

## RISK MANAGEMENT FOR FOOD SAFETY, CONSUMER HEALTH SECURITY

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DOI: <https://doi.org/10.31410/limen.2018.603>

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**Abstract:** *Food production is seen as an aggregate system that is directly dependent on multiple subsystems that ensure each stage of this production with the goal of making safe food. Consumers require from organizations producing food to demonstrate objective evidence in regard to food safety management. Ensuring food safety, as the most important element of their quality, is necessary to be perceived as an essential part of all management activities. Food incidents or food intoxications caused by the use of unsafe foods provoke a serious public interest, as well as expectations to ensure the consumers' health.*

*The purpose of this paper is to analyse existing food safety management mechanisms, to reveal opportunities for increasing food safety through risk management. Applying the science-based approach to risk assessment is one of the reasons to review the current concepts concerning food safety. The introduced HACCP principles are insufficient to cover all aspects of risks concerning food safety and the related health risks to consumers. The advantages and disadvantages, as results of the analysis of the current HACCP principles, can serve as a basis for introducing additional approaches to secure and control risks in food processing and marketing.*

**Keywords:** *management; food safety; hazards, risk, risk management*

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### 1. INTRODUCTION

Ensuring food safety is an activity governed by laws and regulations, and is seen as a joint responsibility of all stakeholders in the food chain. The establishment and maintenance of a food safety management system (FSMS) for food operators is regulated in the national legislation of the Republic of Bulgaria in line with European and global policies on safety of foodstuffs in accordance with Articles 12, 17 and 18 of the Food Act [2] and Ordinance No. 1 of 26.01.2016 on food hygiene [6].

Consumers are increasingly requiring from manufacturers to demonstrate and present objective evidence regarding food safety. Nowadays customer-vendor relations are customer-focused and a company operating in foodstuffs can prosper only if it satisfies to a maximum extent the customer's requirements. The upper hand in the customer-vendor relationship is held by customers, while manufacturers seek to reduce the incidence of dissatisfaction expressed by the end consumer or cases of recall of food products from the market because of health risks.

Recent years have seen the introduction of new technological practices for food production; the implementation of new automated systems in production equipment; advanced technical solutions for automation of registration of data obtained by monitoring the parameters of processes and products; the introduction of new methods of analysis and obtaining swift results,

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but despite all technological and innovative processes, food-related incidents have not decreased in number.

The emphasis in overseeing and ensuring food safety is on its traceability throughout the food chain and covers not only in theory but also in practice the development of effective measures related to the uniform approach in implementing various EU policies: agricultural, economic, social, educational, healthcare, etc., seen as a single regulated and monitored process by all EU countries at different levels: departmental, sectoral and national.

The beginning of the new century saw a disturbing trend of emergence of new diseases in animals and humans. In 2011, the epidemic in Germany caused by E.coli killed 53 people. Some known infectious agents which were thought to have been contained and placed under control caused severe epidemics and epizootic outbreaks – the highly pathogenic avian influenza in 2005-2006 (the epidemic covered dozens of countries in Asia, Africa and Europe). Between 2007 and 2014 the African swine fever spread to eight countries in Asia and Europe, including two Member States of the European Union: Lithuania and Poland. The actual situation and the growing number of notifications drove the European Food Safety Authority to express the opinion that new methodologies and tools to facilitate efficient and transparent sharing of data, knowledge and methods were needed in the field of risk identification among Member States concerning food safety [12].

The European Food Safety Authority carried out a pilot study on emerging risks in order to identify the reasons for such rapid evolution of some infectious agents [1]. These food-related scandals make an increasing number of consumers seek assurance for the quality and safety of food by manufacturers and require objective evidence of that.

The food industry in Bulgaria faces the challenge of producing and providing quality and safe foods. Companies in the food industry are increasingly striving to create and implement standardized food safety management and control systems. Food safety is of paramount importance for a company engaged in the manufacture and supply of food products, both in the national and the global market.

The goal of this paper is to make an analysis by comparing the existing mechanisms for the management of food safety through the HACCP concept introduced by laws and regulations to those developed under the requirements of internationally recognized standards in Bulgaria.

This goal is pursued by reviewing the existing food safety management systems (FSMS) implemented by operators engaged in storage of cereals, and proving the need to implement systems complying with the principles and methods laid down by international standards. Benefits from implementing FSMS as a factor for ensuring food safety and for the increased confidence of consumers in reduced health risk have been identified.

## **2. RISK MANAGEMENT FOR FOOD SAFETY IN THE CEREALS SECTOR**

Cereals are the main raw materials for production of staple food and are present in the daily diet of a large target group of consumers – from children to consumers with dietary health problems. Among cereals, wheat is the major contributor to satisfying the nutritional needs of the population. Wheat is the main raw material for production of milled products, bread and bakery products, including animal feed. According to data published by the National Statistical

Institute [4], the consumption of bread and bakery products in Bulgaria in 2017 was 87.1 kg per capita.

