

EUROPEAN COMMISSION DIRECTORATE - GENERAL FOR JUSTICE, FREEDOM AND SECURITY



PROJECT SUMMARY 27 APRIL 2010



"With the support of the Prevention, Preparedness and Consequence Management of Terrorism and other Security-related Risks Programme" European Commission - Directorate-General Justice, Freedom and Security"

Agreement Number: JLS/2008/CIPS/022



EXECUTIVE SUMMARY

"SecuFood - Security of European Food supply chain" is a 12-month project co-funded by the European Commission in the framework of the European Programme on Critical Infrastructure Protection (CIPs), addressing the program theme "Prevention, Preparedness and Consequence Management of Terrorism and other Security-related Risks".

The aim of SecuFood is to realise an overview of strategies adopted in EU to prevent criminal, and specifically terrorist, attacks against food supply chain.

In Europe, even if it has been identified as a critical sector, food security has received comparatively poor attention in terms of initiatives to reduce potential consequences of deliberate attacks. Moreover, the current analyses and controls on foods and beverages mainly tend to verify compliance to EU legislation (assessing food safety and preventing food adulteration) rather than considering malicious manipulation.

Indeed, conventional controls against food adulteration provide a partial defence against "subtle" large-scale contamination (i.e. those that consider food as a vehicle to delivery CBRN agents), but they appear not specifically designed to counteract "symbolic" attacks (i.e. those aimed to create panic or induce large market shocks).

Unfortunately, after 11 September 2001, the deliberate contamination of food as a way of attacking the population is increasingly considered a real danger. Food should be considered as a possible target for terrorist or criminal attacks aiming to create a lack of trust and spread panic in developed Countries as stressed also by the WHO document on "Terrorist Threats to Food".

Food terrorism is defined by the WHO (2002) as: "an act of threat of deliberate contamination of food for human consumption with chemical, biological or radionuclear (CBRN) agents for the purpose of causing injury or death to civilian populations and/or disruption of social, economic or political stability". Indeed, even if the contamination with CBRN causes a limited number of casualties, this type of action is potentially able to create large terrorising and huge economic impact on the society.

Food terrorism acts are categorised as **internal** and **external** threats, and attackers are grouped into five categories: criminals, protesters, terrorists, subversives and rogue or disgruntled insiders.

In this framework, Food defence is the term to encompass activities associated with protecting the food supply from deliberate or intentional acts of contamination or tampering.

The problem has been raised by the EC Green Paper on Bio-preparedness which aims to address efforts for reducing biological risks and enhance preparedness and response to these risks, in particular regarding the food supply chain. Despite this Green Paper, at present there are no specific European initiatives or campaigns for the prevention of actions against the attacks to the food supply chain, even if some Countries have adopted initiative to contrast such threats.

SecuFood has analysed the food supply chain with the aim to detect the threats and the vulnerabilities at each single step of the food supply chain, comparing them with the existing technological, operational and legal countermeasures today adopted in order to identify best practices and perform a gap analysis to discover critical situations.

The study has been performed considering the following scenarios:

• Analysis of the food supply chain risks to discover threats, vulnerability and, for each step of the food supply chain, the most relevant risks/issues affecting the chain itself. The analysis has been concentrated on eight different types of food selected for their consumption and diversities: dairy products (milk, yogurt), fish, vegetables (prepared salads), beverages (fruit juices), cereal-based (baked products), olive oil and baby food.

• Overview on **technologies** adopted to counteract terrorist or criminal threats. It aims to identify the most valid ones to improve the level of protection of the food supply chain, the capability to efficiently manage sudden crisis and to prosecute criminals.

Analysis of the foodborne incidents to discover threats, vulnerabilities and criminal modus operandi.



• Quantification of the **perceived risk** from public authorities and food operator with respect to intentional contamination of food supply chain to identify their priorities.

• The legal framework to identify main responsibilities inside the different Countries and to compare legislation and organisation. The project has been mainly focused on the legal situation in Italy, Spain, United Kingdom, Denmark and Romania, but it also considered the situation in Countries outside Europe.

SecuFood project investigated a collection of data regarding about 450 malicious incidents occurred worldwide from 1950 to 2008, selected among over 1.000 suspected manipulations of food collected from different open-source databases, literature and partners experiences. The analysis emphasised that, currently, there is no evidence about any terrorist attack against the food supply chain (except for the grapefruit contamination occurred in 1989 in Israel). However, the analysis emphasised that the number of malicious incidents has been constantly increasing in the last years and that a great part of food incidents has been caused by chemical agents and only a minor part of them by biological, radiological or physical contaminants.

The statistic of incidents along the food supply chain shows how the 58% of them happen at consumer level, the 38% were performed inside retail and food service structure while the reaming 4% occurred at harvesting level. Fortunately, to date no incidents at production level, are reported.

These data are coherent with the results of the risk analysis of the food supply chain which emphasises that, in general, chemical agents are riskier than biological ones. This is because in the manufacturing phase there are several controls for biological agents. The chemical risk level is more or less the same along the whole food supply chain; although it decreases at the final steps. Usually, the damage to the consumers is lower because the products are packaged and the terrorist would need a lot of time to contaminate the same volume of product. The manufacturing phase is the riskiest one because an extremely high number of people can die or be injured as consequence of a malicious contamination in this phase. In the case of biological contamination, in contrast to the chemical ones, the manufacturing phase, is the least risky phase because many controls are carried out to detect biological agents. This is due to the fact that these agents are usual in spontaneous contamination. Transport and storing are dangerous phases as there are no biological controls after manufacturing.

According to the experience of Industries who have been suffered episodes of sabotage, the most frequent cases of attacks are due – in order of probability - to:

- mythomaniacs: who want the press to talk about them;
- demonstrative initiatives: non-hazardous to human health, performed by nongovernmental organisations;
- claims by internal company staff;
- terrorist attacks (less likely under the casuistry).

The level of awareness on the damage that can be caused by any deliberate attacks by criminals or terrorists has been evaluated in all areas of great food industry.

The more effective **countermeasures** to prevent food attacks are considered area control, video-surveillance and - mainly - traceability. However, it is essential the development of operational procedures to promote and to facilitate the effective coordination and **information exchange** (including inter-governmental and publicprivate) between different types of stakeholders involved in food defence.

