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FOOD SECURITY – RISKS, CORRECTIVE ACTIONS, MONITORING

ABSTRACT

The paper attempts to make a brief analysis of risks (inventory of resources, identification of hazardous events, prioritizing the hazards control, identification of control measures, defining the operational and critical limits, establishment of the monitoring system), of corrective and validation actions, of hazard identification in the microbial risk assessment, of responsibilities. The methodology used is based on the risk and opportunity analysis and synthesis, the analysis in the context of sustainable development, the analysis and the synthesis of information on the corrective measures, validation and responsibilities. The information was supplemented by information contained in articles and studies published in professional journals, in the National Rural Development Programme (NRDP) 2007-2013, in Romania's development strategies concerning the rural area, biodiversity, sustainable development. The obtained findings allow us to conclude that in a time of global changes such as climate change, population growth, intensified exploitation of resources and ecosphere services, food security and nutrition security are a global challenge, in the context in which the food demand may exceed production capacity. Food security is conditioned by the amount of available food, by its quality and by the access to food.

Key words: agricultural ecosystem, risks and opportunities, sustainable development.

JEL Classification: Q01, Q18, Q57.

1. INTRODUCTION

Food security. According to "the World Declaration on Nutrition" (FAO/WHO, Rome, 1992) and "the Declaration on World Food Security" (FAO/WHO, 1996), "**food security exists when all people, at all times, have physical and economic access to safe and nutritious food to meet the needs of the body, to lead a healthy and active life**".

Food security is a policy at the state and global level. The food and nutrition for the population of the Earth is an international concern of the World Health Organization (WHO), Food and Agriculture Organization (FAO), Codex Alimentarius Commission, etc.

Our times are marked by global changes, which, together with the the climate change, the food security, population growth and increased exploitation of resources, represent a global challenge, in the conditions of the continuous food demand increase.

The right to food is one of the fundamental human rights, making food security become an important issue in the development strategies and policies (Food and Agriculture Organization of the United Nations, 2004).

The changes in the consumption habits of mankind, together with the increase of the amount of necessary food to meet new nutrition patterns have led to agricultural production increase. But this increase in the quantity of food intake must to be carried out in a sustainable way (sustainable development) within the limits of endurance and self-regulating environment.

Romania ranks 51 in the world (Figure 1) in a hierarchy that took into consideration all the food security determinants (Source OXFAM, 2014)[1].

Romania ranks:

• 18 in the world (Figure 2), out of the 125 monitored countries, taking into account the indicator amount of available food (subnutrition level and percentage of underweight children).

• 45 in the world (Figure 3), taking into account the indicator food accessibility level (measured by the price level versus other goods).

• 56 in the world (Figure 4), taking into account the food quality indicator (measured by diet diversity and access to clean water).

• 61 in the world (Figure 5), taking into account the indicator effects on human health of two high incidence diseases (diabetes and obesity).

Certain farming types (from the agricultural ecosystem) may generate a negative environmental impact at local, regional and global level with long-term consequences on the hydrological or climate circuit regulation and on soil quality (UNCED, 1992)[2].

Any modification of the natural self-regulation of the environment impacts food quality, the amount thereof and the access to it, which in their turn are conditional to food security.

The food safety objective of the European Union is to protect consumers' health and interests, while ensuring the proper operation of the single market along the entire agri-food chain (EU Council, 2006).

[1] http://www.oxfam.org.uk/what-we-do/good-enough-to-eat table. Oxfam is an international confederation of organizations that advocate for poverty eradication and has data collected from the World Health Organization, Food and Agriculture Organization, International Labour Organization. In this study 125 countries were monitored. The indexing was performed taking into account: the amount of available food (subnutrition level and percentage of underweight children), accessibility of food (measured by the price compared to other goods), food quality (measured by diet diversity and access to clean water), effects upon health.

[2] UNCED - United Nations Conference on Environment and Development held in Rio in 1992 established 27 principles, with the goal to establish new and equitable global relations through the creation of new cooperation levels among the states, which should respect the interests of all people and protect the overall integrity of the environment and sustainable development.

Figure 1. General classification of the 125 monitored countries.

Figure 2. Classification of the 125 monitored countries according to the available food quantity.

Figure 3. Classification of the 125 monitored countries according to the food accessibility level.

Figure 4. Classification of the 125 monitored countries according to food quality.

Figure 5. Classification of the 125 monitored countries according to the effects of food on health.

The theoretical systematization can be formulated according to the following definitions:

– The **agri-food economy** includes all the activities that contribute to the consumption function in a given society. Seven sectors are involved here: agriculture, agricultural and food industry, agricultural and food distribution, restaurants, related industries and services (that provide intermediate consumptions and equipment necessary for the operation of agri-food chains), international trade and socio-economic consumption units.

