# SAFETY AND QUALITY OF FRESH FRUIT AND VEGETABLES:

## *A TRAINING MANUAL FOR TRAINERS*

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# BACKGROUND

In recent years, agricultural exports to developed country markets have emerged as a potentially major source of export growth for many developing countries. Exploiting this potential, however, poses many challenges. The capacity of developing country exporters to enter these markets depends critically on their ability to meet stringent food safety standards imposed by developed countries. Not only are these standards stringent, but they are increasingly demanding. They now go well beyond traditional quality standards, as suppliers must pay close attention to the responsible use of agrochemicals, energy, water and waste, as well as social and environmental impact. These standards are significantly higher than those prevailing in developing countries, they are subject to frequent changes and are, ultimately, often difficult and costly to meet.

It is anticipated that improving the ability of developing countries to meet food quality and safety standards for horticulture products will facilitate greater international market access, reduce the impact of price competition, stimulate investment and mitigate risk, leading to increased exports. This increase in exports will stimulate commercial production and thus encourage employment creation and increased productivity, benefiting the poor through higher incomes and more jobs.

In July 2005, UNCTAD completed the first phase of a Sanitary and Phytosanitary (SPS) project in three selected African LDCs (Guinea, Mozambique and Tanzania). To enhance the gains of this project in the countries selected, the Standards Trade Development Facility (STDF) provided funds to UNCTAD to design a technical assistance follow-up project in Guinea based on the findings of UNCTAD's study on *Agrifood Safety and SPS Compliance* and on recommendations stemming from the national workshop, which took place in July 2005 in Guinea. The overall objective of the project aims to develop a safety control system for horticultural exports (fruit and vegetables) in Guinea. In particular, the project is intended to (i) improve the capacity of

Guinean producers' associations and export associations to comply with SPS and agri-food safety standards to facilitate exports; (ii) encourage the application of internationally recognized standards by ensuring capacity-building for public and private organizations and; (iii) develop information sharing on standards. The overall strategy used is to work with the horticultural value chain in Guinea (producers, exporters, traders, service providers, public and private technicians, etc.) and to seek EurepGap certification.

In the context of the project, UNCTAD initiated plans to develop four national training workshops for Guinean public and private stakeholders on quality assurance and safety of fresh produce. The participants at these training workshops repeatedly emphasized the critical need for more training opportunities and greater availability of training materials on safety and quality of fresh fruits and vegetables.

## ABOUT THIS MANUAL

The objective of this manual is to provide uniform, broad-based scientific and practical information on the safe production, handling, storage and transport of fresh produce. This manual:

(i) Provides a teaching tool to train trainers who will be conducting courses to facilitate the safe production, handling, storage and transport of horticultural exports produced in developing countries exporting to developed country markets and elsewhere;

(ii) Serves as a resource for trainers preparing and conducting courses to assist those in the produce industry in identifying and implementing appropriate measures to minimize the risk of microbial contamination while reducing other hazards (chemical and physical) and maintaining market quality.

The material in this manual is guidance and not regulation and should be applied as appropriate and feasible to individual fruit and vegetable operations.

## USE OF THIS MANUAL

The information presented includes:

**Principles** – science-based information regarding elements of produce safety and quality.

Topics included are:

- Introduction to food safety and quality
- Food safety of fresh fruits and vegetables
- Good agricultural practices (GAPs)
- Good manufacturing practices (GMPs)
- Principles and practices of food safety management
- Food laws and food safety regulations

**Additional Resources** – include relevant reference documents and web information on issues addressed by this manual.

Users of this manual are reminded of the following important considerations in applying its recommendations:

(i) The manual focuses on risk reduction, not risk elimination. Current technologies cannot eliminate all potential food safety hazards associated with fresh produce that will be eaten raw;

(ii) This training manual provides broad, scientifically based principles. Trainers should encourage operators to use the information to help assess microbiological advances that expand understanding of those factors associated with identifying and

reducing microbial food safety hazards. Awareness of these advances will allow updating of the recommendations and information contained in this manual as appropriate to keep the content current.

## ACKNOWLEDGEMENTS

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We would like to thank all those who very obligingly reviewed the modules of this manual.