Securing the food sector presents unique challenges because agriculture and food systems are extensive, open, interconnected, diverse, and complex structures providing attractive potential targets for terrorist attacks.

An essential aspect in the food terrorism counteracting is represented by the coordinated intervention at different levels (international, EU, national and local) and the correspondent roles played by public and private stakeholders.

SecuFood analysed in details legislation and organisation about food defence in five member states of the European Union indentifying the reference points for measures adopted in bioterrorism counteracting.

The analysis showed that all the considered Countries have specific legislation and agencies devoted to Food Safety and they are involved in early warning alert networks for food contamination. However, except partially for UK, there is no specific legislation about Food Defence. Then, even if there are several mandatory constraints on food operators to improve and guarantee Food Safety (e.g. HACCP), specific requirements about food defence do not exist. All the activities are performed by food operators on a voluntarily basis without coordination. This implies that the level of protection varies largely along the food supply chain.

INDEX:

Executive summary	3
Introduction	6
Analysis of foodborne incidents	9
Risk perception	11
Food defence strategies	14
Risk analysis	18
Technologies	22
Conclusions	24



INTRODUCTION

"SecuFood - Security of European Food supply chain" is a 12-month project co-funded by the European Commission in the framework of the European Programme on Critical Infrastructure Protection (CIPs), addressing the program theme "Prevention, Preparedness and Consequence Management of Terrorism and other Security-related Risks".

The aim of SecuFood is to realise an overview of strategies adopted in EU to prevent criminal, and specifically terrorist, attack against food supply chain.

In Europe, although identified as a critical sector, food supply chain has received comparatively poor attention in terms of initiatives to reduce potential consequences of deliberate attacks. Moreover, the current analyses and controls on foods and beverages mainly tend to verify compliance to EU legislation (assessing food safety and preventing food adulteration) rather than considering malicious manipulation. Indeed, conventional controls against food adulteration provide a partial defence against "subtle" large-scale contamination (i.e. those that consider food as a vehicle to delivery CBRN agents), but they appear not specifically designed to counteract "symbolic" attacks (i.e. those aimed to create panic or induce large market shocks).

Unfortunately, after September 11, 2001, the deliberate contamination of food as a way of attacking the population is increasingly considered a real danger. Food should be considered as a possible target for terrorist or criminal attacks aiming to create a lack of trust and spread panic in developed Countries as stressed also by the WHO document on "Terrorist Threats to Food".

Securing the food sector presents unique challenges because agriculture and food systems are extensive, open, interconnected, diverse, and complex structures providing attractive potential targets for terrorist attacks. The problem has been raised by the EC Green Paper on Bio-preparedness which aims to address efforts for reducing biological risks and enhance preparedness and response to these risks, in particular regarding the food supply chain. Despite this Green Paper, nowadays there are no specific European initiatives or campaigns for the prevention of actions against the attacks to the food supply chain even if some Countries have adopted initiative to contrast such threats.

SecuFood focused its attention on the protection capabilities and on their correspondence to the estimated threats. To this extent, the project developed a methodology to perform gap analysis starting from the deconstruction of selected food supply chain into its macro-steps (production, processing, logistics, distribution, retail): from the farm to the fork. The selected set of types of food represents the whole sector, in terms of origin, shelf life, manufacturing and consumers.

FOOD TERRORISM

Food terrorism is defined by the WHO (2002) as: "an act of threat of deliberate contamination of food for human consumption with chemical, biological or radionuclear (CBRN) agents for the purpose of causing injury or death to civilian populations and/or disruption of social, economic or political stability". Terrorist use of CBRN agents may cause a limited number of casualties, but a large terrorising and disruption of society.

Indeed, the aim of food terrorism may be to generate disease and death using food as a vector to disseminate dangerous agents to a large population or to induce fear and anxiety (and consequently large economic losses or trade disruption) via "symbolic" actions.

Food terrorism acts are categorised as **internal** and **external** threats, and grouped into five categories: criminals, protesters, terrorists, subversives, and rogue or disgruntled insiders.

	Motivation	Actor
Food Safety	Illicit profit selling poor quality food (e.g. fraud). The consequences on wellness of consumers are considered as "negligible" side effects	Performed by the food operator
Food Defence	Create damage by injury consumers or destroying their trust in the food operators	Performed against food operator

Difference between Food Safety vs Food Defence



FOOD SAFETY

refers to the extent to which food is safe to eat. It is related to the handling, preparation, and storage of food in ways to prevent foodborne illness.

FOOD SECURITY

is generally referred to the availability of food and one's access to it.

FOOD DEFENCE

is the security of food and drink and their supply chains from all forms of deliberate or intentional acts of contamination or tampering including ideologically motive attack leading to contamination or supply failure.



- Storing and transporting raw commodities
- Processing and manifacturing raw commodities
- · Storing and transporting processed and manufatured goods
- Distributing goods to wholesale and retail establishments
- Selling good to consumers

SECUFOOD OVERVIEW

SecuFood is focused on the analysis of the general strategies for counteracting the terrorist or criminal threats following two different points of view:

• Strategies along the event. It is referred to the stakeholders (public or private) involved in preventing, avoiding and limiting the effects of the terrorist event, apart from the point of the food supply chain in which the event may occur. These strategies cover all aspects such as prevention, protection, prosecution of criminals/terrorists, surveillance, response and recovery.

• Strategies along the food supply chain. The second point of view concerns the stakeholders (generally private) which operate along the food supply chain (producers, processors, distributors, wholesalers, retailers, etc.) involved in counteracting the terrorist threats for their specific sector of the chain.

Particular attention have been devoted to the technologies adopted for the security of each step of the food chain (unattended sensors or network sensors, pattern recognition, check points, video surveillance, tracking, alarms, cameras and/or other appropriate security equipments, etc.).

In addition to the specific initiatives related to the single steps of the food supply chain, the study investigates the multi-stakeholder approach, based upon an integrated set of measures/initiatives corresponding to a close cooperation among the single operators such as importers, producers, processors, carriers, wholesale and retail sellers, etc. along with the Public Administrations.

Finally, the most common food safety management programmes and risk assessment procedures are examined as consistent means for evaluating the consequences, vulnerabilities, and threats faced by assets, systems, networks, and functions in the food and agriculture sector.



SecuFood has analysed the food supply chain with the aim to detect the threats and vulnerabilities at each single step of the chain comparing them with the existing technological, operational and legal countermeasures in order to identify the best practices and to perform a gap analysis to discover critical situations.



