

## Chapter 2

# Implementation of Hazard Analysis and Critical Control Points System in the Food Industry: Impact on Safety and the Environment

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### 2.1 Introduction

The present economic situation and global market conditions have led companies to look for ways to increase competitiveness by improving production processes, reducing production costs, and improving product quality. In terms of the food industry, two other factors should also be included: the need to ensure food safety and the need to protect consumers' health. Therefore, the existence of a system that ensures food safety is crucial to preserve a company's image and reputation and to increase local and international market shares.

Food safety has become a common concern worldwide, making public health agencies and governments of several countries look for more efficient ways to monitor production chains (Makiya and Rotondaro 2002).

The hazard analysis and critical control points (HACCP) system is widely recognized as a management tool capable of ensuring food safety. The keyword of the system is "prevention" (Mortimore and Wallace 1998), by means of the identification of possible contaminations before they occur, and of the definition of control measures to maximize food safety in every step of the process (Cullor 1997; Leitão 1993). Compared with traditional methods of inspection and quality control based on the analysis of finished products, HACCP facilitates a stricter control of contaminations (Stevenson 1990).

The HACCP system is recognized as an important tool in the reduction of food-borne diseases (FBDs), and it is a global reference in terms of food safety control. It is recommended by the World Health Organization, the International Commission on Microbiological Specifications for Foods, the *Codex Alimentarius*, and food regulatory agencies in various countries.

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## 2.2 The HACCP System

### 2.2.1 General Principles and Definitions

HACCP is a preventive system for the production of safe food products. It is based on technical and scientific principles applicable to every step of the food production chain, from growing/breeding activities, to production and distribution systems, to the moment the food reaches the final consumer (ICMSF 1991).

HACCP systematic analysis identifies raw materials and processed foods that may contain toxic substances or agents of FBDs, or that are potential sources of contamination. It may also determine the possibility that microorganisms survive or grow during food production, processing, storage, and preparation (ICMSF 1991).

HACCP was developed by Pillsbury Company, after a request from the National Aeronautics and Space Administration in the 1960s, to ensure the safety of foods used in the American space program (Bauman 1990). The system has its own specific concepts and terminology, as follows (Bryan 1993; Silva 1999):

- *Hazard*: unacceptable biological (growth or survival of microorganisms), chemical (pesticides, antibiotics, heavy metals, cleaning products), or physical (pieces of glass, metal, or other materials) contamination, rendering the food unfit for consumption.
- *Severity*: magnitude of the hazard or of the consequences to the health of consumers. Diseases may be classified, in terms of severity, as lethal, chronic, or mild.
- *Risk*: probability that the hazard will occur. Risk levels may be high, moderate, or low, and may vary according to the situation.
- *Critical control point (CCP)*: a place, practice, procedure, or process that may be controlled to prevent, eliminate, or reduce the hazard to acceptable levels.
- *Critical limit*: physical (e.g., time, temperature), chemical (e.g., pH), or biological (e.g., sensorial, microbiological) attribute or value determined for each CCP, which indicates that the operation is controlled.
- *Monitoring*: measurement of time/temperature, pH, or acidity, or visual observation of CCPs in order to assess whether critical limits are met; if they are not met, the CCP is not controlled and corrective actions are necessary.
- *Corrective action*: immediate and specific procedures to be followed whenever critical limits are not met.
- *Verification*: additional tests and/or review of monitoring records in order to confirm whether the HACCP plan is working as designed. Verification may cause some of the steps of the process to be changed in order to ensure food safety.
- *Decision tree*: logical sequence of questions that enable the identification of a raw material, step in the process, or ingredient as a CCP.