# ACRONYMS

| | |
|---|---|
| BRC | British Retail Consortium |
| CAC | Codex Alimentarius Commission |
| CCP | Critical Control Point |
| CCvD-HACCP | Dutch HACCP Code (Dutch National Board of Experts of HACCP) |
| CIES | Global Food Business Forum |
| EFSA | European Food Safety Authority |
| EU | European Union |
| EUREPGAP | Euro-Retailer Produce Working Group on Good Agricultural Practices |
| FAO | Food and Agriculture Organization of the United Nations |
| FCD | Fédération des Enterprises du Commerce et de la Distribution (French retail association) |
| FDA | Food and Drug Administration (USA) |
| FMI | Food Marketing Institute (American retail association) |
| FSIS | United States Food Safety and Inspection Service |
| GAP | Good Agricultural Practices |
| GATT | General Agreement on Tariffs and Trade |
| GFSI | Global Food Safety Initiative |
| GHP | Good Hygiene Practices |
| GMP | Good Manufacturing Practices |
| HACCP | Hazard Analysis of Critical Control Point |
| HDE | Hauptverband des Deutschen Einzelhandels (German retail association) |
| ICM | Integrated Crop Management |
| IFS | International Food Standard |
| IPM | Integrated Pest Management |

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|---|---|
| IPPC | International Plant Protection Convention |
| ISO | International Organization for Standardization |
| MAQ | Minimum Acceptable Quality |
| MRL | Maximum Residue Limit |
| OIE | Office International des Epizooties (World Organization for Animal Health) |
| QA | Quality Assurance |
| QMS | Quality Management System |
| QMS | Quality Management Systems |
| RASFF | Rapid Alert System for Food and Feed (by European Union) |
| SOP | Standard Operating Procedures |
| SPS | Agreement on Sanitary and Phytosanitary Measures |
| SQF | Safe Quality Food Standard |
| SQFI | Safe Quality Food Institute |
| SSOP | Standardized Sanitary Operation Procedures |
| TBT | Agreement on Technical Barriers to Trade |
| UK | United Kingdom |
| UNCTAD | United Nations Conference on Trade and Development |
| USA | United States of America |
| USDA | US Department of Agriculture |
| WHO | World Health Organization of the United Nations |
| WTO | World Trade Organization of the United Nations |

## IMPORTANT DEFINITIONS

The following definitions are applicable to this manual:

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| Accreditation | Authoritative process by which a certification body is assessed in its skills and capacities by the accreditation body to carry out certification in compliance with the relevant guidelines |
| Accreditation body | Authoritative body that evaluates and officially accredits the certification (and inspection) body |
| Agricultural water | Water used in the growing environment for agronomic purposes, including irrigation, transpiration control, frost protection, and as a carrying agent for pesticides and fertilizers |
| Biological hazard | Threat posed by living organisms |
| Certificate | Written approval for a product or production process showing compliance with underlying standards. Certificates are usually used only in business-to-business relations (e.g. seller and buyer) and not with end consumer (label). Most food safety certification programmes are of this type. |
| Certification | Procedure by which a third party gives written assurances that a product or a process is in conformity with a corresponding standard. With certification, a product or process may be labelled as certified. |

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| Certification body (certifier) | Third party institution that carries out the certification programme and issues and delivers the certificate. Certification bodies may execute several different certification programmes. |
| Certification programme | A system of rules, procedures and management for carrying out certification, including the standards against which it is being certified |
| Chemical hazard | Threat posed by chemical substances / agents |
| Facility | Building or other physical structures used for or in connection with handling of fresh produce |
| Foodborne disease | Diseases, usually either infectious or toxic in nature, caused by agents that enter the body through the ingestion of food |
| Food contact surface | (1) Surfaces in direct contact with fresh produce; (2) surfaces from which drainage onto the produce may occur; or (3) surfaces from which drainage that contacts the produce may occur |
| Food hazard | A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect on the consumer |
| Food quality | The totality of features and characteristics of a product that bear on its ability to satisfy stated or implied needs |

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| Food safety | Assurance that food will not cause harm to the consumer when it is prepared and/or consumed according to its intended use |
| Fresh fruits and vegetables | Fresh produce that is likely to be sold to consumers in an unprocessed or minimally processed form; fresh produce may be sold as intact produce (e.g. berries) or as cut produce (e.g. broccoli). |
| Inspection body (inspector) | (1) Third party entity that inspects the product or process according to the standard(s) which it is to be certified against and issues the inspection report to the certification body for approval (certification) and issuing of certificate;<br><br>(2) Official body or authority that inspects governmental regulations (not private standards). |
| Label | Symbol or label that can be put on a product indicating that the product or the process to make the product complies with given standards and that this compliance has been certified. Use of label is usually owned by the standard-setting body. A label is usually used in communication with the end consumer. |
| Micro-organism | Includes bacteria, viruses, fungi (yeast and moulds), protozoa (single celled animals) and helminths (worms). Also referred to as microbes. |
| Municipal biosolids | By-products of human waste treatment that may be used as organic fertilizer |