It is critical to note that the reduction of the yields of cereals is related to climate change and the shortage of water. [9] In terms of agro climate, 2017 was characterized by periods of cold weather and severe waterlogging of the soil as a result of the melting snow and the heavy rains during the winter months, followed by excessive heat. The reported damage to crops was caused by frost/drought and white frost (due to the drought that took place in the autumn of 2016 or the lower temperatures in the winter and spring of 2017), storms, torrential rains accompanied by hurricane wind, flood, hail and drought. Despite the impact of these objective factors, in 2017 producers reported higher average yields of cereals compared to 2016, with the result that most of them saw an increase in production. The quantities produced are presented in Table 1 [8].

Table 1: Production of cereals from harvest 2016 and 2017

<i>Crop</i>	<i>Harvested area (ha)</i>			<i>Average yield (ton/ha)</i>			<i>Production (ton)</i>		
	<i>2016</i>	<i>2017</i>	<i>Variation 2017/2016</i>	<i>2016</i>	<i>2017</i>	<i>Variation 2017/2016</i>	<i>2016</i>	<i>2017</i>	<i>Variation 2017/2016</i>
Wheat	1,192,589	1,144,519	-4.0%	4.75	5.36	12.8%	5,662,721	6,132,671	8.3%

The wheat production in 2017 amounted to 6,132.7 thousand tons. This is 8.3% more than the previous year. For Bulgaria, the period 2017/18 was a record in wheat production, with over 6.1 million tons harvested. [3] This necessitated safe storage and handling measures as regards the harvested volumes of wheat, taking into account the objective climatic and vegetative disparities in the mentioned period. A very alarming trend has been observed, namely the use of agricultural crops (including wheat) for non-nutritional purposes, and there is a very significant problem associated with improper storage of cereals. We should also mention the problem of lack of knowledge about the transfer of pollutants during incompatible storage of different types of grains and oilseeds [9].

The above is a reason to require from operators engaged in storage of cereals, particularly wheat, to put in place adequate control measures in the FSMS for those steps of the technological process identified as critical to food safety. The availability of year-round supply of wheat and foodstuffs of plant origin requires the implementation of measures for management of the conditions of their storage. A variety of practices have been implemented in order to lengthen shelf life and assure the quality, such as treatment of cereals with pesticides against live pests.

The food market throughout the food chain has been characterized as an interconnected system with a wide variety of complex relationships. To handle these challenges, food business operators rely on standard systems for ensuring the safety of products and processes. Since all suppliers in the food chain are responsible for food safety, it is imperative to introduce safety systems at every step of the production chain and thereby demonstrate compliance with safety requirements [7].

At a time in which the alarm is raised that the food resources are limited, including depletion of arable land due to daily changes in climate, political or military action, we see increasing security concerns for food safety. Food safety can be achieved through the implementation of a series of measures planned by actions and rules of the documented procedures mostly oriented

towards mitigating the different types of hazards, thus reducing the risks associated with them. This is very often manifested in practice by reduction of microbial contamination of raw materials, reduction of the diseases in plants and animals, reduction of the concentration of accumulated chemical contaminants from the environment and plant health and veterinary measures, reduction of food losses and reduction of nutritional diseases.

The main strategic guidelines are aimed at providing the scientific basis for measures throughout the food supply chain and providing leadership and assistance in the development and strengthening of risk-based, integrated national systems for food safety [10].

Our survey conducted for the period 2013-2018 found that many Bulgarian companies engaged in the storage of cereals currently employ tools to manage the safety of stored cereals that do not go beyond the legal requirements, namely by implementing programs related to Good Hygiene Practices (GHP) and Good Manufacturing Practices (GMP), as well as a HACCP plan with the application of the 7 principles defined in the HACCP concept. The analysis outlines the possibility of comparison of modern food safety management systems with the requirements of internationally recognized standards and prevailing practical models for safety management as prescribed by the legislation. This comparison is made to indicate the weaknesses and strengths of these two systems, which pursue the same goal, namely ensuring the consumption of safe food, but in practice reach different results. Legislated FSMS are compared with those developed and implemented according to the requirements of internationally recognized standards, with the latter being a system which is verified by an independent certification organization [11]. On that basis, each company receives a certificate that proves the ongoing management of food safety in all processes from the creation to the marketing of their products/services to customers and partners. A management system cannot be a regulated product and therefore the certification of the quality assurance system is always a voluntary measure. The validity of the certificates is three years. After expiry of its validity, the certificate is renewed by recertification audit again conducted by an independent certification organization.