HACCP has changed and developed over the years. In 1991, the National Advisory Committee on Microbiological Criteria for Foods published a report determining the basic principles of the system as it is known today (Almeida 1998). Successful implementation of HACCP depends on the understanding and correct

application of these principles (Motarjemi and Käferstein 1999), which were described by Mayes and Mortimore (2003), and by Cullor (1997) as follows:

1. Analysis of hazards and identification of preventive measures
2. Identification of CCPs using a decision tree if necessary
3. Definition of critical limits for the preventive measures associated with each CCP
4. Definition of mechanisms for CCP monitoring, and definition of procedures for using these results to adjust and control the process
5. Definition of corrective actions for deviations in critical limits
6. Definition of a recordkeeping procedure for every control
7. Definition of verification procedures

### ***2.2.2 Prerequisites for the Implementation of the HACCP Plan***

Before the application of HACCP principles, some “prerequisite programs,” such as good manufacturing practices and cleaning procedures, should be established in order to ensure basic hygiene conditions in the processing plant. These prerequisite programs, if correctly implemented, will determine the principles for correct handling of foodstuffs, making HACCP more efficient and easy to manage (Wallace and Williams 2001).

The main prerequisite programs are good manufacturing practices and sanitation standard operating procedures. These programs involve the following aspects: physical structure and maintenance of the premises, water supply, handler health and personal hygiene, pest control, sanitization of premises and equipment, calibration of instruments, quality control of raw material and ingredients, recall procedures, and measures related to consumer complaints (Brasil 1998).

The lack or inadequate implementation of prerequisite programs may lead to more complex HACCP plans, with a greater number of CCPs to be monitored, once hygienic aspects have also been included (Byrne and Bishop 2001). More CCPs means increased difficulty in managing the plan, and affects efficacy in terms of food safety (Roberto et al. 2006).

### ***2.2.3 Steps for HACCP Implementation***

#### **2.2.3.1 Preliminary Procedures**

Management Commitment, Assembling the HACCP Team, and Technical Training of the Personnel

A basic requirement for the implementation of the HACCP system is related to the staff involved in the program, who should be aware of the characteristics of the system and of the necessary commitment involved with it. The management of the company should be committed to the objectives of the plan and should be

aware of the resources that have to be made available. The HACCP team, responsible for creating and implementing the plan, should be multidisciplinary and knowledgeable regarding production, engineering, health, microbiology, and quality assurance issues (SENAI 2000). The team leader should have knowledge of the manufacturing process, leadership skills, and easy access to managers (Mayes 1994; Hajdenwurcell 2002).

The team should also include people involved in daily activities in the company, because they may contribute with information on particularities and limitations of the production process, and their presence may create a sense of commitment to the job.

Employees should be previously trained in good manufacturing and handling practices, as well as in all aspects of HACCP. A continuing education program should be created to enable constant updating (Cezari and Nascimento 1995).

#### Description of the Product; Creation and Validation of the Flowchart for the Process

The HACCP team should know the food product in detail: microbiological and physical–chemical characteristics, ingredients and formula, packaging materials, specifications for storage and transportation, and retail conditions, besides adequate handling procedures, shelf life, and the type of consumer.

The flowchart should describe all the steps, identify the equipment, and define working conditions (temperature, pressure, etc.). Flowcharts are the basis for the identification of hazards and preventive measures, and they should be periodically validated and adjusted, when necessary, to reflect the real processing conditions (Corlett 1998).

The basic conditions for the application of HACCP principles will have been created after the conclusion of these preliminary stages (Wallace and Williams 2001), as summarized in Fig. 2.1.

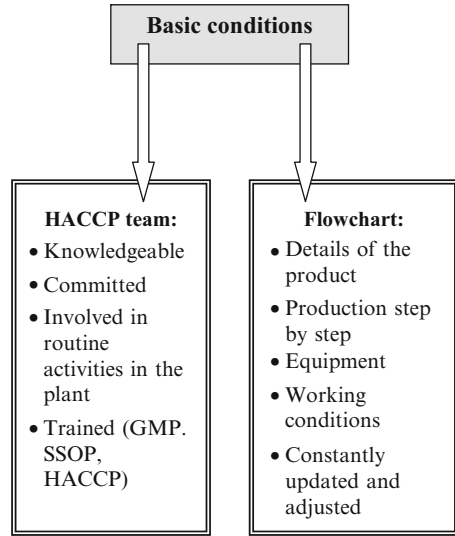
#### 2.2.3.2 Application of HACCP Principles

##### Principle 1: Analysis of the Hazards and Definition of Preventive Measures

The possible physical, chemical, and microbiological contaminations (hazards) should be determined, as well as their respective preventive measures, based on specialized literature, on the knowledge of the raw material, and on the flowchart for the process.