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| Operator | Person or persons responsible for daily procedures and management within a farm or facility |
| Pathogen | Micro-organism capable of causing disease or injury in humans, animals or plants |
| Pest | Refers to any animal of public health importance including, but not limited to, birds, rodents, cockroaches, flies, insect larvae, that may carry pathogens that can contaminate food |
| Physical hazard | Threat posed by materials / mechanical impact |
| Processing water | Water used for post-harvest treatment of produce, such as washing, cooling, waxing or transport |
| Sanitizing | Treatment process by which the number of micro-organisms present in a clean produce or physical surface is effectively reduced without affecting produce quality or safety for the consumer |
| Standard | Product standard: Specification and criteria for characteristics of products<br>Process standard: Criteria for the way and method products are made |
| Standard-setting body | Governmental or private bodies that establish standards which may be the subject of a certification programme |
| Traceability | Ability to follow the movement of a food product through specific stages of production, processing and distribution along the supply chain |

# CHAPTER I

# INTRODUCTION TO FOOD SAFETY AND QUALITY

## Introduction

Due to progress in science and technology and the growing globalization of production and trade of food – and the increasingly stringent national and international legislation that has resulted – today's agri-foodstuffs sector must respect ever stricter standards and increasingly rigorous quality control and monitoring procedures. Product quality is a prime criterion in gaining access to competitive markets. Most marketers will agree that, apart from everything else, commercial markets require a stable supply and consistent quality.[1] Yet paradoxically, over the past decade there has also been an increasing number of food alerts worldwide – BSE (Bovine Spongiform Encephalopathy), dioxin contamination, listeria, salmonella, camphylobacter – creating a genuine crisis of confidence among consumers. This crisis has led to multiple countermeasures, regulations and monitoring programmes for food safety and quality from both the public and the private sector. This chapter introduces the concepts of food safety and quality assurance that have been developed in recent years, and presents an overview of market-relevant quality aspects specifically concerning fresh fruits and vegetables.

[1] FAO, 2001.

# MODULE 1:
# Quality Assurance and Food Safety

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| **Learning outcomes:** | Trainers know the difference between food safety and quality.<br><br>Trainers are aware of systems for food safety management and quality assurance and know about scope of use and limitations for such programmes. |

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| **Definitions:** | Food safety | Assurance that food will not cause harm to the consumer when it is prepared and/or consumed according to its intended use[2] |
| | Food quality | The totality of features and characteristics of a product that bear on its ability to satisfy stated or implied needs[3] |

People have the right to expect food they eat to be safe and suitable for consumption. Foodborne illness or injury is at best unpleasant; at worst, it can be fatal.[4] Using the above definitions, food safety is a component of food quality. In fact, it may be argued that safety is the most important component of quality, since a lack of product safety can result in serious injury, illness or even death for the consumer of the respective product.[5] Quality might be defined differently since it is a term defined by consumers, buyers, food handlers or any other client based on subjective and objective measurement of the product. The ideal of proper product quality therefore also differs between countries and cultures and is difficult to define on an international level.

[2] CAC, 2003.
[3] ISO, 2006.
[4] CAC, 2003.
[5] University of Maryland, 2002.

Safety differs from many other quality attributes like size or colour since it is a quality attribute that is difficult to observe. A product might be of high quality since it appears attractive and yet be unsafe because it is contaminated with pathogens that are hard to detect straight away.

*** GUIDING PRINCIPLES ***

**Food safety versus food quality**

Defects and improper food quality may result in consumer rejection and lower sales, while food safety hazards may be hidden and go undetected until the product has been consumed. If detected, serious food safety hazards may result in market access exclusion and major economic loss and costs. Since food safety hazards directly affect public health and economies, achieving proper food safety must always take precedence over achieving high levels of other quality attributes.