The study has been performed considering the following scenarios:

- Analysis of the food supply chain risks to discover threats, vulnerability and, for each step of the food supply chain, the most relevant risks/issues affecting the chain itself. The analysis has been concentrated on eight different types of food selected for their consumption and diversities: dairy products (milk, yogurt), fish, vegetables (prepared salads), beverages (fruit juices), cereal-based (baked products), olive oil and baby food.
- Overview on **technologies** adopted to counteract terrorist or criminal threats. It aims to identify the most valid ones to improve the level of protection of the food supply chain, the capability to efficiently manage sudden crisis and to prosecute criminals.
- Analysis of the foodborne incidents to discover threats, vulnerabilities and criminal modus operandi.
- Quantification of the **perceived risk** from public authorities and food operator with respect to intentional contamination of food supply chain to identify their priorities.
- The legal framework to identify main responsibilities inside the different Countries and to compare legislations and organisations. The project has been mainly focused on the situation in Italy, Spain, United Kingdom, Denmark and Romania, but it also considered the situation in Countries outside Europe.



ANALYSIS OF FOODBORNE INCIDENTS

SecuFood project investigated a collection of data regarding about 450 malicious incidents occurred worldwide from 1950 to 2008, selected among over 1.000 suspected manipulations of food collected from different open-source databases, literature and partners experiences.

The analysis emphasised that, currently, there is no evidence about any terrorist attack against the food supply chain (except for the grapefruit contamination occurred in 1989 in Israel).

However, a complete analysis of all the deliberate incidents with different intents can be useful to identify the most vulnerable steps in the supply chain, what are the most "efficient" types of agents, how new strategies and technologies allow to protect the consumer from threats.

The problem of malicious contamination has quite equally affected all the developed Countries. Indeed, the prominence of incidences from North America, so as the scarcity in Africa, are mainly due to the polarisation of the source data on English-based information.



Geographic distribution of deliberate incidents to food supply chain

Looking to the distribution per year, it can be notice that even if the number of victims (including deaths plus injuries) does not show any specific trend, the number of deliberate incidents is constantly increasing in the last years.

Incident and victims per year



Victims per year (deaths plus injuries)



Deliberate incidents per year



Analysing the main causes of food incidents, it emerges that the great part of them has been due to chemical agents, while only a minor part to biological, radiological or physical contaminants. This could be achieved to the fact that systems and technologies for food safety are mainly devoted to prevent and/or to avoid food contaminations with biological contaminants. On the other hand, the easy availability of several types of dangerous chemical agents and the absence of specific control to identify the presence of such chemicals (especially for those odorless and colourless) make them the most used and effective contaminants.



Type of contaminant agents

Chemical agent are those mainly used due to the easy availability of such substances and the absence of specific control to discover their presence.

The statistic of incidents along the food supply chain shows how the 58% of them happen at consumer level, the 38% are performed inside retail and food service structures while the remaining 4% occurred at harvesting level. Fortunately, nowadays no incidents at production level are reported.

Analysing the consequences of such incidents, no consumer health damage arise from contaminations performed at the harvesting level. On the other hand the large number of injured people are caused by those action performed at food service or retailer level. Moreover, excluding the incident happened at private consumer level, very rarely the consequences of such contamination are mortal. These results stress that the main part of the attacks to food supply chain are devoted to create panic or mistrust, rather than to kill the people in agreement with the philosophy of a terrorist action.



Incident per supply level

SecuFOOD

Classification of incidents per food supply chain level

Victims per food supply chain level

RISK PERCEPTION

HOW TERRORIST/CRIMINAL THREATS ARE RELEVANT FOR FOOD OPERATORS AND PUBLIC AUTHORITIES?

To answer to this question, SecuFood interviewed food operators and public authorities to detect and evaluate, how the food sector could be exposed to the risks of terrorist attacks, the risk perception, the weaknesses of the supply chain subject to possible terrorist attacks, the effectiveness of the general interventions to prevent, avoid and counteract terrorist attacks (best practices and gaps) and the possible solutions planned by Public Administrations, together with the interventions adopted by the Private Industries operating along the different levels of the food supply chain.

To this end, specific questionnaires have been submitted to significant representatives trying to cover all the following typologies:

• Representatives of the Countries: Italy, Spain, UK, Denmark, Romania;

• Public Administrations with the role of policy making, control and monitoring of the food supply chain, at national and local level;

• Industries of small, medium and large dimensions, operating - for the food products previously listed - at international, national and local level, both in production and in other aspects of the food chain (particularly wholesale and retail distribution).

Results from questionnaires

The results arisen from the analysis of interviews and answered questionnaires demonstrated and strongly suggested that the development of operational procedures to promote and facilitate effective coordination and information exchange (including inter-governmental and public-private) between different types of stake-holders involved in food defence, is essential.

• Level of awareness. The level of awareness on the damage that can be caused by any deliberate attacks by criminals or terrorists has been evaluated in all areas of great food industry.

• Risk analysis. Accordingly with the experience of Industries who have been suffered episodes of sabotage, the most frequent cases of attacks are due – in order of probability - to:

- mythomaniacs who want the press to talk about themselves;
- demonstrative initiatives, non-hazardous to human health, performed by nongovernmental organisations;
- claims by internal company staff;
- terrorist attacks (less likely under the casuistry).



PRIVATE INDUSTRIES

According to the outcome of the research carried out through the questionnaires, the parts of the food chain exposed to the major risks are considered the production, the transport and the retailer distribution, whereas the Industries usually evaluate adequate the safety/security measures they adopt for the technical procedures along the processing phases.

Generally, the Industries considered of the outmost importance the personnel training and periodic updating. Only two Industries declared to avail of a specific anti-terrorism protocol.

The more effective countermeasures for preventing food attacks are considered area control, video-surveillance and - mainly - traceability.



Food operators consider very relevant the risk related to deliberate manipulation of food, while public authorities are more focalised on food safety issue.

PUBLIC ADMINISTRATION

Some Public Administrations believe that more awareness would be necessary - at all the levels involved about the risks of food chain contamination and emergency response planning.

Some of them evaluate useful a tighter cooperation and coordination among all the stakeholders involved in the management of food chain security aspects.

The higher risks of contamination, in the food supply chain, regards the production, the transport and the retailer distribution (as for Industries); in addition further risks are considered related to the importation and control of raw materials.