Although the HACCP system was originally developed to ensure food safety and protect the health of consumers, the definition of hazard is generally broader, considering not only factors that are harmless and of no consequence, but also those that cause “loss of quality and economic integrity of the product” and noncompliance

**Fig. 2.1** Basic conditions for hazard analysis and critical control points (*HACCP*) implementation in the food industry. *GMP*, good manufacturing practices, *SSOP*, sanitation standard operating procedures



with standards defined by the manufacturer. This broader definition of “hazard,” however, may increase the complexity of HACCP, and create a greater number of CCPs (Roberto et al. 2006).

#### Principle 2: Identification of the CCPs

CCPs are the steps in the process where hazards may be eliminated, prevented, or reduced to acceptable levels are identified in the flowchart by using a decision tree, if necessary.

#### Principle 3: Definition of Critical Limits

Each CCP should have a critical limit defined in terms of time/temperature, pH, temperature, acidity, etc., in order to ensure the safety of the process. In some cases, safety limits should also be defined, in a way to prevent that critical limits are exceeded. Critical limits may be defined based on specialized literature, present regulations, or the practical expertise of the HACCP team (Cezari and Nascimento 1995).

#### Principle 4: Definition of Monitoring Procedures

This step involves the definition of controls for each CCP, by means of visual observation, measurements, or laboratory analyses. The frequency with which these controls should be conducted, as well as the person responsible for them, should

