprising TNO Quality of Life Country. Status: Research Institute. Areas of expertise: risk analysis, nutrition intelligence, risk management including food and feed safety, traceability in food chains, carry over, process modelling, analytical sciences and genome typing. Role in ΣChain: Leader of WP4 and contributes to other WPs.

4. Institute National de la Recherché Agronomique (INRA), The Meat Research Unit (MRU), France. Status: research institute. Areas of expertise: meat research, including meat species identification, biogenic amines, rancidity, meat quality. Role in ΣChain: contributes to all WPs.

5. Poznan University of Life Science (PULS), Department of Food & Nutrition Sciences (Institute of Meat Technology), Poland. Status: university. Areas of expertise: evaluation of meat quality, quality management, programming and controlling of meat processing and modelling of meat product quality. Role in ΣChain: participates in several WPs and addresses the production aspects of the project.

6. AGRI-Tech Solutions Ltd. (ATS), Ireland. Status: SME. Areas of expertise: food traceability & safety, risk analyses, food thermal process validation, food auditing. Role in ΣChain: Develop ΣChain and dissemination, commercial development beyond the end of the project, critical links identification for water, lead water chain development and mapping.

7. SINTEF Fiskeri og Havbruk AS, Norway. Status: research institute. Areas of expertise: salmon traceability, development of PCR-based DNA assays and diagnostics, service analysis including traceability and authenticity. Role in ΣChain: leader of WP1, contribute to other WPs, develop chain maps and vulnerability assessments (particularly with respect to farmed salmon).

8. IFQC Ltd., Ireland. Status: SME. Areas of expertise: fish quality standards, dairy quality assurance scheme, traceability, protected geographic indication (PGI), certifications. Role in ΣChain: participate in several WPs, particularly farmed salmon, traceability and systems certification.

9. Instituto de Tecnologia de Alimentos (ITAL), Brazil. Status: research institute. Areas of expertise: chromatograph, spectrometry, electrophoresis, optical and electronic

microscopy, biological and packaging properties. Role in ΣChain: contributes to chain mapping in WP2 (particularly chicken from Brazil), analytical methods, vulnerability identification and framework development of WP1 & WP4.

10. Marketing and Consumer Behaviour Group, Wageningen University (WU), Netherlands. Status: university. Areas of expertise: consumer science, and the impact of all aspects of the food industry on the consumer. Role in ΣChain: assessment of the impact of ΣChain on agri-food, public policy and consumer behaviour, link to the FP6 TRACE project in which WU is a partner.

11. SYNCOM Forschungs-und Entwicklungsberatung GmbH, Germany. Status: SME. Areas of expertise: project management. Role in ΣChain: assisting the project manager (UCD) in the management of the project.

## Work performed and results achieved

**Partner 1: UCD**

**Year 1:**
UCD carried out a study to identify and list skim milk powder contaminants. The main pathways by which contaminants can potentially enter the skim milk powder chain were identified. Control measures and corrective actions for each contaminant were outlined. Detection techniques for the identification of natural, malicious and emerging risk contaminants in skim milk powder were documented in the contaminant database.

UCD carried out a literature survey on the application of radio frequency identification (RFIDs) in food traceability. Preliminary experimental studies were carried out to determine the applicability of ultra high frequency (UHF) Electronic data interchange (EDI) was also reviewed as a potential device for food, feed, and ingredient traceability. Work was started on a new technique to recover information from damaged animal tag barcodes using search algorithms, mainly genetic algorithms.

UCD carried out a literature review of existing risk assessment models, covering a wide variety of hazards and products. Hazards have been grouped into microbiological, chemical and other (physical, virus, etc.). A literature review of appropriate risk ranking models was also carried out. UCD is starting to rank the list of pathogens identified by the four case study partners.

**Year 2:**
Existing published risk ranking criteria for microbial and chemical contaminants were reviewed (**Subtasks 3.2.1).** Separate ranking criteria were developed for the microbial pathogens and the chemical hazards identified in the contaminants database for the four case study products assembled as part of **Subtask 3.3.1.** It was decided that the Risk Ranger tool would be used to rank microbial contaminants. Similarly, a revised risk ranking criteria for chemical contaminants was developed that was more holistic and could be applied to all of the chemical contaminants identified in the contaminants databases.

In **Task 3.3**, the developed criteria were applied to the contaminants identified for one of the four case study products – poultry meat. For the microbial contaminants identified for poultry meat, the Risk Ranger software was applied to each of the pathogens in turn, resulting in a summary ranking table listing the relative risk ranking for the pathogens and an estimate of the number of illnesses expected per 100,000 of the population. However, the risk ranking for salmon and water has been delayed. Details of the risk ranking outcomes for poultry and milk powder are contained in the **Deliverable Report D3.1**.

A generic chain map was developed for skim milk powder (**Subtask 2.1.3,** 2nd Annual report 2008 -WP2-Annex 2). This comprises of Eight sub-chains including a Yoghurt processing chain. Transfer points where responsibility/ownership of raw/ SMP changes where all included.
The full and finalized SMP contaminants list is available in the following report (**Task 1.1**) on the E-chain website (http://www.project.sigmachain.eu/) "*Final Report on Subtask 3.3.1.*" These contaminants were also used and included within the Virtual Room ("E-room") developed by partner SINTEF as internal tool to test the developing framework.

Under **Subtask 2.4.1.2,** the documentation flow accompanying the SMP along the chain from dairy farm to yogurt processing plants was reviewed and assessed. Process validation field trials were started at dairy farms & milk powder processing plants.

In addition, a benchmarking review **(Task 2.2.1)** was carried out on analytical methods for sampling and detecting contaminants along the SMP chain. Sources consulted included ISO, AOAC, IDF & CODEX handbooks and standards.

A technical literature review was carried out on existing and upcoming electronic tracking and tracing systems in the four products industry (SMP, poultry, salmon and drinking water) (**Subtask 2.3.1)**. It included both linear, 2D and "3D" "barcodes", RFID; and ebXML, EDI, and the EPC Network but also the effects of adverse environmental conditions on the operation of each technology, error correction, failure modes and consequences of failure on the integrity of traceability information. New developments in electronic tracking and tracing systems (**Subtask 2.3.2**) was also reviewed and evaluated.

