

# Security of the Food Supply Chain

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**Abstract—** The food supply chain could become a dangerous weapon in the hands of enemies, for this reason the strategies developed to fight food adulteration (food safety) should be complemented with specific actions devoted to improve food “security” in the sense of food defence. This paper illustrates the methodological approach used in the EU project *SecuFood* to analyze threats, vulnerabilities and countermeasures existing in major European countries about what concerns deliberate attacks and manipulations of food.

## I. INTRODUCTION

THE 11<sup>th</sup> of September 2001 is remembered as the date that showed as daily used infrastructures can become a weapon of mass destruction if they fall in the hands of terrorists or criminals. Those events have seriously posed a doubt about the security of daily systems and infrastructures.

The air transport is surely perceived as one of the most dangerous and attachable infrastructure. However, this perception does not find on solid bases because the air transport has a reduced number of vulnerable points, i.e. the airports, and has a high level of security measures currently applied worldwide.

Other civil infrastructures of daily use are less perceived as dangerous, but are, actually, more vulnerable, and do not show a so capillary security control because they are used or managed by a large number of subjects, in different sectors.

Sectors in which these problems are particularly felt are those of health and food [17]. In fact, immediately after the 9/11 the World Health Organisation (WHO) stressed the risks due to Food Terrorism, defined as “an act or threat of deliberate contamination of food for human consumption with biological, chemical and physical agents or radionuclear materials for the purpose of causing injury or death to civilian populations and/or disrupting social, economic or political stability” [1].

The WHO report on “Terrorist threats to food: guidance for establishing and strengthening prevention and response systems” [1], highlights the importance of the primary responsibility for managing emerging international threats to

public health. This guide is addressed to policy makers, but also to food industry and consumers, and it encourages the adoption of further regulation in the food safety systems, to take in consideration the food terrorist threat.

This because an action by terrorists aiming to affect the food supply chain can lead death and disease, with a high and widespread diffusion among the population.

This is only one of the initiatives promoted by the WHO for preventing threats to food, whose necessity was highlighted also by the resolution adopted during the 55th World Health Assembly (WHA 55.16) [2], which expressed concerns about civil threats by deliberate actions through biological, chemical or radio nuclear means. WHA 55.16 stressed specifically that a possible and effective way to disseminate these agents and materials is the food.

In this contest, the WHO’s International Health Regulation [3] states that in the case of incidents involving deliberate contamination of food, the national public authorities have the responsibility to inform the WHO International Food Safety Authorities Network (INFOSAN).

The theme of the protection of the food supply chain, intended as food defence, has a great attention in the USA [6] being it recognised as one of the 17 national critical sectors [13], [14], and a specific work plan [5] has been recently released. In spite of this, USA registered from 2006 to 2008 many cases of salmonella or *E. coli* outbreaks, caused by different food contaminations. These outbreaks involved several small or large portions of the USA and caused a certain number of victims, some of which required hospitalisation, a few of which was dead. In most cases the Food and Drug Association and the local authorities were unable to determine the cause of the outbreaks [8].

The incidents occurred in the USA demonstrate as the public health, in relation to the food supply chain, is exposed to significant risks, although the efforts to guarantee the security of the food infrastructure. Obviously, these risks are applicable to all the countries and the geographical areas, as stressed for example by the specification carried on in UK by the Centre for the Protection of National Infrastructure (CPNI) [12] and by the Asia-Pacific Economic Cooperation’s (APEC) Counter Terrorism Task Force (CTTF) [16].

In particular, in Europe the attention to the theme of the food supply chain protection has been very low in the last years; the problem has been raised by the EC Green Paper on Bio-Preparedness [18], which aim is to address efforts for reducing biological risks and enhance preparedness and response to these risks, in particular regarding the food

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supply chain. Despite of this Green Paper, at present there are not specific European initiatives or campaigns for the prevention or the action against the attacks to the food supply chain.

In this framework the European Commission promoted the road-map initiative SecuFood with the aim to analyse the threats, vulnerabilities and countermeasures existing in the major European countries about what concerns deliberate attacks and manipulations of food. In the following sections we illustrate the methodology developed to manage this activity.

## II. FOOD SAFETY AND FOOD SECURITY

Dealing with food threats, naturally or maliciously occurred, it is useful to explain the meaning of “food supply chain security” and to stress the similarities and the differences existing with respect to the “food safety”.

*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 illness, injury or death in the consumer [15]. The unsafety can be due to the presence of bacterial, viral or parasitic agents, or to the contamination by chemical or unsafe materials.

The food safety is then intended as the control against the introduction on the market of dangerous products, or not compliant with laws and regulations. It is ever a criminal action, but in this case the aim is an economic illicit advantage for the producer or the retailer.

Regulations in Europe (and partially in USA), guarantee a high level of food safety to the population [4].