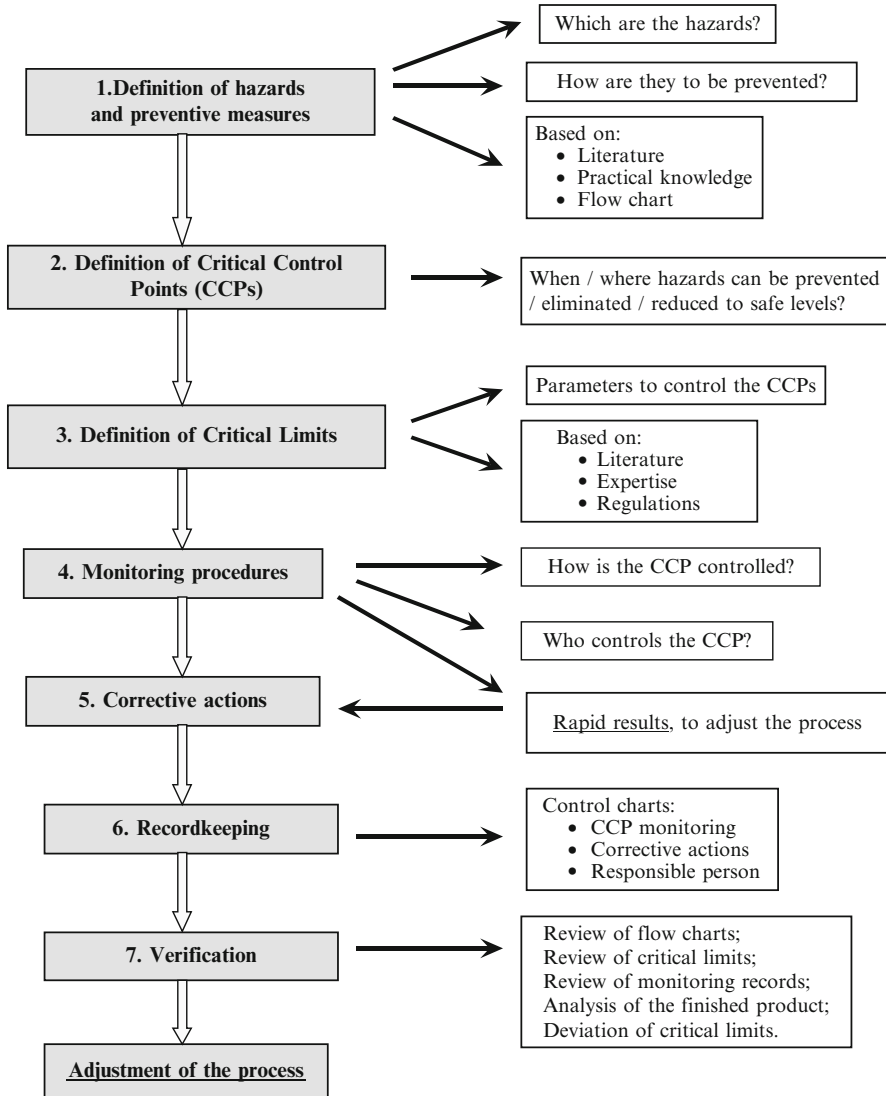


Fig. 2.2 HACCP principles and their application in the food industry

also be defined. The choice of the monitoring procedure should take into account how easy and fast results are obtained to ensure that the process is adjusted without delay, and that the flow of the process is not affected.

Inspection and calibration of the equipment used in CCP monitoring should receive special attention during this stage.

### Principle 5: Definition of Corrective Actions

When monitoring shows that critical limits have been exceeded, previously determined corrective actions should be immediately put in place to control the CCP.

### Principle 6: Definition of Recordkeeping Procedures

All CCP monitoring procedures should be recorded in control charts, which also have to show the necessary corrective actions. The recordkeeping system should, whenever possible, be integrated in the routine charts of the company to prevent the buildup of time-consuming forms to be completed. Only necessary changes should be made in the charts, such as fields for describing corrective actions and for the signature of the person responsible for the procedure (Mortimore and Wallace 1998).

### Principle 7: Definition of Verification Procedures

Verification procedures should be performed periodically to assess whether the HACCP plan is working properly. The following methods of evaluation may be used: review of the flowchart for the process, review of the critical limits, review of CCP monitoring records, laboratory analyses of the finished product, and analysis of deviations in critical limits.

Verification procedures enable adjustments in the HACCP plan, and may ensure the safety of the food. A general overview of the HACCP principles and their application in the food industry can be seen in Fig. 2.2.

## 2.3 Impact of HACCP in the Food Industry

### 2.3.1 *How the Food Industry Perceives Application of HACCP*

HACCP has become an international standard in food safety assurance. Recommended or mandatory use of HACCP is found in the regulations of several countries, and governments, industries, and consumers are showing growing acceptance of the system. The following were the most relevant cases of HACCP adoption (Fermam 2007):

- In 1972, the Food and Drug Administration (FDA) determined the use of HACCP for low-acidity canned foods. Nowadays, the FDA and the US Department of Agriculture require the use of HACCP for fish (since December 1995), poultry, and beef (since July 1996) products. The FDA has required that both US and foreign fruit juice producers use HACCP in their manufacturing processes since January 2001. The same requirement was determined for swine exporters.

- In Brazil, HACCP was made mandatory by the Ministry of Health, in 1994, for all food-handling facilities, by means of *Portaria* 1428 of October 26th, 1993. In 1998, the Ministry of Agriculture determined the use of HACCP in facilities that handle products of animal origin, by means of *Portaria* 46 of February 10th, 1998.
- In the European Union, HACCP is found in Council Directive 93/43/CEE, on the hygiene of food products. This directive was incorporated in the food safety white paper, on January 12th, 2000, and has been periodically revisited and refined with further regulations.
- The Government of Canada, in a joint effort with the fishing industry, introduced in 1993 the Quality Management Program, considered to be the first HACCP-based mandatory inspection program in the world. Canada is moving towards the implementation of a Food Safety Enhancement Program for Agriculture, a system to ensure the safety of all foods, which may further stimulate the adoption of HACCP.

Even in countries where HACCP is not mandatory, training of inspectors is based on this methodology. Some of the reasons for the adoption of HACCP by the food industry are responses to legal requirements, interest in export markets, anticipation of future requirements, and need to lower costs or to increase food safety (Donovan et al. 2001).