A greater response rate by the Public sector - compared with the Private sector - shows a higher availability in providing information by this sector and could signify a major consciousness of the issues related to food terrorism.



Public authorities

While Public Authorities favour to consider separately the risk related to criminals with respect to terrorist one (largely due to the presence of separate competence and structures), food operators tend to assume an "all hazard" approach.

Even if there are not relevant differences among the steps of the food supply chain in terms of vulnerability, the importation, distribution and serving are evaluated as the more critical points for terrorist or criminal attacks.



Food supply chain vulnerability

Private food operator

Public authorities poses strong attention on importation and primary production, while food operators consider more riskily those phases not directly controlled (i.e. wholesale distribution and retailer).

It is crucial the enhancement of scientific and technical expertise and the involvement of necessary resources to risk management, risk assessment, risk-based food inspection and auditing, laboratory analysis, data collection and management, etc. in accordance with international recommendations and requirements; the implementation of an up to date real-time tracking service, associated with food protection and the detection of contaminants in the food supply chain represents an essential tool to increase the transparency of agricultural products and enhance the sustainability, profitability and organisation of the industry as well as the safety, security and quality of the products.

The ICT tools / procedures utilised and the links among Industries and Public Administrations constitute crucial elements in the prevention of attacks against food supply chain.

FOOD DEFENCE STRATEGIES

Food defence is the term to encompass activities associated with protecting the food supply from deliberate or intentional acts of contamination or tampering.

Securing the food sector presents an unique challenge, because agriculture and food systems are extensive, open, interconnected, and complex structures providing attractive potential targets for terrorist attacks.

The efforts for developing effective strategies and programs for protecting the food supply chain are made more difficult - among others - by the following issues:

• Agricultural and food production facilities are generally scattered throughout the territory, making difficult the coordination of security responses from intruders in large territorial areas;

• The food supply chain is fed by a wide range of imports continually entering into the Countries from all around the world;

- Illegal importation strongly increases the problem due to the total absence of controls on such products;
- A variety of potential biological and chemical agents could contaminate the food supply, and the possible scenarios for deliberate contamination events are essentially limitless;
- Public health systems are complex. Responsibilities for prevention and control may overlap or may been shared among authorities of different Institutions;
- Public health resources to assist industry and to coordinate effective strategies are generally limited;

• In many countries, effective food control is damaged by the existence of fragmented legislation, and weaknesses in surveillance and monitoring;

• Stakeholders, often in charge for counteracting terrorist or criminal acts, do not have sufficient information or preparedness for the management of terrorist threats to food at disposal.

Food Defence strategies generally consider the following aspects:

• Food vulnerability assessment: the purpose of an assessment of vulnerability is to identify the properties and potential consequences of deliberate contamination of food by harmful agents, to identify relative priorities and to commit national resources in a proportion consistent with these priorities.

• Preparedness planning: the purpose of preparedness planning is to build a response system that links all the players needed for effective management of an emergency and to develop coordination, communication and integration among local, regional and national resources.

• Prevention and surveillance: implementing reasonable security measures related technologies, surveillance systems, etc., aspects related to restrict the access of harmful agents may be implemented.

• Detection and response: aimed to develop strategies and technologies to early identify the infectious disease attacks, whatever the origin of the outbreak, to faster reaction, mitigate and limit the effects.

• Recovery: is the ability to recover from an attack financially and emotionally and to rebuild the physical assets and customer base for the business.



Sector	Detection	Response	
Food and Agriculture	 Development of field kits to rapidly determine presence of pathogens Training of livestock owners Random sampling into food production processes Trained personnel to read samples and determine security Use of microbiology laboratory (on site or shared outsourced facility) to confirm presence or absence of pathogens on equipment or products Rapid and secure communication systems for sharing information on unusual events or occurrences within the industry 	 Availability of biosecurity measures including decontamination and disinfection Procedures for safely handling and disposing of contaminated products Culling of infected animals or animals suspected to be infected Control of carcasses which might spread the agent of food contamination Product recall of suspected or known contaminated food products and animal by-products Securing the food supply chain 	
Health Care	 Trained health care professionals and technologists aware of the symptoms in humans caused by potential agents Use of diagnostic and clinical tools and equipment (e.g. microbiology, medical imaging) Prompt identification of agents by a coordinated network of suitably resourced laboratories Detection of infectious disease in patients Improved coordination, communication, and information sharing between the public and private sectors 	 Effective vaccines, chemoprophylactics and therapeutics being readily available Provide care in hospitals or alternate locations Provide preventive or post-exposure public health solutions such as isolation and quarantine Effective communication of information to minimize the potential for chaos and panic 	

The chart illustrates some of the competences involved in Food Defence

An essential aspect in counteracting food terrorism is represented by the coordinated intervention at different levels (international, EU, national and local) and the corresponding roles played by the public and private stakeholders.

The following table reports some of the main agencies involved at international level:

Organizations	Regulations / Rules	Networks	
INTERPOL supports national and inter- national capacity to counter the threat, focusing mainly on bioterrori- sm-prevention police training		INTERPOL's global police communications system enables police in all member countries to request, sub- mit and access vital data instantly in a secure environ- ment	
FAO operates in order to "raise levels of nutrition, improve agricultural productivity, better the lives of rural populations and contribute to the growth of the world economy"	General principles for Good Agricultural Practices (GAP) are a collection of princi- ples to apply for on-farm production and post-production processes, resulting in safe and healthy food and non-food agricultural products	International Food Safety Authorities Network (INFO- SAN) promotes the exchange of food safety information	
World Health Organization (WHO) coordinates the worldwide disease sur- veillance networks and assesses the health risks associated with hazardous agents	International Health Regulations (IHR) establish an extensive legal framework for international public health surveillance, assessment and response by WHO and the Member States	and improves collaboration among food safety authorities at national and international levels. 177 national authorities are members of the INFOSAN network. Each member country has designated one or several INFOSAN Focal Points Global Outbreak Alert and Response Network (GOARN) operates in partnership with INFOSAN for the rapid identification, confirmation and response to	
Codex Alimentarius Commission (CAC) develops food standards, guide- lines and related texts under the Joint FAO/WHO Food Standards Programme.	Codex Alimentarius is an evolving collection of internationally adopted food standards, guidelines, codes of practice and other recommendations	outbreaks of international importance	

At EU level, there is a consolidated legislation concerning food safety that includes:

• Regulation EC 178/2002: contains general provisions for traceability defining responsibilities and duties in terms of traceability, of all Stakeholders in the Food and Animal Feed sectors (owners, producers, distributors). One of its objectives is to establish common definitions and to lay down guiding principles and legitimate objectives for food law in order to ensure a high level of health protection and the effective functioning of the internal market.