On the other side, the term “*food security*” assumes at least two substantially different meanings. Indeed, food security is generally referred to the availability of food and one's access to it. The Food and Agriculture Organisation (FAO) defines food security as the physical and economic possibility by all people and at all times to reach “sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life”. The meaning of food security, in this case, is then mainly related to the contrast to poverty, hunger and starvation.

The other meaning of the expression “*food security*” is more related to the usual meaning of “security”, and refers to the “defence” of food products. In fact, “food defence” can be referred to those actions to counteract criminals or terrorists, which “use” the food supply chain as a mean for the attack to an industry, a group of person, a community or a country. The UK CPNI and British Standard Institute (BSI) define to this end the food defence as “the security of food and drink and their supply chains from all forms of malicious attack including ideologically motive attack leading to contamination or supply failure” [12].

## III. THREATS TO FOOD SUPPLY CHAIN

As it is explained in [1], the potential effects of a terrorist

attack to the food supply chain could be found in different aspect of the society: first of all, a terrorist attack through food could cause human disease and death.

Despite that, the aim of a terrorist action is always to create fear and anxiety in the population: this can easily result in a political destabilisation, causing a reduced confidence in the government and the political system.

In [11] it is reported a systematic examination of intentional and malicious contaminations of food happened in the period from 1950 to 2008, on the basis of open-source information. This analysis emphasises that almost 98% of the incidents occurred downstream in the food supply chain (e.g. at retail outlets, foodservices, home, workplace). Typically the agents used are commonly available as household, agricultural, or industrial chemicals. When more esoteric agents were used, the perpetrators often worked in a facility using such agents and had access and knowledge of their use. Even so, the public health impact of the spare examples of biological or radiological cases, all occurred at the consumer's or retailer's level of the food supply chain, is very small.

Hence, it can be assumed that the primary aim of a deliberate contamination is to provoke economic losses or trade disruption, rather than concrete injury to people. In fact industries in many sectors could be put out of business, with severe effects to the whole country, especially in low income countries, in which an attack to food supply chain could affect the development and increase poverty situations and food lack. Real or perceived threats can also damage the tourism, that is economically important for many countries.

Then a distinction should be made between actions aiming at spreading pathologies in large groups of people and those aiming more “specifically” to the creation of a social and economic damage.

The effect produced by the actions able to spread toxic chemical compounds to a large portion of a population through the contamination of foodstuffs is greater as much as the contaminating agent is inserted in a higher level of the supply chain. Indeed, this permits a late and more difficult localisation of the contamination, especially when the effects are not immediate. In effect several toxins could survive to processing used in food industries. Moreover when a toxin or another contaminant agent is dispersed in one of the first step of the food chain, it becomes more difficult to identify and isolate the source of the contamination, after the industrial elaboration.

A capillary monitoring against such adulteration is made more difficult due to the food import; in effect many industries use imported raw materials. A certain percentage of food in fact is coming from external countries (in the USA this percentage is about 15%), but this percentage increases taking into account food from illegal importation, that avoid the control examinations, worsening the problem of the identification and isolation of contamination sources.

On the other side, a malicious contamination does not

require a high number of victims to be efficient, but it is sufficient to find a particular contaminated food product, to create hysterical reactions in the population and then spread panic. The examples of the mad cow disease and of the avian flu show as the modification in the behaviour of the consumers can cause considerable negative effects on the market, with bad consequences for the producers.

This type of action can be considered, for some aspects, the most efficient if the criminal wants to cause economic or social damages to the subject (that can be a producer or a country). Moreover this type of attack is simpler for the criminal, since it can be made in any part of the food supply chain, also in the least controlled and protected part.

As reported in [7], the most probable targets of the food supply chain are food vendors, among which retailers but also restaurants, food producers or particular and relatively close groups of food consumers, as military basis, schools, ships and aircrafts: in these last examples of groups, the criminal has the possibility, through food contamination, to infect an entire community.

#### IV. METHODOLOGY ANALYSIS

Providing a complete survey of existing measures for food safety and security management is fundamental for the detection of possible way to improve food defence.

In SecuFood, we follow a multi-step procedure aimed to identify all the relevant elements.

The first step is the identification of the European public authorities involved in the food security, safety and (if existing) defence and the acquisition of information about strategies adopted to contrast food adulteration.

In parallel, we identify the main private actors involved in the food supply chain and collect, via specific questionnaires and face-to-face interviews, information about the operative actions that they adopted to implement the legislative and “company” prescriptions. The analysis has been conducted within a limited number of Member States (Italy, Spain, United Kingdom, Denmark, Romania), that has been chosen to be significant of the European scenario, with the coverage of rich and poor, old and new, large and small MSs, in all European geographic areas, with a particular attention to those countries that have developed a greater attention to safety and security standards in laws, rules and strategies.

The second step is devoted to characterise the food threats. However, because the food supply chain is very large and cover different sectors, geographical areas and types of stakeholder, we concentrate the attention on the most significant classes of food, specifically milk, yoghurt, fish, prepared salads, fruit juices, baked products, olive oil and baby food.