Food safety and quality assurance in fresh produce should be ongoing processes that incorporate activities from the selection and preparation of the soil in agricultural operations through the final preparation and consumption of the food. Both food safety and quality assurance (QA) should focus on the prevention of problems, since once safety or quality has been reduced it is difficult or impossible to restore. Also, implementing QA programmes should help ensure that problems experienced in the past do not affect the future product the same way.

**!**

Food safety and quality assurance programmes should always focus on preventing problems, not simply curing them. Once product quality has been undermined, it is virtually impossible to restore.

Diverse technical and analytical skills are needed to implement and manage a food safety or quality assurance programme. A food safety or QA programme within a food operation requires a strong, semi-

independent position to act and react according to safety and quality criteria, independently of daily production management. A separate QA department that reports directly to the general management is recommended.[6] Although safety is an essential component of quality, food safety assurance is not always included in QA programmes.

The proliferation of diverse food safety and quality management standards has created a situation that can be characterized by a lack of clarity. The different understanding and use of key concepts by various standard-setting bodies has added to this confusion. The following table seeks to clarify these different concepts, standards and systems, and refers to the chapters of this manual in which the relevant system is dealt with.[7]

| **Tool / Programme / Standard** | **Content and scope of activities** | **Coverage** |
|---|---|---|
| Good Practices | Guidelines and basic requirements for a company's activities to ensure proper practices for prevention of safety and quality hazards. Good practices are often referred to as "prerequisites programmes", since they form the basis of food safety management. | |
| Good Agricultural Practices (GAPs) | Guidelines for agricultural production | Chapter III |
| Good Manufacturing Practices (GMPs) | Guidelines for food processing and handling | Chapter IV |
| Good Hygiene Practices (GHPs) | Guidelines for proper hygiene and sanitation | |

[6] University of Maryland, 2002.
[7] FAO, 2006.

| **Tool / Programme / Standard** | **Content and scope of activities** | **Coverage** |
|---|---|---|
| Standard Operating Procedures (SOPs) | Description of each step in the production and the way that these steps are to be performed | |
| Standardized Sanitary Operating Procedures (SSOPs) | Fully recorded and detailed description of cleaning and disinfection procedures to ensure their correct implementation | Chapter IV |
| Quality Management Systems (QMSs) | QMSs ensure that a company's production process and services meet the company's objectives and satisfy the customer's quality requirements. QMSs in food operations usually have a wider scope than food safety since they cover all quality elements. The reference norm for QMSs is ISO 9000. | Chapter V Module 3 |
| Hazard Analysis of Critical Control Points (HACCP) | A systematic approach to the identification, evaluation and control of food safety hazards. HACCP aims at preventing identified potential problems from occurring. | Chapter V Module 2 |
| Food Safety Management Systems | Application of QMSs within the area of food safety. Implementation of good practices is a minimum requirement (prerequisite programmes); implementation of HACCP and QMS should also be included. | Chapter V Module 1&3 |

## MODULE 2:
## Quality Attributes, Food Standards, Grading and Inspection

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| **Learning outcomes:** | Trainers understand the types of quality attributes associated with fresh fruits and vegetables and the various relevant measurements.<br><br>Trainers understand the purpose of food standards, grading and inspections in the context of international trade and handling of fresh produce. |

### A. Quality attributes

Quality attributes of fresh fruits and vegetables can be classified into three classes according to the occurrence of product characteristics when they are encountered or consumed:

| Class of attribute | Quality attribute | Measurement of quality attribute |
|---|---|---|
| **External** | Appearance (sight) | Visual evaluation of size, shape, gloss and colour<br>May be accompanied by visual guides and colorimeters |
| | Feel (touch) | Manual evaluation of firmness and texture<br>May be accompanied by mechanical texture analysis |
| | Defects | Visual evaluation of absence of defects or deterioration of colour<br>May be accompanied by mechanical methods (e.g. ultrasound) |

| Class of attribute | Quality attribute | Measurement of quality attribute |
|---|---|---|
| **Internal** | Odour | Mostly qualitative and subjective evaluation by smelling.<br>May be accompanied by technical methods (gas chromatography) |
| | Taste | Oral tasting (sweetness, bitterness, sourness and saltiness)<br>Technical quantification of taste compounds (e.g. chromatography) |
| **Internal** | Texture | Includes tenderness, firmness, crispness, crunchiness, chewiness, fibrousness which are measured by applying force to the produce; additionally, textural characteristics are evaluated as “mouthfeel”. |
| **Hidden** | Wholesomeness | Wholesomeness is difficult to measure objectively; it can be described as “freshness” “produce integrity”; it also has a “sanitary” component meaning how clean / hygienic the product is. |
| | Nutritive value | Nutritive value is measured by the content of nutrients such as fat, carbohydrates, protein as well as essential vitamins, minerals and other substances that influence human well-being. |
| | Food safety | Food safety can be measured via the examination of food items with regard to their pathogenic microbial load, content of chemical contaminants or presence of physical foreign matter in the produce. |