– The **food economy** concentrates the activities related to meeting the people's nutritional needs, manifested through the relation between the biological needs and the capacities of access to food, in parallel with the food supply and supply capacity; the entirety of this domain may represent a finality of the agri-food economy.

– The **agricultural economics** deals with an economy branch, whose sphere of activity is related, to a significant extent, to the upstream and downstream industries, including the intermediary activities and having priority openness to rural economy.

– The **rural economy**, a much wider field, comprising all the economic processes, their extra economic social connotations at the rural area level and in the rural communities in particular.

The agri-food system appears as a totality of the upstream agriculture material production branches, providing necessary productive or non-productive inputs and services, the agricultural production itself, the food industries, storage, transport, distribution and marketing network to the final consumer – the population.

2. STATE OF KNOWLEDGE

Food safety starts from the raw agricultural products used in food production and ends up at the moment of food consumption, on the basis of "*from farm to fork*" concept (according to EU and WHO). All these can be tracked by the traceability systems. Thus food safety and food security can be ensured by providing data on the characteristics of foodstuffs. This is achieved by traceability reports throughout the food chain (Alpas and Kyimaz, 2011).

But what are the agri-food chain levels in which risks may arise? They may occur at the following levels:

A. Agriculture and Transport. Quality raw products are essential for the final food product safety. From farm to food processors, the product might be chemically or biologically contaminated. Out of this reason, there is a specific legislation that refers to this part of the food chain: legislation on hygiene and food safety (transport and storage) and ISO[3] standards on food storage and delivery.

B. Production, Processing and Distribution of Foodstuffs. Currently, the food industry is based on modern systems of quality management in order to ensure food quality and safety on the market.

C. Food Packaging. Food packaging must maintain the integrity, safety and food quality during the transport, in wholesale and retail shops and to people's houses. Packaging extends the shelflife of food and contains important information on the label[4]. Using the information on the label, the transport and retail companies can identify the source of potential risks. The following information must appear on the food label: product name, list of ingredients in descending order of weight, durability, weight, utilization/storage conditions, name and address of the food manufacturer or importer, details on the origin of the food product.

D. Food consumption. The role of consumers continues at home and is equally important in ensuring food safety. There are some important rules for

[3] List of Romanian standards that adopt the European and international standards in the sanitary-veterinary and food safety field: SR EN ISO 13366-2:2007, SR EN 14132 2004/AC:2007, SR ISO 16649-1:2007 şi SR ISO 16649-2:2007, SR ISO 18593:2007, SR ISO 21528-2:2007, SR EN ISO 21570: 2006/AC:2007, SR ISO/TS 22003:2007,SR EN ISO 22005:2007, SR ISO TS 22964:2007.

[4] (EU) Regulation no. 1169/2011 of the European Parliament and of the Council of 25 October 2011 on informing consumers about foodstuffs put together the food labeling Directive 2000/13/EC and Directive 90/496/EEC on nutrition labeling in order to improve the levels of information and protection of European consumers, so that consumers may have at their disposal clear essential information under an easily understandable form.

handling food safely at home, such as compliance with the hygiene and sanitary norms for hands and utensils, rules to prevent cross-contamination, fast cooling of food products that are properly cooked, appropriate refrigeration. New challenges and risks for consumers' health and interests arise as a result of the food chain globalization. Under the EU food safety policy, the main objective is to reach the highest possible level of human health and consumers' interests protection in relation to food. There is a close collaboration between experts from different fields such as chemistry, biochemistry, microbiology, toxicology, immunology, food science and biotechnology, hygiene, health, nutrition for ensuring food safety.

3. MATERIAL AND METHOD

The methodology that was used in the paper was based on the detailed analysis and synthesis of risks and opportunities in the context of sustainable development, analysis and synthesis of information on corrective, validation measures and of responsibilities. The method of data collection was primarily quantitative, as it is a generalizable, deductive and objective method. The information was supplemented by the information contained in articles and studies published in professional journals, in the National Rural Development Program 2007-2013, in the rural development strategies, biodiversity and Romania's sustainable development strategies. For the quantitative analysis method, the risk analysis was used (resource inventory, identification of hazardous events, prioritization of hazards control, identification of control measures, defining operational and critical limits, establishing monitoring system), the analysis of corrective and validation actions, identification of hazards in the assessment of microbial risks and of responsibilities.

4. RESULTS AND DISCUSSIONS

The food safety system contains the latest scientific data and the harmonization of the European legislation with the national legislation.

The international (WHO, FAO, Codex Alimentarius) regulations specify three steps in risk analysis.

1. Risk Assessment – includes hazard identification, characteristics, exposure to risk. The purpose of this evaluation is to investigate the nature of potential infestation sources (physical, chemical or biological) – **System evaluation**.