• Regulation EC 852/2004: on the hygiene of foodstuffs. It contains general hygiene requirements for all food business operators. It also covers the following operations that are associated with primary production:

- The transport, storage and handling of primary products at the place of production, provided that this does not substantially alter their nature;
- The transport of live animals, where this is necessary to achieve the objectives of this Regulation;
- In the case of products of plant origin and fishery products: transport operations to deliver primary products, the nature of which has not been substantially altered, from the place of production to an establishment.

• Regulation EC 853/2004: laying down specific hygiene rules for food of animal origin, supplementing Regulation 852/2004. They apply to unprocessed and processed products of animal origin. Unless expressly indicated to the contrary, they not apply to food containing both products of plant origin and processed products of animal origin. However processed products of animal origin used to prepare such food shall be obtained and handled in compliance with the requirements hereby established.

• Regulation EC 854/2004: laying down specific rules for the organisation of official controls on products of animal origin intended for human consumption. All food businesses are required to be registered with the competent authority; which competent authority will depend on the type of business. Food business operators (except farmers and growers) are also required to put in place, implement and maintain a permanent procedure, or procedures, based on HACCP principles. The legislation is structured to ensure that the appropriate level of public health protection is in place without placing unnecessary burdens on businesses. Food businesses can apply the legislation flexibly and proportionately according to the nature of the business.

The following table reports some of the main organisations involved in food safety and security at EU level:

Organizations	Regulations / Rules	Networks	
Health Security Committee (HSC) provides exchange of information on health-related threats from acts of terrorism or any delibe- rate release of biological or other agents		Rapid Alert System-Taskforce on Biological and Chemical Agent Attack (RAS-BICHAT) is a network for information exchange, consultation and coordination for the handling of health issues related to attacks	
Global Health Security Initiative (GHSI) is an informal group to fill the gap for like- minded countries to address health issues, improving International Communications and Risk Management	"Green Paper on Bio-Preparedness" has the objective of stimulating a debate and launching a process of consultation at European level on how to reduce biological risks, and to enhance preparedness and response	Rapid Alert System for Food (RASFF) has the scope to provide food and feed control authorities with an effective tool to exchange information about measures taken responding to serious risks detected in relation to food or feed	
European Food Safety Authority (EFSA) has the aim to improve EU food safety, ensure a high level of consumer protection and restore / maintain confidence in the EU food supply chain			



SecuFood analysed in details also legislation and organisation in five member states of the European Union indentifying the reference points for measures adopted in bioterrorism counteracting.

Country	Plans against terrorist at- tacks	Plans for food defence	Public Administrations at central level	Public Administrations at local level	Prevention and preparedness initiatives	Procedures for emer- gency management
Italy	National Defence Plan for BCRN ter- rorist attacks	Plan document on essential criteria for the identification of adverse events following terro- rist acts	Ministries, National Com- mittees, Institutes with different tasks for food supply chain safety. Police arm devoted to investigate against food contamination	Offices, Local Health Units, Laboratories in charge for preven- tion and retrieval of risks factors for food supply chain	Tests on samples, technical and scientific support to Government Au- thorities and local bodies carried out by ARPA labora- tories	Communication network among the public Stakeholders to tackle with pos- sible harmful events concerning chemical / biological agents
Spain	Organic Law 1/1992, of Protection of Citizen Security	Strategic plan for food control 2007-2010	Ministries (Ministry of Health and Consumer Affairs, Ministry of the Environment, Rural and Marine Affairs), Spanish Food Safety and Nutrition Agency, Police Corp (Civil Ward)	Autonomous Communities	Risk assessment by Autonomous Communities	Protocols establi- shed in case of any food emergency
UK	Plan and strategy against the full range of national security risks, including ter- rorist attacks	Plan and stra- tegy against the full range of national securi- ty risks covers also attacks to the food chain	Relevant Public Admini- stration addressing food security issues (Agencies, Secretariats, Ministries). Epidemiological investi- gation arm of the National Public Health Service for surveillance of infectious disease and support for outbreak investigation	Relevant PA ser- vices (Laboratory, Surveillance centres) and medical doctors addressing food security issues	Support, advi- ce and training offered by FSA, HPA and CPNI to medical doctors, business, public and private organi- sations	Consolidated pro- cedures for handling outbreaks
Denmark	Emergency preparedness and response system	The Emergency preparedness and respon- se system is also geared to handle larger tasks including bioterrorism acts	Ministries (Agriculture and Health), Institutes, Emergency management Agencies	Regions and Mu- nicipalities at local level responsible for maintaining a rescue preparedness of sufficient strength to combat accidents involving hazardous materials	National prepa- redness assured by different Public Administrations and the Civil Pro- tection League	Emergency interven- tions split in three different geographic levels (municipali- ties rescue service, support points, governmental emer- gency management centres)
Romania	Rapid alert system for direct and indirect risks for consumer safety	National legislation for whole foodstuff and specific regulation for special pro- ducts	Ministries (Health, Agricul- ture, Interior) and coopera- ting Institutions	Local structures, which assure in their jurisdiction zones, coordination, addressing and control of emergency situations	Risk evaluation, risk management measures, provi- sion of scientific opinions by AN- SVSA	Involvement of Public Professional Services for Emer- gency Situations and Operational Centres for Emer- gency Situations. National System for Emergency Call

The analysis showed that all the analysed countries have specific legislation and agencies devoted to Food Safety and they are involved in early warning alert networks for food contamination. Between the five member states of the European Union here analysed, Italy (and partially Spain) has a specialised Police corps to contrast food adulteration. However, there is no specific legislation about Food Defence (except partially for UK). This comports that even if there are several mandatory constraints on food operators to improve and guarantee Food Safety (e.g. HACCP), any specific requirements about Food Defence do not exist. All the activity are performed by food operators on voluntarily base without coordination. This imply that the level of protection varying largely along the food supply chain.