**Year 3:**
As part of Workpackage 3 (Risk Modelling and Ranking), UCD revised the preliminary risk ranking model for chemical contaminants developed in year two of the project in light of the experience gained in applying the model to the four case study products – water, skim milk powder, salmon and poultry. The model now categorises the chemical hazards into four main groupings – prohibited, permitted, environmental contaminants and others, before applying a ranking technique that considers both the severity of the contaminant and the likelihood of its occurrence. The model also allows for qualitative assessment of chemical hazards in situations where insufficient data is available to complete the quantitative ranking. The revised chemical risk ranking was reviewed with industry experts at two separate workshops in Dublin and Kulmbach. A favourable response was received at both workshops for the proposed risk ranking approach. Risk ranking for the two remaining case study products – water and salmon was completed using the revised risk ranking approach in this reporting period. Risk ranking of the two other case study products was completed in year two. The final outcome of this Workpackage was Deliverable Report 3.2 – Generic risk model capable of quantifying risk and providing risk rankings, and this deliverable report describes the revised risk ranking approach for chemical hazards as developed by the project. The previous

Deliverable Report 3.1 describes the approach adopted by the project to rank microbial hazards. Under subtasks 3.5.1 (develop user interface) and 3.5.2 (testing and validating interface) it was originally planned to develop an electronic user interface to allow users calculate the priority risks for a particular hazard. However at the Wageningen partner meeting, November, 2008, it was decided by the project management meeting that the risk model would be presented in book form in the Stakeholder's Guide and that this would be made available on the project web portal. Accordingly, no further development work tool place on the user interface.

As part of Task 2.3 (Electronic Tacking and Tracing Systems), a review of information, error detection and/or correction theories of the most important electronic tracking and tracing technologies for food products was carried out. These technologies included linear and two-dimensional printed graphic identifiers (PGIs), Class-1 Generation-2 RFID, and TCP/IP-based tracing applications. As GS1 linear barcodes tend to dominate the food distribution and retail sector, information theory, error prevention, detection and probability of incidence of error – given the probability of a shift of a bar or space – they have briefly been discussed in the first portion of the technical progress report. Causes of error in linear barcodes, some of which were applicable to two-dimensional PGIs, were also presented. As the PDF417 is one of the most widely used two-dimensional PGIs for official documents such as passports, with capabilities for binary and alphanumeric data, and being widely accepted in industry, their graphic designs as well as error coding were evaluated. The ECC-200 version of the Data Matrix symbol was also discussed, as it is part of the GS1 identification symbology. Its error correction and detection provisions have been outlined. Class-1 Generation-2 ultra high frequency radio frequency identification (UHF RFID) was also considered in the general framework of error detection and correction, in the context of communication between the reader and tag. Similarly TCP/IP-based tracing applications were also discussed including underlying error detection methods. The report concluded with appendices on the basic concepts underlying error coding including binary arithmetic, block codes coding and decoding using matrix notations, and the Galois Field as a key foundation of error coding.

As part of the UCD contribution to Task 2.4 (Identification of Potential Vulnerabilities to Contaminants), the following tasks and subtasks were completed in the reporting period. Chain vulnerability nodes/links were identified and the skim milk powder chain vulnerability systems were presented. Task 2.4.1 – Final report on review of documentation flow accompanying product along the chain was delivered. Deliverable 2.2 – completion of chain map for milk powder was delivered. Subtask 2.2.2 – Annual periodic report on benchmarking for milk powder was completed. Tasks 1.3 and 1.4 – Annual periodic activity reports on "proposal for recommendations to develop corrective measures" and "construction of a preliminary conceptual framework including corrective measures for skim milk powder chain" were completed. Milestone 2.3 – Benchmarking for milk powder was completed. A 30-month report on the identification of potential vulnerabilities to contaminants was delivered. Template 8.5 – on how to identify monitoring plans and results of analyses of (identified) contaminants in the product chain was completed.

**Partner 2: MRI**

**Year 1:**
BFEL-KU carried out a literature survey on available sources of information on contaminants. A report was produced and resulted in the setting up of an informative contaminants database

for use by all partners. Inputs to the database were also obtained from poultry meat and feed producers and poultry meat processing plants were visited to obtain process flow information.

A protocol for the chain mapping process was developed and integrated into the preliminary framework by Partner 7. A comprehensive literature study was carried out on all stages of chicken meat production. A full generic chain map flow diagram for chicken and feed chain was completed.

An authentication method was developed for common domestic poultry species (chicken, turkey, goose, duck, quail, pheasant and guinea fowl) on DNA analysis using PCR. Methods for the determination of the levels of veterinary drug residues (sulphonamides) in poultry meat were outlined.

**Year 2:**
Partner 2 (MRI-KU) performed two tasks within this reporting period. The first one was to provide expert knowledge in the field of poultry meat production. Within Workpackage 1 MRI-KU carried out a literature survey for determination of Best Manufacturing Practices (BMP) in poultry meat production. MRI-KU also elaborated general working procedures for "Identification of contaminants and of the critical links in the poultry meat production chain" and for "Deriving control and corrective measures to avoid hazards in the poultry meat production chain" for use within the framework.

Furthermore MRI-KU was part of the working group "Contaminants", which discussed various aspects of the WP 1 database concerning completeness and structures. MRI-KU provided priority contaminants concerning poultry meat in co-operation with Workpackage 3 leader (UCD).

Within the scope of Workpackage 2 MRI-KU in co-operation with partner 5 (PULS) and partner 9 (ITAL) elaborated a detailed chain map of poultry meat production. The respective milestone **M 2.1** chain map for poultry meat has been achieved. Being sub-task leader **2.1.1** "Harmonization of analytical methods" MRI-KU organized the evaluation of experiences, previous knowledge and possible resources of the partners involved with each chain regarding analytical techniques and methodologies. The respective **milestone 2.1**, Harmonisation of analytical methods, was achieved. MRI-KU lead **Task 2.4** "Identification of potential vulnerabilities to contaminants". Therefore the development of a preliminary working procedure – integrating the 4 relevant case studies – to fulfil all subtasks, was an ongoing task. Within the reporting period working procedures concerning documentation flow and physical and electronic tags were confirmed by discussions with case study leaders.

Secondly MRI-KU is WP 2 leader, and therefore provided the technical management on WP 2. Meetings on WP level were organised, a joint approach to the realization of the specific objectives of the WP was provided and the communication between the partners involved was encouraged and supported. As a member of the project board, MRI-KU was represented at board meetings.

**Year 3:**
As WP2 leader, MRI provided the technical management of the Workpackage, and continued to organize meetings etc as outlined above.

Within the reporting period the two main deliverables in WP 2 were: **Deliverable 2.1**; Preliminary chain maps for the four "vulnerable" products, and **Deliverable 2.2**; Full chain

map for each of the designated four "vulnerable" products. MRI provided a strategy for content and layout, coordinated the work of the partners involved and accomplished the final delivery.