We consider the food supply chains decomposed into macro steps, as illustrated in Fig.1. The typical workflow for a generic food includes the farm in which animal and/or plant production takes place, the processing occurring in the industries, the logistics including the storage and the

transportation, and the wholesale that will be supplier for retailers and food services, as restaurants or centralised kitchens for schools or companies.

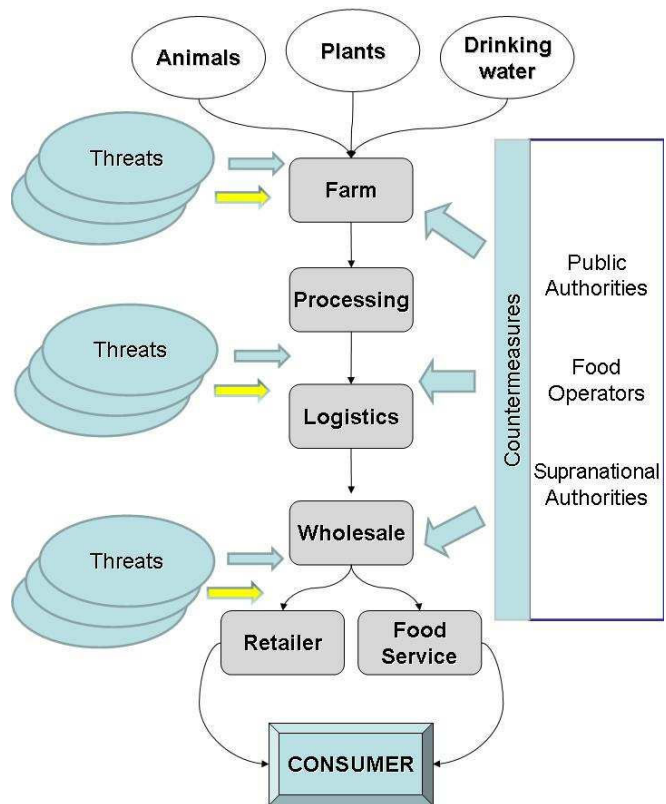


Fig 1. The SecuFood vision. The study will identify, with respect to each step of the workflow in the food supply chain, the different threats and the effectiveness of the corresponding countermeasures developed by Public Authorities, Food Operators or Supranational Authorities.

For each of these macro steps, the specific threats have been identified, in terms of contamination through chemical, biological or others instruments [9]. All these types of contaminating agents can be added during harvest, storage, processing, preparation and finally in serving to the consumer.

For each threat and each food type, the corresponding feasibility and possible impact is also considered, taking into account the accessibility and manageability of the contamination agents and the possible effects. Moreover a classification have been done per objectives, distinguishing between attacks aimed to provoke death in a large part of the population and those devoted “only” to trigger a state of fear and anxiety in the citizens. For this last classification the fact that often the distinction between voluntary and accidentally occurred incidents cannot be determined with a high certainty has to be taken into account [8].

Experts from specialised police corps have analysed threats considering statistical incidence, feasibility and expected effects of different type of risks, giving a ranking of degree of danger and probability of occurrence.

In the last step of the SecuFood procedure all the results from the above mentioned analysis about the threats and the countermeasures along the food supply chain have been merged and cross-mapped to perform a gap analysis in order to verify and qualify the overall degree of effectiveness of the procedures against malicious attacks. For each level of the food supply workflow the effectiveness of the different adopted countermeasures have been verified and valued, and then the capability to prevent and minimise the corresponding risks and to efficiently manage the consequences of an attack will be qualified.

The final aim of this comparison is to identify best-practices and weak points in the national and international existing measures for food defence.

## V. CONCLUSIONS

The first results of our study highlight that currently the countermeasures for the food safety developed by the European Commission and by each Member State, including those against food frauds and infectious diseases, provide a valid food defence. In fact, these measures allow the detection of malicious elements in food products, and permit to start a process of contrast through isolation and recall. This type of measures imposes to the producers the use of specific traceability tools and surveillance systems (e.g. HACCP, Hazard Analysis & Critical Control Points), that is a preventive action against different type of malicious actions. The weak point in the implementation of the existing regulations is often, as confirmed by [10], the communication between local authorities and suppliers.

Another important source of risk is due to the illegal food import, that eluding food import safety controls make easier the spreading of pathogen agents into the food supply chain.

The preliminary results of the study highlight that another weak point in the protection of food consists, in particular, in large retailers and food services, in which the food products are accessible to the end users, allowing in most cases the manipulation of products with the introduction of toxins, poisons or other chemical composts.

In the case of this last type of actions a first and common tool for countering them should be a larger use of monitoring systems, that could merge the need of protect “security” of the economic operator and “safety” for the end users and all the citizens.

Even if, as stressed by the CPNI, “undertaking a major attack on the food supply chain is much more difficult than at first it may be believed” [12].

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