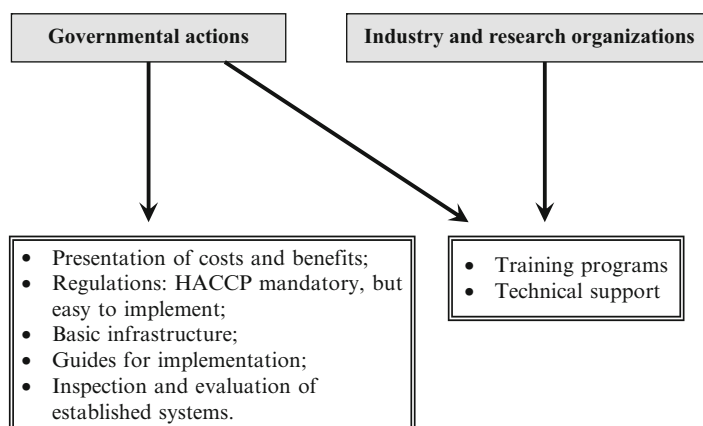
Although the system is recognized as an efficient tool in food safety assurance, and despite the efforts of several countries, broader use of HACCP is still prevented by some barriers, described in the following paragraphs.

Studies have shown that HACCP adoption is related to the size of the company and to the market where it is established. Export companies, because of their needs and of their interest in maintaining access to markets, are motivated to meet the standards determined by other countries (Donovan et al. 2001). This is also true for large companies: they have greater financial resources, and personnel with the necessary technical knowledge, making the adoption of the system easier.

The lack of clear understanding of HACCP principles, the implementation process, and the costs/benefits involved is a barrier for the voluntary adoption of the system (Ehiri et al. 1995).

According to Taylor (2003), the implementation of the system has been largely motivated by the requirements of clients, especially in large companies, such as supermarket chains, which demand from their suppliers documented proof of the use of HACCP. Still, according to Taylor (2003) author, for smaller companies whose clients are the final consumers, the greatest pressure for the implementation of the system comes from legal requirements. In countries where regulations are not strict, these companies may not be motivated to adopt HACCP.

Therefore, in small or medium-sized companies, the use of HACCP is still restricted (Taylor 2003; Ehiri et al. 1995). According to Henson et al. (1999), high costs related to the economy of scale and the lack of a clear understanding of the benefits, considered to be limited or of an intangible nature, hinder HACCP adoption. The implementation of the system is still more difficult in companies that operate with small profit margins.



**Fig. 2.3** How governments can stimulate HACCP adoption

Other obstacles and difficulties faced by smaller companies are lack of knowledge of the principles of the system, and how they would fit into their reality (methodology), lack of knowledgeable technical personnel (particularly in hazard identification and monitoring), difficulty in recordkeeping, and greater turnover of employees. However, many of these problems stem from the fact that, most of the time, managers and employees are not adequately trained (Motarjemi and Käferstein 1999), making these companies depend on external consultants (Taylor 2003).

Studies carried out by Buchweitz and Salay (2006) in food services in the region of Campinas, Brazil, showed that the lack of information and economic factors are the main reasons for not adopting HACCP. The government and its agencies have a fundamental role in facilitating and stimulating the adoption of HACCP, mainly in small companies. The following aspects should be approached in the process (Suwanrangsi and Keerativiriyaporn 2004), as summarized in Fig. 2.3:

- Demonstration of the benefits of the plan, such as reduction in the number of errors in the manufacturing process, improved company image, and reduction of the costs involved
- Mandatory adoption of HACCP, by means of regulations that make implementation simple
- Creation of training programs for the food industry and for employees of governmental agencies, in a joint effort by the government, research organizations, and the food industry
- Technical support for the companies, also in a joint effort by the government, research organizations, and the food industry
- Implementation of the required basic infrastructure, such as electricity, routes of access (roads), and treated water

- Availability of HACCP implementation guides with all the necessary technical data related to safety standards and regulations, as well as open communication channels with government agencies
- Definition of programs for inspection and evaluation of the systems that have already been implemented according to present regulations

### ***2.3.2 Impact of HACCP on Food Safety***

During the past decades, the quest for safety has been challenged by important changes in food production, such as innovations in manufacturing processes, reduced intervals between production and consumption, increased product shelf life, and increased prevalence of some microorganisms (Stevenson 1990; Bauman 1990).