Within WP 2, **sub task 2.1.6**; Compilation of applied and/ or developed analytical methods, MRI was engaged in two lines of work: a) the development or adaptation of analytical methods to determine sulphonamide residues in poultry meat by varying LC techniques and b) the authentication of common poultry species in meat and processed meat products by means of PCR.
Results from this sector of work were presented at the 43rd Kulmbach Week, 6th of May, 2008 as well as at the 54th International Congress of Meat Science and Technology; ICoMST, Cape town, South Africa, 10.-15.08.2008.

Within WP 2, **task 2.4**; Identification of potential vulnerabilities to contaminants, MRI was responsible for carrying out the case study on the poultry meat production chain vulnerability to contamination. To this end the documentation flow accompanying the products poultry feed as well as poultry meat was reviewed. The application of prevalent physical or electronic tags in the chain was reviewed. The suitability of new, innovative tags was assessed under the given environmental conditions in the poultry meat production chain (in co-operation with partner 1 (UCD)). The availability and applicability of analytical methods to detect the identified priority contaminants in the poultry meat production chain, including feed chain, were assessed and evaluated (in co-operation with partner 4 (INRA)). Finally the traceability process in terms of exposure of the poultry meat production chain and the respective feed chain to undesired agents or substances at critical chain links was evaluated. In the evaluation process a FMEA (Failure Mode and Effect Analysis) method, specifically modified within the scope of the project, was applied. The final evaluation process was accomplished in co-operation with partner 9 (ITAL).
Results from this sector of work were presented at the Relay Workshop: Pesticides and contaminants in food – the safety issue, University College Dublin; Ireland, 11th of June, 2008, at the XXIII World's Poultry Congress, Brisbane, Australia, 30.06.-04.07.2008, at the ΣChain International Workshop 6th-7th May 2009 and at the XIX European Symposium on the Quality of Poultry Meat; Turku; Finland, 22.-26.06.2009.

MRI organized within the scope of the 44th Kulmbach Week the international workshop: "ΣChain – Developing a *Stakeholders' Guide* on the vulnerability of food and feed chains to dangerous agents and substances" 6th – 7th of May 2009 in Kulmbach, Germany. The workshop gave a comprehensive overview of the development and application of the *Stakeholders' Guide* for participants interested in current questions of food and feed safety.

As a member of the project's board, MRI was represented at board meetings.

**Partner 3: TNO**

**Year 1:**
TNO had a lead role in the development of the first version of the conceptual framework for identifying and prioritising critical links in the total chain. Extensive discussions regarding the framework were held with all partners during the plenary and work package meetings.

TNO is responsible for the benchmark of analytical methods for water. TNO produced a comprehensive review, including and compiling known methods from recognized organisations such as ISO, CEN (and NEN, Dutch Normalisation Institute), USEPA. A draft report was submitted to the respective task leader (AUP).

TNO produced a document with harmonised notations based on the ISO standard on process description. Such harmonisation facilitates monitoring the use and validation of the framework in WP4.

TNO developed a scheme showing all interaction between WPs and tasks throughout the course of the project, ultimately aimed at delivering the Stakeholders Guide. TNO developed a glossary with relevant terms and definitions for the project. A literature review was drafted to identify existing 'best practices' in the food and feed chains regarding vulnerability assessment. A basic procedure to monitor and audit the use of the draft framework in the case studies including evaluation criteria was set up.

TNO experts in toxicological and microbiological risk assessment and management carried out quick scan (literature) reviews of vulnerabilities in the four designated chains of the case studies. These documents serve as a benchmark for the WP4 leader when evaluating the use of the framework in the case studies.

**Year 2:**
In the second period TNO performed extensive work for the conceptual framework which forms the core of the eventual Stakeholders' Guide. There was very close cooperation and considerable scientific and consultancy input on the development of the risk ranking principles and methodology with UCD as WP leader.
TNO produced several documents on best manufacturing practices and corrective measures for specific subjects in the food production chain, i.e. feed production and hygienic design of production. TNO also produced a review document on analytical techniques (both chemical and microbiological) for water.

TNO contributed to discussions on the setup and preliminary results of the Delphi studies from/at WU in order to realise best integration of the consumer and socio-economic research with the development of the framework.

As WP4 leader, TNO is the main contributor and executor of this WP.

Under **task 4.1** TNO developed the monitoring protocol and has set evaluation criteria for this, based on a literature review showing that no consistent systems for assessing chain vulnerability are in place in the food/feed chain. In further developing the preliminary conceptual framework (in three consecutive versions) and using the already gathered early information from the case studies, the validation of the preliminary framework were completed. Milestones 4.1 and 4.2 were achieved.

Under **task 4.3** TNO monitored the use of the framework in the case studies, conforming to the predefined protocol audits. Results of discussions with the respective case-study leaders resulted in accentuating the monitoring protocol and its focus points.

TNO prepared the formal evaluation of the conceptual framework under **task 4.4.**

TNO organised discussions with WU and ATS regarding the main demonstration activity, i.e. the Risk Managers Workshop.
Under **task 5.3** TNO gave several lectures and presentations on food safety and risk management, including regular contacts with Netherlands based food companies.

**Year 3:**
In the third year of the project the main activity for TNO was to deliver the Stakeholders' Guide. Other work included the finalization of the framework and its validation in the case studies.

The finalization of the framework in the third year involved fine tuning the results from earlier work in year 1 and 2, and writing a deliverable report.

The validation of the use of the framework in the case studies (WP2) involved continuous cooperation between all partners. The development of the (theoretical) framework and the practical experience in the case studies led to an iterative process of co-development. In the third year the emphasis of TNO activities was on monitoring the elaboration of the case studies.

As part of this work TNO has sent out a questionnaire to all partners to evaluate the results of the project (with focus on the framework and case studies) and the overall view on the project and the cooperation. The results are shortly described in the deliverable report.

The main objective of the project was to produce a Stakeholders' Guide for chain vulnerability assessment (SG). TNO had the responsibility to coordinate and produce this guide at the end of the project. The SG is a stepwise procedure and an informative background paper. It is to be published as a book in August 2009.

In the third year TNO was involved closely in important workshops. This risk manager's forum focused on getting direct feedback on the project ideas, progress and results from possible future users of the guide.

**Partner 4: INRA**

**Year 1:**
INRA participated in the construction of the structure of the contaminant database and contributed to the section 'other food chain'.

INRA collected information on standardized methods for the detection of contaminants in poultry meat. These contaminants were selected according to different criteria including the overall estimated relative public health concern associated with these compounds in previous surveys and the availability of analytical methods enabling their analysis. The reference methods currently used by both recognized and legal institutions such as US Food Drug Administration or Food Safety and Inspection Service of the US department of Agriculture, and by scientific literature were recorded. For each method, various items were recorded including the name and the type of the method(s), the targeted compounds, the source of information, various indicators related to the performances of the methods and information regarding the availability of the method over the consortium.