2. Risk management – the behaviour in relation to the identified risk is established. This behavior depends on two critical factors: a) the level of risk is acceptable (critical point) and b) the required measures so that this level may not be exceeded – **Operational monitoring**.

3. Risk communication – this process is an interactive exchange of information and solutions to address the risks between two crucial parts: a) the responsible persons in risk assessment and management and b) consumers or other stakeholders –**Management and Communication**.

A further evaluation is achieved by locating the possible vulnerable points of risk occurrence.

The first component is **System evaluation**. This has as first level **team establishment and resource inventory**. A multidisciplinary team is required as starting point in risk assessment, consisting of managers, engineers (operations, maintenance, design and investments staff), quality control of samples (micro-biologists and chemists) and technical staff involved in daily activities, with a good knowledge of the system and the (projected) dangers for food safety.

Identifying dangerous events. The chemical hazards and the toxicity of chemical compounds depend on a number of factors, such as:

a. Frequency and amount of vehiculated chemical contaminants;

b. Synergism or antagonism between chemical pollutants and food;

c. Attenuation or increase of pollutant toxicity depending on the metabolic changes in animal or plant tissues.

The chemical contaminants are classified as follows:

– Mycotoxins (e.g., aflatoxins, fumonizins, trichothecenes, patulin, ochratoxin) ELISA (Enzyme-linked Immunosorbent Assay) immunoassay and HPLC techniques;

– Heavy metals in food and packages;

– Migration of toxic components from packaging (monomers, phthalates);

– Nitrates, nitrites, pesticides, fungicides, etc. (farming practices);

– Dioxins and furans (burning of stubbles and forests, chemical industry, etc.);

– Acrylamide (unprotected food processing at temperatures over 180°C).

The chemical contamination of food results in :

– Antienzymatic (digestive) action (GI) - preservatives;

– Despoiling and stressful action;

– Allergenic activity (antibiotics, preservatives, antioxidants, flavors, etc.).

– Antienzymatic action – pesticides or heavy metals, etc.;

– Mutagenic, teratogenic and mainly oncogenic action of certain pollutants or food additives;

– Irritation and keratinization of mucosa – preservatives, oxidants or flavours.

The effects of chemical pollution: slow growth, can affect reproductive capacity, the body's immune potential, effects on the liver, kidney tissue and sometimes on the nervous, hematopoietic and endocrine systems, hematopoietic organs or directly on erythrocytes (or white series).

The biological hazards (risks – bacteria, viruses and protozoa) generally come from contamination with human or animal wastes, although opportunistic pathogens may also develop under certain conditions in other hosts as well. In general, the contamination with organic human material can be used as a primary starting point for identifying the most dangerous events. The quantitative assessment of biological hazards can be used to quantitatively estimate different contamination modalities, improving the defense on the most important way of transmitting infectious germs. The development of control along the major routes of transmission of biological agents increases the importance of minor pathways, the latter being considered in various biological risk management scenarios. The quantitative

assessment of microbial risks can be also used to establish the significance of "bad days" (the temporary effect, lower performance of treatment).The treatment effectiveness varies and most risks are associated with these bad days. The analysis of hazards and of critical control points can solve up these "bad days" issue, but it is less suitable for the evaluation of minor ways of disease transmission.

Similarly, the quantitative assessment of biological risks can determine the significance of certain modalities to avoid the critical control points (spatial effect) like that of a weaker performance filter, from a set of parallel filters. If the performance of this filter is severely compromised, the adequate performance of other filters will not compensate this deficiency.

Through quantitative assessment of biological risks we can compare the risks for different hazards and the hazardous events can be evaluated under alternative scenarios.

Prioritization of hazard controls. In any system, there may be several hazards and hazardous events, as well as a large number of potential control measures. Therefore, the priorities for the control measures must be defined first of all. The prioritization matrices are hierarchization tools of control measures, to focus on the most significant hazards. By using a semi-quantitative assessment of prioritization, the score for each identified hazard is calculated, within the necessity to establish current risks. The likelihood and severity of each risk can be thus calculated and a critical point can be established, above which the hazards need to be taken into consideration. **A quantitative assessment of biological risks provides for the prioritization basis**.

Identification of control measures. The control measures or "barriers" represent any activity that can reduce the hazard levels, either by reducing the entry of pathogens or by reducing their proliferation. The so-called "principle of multiple barriers" represents the basis of emergency plans. For certain control measures (such as the treatment processes), one can define the operational acceptability limits and the operations can be directly or indirectly monitored.

The second component of the evaluation is the **Operational monitoring**.

A first level of this component is **defining operational and critical limits**. For the control measures, operational or critical limits are established. The limits are set for certain parameters that can be monitored or the aspects concerning the adequacy of control measures are specified. The current knowledge and experience can be used as guidelines for the establishment of limits.