External attributes play an important role in a consumer's purchasing decision, whereas internal or hidden attributes often affects a consumer's decision to repurchase a product. The combination of external, internal and hidden attributes determines the overall acceptability of a product.[8]

## B. Food standards

Standards provide common frames of reference for defining products. Food standards specify precise criteria to ensure that products fit their stated purposes and meet the legitimate expectations of consumers. This makes standards useful to consumers, the food industry and regulatory bodies. Food standards may include specifications for product appearance, quality, nutritional value, product safety, labelling, packaging, methods of analysis and sampling.

**!**

Food standards are used to maintain uniformity of product quality and safety, to gain market access and establish market presence, to provide different consumers with equal information about the product and to prevent economic fraud or market exclusion. Standardization allows for correct food labelling – the basis for consumer confidence.[9,10]

In recent years, various bodies have developed food standards. Depending on where products are to be sold, these might include national and international entities as well as public or private bodies. In order to harmonize standards and coordinate joint efforts by public and private bodies, the Codex Alimentarius Commission (CAC) of the United Nations Organization should be taken as the main reference and common basis for food standards today.

[8] Pattee, 1985.
[9] FAO, 2006.
[10] CAC, 2005.

The Codex Committee on Fresh Fruits and Vegetables is responsible for elaborating worldwide standards and codes of practice for fresh produce. Codex standards are a combination of grading for quality, inspection for wholesomeness and safety and freedom from economic fraud. For more information about international food standards and laws, consult Chapter VI, Module 1 of this manual.

## C. Grading and inspection

### Grading

Grading of products is usually a voluntary programme used by the industry. Grading standards describe the quality requirements for each grade of product, giving the industry a common language for buying and selling.[11] Grading is based on certain characteristics, generally related to external attributes of appearance such as product size, shape and colourization. Grading usually does not imply criteria for food safety. Grading standards are developed and adopted either by private industry or national bodies and might be mandatory for export.

### Inspection

Fresh produce is inspected by either governmental agencies or other authorized bodies to ensure a product's adherence to regulations regarding quality, wholesomeness and food safety or specific mandatory requirements within the supply chain. Inspection is usually mandatory and involves official authorities.

[11] University of Maryland, 2002.

**!**

**Grading versus inspection**

- Grading is a voluntary programme of the food industry for product classification based on mostly external attributes and characteristics. Grading does not usually pertain to food safety.
- Inspection is generally a mandatory process conducted by governmental authorities or other agencies to ensure a product's wholesomeness, safety and adherence to regulations.

## MODULE 3:
## Produce Deterioration, Spoilage and Post-harvest Losses

| | |
|---|---|
| **Learning outcomes:** | Trainers are sensitized to causes of spoilage and deterioration of fresh produce and their effects on quality, food safety and consequences of harvest losses. |

Fresh fruits and vegetables are highly perishable commodities that can easily spoil or deteriorate during produce handling along the supply chain from the producer to the final retailer. Fresh produce spoilage and deterioration often result in rapid decay and thus in product loss for human consumption. Post-harvest product losses due to spoilage can be as high as 50 per cent, and even higher for some commodities in developing countries. Accordingly, reduction of these losses, particularly if they can be avoided economically, would be of great significance for producers and consumers alike.