**Year 2:**
During this period, the work of INRA was focused on WP2. Its activity focussed on (a) developing analytical methods for determining various types of contaminants in food matrices, and (b) performing together with other project partners the benchmarking of analytical methods for the poultry meat chain.

**Sub-task 2.1.6: compilation of applied and/ or developed analytical methods**
During this reporting period, the presence of benzenic and halogenated volatile contaminants in meat, milk and seafood products was investigated using Gas-Chromatography-Mass Spectrometry (GC-MS) and Comprehensive bidimensional GC-MS techniques (C-GCxGC-MS). Around 100 of these compounds were identified in these animal food products. A paper regarding the "determination of benzenic and halogenated volatile contaminants in animal food products" was accepted as a poster presentation at the 32nd International Symposium on Capillary Chromatography and 5th GCxGC Symposium, Riva del Garda, Italy, May 26-30, 2008.

**Sub-task 2.2.4: benchmarking for poultry meat**
In task 2, **subtask 2.2.4**, the benchmarking work was focused on those analytical techniques that are applicable to poultry meat, fat, organs and eggs and in water and feeds consumed by poultry. The work was focused on analytical techniques dedicated to the determination of targeted contaminants. These contaminants were selected according to different criteria including the overall estimated relative public health concerns associated with these compounds in previous surveys and the availability of analytical methods enabling their analysis. In the benchmarking process particular attention was paid to the reference methods currently recognized by legal institutions and/or used in the scientific literature.

**Year 3:**
During year 3 of the project, Partner 4 carried out two actions in WP2, subtask 2.1.6 (*Compilation of applied/developed analytical methods*):

Action 1.- Determination of VOC in animal food products.
A study was undertaken to confirm the presence of benzenic and halogenated volatile contaminants in meat, milk and seafood products by using GC-MS and comprehensive bidimensional GC-MS techniques (CGCxGC-MS). This study evidenced that animal feeding is one of the main way of food contamination by these compounds and that, compared with the GC-MS technique, the comprehensive bidimensional GC-MS technique (CGCxGC-MS) reveals a much larger number of benzenic and halogenated compounds in animal food products including milk, meat and sea products.

Action 2 - Determination of indirect tracers of animal dietary exposure to different types of contaminants in the poultry chain.
An experiment was set up to evaluate the potential of the composition of the animal tissues in volatile organic compounds (VOC) to generate a metabolic signature as a more cost effective alternative to the direct determination of the contaminants by reference analytical methods for the discrimination of non contaminated animals from their contaminated counterparts. The preliminary results showed that using a global mass spectrometry fingerprint by GC-MS, the VOC metabolic signature allowed discriminating non contaminated chickens from counterparts contaminated with PAHs, PBDEs or coccidiostats, but not with those contaminated with dioxins or PCBs.

In WP4, Partner 4 has contributed to the development of the Stakeholders' Guide (task 4.6), in particular for those sections dealing with the identification of hazardous substances (HtG 3), with the entry points, dynamics and control of contaminants of concern in the chains (HtG 5), with addressing food chain vulnerabilities (HtG 8), and for the two annexes (Annex 1– Information sources, and Annex 2–Analytical techniques). Partner 4 work focused on the identification of the major contaminants and their entry points in the food chains and on the identification and evaluation of the analytical techniques for the detection and determination of these contaminants. Partner 4 also contributed to the reviewing of the whole content of the Stakeholders' Guide.

**Partner 5: AUP (PULS)**

**Year 1:**
During year 1 AUP participated in research in determination of authenticity of poultry meat using PCR and electrophoresis techniques. Tests were extended to cover poultry, pork and beef. AUP performed verification electrophoresis (SDS-PAGE, IEF, 2-DE) and PCR methods, which were concerned with identification of authenticity and were based on analysis of protein. The research involved using Western Blotting, mass spectrometry and sequencing of early separated protein. The aim of the PCR study was to assess the possibility of distinguishing three kinds of meat (chicken, beef and pork) on the base of the PEVK region (region which is in protein – titin/connectin).

Additionally, partner 5 carried out a thorough review into European and Polish national legislation concerning: internal/external European trade of fresh poultry meat and meat productsand of live poultry animals.

For the production, storage and trade of animal feed a very similar model was elaborated consisting of the primary production of feed, storage, transport, the production of feed end products, again storage and retail combined with the corresponding risks and legislation.

AUP co-operated with other partners, particularly with INRA, TNO, UCD, SINTEF and BFEL-KU, in order to examine the analytical techniques currently in use for identification of contaminants and/or indirect tracers possibly triggered by the presence of contaminants in the feed chain.

AUP carried out a literature review of existing quantitative risk assessment models of the vulnerability of the food and feed chains to contamination.

**Year 2:**
PULS took part in the evaluation of possible contaminants at each link in the poultry chain. This evaluation was based on information obtained from literature and an experts' panel. Identification of the contaminants chain-entry pathways for the poultry chain was done using poultry chain maps developed in WP2. Information on the critical links and possible natural or malicious origin and emerging risks was collected.

PULS cooperated in the frame of the benchmarking task with INRA, TNO, UCD, SINTEF and MRI in evaluation of analytical techniques, which are currently in use for identification of contaminants in the food and feed chains. PULS provided a benchmarking protocol for the new database. Partner 5 took part in research related to the determination of authenticity of poultry meat with the help of protein based methods (2-D electrophoresis) and DNA based techniques (PCR).

PULS performed a literature review of existing quantitative risk assessment models of the vulnerability of the food and feed chains to contamination. Partner 5 participated in drawing up a list of priority contaminants for the four products chains (water, milk, poultry, and fish). We collected alerts from RASF which appeared in 2007-2008.
Because the risk from food-borne contaminants is a combination of the likelihood of exposure to a contaminant, the likelihood of illness arising from exposure and the severity of the resulting illness, PULS collected data relating to infectious diseases and poisoning, the poultry meat consumption and the livestock production in Poland, export and import of poultry according to geographical area.

PULS participated in forming a Risk Manager's Forum to assess the validity of the conceptual framework and the consequences of managing the critical links identified in each of the case studies. Partner 5 participated in organizing two focus groups in Poland. The objective of these focus groups was to gather information regarding consumer concerns on: food safety/risk, information and traceability.