Based on the comparison, guidelines for the improvement of the respective system have been laid down, through the development and implementation of a certified food safety management system (presented in Table 2). The results of the comparative analysis give grounds to assert that companies need to *implement mechanisms* for strategic and tactical management of food safety. This improves the *internal structure and the interaction with the factors of the external environment* in the long term. Otherwise, the discrepancies will deepen and the established practice of safety management for cereals will increasingly move away from the growing demands of consumers, who expect to consume food that is safe for their health.

Table 2: Comparison between modern food safety management systems and applied models of safety management as required by the legislation in the Republic of Bulgaria

<b><i>Modern food safety management systems (FSMS) under the requirements of internationally recognized standards in the cereals sector</i></b>	<b><i>Food safety management systems (FSMS) under the requirements of laws and regulations in the cereals sector</i></b>
<b>At the level of strategic and tactical management of food safety</b>	
Mechanisms have been developed for strategic and tactical management of safety. Within the strategic management, basic guidelines and objectives are set in the long	Lack of competently prepared strategies, technology projects and business plans for the companies, in accordance with regulatory requirements.

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<p>term, and then strategies are developed to achieve the objectives by defining a Safety Policy. Policies are then announced and the personnel are urged to get familiar with them.</p> <p>The parameters of the strategies are formulated in strategic plans and measurable objectives related to reduction or mitigation of hazards with a view to ensure food safety. Ensuring the integration of food safety requirements in the business processes of the organization. Safety management is conducted by applying the process approach with provision of resources. The senior executives demonstrate the continuous improvement of FSMS by applying a leadership approach.</p> <p>Determining the context of the organization, by defining the extent of the impact of external and internal factors related to food safety. At the strategic level, this influence is regularly reviewed and the information related to the dynamics of these external and internal circumstances is updated.</p> <p>Effective exchange of information with stakeholders in the food chain about issues related to food safety.</p> <p>Identification of the needs and expectations of stakeholders with applicable statutory, regulatory and customer requirements in terms of food safety, and establishing mechanisms to respond to these requirements. This information is then reviewed and updated by the HACCP team and the senior executives in order to achieve the objectives and ensure food safety.</p> <p>A safety team is formed with clearly defined responsibilities and powers, and the necessary qualifications and competence. A team of specialists in the sector.</p> <p>Clearly defined responsibilities and powers of all employees with regard to safety, and reporting upon detection of deviations of the set parameters for the purpose of</p>	<p>The goal is compliance with the minimum regulatory requirements regarding the safety of stored cereals.</p> <p>Existence of many small companies with poor production resources (agricultural cooperatives or warehouses of farmers).</p> <p>Lack of sufficient financial resources to develop FSMS that exceed regulatory requirements.</p> <p>Lack of competent personnel for the preparation of documented rules relating to the application of the safety principles set by the HACCP concept.</p> <p>The impact of external and internal factors related to food safety is not documented and taken into account.</p> <p>Only what is required by the regulatory provisions is taken into account, but not the requirements of stakeholders.</p> <p>Lack of proper identification of the responsibilities and powers of the safety team leader, including their qualifications and competence regarding cereals-related risks for the health of consumers. The team is only identified on paper.</p> <p>There is no adequate training and competence-raising for the food safety team, the latter exists only "on paper" so as to meet the requirements.</p> <p>Lack of sufficiently qualified personnel and professionals in companies, with respect to the implementation of best practices in the supply and subsequent storage of cereals.</p> <p>The risk is limited to the assessment of hazards in the technological process and the determined critical control points (CCP).</p> <p>Processes are not identified; only programs for management of the self-control system are introduced (GHP and GMP) and HACCP plan for the product.</p>

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<p>identification of hazard or risk related to safety.</p> <p>Thinking based on risks and opportunities associated with events and their consequences related to the efficiency and effectiveness of the FSMS.</p> <p><b>Identification of risks related to public health.</b> Actions planned to address these risks and possible outbreaks, rules governing actions in the production process concerning product safety. Action planning to address the risks and use opportunities to avoid risk and risk-taking, to remove the source of risk, change the probability or consequences, share the risk or accept the risk through informed choice.</p> <p>Adequate response in case of changes related to the functioning of FSMS processes, dangers, statutory requirements or the requirements of stakeholders.</p> <p>Opportunities to be identified can constitute the basis for improvement by adoption of new practices – use of new technologies, modification of products or processes, introduction of new practices to control hazards, fulfilment of the requirements related to food safety.</p> <p>Defining the rules for communication with external stakeholders and the rules within the organization (vertical and horizontal).</p> <p>Planning of measures for the effective control of processes and products – planning internal audits, audits by a second party, and certification audits by a third party.</p>	<p>Lack of technical or technological documentation guaranteeing the production processes of the company.</p> <p>The working teams of cereals facilities are with insufficient staffing and inadequate qualification in terms of understanding the different hazards.</p> <p>Inadequate actions in case of changes related to regulatory requirements or customer-specific requirements related to product safety.</p> <p>Lowered and insufficient control of the incoming supply of cereals (in terms of impurities, contamination, moisture, etc.).</p> <p>Poor control by the competent authorities concerning the frequency and thoroughness of inspections.</p> <p>Lack of basic technological equipment.</p> <p>Inadequate care by managers regarding the health of the personnel with the participation of Occupational Health Services (OHS).</p> <p>The experience gained in the field of grain storage is a prerequisite for availability of ready solutions in case of discrepancies relating to the rules of storage and its parameters in order to protect products from phytopathogenic diseases.</p> <p>The HACCP system covers only the dangers in the stages of the technological process with a focus on defining control measures in the analysis of any threat aimed at its reduction or elimination. The steps of the technological process are evaluated with the tool known as "Decision Tree", which leads to the determination of steps specifically designed to eliminate a hazard or reduce it to an acceptable level.</p>
<p><b>At the level of operational safety management</b></p>	
<p>In operational terms, there are three main subsystems for food safety management</p> <ul style="list-style-type: none"> <li>• Subsystem for interaction with the external environment. The purpose of this</li> </ul>	<p>Within the scope of FSMS, the requirements for the infrastructure in terms of the current conditions of the manufacturing site are interpreted.</p>