All fruits and vegetables are living parts of plants containing 65 to 95 per cent water. They continue their life metabolisms after harvest and thus change their characteristics depending on product handling, storage

and treatment, all of which have a decisive impact on the life of the product. The nature of the produce strongly influences its vulnerability to different types of deterioration. The following table presents an overview of the main causes of post-harvest losses for different groups of fruits and vegetables.[12]

| **Product group** | **Main causes of post-harvest losses and poor quality** |
|---|---|
| **Root vegetables**<br>Carrots, beets, onions, garlic, potatoes, sweet potatoes | - Mechanical injury and improper curing<br>- Sprouting<br>- Water loss and decay<br>- Chilling injury |
| **Leaf vegetables**<br>Lettuce, chard, spinach, cabbage, spring onions | - Mechanical injury<br>- Water loss and decay<br>- Relatively high respiration rates<br>- Loss of green colour |
| **Flower vegetables**<br>Artichokes, cauliflower, broccoli | - Mechanical injury<br>- Water loss and decay<br>- Discoloration<br>- Abscission of florets |
| **Immature fruit vegetables**<br>Cucumbers, squash, eggplant, peppers, okra, snap beans | - Bruising and other mechanical injury<br>- Water loss and decay<br>- Over-maturity at harvest<br>- Chilling injury |
| **Mature fruit produce**<br>Tomatoes, melons, bananas, mangoes, apples, grapes, cherries, peaches, apricots | - Bruising and other mechanical injury<br>- Water loss and decay<br>- Over-ripeness at harvest<br>- Chilling injury |

[12] University of Maryland, 2002.

**!**

Deterioration and spoilage of fresh produce may be the result of biological, microbiological, physiological / biochemical or physical factors acting on the products. These factors are usually the result of a lack of proper training for product handlers, inadequate storage structures, unsuitable handling technologies, ineffective quality control and adverse environmental conditions. Also, time is a key determinant of deterioration. [13]

| **Deterioration factor** | **Determining causes** |
|---|---|
| **Biological and physiological** | |
| - Pests (e.g. insects, rodents, birds) | - Inadequate good agricultural / manufacturing practices |
| - Spoilage micro-organisms (e.g. bacteria and fungi) | - Inadequate hygiene and sanitation practices |
| - Respiration rate | - Excessive heat and high temperatures |
| - Ethylene production | - Environment (temperature, atmospheric pressure) |
| - Growth and development | - Time and environment |
| - Maturation, ripening, senescence | - Time and environment |
| - Transpiration and water loss | - Time, environment and improper packaging |
| **Chemical and biochemical** | |
| - Enzymic | - Environment, handling and bruising |
| - Oxidation | - High oxygen concentration and availability |
| - Non-enzymic changes | - Improper packaging, composition, heat |
| - Light oxidation | - Improper packaging |

[13] Satin, 2000; Potter and Hotchkiss, 1995.

| Deterioration factor | Determining causes |
|---|---|
| **Physical** | |
| - Bruising and crushing<br>- Wilting<br>- Texture changes<br>- Moisture changes | - Improper handling and packaging<br>- High relative humidity and improper packaging<br>- Environment and improper packaging<br>- High relative humidity and improper packaging |

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*** WEB INFO ***

**Additional information and documentation on Chapter I**

| | | |
|---|---|---|
| International Portal on Food Safety, Animal and Plant Health (IPFSAPH) | Official website | www.ipfsaph.org |
| US Government Food Safety Information | Official website | www.foodsafety.gov |
| EU Food Safety Programme | Official website | www.ec.europa.eu/food/index_en.htm |
| WHO Food Safety Programme | Official website | www.who.int/foodsafety/en |
| Joint Institute for Food Safety and Applied Nutrition (US Institution) | Official website | www.jifsan.umd.edu |
| Official Website of Codex Alimentarius Commission of FAO / WHO | Official website | www.codexalimentarius.net |
| UK Food Standards Agency | Official website | www.food.gov.uk |

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|---|---|---|
| Quality Standards Fresh Fruits and Vegetables<br>US Department of Agriculture (USDA) | Official website | www.ams.usda.gov/standards/stanfrfv.htm |
| Fresh Produce Grading: Standards for US<br>USDA and AMS | Official website | www.ams.usda.gov/fv/fvstand.htm |

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# CHAPTER II

# FOOD SAFETY OF FRESH FRUITS AND VEGETABLES

## Introduction

Market-oriented, successful food production must focus on the final consumer. The aim of fruit and vegetable production is to deliver a safe and wholesome final product to the consumer. Nevertheless, fresh fruits and vegetables have recently been identified and confirmed as a significant source of pathogens and chemical contaminants that pose a potential threat to human health worldwide.[14] In order to develop proper practices and methods of production, hazards and the risks that they may impose to consumer health have to be fully understood. An understanding of the agents that affect fresh fruit and vegetable safety and quality makes it possible to develop practices to minimize potential negative impacts. This chapter defines the most common potential hazards associated with fresh fruit and vegetables and provides information about the role of fresh produce in causing foodborne diseases and their influence on consumer health.