**Year 3:**
During the year 3 PULS took part in the evaluation of the conceptual framework within the consortium at plenary meetings.PULS continued research related to the determination of authenticity of poultry meat with the help of protein based methods (SDS-PAGE, two-dimensional electrophoresis) and DNA based techniques (PCR) **(Task 2.1.6)**. PULS prepared two review reports on authenticity of food products. The first report summarizes the authenticity issues of meat and meat products and gives a review of methods which can be employed in meat authenticity and species identification. The second was prepared in cooperation with MRI and SINTEF and summarizes the authenticity issues of traditional and regional food product. Designed in MS Access the Detection Methods Database was helpful with regards to methods for detecting and analyzing priority contaminants in cooperation with other partners, particularly with INRA, TNO, SINTEF and MRI **(Task 2.2).** A list of the most appropriate techniques (reference, rapid and methods from literature) for a given chain was created.

PULS took part in risk assessment of priority contaminants at each link in the poultry chain, especially nitrates and nitrites.PULS participated in forming a Risk Manager's Forum to assess the validity of the conceptual framework and the consequences of managing the critical links identified in each step of the case studies (WP4&WP5). A draft Stakeholder's Guide, parts I & II, were reviewed and discussed jointly with project partners.

Three participants from Poland took part in a Risk Manager's Forum workshop (two of which were not from the EChain project) **(Subtask 5.2.3)**. PULS investigations in the EChain project were related to species identification.
Summarised results of our experiments will be presented at an International Conference "Quality and Safety in Food Production Chain", 24-25$^{th}$ September, Wroclaw, Poland. Within

the reporting period two papers connected with authenticity issues and one with risk assessment were elaborated:
Spychaj A., Mozdziak P.E., Pospiech E. 2009. Identification of poultry meat from pork and beef on the basis of the titin PEVK region using PCR. J. Muscle Foods, 20, 341-351.
Pospiech E., Frankowska A. Nitrates III and V – their application and future in food processing. Medycyna Weterynaryjna – accepted for printing.
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**Partner 6: ATS**

**Year 1:**
ATS categorised and defined drinking water quality. A water quality study for Ireland has been compiled under: sanitary authority supplying drinking water (where necessary, as some homes have private supplies); type of water supply (public supply, public/private group scheme and private supplies); water source (point in the hydrological cycle from where the drinking water is extracted, eg. groundwater, surface water, or a mix of the two); the population served from a given supply and the volume of water used per day ($m^3$/day); filtration and/or treatment type where applicable, eg. coagulation and sedimentation, chlorination and fluoridation. A generic chain map flow diagram for water has been completed.

Preliminary assessments from all the partners have begun, as how to best precede with the demonstration activities.

**Year 2:**
**Task 5.1:**
Workshop and demonstrations activities for key stakeholders (scientists, legislators, industry and general public) under these headings were carried out by the relevant partners, in particular the chain map leaders, while addressing tasks in WP1, WP2, WP3 and WP4. For example, the Salmon chain map & case study leader had to set meetings and give, on several occasions, presentations on the Σ-chain project's goals and objectives to processing plants owners and Quality Assurance Managers while investigating the integrity of the Salmon chain or to State Laboratories Managers and Health Inspectors while investigating the sampling techniques, authenticity and detection methods of particular contaminants (See M5.1 report).

**Task 5.2:**
A workshop for Legislators and industry was organised.
A Risk Manager's forum was also under planned (September 2008) with the objective of refining the framework for identifying food and feed chain vulnerabilities in consultation with risk managers.

**Task 5.3:**
Σ-chain was also showcased at public lectures, international scientific conferences and congresses by the relevant partners while carrying out tasks in WP1, WP2, WP3 and WP4. (See M5.1 report)

**Task 5.4:**

An internal portal was developed by partner 11 (SYNCOM) and can be found at the following link www.sigmachain.eu. This portal was used as the communication hub for the entire consortium as a help to track day-to-day progress and to share reports, reports templates, disseminations outputs and other documents. Each partner was given an access log-in name and password in order to upload or access these documents.

Another website named "the E-room" was developed as a virtual database platform to store information relevant to the various WP and test/demonstrate various parts of the framework.

**Year 3:**
In this period effort was divided between WP1 **(Tasks 1.4 & 1.5)**, WP2 **(Tasks 2.3 and 2.4)**, WP4 **(Task 4.6)** and WP5 which ATS is the appointed leader as follow:

WP1's aim was to develop a conceptual Framework to identify and prioritise critical chain links while WP4 aimed to validate WP1's conceptual Framework towards the development of the Stakeholder's Guide to assess and identify contamination vulnerability in EU food and feed chains. Partner SINTEF was leader of WP1 while partner TNO led WP4. As such, both workpackages were complementary and efforts carried out in one were often used or transferable in the other.ATS took part in the development, evaluation and validation of Σ-chain's framework.

ATS is responsible for the WP2-Drinking water case study. Following the development, in period 2 (year 2), of a complete traceability chain map for drinking water, work focused on **Task 2.4 (Identification of potential vulnerabilities to contaminants)** which includes the Review of the documentation flow accompanying the product along the chain **(Subtask 2.4.1)**, the assessment of the appropriateness of physical or electronic tags **(Subtask 2.4.2)**, the assessment of available analyses and technology to detect the identified contaminants **(Subtask 2.4.3)** and the evaluation of the traceability process in terms of exposure of the food or feed **(Subtask 2.4.5)** after which finally vulnerable steps were identified in the Drinking water chain.
The second objective of this task was to present a chain vulnerability optimisation system. This process consisted of:

1) Prioritising vulnerable steps according to their risks for vulnerability by Failure Mode and Effects Analysis methodology (FMEA)
2) Integration of further control methods and/or corrective actions
3) Prioritising vulnerable steps a second time by FMEA methodology

After a thorough assessment of the drinking water chain, it emerged that two steps, namely "The Water storage step after disinfection with Chlorine" and "The presence of lead pipes within the distribution network" present or introduce a vulnerability to the chain to certain chemical contaminants. These vulnerabilities were assessed using the FMEA methodology and it was found that these two vulnerabilities scored a relatively low risk, respectively VPN = 16 and 6 (out of 150). A series of corrective actions were proposed which would halve the risk bringing hem to an even lower risk rank.

ATS is leader of WP5 which aims to bring the results of the previous four work packages (WP1-WP4) to the industry's stakeholders (manufacturers, processors, regulatory authorities) and general public. In this period, the main dissemination and demonstration activities organised by ATS were:

- One national workshop entitled "Pesticides and contaminants in food – the safety issue" on the 11th June 2008 in University College Dublin (Ireland) targeting the Food Legislators & Food Industry organised by ATS
- One International Risk Manager's Workshop that also took place in Dublin last September 2008 at the 5* Radisson SAS hotel but gathered members of nationally and internationally recognised private and public institutions (also organised by ATS).
- The publication of a two pages executive summary in the 10th Issue (2009) of "**Projects**.**eu** magazine" (http://www.projects.eu.com/) that will also be downloadable from the project website.