As the food chain became global, FBDs are seen in a new dimension (Motarjemi and Käferstein 1999) and now represent one of the greatest health problems worldwide, affecting millions of people a year (Germano 2003) and leading to significant economic and social consequences (Ruegg 2003; Silva 1999).

Data from the World Health Organization show that, in 2005, 1.8 million people died of gastroenteritis caused by contaminated food and water (World Health Organization 2007). In spite of the technological progress in food production and control, the occurrence of these diseases has recently increased, even in developed countries (Franco and Landgraf 2003).

Food hazards or contamination may come from primary production, still on the farm, from inadequate handling or storage in the food industry, or from errors during preparation at home or in other places where the food is consumed.

Although they have not recently become an issue, FBDs have become increasingly important lately, both in terms of magnitude and in terms of health consequences for the general population. Factors related to the supply chain, demographic situation, lifestyle, health system infrastructure, and the environmental conditions of each country influence the prevalence, increased frequency, and consequences of these diseases (Motarjemi and Käferstein 1999).

When all these facts are taken into account, HACCP is an important tool in modern quality management in the food industry, ensuring the integrity of the product, preventing FBDs, and protecting the health of the consumer (Mortimore and Wallace 1998).

However, HACCP will only become effective when its principles are correctly and broadly applied in all stages of the food production chain. Some of the reasons for the recent increase in FBD frequency all over the world may be failures in implementation or limited application of HACCP, mainly in small companies; lack of knowledge of the final consumer, keeping inadequate food handling practices alive; and low rates of HACCP adoption in developing countries, where most of the FBD outbreaks occur.

### **2.3.3 *Impact of HACCP on the Economy: Cost/Benefit of the System***

In general, companies find it difficult to clearly picture the costs and benefits of HACCP (Maldonado et al. 2005). Lack of knowledge of the principles, and of how the plan works, makes it difficult to identify and separate HACCP expenses from production costs (Buchweitz and Salay 2006; Donovan et al. 2001). Therefore, as they are basically interpreted by the perception of the managers, they may be overestimated.

HACCP generally involves high fixed costs related to the creation of the plan, training of the workers, and acquisition of equipment, requiring an economy of scale (Unnevehr and Roberts 1996). Maldonado et al. (2005) emphasized the importance of evaluating the magnitude of costs before the system is implemented. However, this is quite uncommon, as confirmed by Henson et al. (1999), who showed that less than 15% of the companies estimated the costs involved before they began HACCP implementation.

Total relative costs of HACCP involve the sum of all resources made available at the different stages. The technological level of the individual plant and noncompliance with prerequisite programs contribute to greater costs in the implementation of the system (McAloon 2003; Suwanrangsri 2000). Prerequisite programs determine adequate implementation of good manufacturing practices, and make adoption of the program easier owing to the reduction of the number of CCPs (Bata et al. 2006; Henson et al. 1999). A great number of CCPs make management difficult and make auditing procedures too time-consuming (Wallace and Williams 2001).

In the initial phase of the plan, the main costs are related to the use of external consultants (when required), and to the use of the HACCP team in other positions, different from their routine ones (Bata et al. 2006). In the implementation stage, costs are related to training of employees and adjustment to prerequisite programs and specific HACCP items, such as new equipment, laboratory analyses, and adjustments in the process and in the structure of the plant.

During the maintenance phase, costs are mainly related to time consumed in monitoring CCPs and recording corrective actions (recordkeeping procedures), as well as to hiring people to monitor CCPs (Motarjemi and Käferstein 1999; Roberto et al. 2006; Donovan et al. 2001; Caswell 2000). According to Henson et al. (1999), although difficult to measure, the cost related to the time consumed filling in forms and records is generally greater than expected.