RISK ANALYSIS

THREATS IDENTIFICATION

The risks have been analysed for each step of the food supply chain evaluating the corresponding effects taking into account the adopted counteract resources.



It is very difficult to forecast the probability of a terrorist attack: this is due to the almost impossibility to know the motivations, the intents and the capabilities of terrorists. SecuFood focused its attention on detecting vulnerabilities in the food supply chain with an approach mainly qualitative on risk assessment with the purpose to identify its vulnerabilities.

The risk assessment has been applied to a selection of food products. The selection has been made with the aim to get a representative collection of the whole food sector: fresh and processed products of both animal and vegetal origin, basic food and non-basic food products, liquid and solid foods, and different shelf lives. Starting from several previous studies on agents able to contaminate food and extensive interviews with experts, we have identified a list of more than 40 chemical and biological agents that can be considered as possible hazards to the food supply chain. These agents are not exhaustive of all, but we focused our attention both on those already used for intentional contamination and on these having high probability to be used in attacks, due to their ability to cause death or harm.

The level of risk is estimated with the Risk Assessment Matrix, where rows represent the likelihood of the attack and columns represent the consequences of an attack with a particular agent.

	Consequences						
		Insignificant	Minor	Moderate	Major	Catastrophic	
Likelihood	Almost Certain	Μ	н	н	E	E	
	Likely	L	Μ	н	н	Е	
	Possible	L	L	Μ	н	н	
	Unlikely	т	L	L	М	н	
	Rare	т	т	L	L	М	

ORM Matrix

Legend: E: Extreme Risk, H: High Risk M: Medium Risk L: Low Risk T: Tolerable (permissive) Risk



The consequences of an attack are classified on a 1-5 ranking scale depending on the severity of the effect of the contaminant agent

- 1 insignificant: irrelevant injuries sustained, news limited to specialised press, no significant economic losses
- 2 minor: no relevant illness, some mass-media coverage, marginal economic losses;
- 3 moderate: some people require medical attention, considerable mass-media attention and economic losses by food operators;
- 4 major: some deaths, severe injuries, anxiety in the population, considerable economic losses by the food operators (bankruptcy);
- 5 catastrophic: a large number of deaths, large-scale panic in the population, significant impact on national economy.

However, different methods have been used to catalogue the consequences of biological and chemical agents:

• Consequences of biological agents are measured by the effects and the number of people affected in the attack;

• Consequences of chemical agents: the severity of the consequences is considered in terms of lethal doses. The agent is considered more dangerous smaller is its lethal dose.

CHEMICAL AGENTS TOXICITY CLASSES					
Consequences rank	Toxicity Rating	Dose	For 70kg person (150lbs)		
Catastrophic	Super Toxic	Less than 5 mg/kg	1 grain (a taste - less than 7 drops)		
Major	Extremely Toxic	5-50 mg/kg	4ml (between 7 drops and 1tsp)		
Moderate	Very Toxic	50-500 mg/kg	30ml (between 1 tsp and 1 fl ounce)		
Minor	Moderately Toxic	0,5-5 g/kg	30-600ml (between 1 fl oz and 1 pint)		
	Slightly Toxic	5-15 g/kg	600-1200ml (between 1 pint to 1 quart)		
Insignificant	Practically Non-Toxic	Above 15 g/kg	more than 1200 ml (more than 1 quart)		

The Likelihood is the probability that an attack will occur. We estimated such quantities considering two variables: probability of access to the contaminant and the vulnerability of the food supply chain.

"Probability of access" is the probability that a terrorist could access to hazardous substances. The easier the agent is to access (in term of availability, accessibility, and transportability), higher is the probability of being used for an attack.

Vulnerability, for our purposes, is considered to be a measurement of how a given facility is susceptible to attack. This is going to be an important variable in determining which target is chosen by the terrorists. If the vulnerability of a specific point in the supply chain is high, it is more likely that that specific point will be chosen by terrorists.

The vulnerability differs depending on the step of the supply chain. For manufacturing, for instance, the variables taken into account are:

- type of process, security: alarms, cameras, etc.,
- quality controls: where they have quality controls and how easy it is to detect the agent,
- policies regarding employees: use of safety equipment, where employees have total or restricted access, where the uniforms are laundry at home, etc.,
- surveillance of visitors: registration of them and the possibility of a visitor to being alone, hygienic measures, safety equipment, etc.

For transport we have taken into account:

- the type of truck required: refrigerated truck, tanks, etc.,
- the form of the product when it is raw material (liquid, solid),
- the type of package when it is a manufactured product (hard package, glass package, open-air product, etc.),
- the type of package, accessibility to the warehouse and the type of warehouse



BIOLOGICAL AND CHEMICAL RISKS

A comparison between biological and chemical risk level was performed. The results are reported in the following chart.



Comparison Biological/Chemical Risk Level

This chart shows the risk level by sector split into the two types of agents analysed throughout the study (notice that for the oil we consider only chemical agent because no biological agents can grow in that product). The red line is the average risk level for both types of agents.

In general can be observed how the chemical agents are riskier than the biological ones. This is because in the manufacturing phase there are several controls for the biological agents. The riskiest product is fresh fish, due to its vulnerability since it is not protected at any point along the supply chain. On the contrary, the most secure product is 4th range salads.

In the processed products the risk level is higher for chemical agents than for the biological ones. Usually, processed food includes thermal treatments which exerted some sterilisation. The food less processed is more susceptible to microbiological contamination as they are not involved in thermal processes.

The bread, even if it goes through a thermal process, it is a product submitted to an higher risk of contamination with biological agents with respect to the chemical ones because it is unprotected throughout the whole supply chain.



The chemical risk level is more or less the same along the whole food supply chain. However, it decreases at the final steps. Usually, the damage to the consumers is lower, because the products are packaged and the terrorist will need a lot of time to contaminate the same volume of product. The manufacturing phase is the riskiest phase because an extremely high number of people can die or be injured.



Phases of the supply chain



In the case of biological contamination, in contrast to chemical agents, the manufacturing phase is the least risky phase, because many controls are carried out to detect biological agents. This is due to the fact that these agents are usual in spontaneous contamination. Transport and storing are dangerous phases as there are no biological controls after manufacturing. This can be observed in the figure representing the vulnerability to biological agents, with the exception of fresh fish. In this particular case, there is not a manufacturing phase because the product is not processed.