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<p>subsystem is the most comprehensive interaction with factors relevant to the requirements of stakeholders to safety, Management of processes related to the maintenance of infrastructure, personnel and working environment.</p> <ul style="list-style-type: none"> <li>• Subsystem for planning and control of safety. The main feature is that in the planning and control responsibilities and powers are distributed horizontally, i.e. to the immediate executors of the operation and with a clear definition of these responsibilities in the documented rules of FSMS.</li> <li>• Subsystem for continuous optimization of safety: it is regarded as a dynamic value. At the linear level, mechanisms are developed to improve safety management, participation of members of the HACCP team (periodic review of the risks for specific products and the adequacy of control measures in respect of such risks).</li> </ul> <p>Establish, maintain and continuously update FSMS by using externally developed elements of prerequisite programs, hazard analysis and the plan to control hazards.</p> <p>FSMS is specially adapted to the processes and products of the organization by the appropriately qualified food safety team.</p> <p>Trainings related to food safety in case of emergency, force majeure, including simulation of measures adopted for the management of safety risks.</p>	<p>Batches of cereals which are very small in volume and heterogeneous in quality in terms of microbiological and chemical purity.</p> <p>Reduced control of hygiene and cleaning of transport facilities in receiving deliveries of cereals, including warehouse capacities.</p> <p>Improper personnel behaviour at work.</p> <p>Unsuitable buildings and production facilities intended for acceptance and subsequent storage of cereals.</p> <p>The FSMS put in place: contains rules for prerequisite program that hardly vary due to changes in the environment, the system is only updated upon instructions by the supervisory authority. The HACCP system is based on the principle Good practices for the sector, and in most cases it covers universal, not specific rules for a particular company.</p> <p>Incoming control is performed visually, with the exception of organizations with own laboratories for physico-chemical analysis. It can be assumed that the deliveries may contain real hazards.</p> <p>Insufficient measures and actions regarding deratisation and disinfestation of infrastructure and products.</p> <p>Treating cereals with fumigants upon detection of live pests. In most cases, the prevalence of live pests is increased many times and requires the use of high concentrations of chemicals for treatment. This in turn causes increased chemical residues in the grain mass;</p> <p>Not uncommonly, the documented HACCP system requires the use of external licensed pest control company, but in practice only internal measures are applied by the employees themselves to address emerging problems with pests.</p> <p>Intersection of the traffic flows of raw material, finished product, personnel and waste.</p>

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	<p>Lack of sufficient storage space for control of storage parameters.</p> <p>Lack of sufficient storage space for separate storage of heterogeneous batches.</p> <p>Low level of personal hygiene of the personnel.</p> <p>The HACCP team does not review the recorded parameters specified in the CCP, when a trend is noticed for them to go beyond of the specified limits.</p>

### 3. CONSLUSIONS

The following conclusions can be drawn: the existing traditional systems based only on legislation show a lack of long-term management perspective, i.e. there is virtually no strategic and tactical management. Food safety management is not subject to specific targets for improvement of the organization; instead, it is oriented towards removing negative aspects or discrepancies identified during inspections. Thus the decisions on change management are very often vague and inadequate. All this leads to a fear of change and passivity. As a result, this type of management has little chance of development, i.e. it maintains the existing production levels with no prospect of large-scale expansion and market positioning and last but not least, the safety of the products sold remains is still regarded with suspicion by consumers.

Certified FSMS and the implementation of risk management measures create the basis for increased efficiency of the system and thus ensure the achievement of better results and prevention of negative consequences. On this basis, priorities are set to ensure the safe storage and market placement of cereals.

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