In terms of human resources, lack of trained personnel to develop and implement all aspects of HACCP make most of medium-sized companies use external consultants (Bata et al. 2006), increasing the cost of the system.

In relation to employee training, the following costs should be considered: external costs incurred by the HACCP team, including trips, transportation, meals, and loss in productivity caused by team members being away from regular positions,

or when all employees have to be trained, and by a complete interruption in the production cycle (Donovan et al. 2001). Staff training is the basis of the plan and is the key element for the motivation of the team, including plant staff, managers, and supervisors, normally cited as the main obstacles to HACCP implementation in the companies (Henson et al. 1999; Maldonado et al. 2005).

The greater or lesser impact of these elements on total HACCP costs depends, however, on the particular characteristics of each plant (Bata et al. 2006). Implementation of the system may take from some months to several years, and depends on the qualification of the employees, the complexity of the production process (Donovan et al. 2001), the number of CCPs, and the initial condition of the plant.

As for the advantages attributed to the HACCP system, there are several recognized benefits, many of them of an intangible nature or difficult to quantify. The main beneficiary is the consumer, because the system may ensure food safety and lead to the production of higher-quality products (Caswell 2000; Bauman 1995).

Benefits to the public sector are related to the reduction in costs for public health services and sick leaves, besides making it easier for regulatory agencies to monitor processes and products, saving time in audits and decreasing costs in analyses (Donovan et al. 2001; Unnevehr and Roberts 1996).

However, the companies are beneficiaries of most of the advantages of HACCP implementation, by becoming aligned with governmental regulations, and reducing the number of incidents related to the production of unsafe food (Bauman 1995). Economic advantages are related to better control of the process, less reprocessing of products, decrease in raw material and finished product losses, reduction in microbiological counts and consequent increased shelf life of the products, and gains in production efficiency (Henson et al. 1999; Donovan et al. 2001; Maldonado et al. 2005).

Hajdenwurcell (2002) demonstrated other advantages, such as the reduction in the number of laboratory analyses necessary for the finished product, reduction in sampling plans to control the process because of preventive control of CCPs, and reduction in the number of noncompliant products. Hajdenwurcell (2002) also observed that human operational errors may be less frequent owing to better training and greater awareness of the handlers.

After HACCP was implemented in Cargill, McAloon (2003) reported that the system enabled better control of the process, reduced losses and reworks, increased food safety, and improved employee commitment. Besides, McAloon (2003) reported increased productivity and lower production costs. Marthi (2003) showed that when HACCP was implemented in the fishing industry in India, productivity increased owing to fewer interruptions in the production process and to better quality of raw materials.

The use of HACCP increases exporting possibilities, because the system enables harmonization with international trade requirements (Unnevehr and Roberts 1996) and contributes to a positive image of the company, improving consumer confidence and reducing the possibilities of product recall (Ehiri et al. 1995; Motarjemi and Käferstein 1999).

According to Bauman (1995), the high costs of recalls are related to destruction of the products, momentary decreases in sales, and reduction in future sales caused by negative repercussions. Besides, legal actions and financial responsibility should also be considered, as well as costs that are difficult to measure, such as damaged company image and effects on the sales of other products.

In a study among fish-processing industries in Brazil, Donovan et al. (2001) showed that HACCP led to better quality of raw materials owing to greater control of suppliers and, consequently, to final products of higher quality.

The advantages of HACCP related to company image are more difficult to assess. They are, however, undeniable, because the system improves competitiveness and leads to longer permanence in the market, greater consumer confidence, better product/service compliance (Bata et al. 2006), and lower rates of consumer complaints (Motarjemi and Käferstein 1999). In the present, highly competitive market, these gains may make the difference between commercial success and failure.

Reduction in microbiological counts of the products, the ability to attract new clients and to keep existing consumers satisfied were recognized as the greatest benefits of HACCP implementation in dairy factories in the UK (Henson et al. 1999). However, Maldonado et al. (2005) observed that the perception of the benefits by the consumers depended on their awareness of food safety issues.