These workshops proved extremely useful in validating the efforts of the consortium. Industry and legislators welcomed and praised the efforts of the consortium in developing such holistic guide.

The executive summary was also presented and distributed at the recent International Workshop "Developing a Stakeholders' Guide on the vulnerability of food and feed chains to dangerous agents and substances" that took place last 6 - 7 May 2009 at the Max-Rubner Institute (Kulmbach, Germany).

Recently, it was also decided that the E-chain website would be best suited for the long term Σ-chain promotional effort. SYNCOM agreed to maintain and update the website for at least 6months after the official project end (June 2009). This may be extended as a series of internet and public launches and dissemination exercises have been planned for September and November 2009. Users will be able to find, downloadable documents & summaries, additional information on the project workpackages and details of the 11 partners including addresses and contact numbers should interested parties wish to seek additional advice / consultancy.

**Partner 7: SINTEF**

**Year 1:**
SINTEF was leader for WP1. They also participated and were leader for subtasks involving the collation of information about relevant contaminants. To collect information efficiently, an additional activity was devised, namely to construct and manage a database made available to all implicated participants. SINTEF designed a database in Access which became basic to collect relevant information for WP1 and WP2.

SINTEF, together with partner 8, has filled in the database with information for farmed salmon, information specified and needed according to **subtask 1.1.1 to 1.1.3** and **subtask 1.3.2.** SINTEF participated in **task 2.1** drawing up a chain map for farmed salmon together with IFQC. SINTEF reviewed benchmarking of analytical techniques and collected information about techniques used for detection of contaminants in farmed salmon.

SINTEF submitted one scientific publication and contributed one presentation to an international scientific conference (see lists of publications), and prepared and submitted two abstracts for two conferences to be held in 2007 (the 4th SEAFOOD plus Conference and the 4th Brazilian Meat Science and Technology Congress).

**Year 2:**
**Workpackage 1**
**Task 1.1:** The contaminant database was finalized by adding information to the contaminants that lacked data and by adding new contaminants to the Database.

**Task 1.3:** A literature survey was made to study the existing BMPs. Based on this survey and the existing knowledge inside the Sigmachain-project the **Subtask 1.3.2**. was fulfilled, with the recommendations to develop corrective measurements for the identified risks and hazards for the farmed salmon chains. Based on the documents of recommendations for the three other products, a generic document was prepared in by SINTEF, "Generic identification of recommendations to develop corrective measurements for identified risks".

**Task 1.4:** Five working procedures for the farmed salmon chain were prepared; (1) Working Procedure with the criteria to select the hazards in the farmed salmon chain, (2) Generic Working Procedure with the criteria to select the hazards, (3) Working Procedure for the BMPs and Corrective measures in the farmed salmon chain, (4) Generic working procedure for the BMPs and Corrective measures, (5) Working procedure for **Task 2.2** Benchmarking: Criteria to compile methods to detect and quantify contaminants in the farmed salmon food chain.

**Workpackage 2**
**Task 2.2:** A list of prioritized contaminants was prepared by collaboration between SINTEF and IFQC and these were: *Listeria monocytogeneses*, *Clostridium botulinum*, *Staphylococcus aureus* and Malachite and Leuco Malachite Green, Crystal Violet, Mercury, Cadmium, Ox tetracycline, Chloramphenicol, Melamine, PCB's.
Methods for the detecting and analyzing contaminants and unwanted substances in the salmon chain were collected. A database, named "Detection Methods Database", was designed. A user manual for this Detection Method Database "User manual for Detection Methods Database, ΣChain Project" was prepared by SINTEF.

**Workpackage 5**
Three communications to International Conferences were prepared: **(1) Martinez, I., et al. (2007).** Verification of traceability information, detection of contaminants and recommendations to ensure safe and high quality aquaculture products. Aquaculture Europe 2007 Conference. October 24-27, 2007. Istanbul, Turkey. **(2) Martinez, I. (2007).** Analytical methods to differentiate wild from cultivated seafood. 4th Brazilian Meat Science and Technology Congress. 9-11th of October 2007, Campinas, State São Paulo, Brazil. **(3) Martinez, I**., **et al. (2007)**. Safe production of farmed Atlantic salmon: Identification of vulnerabilities in the production chain. Fourth SEAFOOD plus Conference. Bilbao, Spain, 4-6th June 2007.

**Year 3:**
The main actions in this reporting period have been the construction of the preliminary conceptual Framework **(Task 1.4)** and the final conceptual Framework **(Task 1.5)** for any food chain.

**Task 1.4:** Construct a preliminary framework including corrective measures Objectives: The objective of this task was to construct a preliminary conceptual framework including corrective measurements.

A preliminary conceptual framework including corrective measurements was constructed and finalised based on the inputs from **Task 1.1.** to **Task 1.3.** This framework was further developed in **Task 1.5**. On the 6th plenary meeting in Clermont-Ferrand in June 2008 the framework was further discussed and developed.

**Task 1.5:** Construct a final conceptual framework including corrective measurements for any food chain: **Task 1.5** further extends **Task 1.4** and is covered by the report: **Task 4.5.1** Conceptual framework development and **Task 1.5.1** Construct a final Conceptual framework for any food chain by H. J. Cnossen (16.01.09).

**Partner 8: IFQC**

**Year 1:**
IFQC has assisted the development of the database terminology and has identified reviewed and assessed 66 contaminants during the data entry phase of the contaminant database. In addition, all contaminants identified by partners in the farmed salmon database have been jointly reviewed by the WP1 leaders and IFQC.

IFQC has supported the development of the Chain Map 'construction' criteria and terminology and has detailed a generic feed and food chain for farmed salmon, representing the significant producer in the Northern Hemisphere (Norway). Information of the geographic differences has also been gathered to enable representative chains to be constructed for Ireland, UK, Chile, Canada and Tasmania. These geographic differences are borne out of a number of reasons: economy of scale; level of capitalisation/infrastructure; legal framework for inputs (e.g. medicines) and legal/marketing considerations regarding farming practices (e.g. harvesting/welfare).

**Year 2:**
**Subtask 1.3.1:** IFQC has identified and reviewed a number of Industry Standards and Codes of Practice which have been adopted by National salmon farming and feed industries in order to demonstrate to a variety of stakeholders that the sector is farming in a legal, responsible and sustainable manner. A legal review (European) of feed legislation has been performed which provides a basis of minimal requirement which respect to manufacturing practices.

With respect to Best Manufacturing Practice attention was focused on practices which were identified with the prevention of contamination from both priority contaminants and in general, where BMP supports a more general prevention of any type of contamination. Therefore, the shortlist taken from this database of contaminants was chosen as suitable examples for describing the BMP for their avoidance or elimination and detection, and subsequent elimination (if possible) through corrective measures once the feed-food chain is contaminated. This information is used to assess their chain entry pathways and ultimately, the vulnerability of the chain to contamination.