TECHNOLOGIES

Interviews and questionnaires submitted to food stakeholders and Public Authorities allowed to point out the needs in terms of technology regarding the defence of food supply chain.

Although only one food industry declared to have experienced cases of food intentional contamination, all the operators are susceptible to this problem. The interviewed food operators from industrial sector consider the production, the transport and the retailer distribution as the weakest parts of the food supply chain, and public authorities also mentioned importation level. Among the countermeasures to protect these phases from criminal or terrorist attacks they declared to adopt or, at least, to have proposed area control, video-surveillance, and, mainly, traceability.



Even if almost all the industries have at their disposal these types of internal controls (mainly for quality assurance rather for counteracting terrorist or criminal attacks), these controls could be useful and effective – to some other extents, - also for preventing malicious attacks.

European food industry and European research institutions have a great number of technological tools to prevent food contamination, aiming mainly to enhance food safety. However, in order to be effective also for food defence, they need to be extended so that they also consider the nature and the peculiarities of malicious contaminating agents and actions.

In this context, the implementation of an up-to-date real-time tracking service, associated with food protection and the detection of contaminants in the food supply chain represents an essential tool to increase the transparency of agricultural products and enhance the safety, security and quality of the products.

Among others, the technologies that appear more suitable are:

TRACEABILITY

Traceability refers to the completeness of the information about every step in a process chain. The European Union's General Food Law (2002), made traceability compulsory for food and food operators and required those businesses to implement traceability systems. In food processing the term traceability refers to the recording, through means of barcodes or RFID tags and other tracking media, of all movements and steps of products within the production process. Where traceability has been closely adhered to, it is possible to identify, by precise date/time and exact location which goods must be recalled, and which are safe, potentially saving millions in the recall process. The EU introduced its Trade Control and Expert System, or TRACES, in 2004. The system provides a central database to track movements of animals within the EU and from third Countries. Traceability is essential, particularly with raw materials, to assess if control procedures have been applied and are effective.



NANO-BIOSENSORS FOR FOOD DEFENCE

The success of technological devices for food defence depends on their ability to interact with the biological environment. A new trend for technologies that allow to detect food hazards are the so-called Nano-Biosensors. Recent advancements in nanotechnology have created a variety of top-down techniques that can reach feature sizes of 100 nm or less, thus approaching a size range very relevant to biology. At the same time a number of self-assembly based techniques have been developed and can be used to create artificial nano-structures imitating biological systems with similar or even superior performances. The combination of these new top-down and bottom-up approaches enables us to interact with complex biological systems: tissues, cells, proteins and DNA in an unprecedented manner.

Nanostructured biosensors ensure better prevention, guarantee minor contaminations and a stronger protection thanks to a smaller public exposure and a faster response. All these aspects are devoted to provide a safe and secure food, protecting public health and reducing the chance of successful attacks. Nano-biosensors offer some advantages like rapid detection time, high sensitivity and compatibility with data processing technologies.

A very interesting nano-sensor exploits the DNA barcode technology. DNA barcoding is a taxonomic method that uses a short genetic marker in an organism DNA to identify if it belongs to a particular species. Although barcodes are sometimes used to identify unknown species or assess whether species should be combined or separated, this kind of usage shifts the limits of what barcodes are capable of. The great innovation introduced with DNA barcoding is the standardisation of the method. Thanks to several scientific papers, different research groups are promoting ambitious projects with the aim to associate to every living organism one or few DNA sequences able to univocally identify it.

ANTITAMPERING

Food tampering is the intentional contamination of a food product, with the intent to cause harm to the consumer or to a private company. In particular, the expression "food tampering" usually refers to anything that may affect any part of the food product, such as the product itself, or that can affect the packaging and the label.

Several measures to prevent food tampering in the food supply chain already exist, such as a strong surveillance and inspection programmes, and, in some cases, a well-established emergency food recall system. On the other hand, the food industry is reviewing current procedures and controls to take into account the potential of tampering or terrorist actions, and to make appropriate improvements.

In the contest of food tampering, also consumers play a role in preventing illness. In this perspective the U.S. FDA delivered a document regarding some tips to keep consumers safe, mainly concerning how to detect product tampering both at the grocery store and at home.



CONCLUSIONS

Nowadays the food sector, in particular in Europe, has systems to prevent spontaneous contaminations: HACCP and traceability. However, as several recent studies showed, and some episodes stressed, the deliberate contamination of food is a real risk and it must be adequately managed, especially since food stakeholders have little perception of this risk.

A distinction between Food Safety and Food Defence has to be made. The former refers to the extent to which food is safe to eat, i.e. compliance with legislation. In fact, it is related to the handling, preparation, and storage of food in ways to prevent foodborne illness comprising also aspects related to frauds. The latter is the term to encompass activities associated with protecting the food supply from deliberate or intentional contamination or tampering.

The consequences of food contamination can be different depending on the step of the supply chain where it is deliberately performed. When the attack takes place in the first steps of the supply chain, it could affect more people, in spite of the severe controls that Companies usually make. On the contrary, if the attack takes place in the step of the chain closest to the Consumer, it has a greater probability of success but it would affect fewer people. However, such type of attack is able to create panic, mistrust with huge economical consequences.

Transport and storing are steps more vulnerable than manufacturing. The product is, usually, protected by the container, but there is less vigilance with respect to manufacturing process and the time of exposition to vulnerability is longer. In general, the transport of the final product (protected by the packaging) seems less vulnerable than the transport of raw materials. However, the farmer is more dangerous of the latter, in terms of deliberate attacks, because the probability of being detected for a malicious contamination of the final product (during the transport or in the warehouse) is very low and the risk for the consumer to be contaminated being very worrying.

The analysis carried out on specific foods has shown more dangerous risks in attacks using chemical than biological agents. The main difference in the probability of success using chemicals or biological agents is due to the quality assurance adopted. There are very few controls for chemical agents in the food sector, while biological agents are much more controlled.

Almost all the European Countries have not specific legislation addressing food terrorism, because of an evident lack of awareness about related threats. Food operators, and partially Public Authorities, have a little perception of the possible risks related to deliberate contamination.

They think that their processes are secure and their controls are adequate. However, when is asked to them where in their manufacturing process terrorists could attack, they often answer that it could be anywhere. On the other hand, they admit that vulnerabilities are present in the whole steps of the manufacturing process today performed.