Khatri and Collins (2007) reported the benefits of HACCP implementation in meat industries in Australia, such as the reduction in losses and reworks of non-compliant products, besides reduction in the number of consumer complaints, improved hygienic conditions of the products, and increased market shares for the companies.

The greater the number of studies that demonstrate the costs and benefits of HACCP to food industries and discuss the elements that make them up, the greater the number of companies that will be motivated to adopt the system (Henson et al. 1999).

### ***2.3.4 HACCP and the Environment***

The present integrated economy increasingly demands a more proactive environmental posture from the production sector, making companies reevaluate their competitive strategies. The search for sustainable development demands a review of traditional standards of waste production, manufacturing procedures, and environmental management systems, including practices aiming at waste management and efficient use of nonrenewable resources (Tanimoto et al. 2008).

As new concepts are brought into this discussion, present consumption and production standards must be reviewed and aligned with increasingly clean and sustainable productive processes. “Clean production” involves the use of technologies that enable the use of fewer natural resources, such as water, energy, and raw material, as well as the reduction in waste production and in environmental impacts. Other measures related to production and consumption are also involved

in “clean production,” such as good operational practices and reduction in losses, adequate storage and discard of residues, redesign of products and production processes, and minimal and efficient use of raw material and energy (Andrade et al. 2001).

Although HACCP was originally conceived to ensure food safety, there are other recognized benefits related to the use of the system, such as reduction in losses during food production. Better trained employees and monitored procedures are responsible for this benefit, because systematic monitoring of some steps of the process leads to immediate responses when critical limits are exceeded, in a way that hazards are controlled without delay, preventing errors and losses during the process. Therefore, fewer failures in the process lead to fewer noncompliant products, that is, fewer products that are rejected and discarded. In the lack of strict control of the process, as proposed in the HACCP system, errors are only identified in the finished product, making reprocessing impossible most of the times, and leading to even greater losses.

Discard of finished product implies added costs for the company and for the environment, mostly related to the necessary treatment of the material before it is discarded, such as the use of energy, water, and chemical products, as well as the cost of the discard process per se. For example, residual waters of food industries, such as dairy or meat plants, contain blood, fat, meat residues, whey and amounts of milk, cheese, yogurt, dairy drinks, and butter. Treatment of these residues involves large amounts of water and produces large volumes of effluent that still have high concentrations of organic material and should be adequately treated before being disposed of into natural water bodies (Chaves 2006). Therefore, HACCP contributes to the reduction of losses in all steps of the process, and has a positive impact on environment conservation.

Packaging material is often discarded together with the products, and it is a waste of natural goods. Although materials such as cardboard, plastic, and cans may be reused after recycling, they are not always recycled and may overload landfills. According to Marinho and Kilperstok (2000), prevention of environmental pollution is a positive attitude that minimizes and may even prevent waste production by means of changes in the types of materials used, or in the production processes.

The use of high-quality raw materials, obtained from reliable companies and stored in adequate conditions, is an indispensable requisite for the quality of the final product (Góes et al. 2001; Ehiri et al. 1995). These issues are approached and foreseen by the HACCP system, as part of the reception of ingredients and raw materials in the food industry, and are important CCPs (Forsythe 2002).

Many of the raw materials delivered to the food industry come directly from primary production (i.e., from farms), where levels of contamination, mainly chemical contamination, may pose serious risks to the health of the consumer, especially in developing countries. Thus, this CCP requires critical limits for the presence of chemical contaminants, ensuring quality control of raw material, and leading to greater environmental awareness and responsibility of the suppliers, by means of controlled and rational use of pesticides and drugs of veterinary use.

Ehiri et al. (1995) and Mortimore and Wallace (1998) showed that auditing suppliers is an important element in monitoring this CCP, because it prevents many

problems that would only be identified at the moment of reception of the materials in the food industry, and enables the evaluation of quality standards of the suppliers. In this context, HACCP contributes to stimulating the responsibility of the industries in relation to food safety and quality, and environmental protection.

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