With respect to the feed chain, IFQC made one visit to a salmon feed supplier during this reporting period. There was additional interaction with some of the raw materials suppliers to the salmon feed industry. Several visits to salmon farm enterprises took place to support the review of BMP.

**Subtask 1.3.2** At the same time as the evaluation of BMP, corrective actions have been described with respect to the identified contaminants.

**M1.3** The milestone report combines the output of activities carried out in **Subtask 1.3.1 and 1.3.2** for farmed salmon.

**WP 2:**

An associated generic salmon feed production chain map has been assembled for a standard extrusion manufacturing process. The chain map had to simply describe the process steps in the chain, the links between each step and also visualise where inputs and outputs were derived. Verification of the flow chart has been undertaken through comparison of the map with a number of industry production flow charts, supporting information, process HACCP plans and on site discussions. A number of meetings (2) and conference calls took place between partners during the development and defining of the global chain map for farmed salmon.

**WP3:**

IFQC has collected information on different risk assessment processes and methodologies as part of the broader understanding of the risk assessment methods that can be applied to food contaminants.

**Year 3:**

A major part of the work undertaken throughout the period has been focussed on the deliverables associated with WP1, WP2 and WP4 in the supporting activities concerned with the validation of the framework (case study farmed salmon) and development of the Stakeholders Guide.

**WP 1:**

Activities have included the review of the salmon contaminants with respect to the farmed salmon chain map and the prioritization of contaminants. Prioritization has been undertaken in parallel with the work of WP3 toward the development of a risk ranking model for chemical contaminants.

WP1 also developed a series of support review papers for the salmon case study commencing in 2007 and continuing into the 2008 period. These have included the Best Manufacturing Practice and, proposals for corrective measures for identified risks. IFQC supported the review and supplied industry knowledge to the reports for the Salmon Farming Cycle and Feed Manufacture.

The reviews supported the WP2 activities toward defining and validating the chain mapping activities and connected sub-tasks including; documentation flow for farmed salmon, scope for electronic tagging for fish and the wider assessment of the traceability process for farmed salmon from egg to plate.

A much greater task has been the methodology appropriate to assess the vulnerability (nodes/links) of the feed-food chains to the identified (priority contaminants). Vulnerability has been defined and a first stage ‘working example’ of how this can be applied to food chains has been developed through the conceptual framework. Traceability (or loss in traceability) has been identified as a critical factor that affects the vulnerability of feed-food

chains to contamination. The combination of poor traceability and high contaminant prioritisation has provided the essential information to undertake the assessment of chain vulnerability. Expert knowledge brought together information on contaminant characteristics, presence, entry routes, controls and corrective actions; absence/presence of sampling programmes, availability of reliable analytical techniques, existing or emerging contaminant factors to be part of the evaluation process and combined with the risk ranking information.

A rationale and consistent approach to managing and applying contaminant knowledge was tested using a combination of classical risk assessment procedures; namely Failure Mode Effects Analysis (FMEA) and classic HACCP procedures. FMEA is a method of reliability analysis that improves the operational performance of production cycles to reduce risk levels. The chain map steps, nodes and links combination with the relevant contaminants, were assessed according to a modified version of the FMEA. The result of the assessment was the assignment of Vulnerability Priority Number (VPN), based on a combination of severity x likelihood and detection. Corrective measures proposed within WP1 review activities have been applied and VPN re-assessment was undertaken to assess the relative impact on vulnerability. The process is iterative in function, in that the results are approximations based on the quality and extent of information available.

**Partner 9: ITAL**

**Year 1:**

In WP1**,** initially information was gathered on ITAL's potential to conduct contaminants analyses and the main methods available. ITAL's data from recent work on contaminants in marine fish was reviewed. One of the ITAL's collaborators summarized and gave a short seminar on a paper based on the work of Hite *et al*. (2004), a comprehensive work on contaminants on farmed and wild salmon and also relevant for risk assessment studies. A report on a recent outbreak of Diphyllobotriasis in the city of São Paulo was issued including the measures taken by Brazilian Government Agencies. As *Salmonella* is the most important bacterial contaminant of chicken, two studies were carried out on occurrence of *Samonella sp* in chicken meat, assessing how and which species of Salmonella disseminated into the meat from the grower link of the production chain to the meat carcass in the abattoir, and, the occurrence of *Salmonella*, *Campylobacter* and *Listeria* in sample of carcasses, cuts and giblets collected from local slaughtering plants.

ITAL created a flow diagram of the milk production chain in Brazil as well as a flowchart of the production of powdered milk. A review of the Brazilian chicken meat production chain was carried out and the mapping of the production chain was completed.

A short review about Bio security in chicken farms was carried out with the aim of detecting the entrance of dangerous substances or organisms in specific links of the chain as well as the appropriate preventive measures. A short review on electronic tracing was carried out and contacts were made with a supplier of electronic labels. Collaborative work was established with the Automation Department and Foods Process Control of the food Engineering College of the State University of Campinas and a pilot test will be carried out in April 07 using beef cuts as a model to have a practical experience on the use of this type of label.
In WP4 a short review on Focus Group studies with food was carried out and work planned for determining consumers' risks perception on consumption of consumption of the four case

studies products. The results will serve to compare consumer's perception in Europe and Brazil.

**Year 2:**
**In WP1**, as the framework for the whole project was evolving, activities were cantered on the corrective measures for the food chains. As these measures are linked to BMF the latter were reviewed for foods in general, milk products and water. Legislation from EU, Brazil, USA and recommendations from the WHO were compared regarding drinkable water. The Brazilian legislation for milk powder was reviewed and this work overlapped with WP3. A short seminar on "Conceptual Framework" was held at ITAL to clarify its meaning to collaborators.

**In WP2,** the chicken chain links and sub chains were critically evaluated by consulting industry specialists, legislation and literature. Brazilian legislation on chicken processing was linked to the pertinent processing steps. The same procedure was adapted regarding the Brazilian soy and soy meal chains, from farm to port. The validation of the chains by industry and government was started. Addressing the international trade, ITAL was part of a study regarding the difficulties chicken exporters have when exporting to EU, work that overlaps with WP4. The milk chain was critically analyzed by ITAL milk researchers, resulting in a document, who made the pertinent remarks. Also, in this WP, the Brazilian drinking water chain was drawn.