Common guidelines for the implementation of preventive measures and effective ways to deal with critical situations have been represented starting from the results arisen from the analysis of the answered questionnaires and interview with food Industries, Stakeholders and Public Authorities. These common guidelines are following reported:

- The opportunity to organise discussions panels with Industries and Public Authorities to increase awareness and share information, experiences and best-practice;
- The implementation, by the European and National Authorities, of databases of terrorist / criminal events that have occurred, available to all the stakeholders;
- The setting up of a stronger Private and Public cooperation, in terms of sharing information and in creasing communication, availing also of public databases;



- The establishment of more effective preventive measures at EU level and the reaching of an agreement on minimum requirements to be applicable along the food supply chain as preventive measure;
- The opportunity of incorporating in the quality systems procedures, of specific sections concerning food defence;
- The improvement of the collaboration between Industries through Associations of Category to uniform the methods in use to check the security of food;
- The production of regulations and strategies considering that the interfaces between components of the chain, where food changes hands, are the sites most vulnerable to terrorist attacks;
- The research, evaluation and adjustments to operational plans of new technologies for food defence. Priority should be given to effective security solutions able to complement and to improve the business processes already in place. Specifically, technologies to be improved are those related to the traceability of the product; the supervision of the product to prevent any anomaly manipulation; the detection of any contamination or tampering;
- The development of methodologies and tools for early warning and information sharing to support police corps to contrast criminal organisation;
- The need of producers devoted to the food sector to develop security plans for managing the risks of malicious contaminations. The approach of the HACCP for non intentional contamination could be a suitable way.

For what concern food operators, Good Manufacturing Practices (GMPs) and employees screening are more and more important. Facilities accesses should be controlled. Reducing the points of access should be considered. Access to the building should also be restricted and organised in such a manner to meet the needs of the production but to prevent uncontrolled access from outsiders.

In conclusion, there is no actual reason to create panic or psychosis in the consumers, since the large part of our foods is safe and well controlled. However, to be able to guarantee the consumer health, it is mandatory:

- To extend the quality assurance procedures and the monitoring activities along all the food supply chain;
- To extend the detection of food tampering and/or the addition of exogenous agents.

This is necessary not only to discourage terrorist attacks, but especially to prevent, mitigate and contrast any criminal manipulation of food. Obviously, the very first step is the acknowledge and the awareness of the food stakeholders about such threats.



• UNIVERSITÀ CAMPUS BIO-MEDICO DI ROMA:



The University Campus Bio-Medico of Rome is the first thematic Italian University centered on the care of the Person. It includes two faculties (Medicine and Engineering), an University Hospital and only one macro-department, the CIR- Center of Integrated Research a reference scientific pole of Lazio Region. To CIR belongs all the research activities of the Faculties of Medicine and Engineering with the aim to stimulate interdisciplinary and translational research with a bidirectional flow of information from the research lab to the Patient's bed. CIR represents the relay core for general planning and organization of all the research activities running within the different University structures (Faculties, Laboratories, Clinical wards etc). The CIR engineers are active in the field of Chemistry and Biomaterials, Critical Infrastructure, Homeland Security, Mechatronics Systems, Food Technologies.

On the basis of the large experiences acquired over more than ten years by its researchers in the field of critical infrastructure protection and security, this year UCBM activated, as first experience in Italy and Europe, a Master on Homeland Security with the contribution of Italian law enforcement agencies and the support of the major Italian players in the field of security.

• UNIVERSIDAD DE NAVARRA:



The TECNUN School of Engineers of the University of Navarra in San Sebastian offers 9 Bachelor's degree subjects and range postgraduate studies: master and doctoral programs. The teaching principle at TECNUN is based on the integral education of its students in both, professional and human terms. The cornerstones of its educational model are the highest level of teaching, together with individual academic and careers counselling, and field-leading research. The School of Engineering's research is carried out in close collaboration with Centre of Technical and Research Studies of Gipuzkoa (CEIT), a research centre, with which the School shares staff, labs and library. This way the theoretical approach of science is complemented with the applied research carried out at CEIT, an institution focused on industrial applications. Researchers are thereby trained in cutting-edge technologies and their applications and this in turn improves the quality of teaching.

• EUROPEAN BUSINESS ASSOCIATES SRL:



EBA operates furthermore in the field of project management, market analysis, macro and micro economic studies for SMEs, technological transfer of Research and Development results.

In the development of its services, EBA avails of a professional multidisciplinary team, with a mix of technological and market competencies, recruited at EU level.



• ISTITUTO SUPERIORE DI SANITÀ:



The "Istituto Superiore di Sanità" (ISS, the National Institute of Health in Italy) is the main Italian institute of scientific-technical research, control and advice in public health. The Institute is organized in Departments, National Centres and scientific-technical services. It performs different activities for surveillance, control and promotion of public health as research, control and intervention, advice, conferences, courses and publications. ISS is the national focal point of EFSA in technical and scientific matter. The GMO and Mycotoxin Unit is part of the Department of Public Veterinary Health and Risk Assessment of ISS that guarantees the food and feed safety and takes care of food and feed contamination emergencies. The Unit takes part to GMO and Mycotoxin risk assessment and deals with all the issues related with GMO and Mycotoxins analyses along the agri-food and feed chain including multi target method development, method validation, traceability implementation and sampling method development.

• COMANDO CARABINIERI PER LA TUTELA DELLA SALUTE:



Carabinieri Headquarters for Healthcare is a specialised Command of Carabinieri Corps depending on the Ministry of Health. Personnel is composed by 1000 Carabinieri, located all around Italy and the main goal is to protect public health. Personnel that enters into this Specialised branch assumes the title of "sanitary inspector" thus giving them the authority to conduct verifications in all areas where medicines and food are produced, distributed and deposited (also in hospitals, nursing homes and pharmaceutical businesses) in order to determine the proper production, stocking, conservation and distribution. The activities of control connected to the qualification of sanitary inspector are conducted through the inspection of the hygiene within businesses, the sampling and analysis of products, the examination of documents of authorisation and the control of the examining systems installed by the businesses and the relative results. If crimes arise the personnel conducting the inspection, in the vest of judicial police authority, refers to the competent magistracy so that further investigation can be developed.



Website: http://secufood.unicampus.it/ Project Coordinator: Roberto Setola, Università Campus Bio-Medico di Roma Email: secufood@unicampus.it