Establishment of the monitoring system. The monitoring consists of all measures and actions leading to a planned sequence of measurement or observation of the control parameters, so as to assess whether the control measures operate properly. Monitoring should be carried out in conformity with a plan for the collection of samples so as to prevent potentially unsafe material supply. The monitoring, among other characteristics, determines the period for which a likely collapse of the protection systems against undesired events may remain unnoticed or unannounced. From practice it is known that a longer exposure to a pathogen will lead to a higher risk of disease. Each solution/scenario or a combination of

solutions has to comply with the established health targets. This quantitative assessment of biological hazards can be used as a tool for designing monitoring programs. When the target limits are exceeded, corrective actions are needed that will bring the system under control. If the critical limits are exceeded, urgent actions are needed to prevent non-compliance with health targets and thereby increased health risks. There are different levels of corrective actions. These may be limited to control measures, which, although exceeding certain limits, may include more stringent control measures or can act with a relatively higher efficiency. The quantitative assessment of biological hazards can be used to determine what limit, which goes beyond the limit of individual control measures, can be reached in non-respecting the system in its entirety, so as not to cause major effects on the protection of staff.

The practical application. The implementation of monitoring programs is seen as an iterative process. At each new iteration a larger amount of information is available, which leads to an improvement of the risk management process. Similarly, the quantitative assessment of biological risks can be completed with more specific data, so as to improve the accuracy of risk assessment, as the evaluation is resumed.

In practice, many questions arise whose answers lead to the improvement and optimization of monitoring programs of events at the workplace. Does my system satisfy the basic health targets? The answer to this question typically requires a quantitative risk assessment.

Other problems requiring quantitative answers are:

What is the priority of the various hazards/hazardous events, which may focus on the risk management into question?

Where can I set my operational and critical limits?

How much monitoring is required?

What is the required level of corrective actions?

The quantitative biological risk assessment provides much more objective information than experts' opinions, with a scientific basis, supported by experimental data evaluation, leading to a more solid basis for risk management.

The biological risk assessment provides for a better understanding of problems and identifies the important data. In addition, risk characteristics allow us to focus and prioritize the research to those areas where important pieces of information are missing.

A third component of the evaluation is **management and communication**.

The first level of this component is **to establish corrective actions**. The corrective actions will ensure food safety by strengthening the critical control point or by implementing additional control measures. These actions must be completed in a sufficiently small time period to meet specific requests. There are cases where significant deviations of the control measures are produced. These are outside the scope of corrective action. Such unpredictable incidents are less frequent and they require an appropriate response. The normal development of operations can be maintained by the existence of an emergency plan. This must be available and

applied promptly, in the case when an operational or critical limit has been exceeded. The plans for incidents and emergencies (natural disasters, intentional contamination etc.) are required to ensure the safe development of activities under these exceptional circumstances.

A second level of the management and communication component is called e**stablishment of validation and verification**. The validation and verification criteria must be established. The previous information, i.e. databases, is supportive for this stage.

Communication. The regulations on the biological or chemical infestation risks are based on defining a reference level of acceptable risk. Risk communication by authorized persons is a sensitive issue. The open and transparent communication, as well as choosing the presentation modality (i.e. discussions on risk assessment or safety evaluation) is extremely important.

Besides the three main components of risk assessment, there are also support programs, support processes.

The adequate staff training, involving all the responsible entities in obtaining safe products, in the safe development of procedures for good operational practices or monitoring methods are all good examples of support programs.

5. CONCLUSIONS

a. Currently, there is the possibility of on-line monitoring and carrying out risk assessments and communicating preventive measures without the physical presence of experts in the establishment. There are increasingly efficient and advanced tools for on-line monitoring, data processing and process control. One element in this context is the need for the calibration and verification of measuring control instruments, especially when the process of parameters monitoring is automated.

b. Out of the above-mentioned elements, it results that for the purpose of food security, the evaluation of the hazards categories, of critical limits, of communication plays a major role in identifying the main risks, threats and food vulnerability.

c. Priorities of food security in the next period:

– hygienization of water sources;
– development of agricultural research to promote new modern farming technologies;
– improving the management of natural resources;
– promoting sustainable development in less-favoured areas;
– support to a healthy national and international trade.

d. The mass communication methods should target prevention, as essential element in food security.

e. Identifying the overlapping areas and the deficiencies in the responsibilities of the active institutions in food safety management, evaluation of the best option.

These institutions must form a homogeneous structure, with a clear definition and complementary tasks, capable to have a coherent response with immediate and effective results.

f. A special, individual role is played by risk communication, as transparency is needed to maintain the confidence in regulators, from the part of consumers and trade partners.

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