**In WP3** ITAL compiled data on bottled water production and consumption in Brazil. Three papers were prepared on risk evaluation for tap water, meat traceability and on chemical, physical and biological contaminants in poultry. Also, some of the documents with support data (agricultural) for risk ranking activities were updated. Other activities, regarding the milk powder legislation and drinkable water, overlapped with WP1.

**In WP4** work was centered on focus group and consumer survey activities. A quantitative survey of consumer perception of food risks in Brazil was carried out and a report produced. Two focus group studies were successfully conducted and the data sent for analysis to WU.

**In WP5** the main dissemination activity was the organization of full session on SIGMA chain at the IV Brazilian Congress of Meat Science & Technology in October. Other activities included meetings with members of trade associations, industry and government. Also, two articles appeared on ITAL´s internal bulletin and ITAL's website.

**Year 3:**
During this last period, ITAL has assisted with the revisions of deliverables and with the discussions regarding the methodology being used, including taking part in meeting such as the one held at Clermont-Ferrand.
University, government and industry experts were presented to the Σ Chain Risk Ranking methodology in meetings that preceded the Seminar on Risks and Tracking and Tracing on Water that took place at ITAL. This methodology was then discussed at the Seminar and the results were presented at the Wageningen meeting.
The Σ Chain Risk Ranking methodology was also presented at the Seminar on Risks and Tracking and Tracing on Chicken Meat that also took place at ITAL.
Also regarding Risk Ranking, ITAL has actively helped with the evaluation of the tables associated to FMEA, related also to WP2.

Below is a list of the main activities conducted during this period:

| Activity | ITAL staff members involved |
|---|---|
| Revisions of documents and participation in Σ Chain meetings | Nelson Beraquet, Mariana Castrillon, Tadeu Facco, Ricardo Gonçalves |
| Preparation of documents, participation in meetings and discussions previously to the Seminar | Nelson Beraquet, Neliane da Silveira, Tadeu Facco, Mariana Castrillon, Ricardo |
| Participation in the Water seminar (organization and technical discussions) | Tadeu Facco, Neliane da Silveira, Luciana Miyagusku, Nelson Beraquet, Mariana Castrillon |
| Participation in the Chicken Meat seminar (organization and technical discussions) | Nelson Beraquet, Eunice Yamada, Luciana Miyagusku |
| Evaluation of FMEA tables | Nelson Beraquet, Luciana Miyagusku |

**Partner 10: WU**

**Year 1:**
Wageningen University completed a literature review on consumer views of issues pertinent to Sigma Chain, namely – food risk/safety, traceability, ethical issues and trust.

Two pilot consumer focus groups were selected to test questions and identify areas for investigation in the main stage focus groups to be conducted as part of **subtask 4.4.1** as well as possible areas for investigation in the risk managers and other stakeholder's forum.

One expert focus group was selected to identify areas for investigation in the risk managers and other stakeholder's forum, as well as the main stage focus groups to be conducted as part of **subtask 4.4.1**.

A draft questionnaire was prepared for the risk managers and other stakeholder's forum. The research approach has been presented and discussed at the plenary progress meetings.

A paper was written and submitted for peer review and publication in *Trends in Food Science and Technology*.

**Year 2:**
**1. Convened the virtual workshops**:
Two virtual workshops held through Delphi method: first in June 2007 and second in October 2008 (**Milestone 4.3** achieved).

Objective: getting feedback from different stakeholders in the field of risk management on the construct of conceptual developed to identify vulnerabilities associated with food and feed chain.

Data analysis and preparation of consumer impact report was underway.

**2. Pilot focus groups:**

Pilot round organized in October 2008 in Netherlands.

Consumer concerns on different aspects of food chain safety including sustainability and food chain length analyzed.

**3. Development of protocol and organization of main stage focus groups:**
Protocol was modified at WU with emphasis on food chain contaminants and consumer risk ranking for different food products in line with technical annex.

Main stage focus groups have been already conducted in Netherlands, Poland, France, Brazil and Ireland.

**4. Contributions to WP5: Planning of risk manager's forum:**
Objective: refining the framework for identifying food and feed chain vulnerabilities in consultation with risk managers as a part of developing stakeholders' guide.

Targeted for September 2008, mini-committee was formed among partners to discuss the organizational issues.

Data streams identified: Delphi based survey results and focus group results.

**Year 3:**
**Contribution to concerned work packages:**

**1. WP 2: Case study for four products**

- **Contribution to addressing consumer issues:**
  - A comparative study to compare the results of consumer and expert survey results with the results of technical case studies was planned and completed
  - Completion of **D 2.2** and **sub-task 2.4.4** (completion- February 2009)

**2. WP 4 and WP 5:**

- Consumer impact assessment through focus group studies completed
- Contribution to planning and organization of Risk Managers' Forum held in Dublin on 16-17 September 2008. Feedback obtained from participants on consumer issues and efficacy of Sigma Chain risk mitigation framework
- Chapters on consumer and expert concerns for food chain vulnerabilities, and methods in stakeholder research authored for the **Stakeholders' Guide** developed
- Completion of all sub-tasks, milestones and deliverables as planned

**Dissemination:**

- Kher S.V.; De Jonge, J.; Wentholt, M.T.A., and Frewer, L.J. (2008) Understanding consumer perceptions of food contaminants and vulnerabilities associated with food

chains: Results from a cross-national study. Presented at the Annual Conference of Society for Risk Analysis, 7 -10 December, 2008 Boston, USA

- Stakeholder involvement in food chains. The Risk Managers Forum, Sigma Chain, Dublin 16th September, 2008.
- Frewer, L.J. (2009) Invite presentation. Consumer perceptions of the risks and benefits of food production and the vulnerabilities associated with food chains; implications for communication. Cost action, Milan, Tuesday 17th March 2009.

**Publications:**

- Kher, S.V.; Frewer, L.J.; De Jonge, J.; Wentholt, M.; Howell Davies, O.; Lucas Luijckx, N.B., and Cnossen, H.J. (in press) Experts' perspectives on the implementation of traceability in Europe
- Kher, S. V; De Jonge, J; Wentholt, M.; Deliza, R; Cunha de Andrade, J.; Cnossen, H. J.; Lucas Luijckx, N. B.; Frewer, L. J (in preparation) Consumer perceptions of risks of chemical and microbiological contaminants associated with food chains: A cross-national study
- Frewer, L.J. and Kher, S.V. (submitted) The role of food chain traceability in food risk mitigation: Expert and consumer outlook. Food Science Central, IFIS Publishing **(Popular article for online publication resource)**

**Partner 11: SYNCOM**

SYNCOM assisted the coordinator with the Management Activities in the Sigmachain project including structuring of the work, assistance in monitoring the progress, preparation and organisation of project- and board meetings as well as the set-up of the web presentation and the maintenance of the online intranet of the project.