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## MODULE 1:
## Safety Hazards in Fresh Produce: Biological, Chemical and Physical

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| **Learning outcomes:** | Trainers are aware of the major biological, chemical and physical health hazards in fruit and vegetable production and know about their main causes, effects and prevention measures. |

[14] Improving the safety of fresh fruit and vegetables, 2005.

The production of fresh fruits and vegetables embraces different activities such as farming, harvesting, post-harvest treatment and processing. Within all these activities, specific hazards exist that affect product safety and quality and might therefore pose a health risk for the consumer.

In order to reduce this risk and to increase produce safety, it is necessary to first assess the potential hazards in the production environment. Once the potential sources of produce contamination or other hazards have been identified, practices can be implemented to control, reduce or eliminate them. Accordingly, Module 1 supplies an overview of the major known food safety hazards associated with the production, handling and processing of fresh fruits and vegetables.

## A. Biological hazards

Biological hazards in fresh produce come from micro-organisms such as bacteria, fungi (yeasts and moulds), protozoans, viruses and helminths (worms), which can also be termed microbes. In some cases, microbial contamination is indirectly introduced by pests. The term pest generally refers to any animals of public health importance, such as rodents, birds, insects (e.g. cockroaches, flies and their larvae), that may carry pathogens that can contaminate food.

Micro-organisms capable of causing human disease may be found in raw produce. Sometimes they are part of the fruit or vegetable microflora as incidental contaminants from the soil and surroundings. In other instances, they are introduced into or on food by poor handling practices in agricultural production or post-harvest processes.[15]

[15] CFSAN, 1998.

**!**

**Biological hazards in fresh fruits and vegetables come from pathogenic micro-organisms:**

- Bacteria
- Fungi (yeasts and moulds)
- Parasites (e.g. protozoans and helminths)
- Viruses

**The primary sources of microbial contamination of fresh fruits and vegetables are:**

- Human and animal faeces (e.g. untreated manure / faeces or municipal biosolids and sewage fluids)
- Contaminated water (agricultural and processing water)
- Contaminated soil, dust, surroundings and handling equipment
- Poor sanitary practices throughout the production chain (contamination by humans or animals)

## Bacteria

Bacteria pose a common food safety risk due to their omnipresence in our environment. Pathogenic bacteria potentially contaminate fruit and vegetables in all stages of the production chain. The number of individual bacteria that must be present to cause actual human disease varies with the type of organism as well as the age and condition of the host. The following table lists the most important bacterial pathogens that are reported to be associated with fresh produce:[16,17]

[16] FDA, 2005.

| Bacterial pathogen | Main characteristics and effect on human health |
|---|---|
| *Camphylobacter spp.* | *C.* is one of the most common bacterial causes of serious diarrhoeal illness. *C.* is commonly found in the intestinal tracts of animals or untreated water. Symptoms of *C.* infection, which usually occur within 2 to 10 days after the bacteria are ingested, include fever, abdominal cramps and diarrhoea (often bloody). |
| *Clostridium botulinum* | *C.* is commonly found in soils and is the causing agent of botulism, a serious paralytic illness caused by a nerve toxin that is produced by *C.* The toxin acts as a muscle paralysant and leads to symptoms including double vision, muscle weakness and eventually paralysis of the arms, legs, trunk and respiratory muscles. In foodborne botulism, symptoms generally begin 18 to 36 hours after ingestion of contaminated food. |
| *Escherichia coli O157:H7* | *E. coli* O157:H7 is a highly pathogenic strain of the bacterium *Escherichia coli*. It produces a powerful toxin that can cause severe illness. *E. coli* O157:H7 is commonly found in intestines of cattle, deer, goats, and sheep and may contaminate soil and water. *Escherichia coli* O157:H7 infection causes severe bloody diarrhoea and abdominal cramps. |
| *Listeria monocytogenes* | *Listeriosis* is a serious foodborne infection caused by *L.* which is found in animal intestines, soil and water. Fresh produce may become contaminated from the soil or from manure used as fertilizer. Common effects of *Listeriosis* are fever, muscle aches and serious gastrointestinal symptoms. If infection spreads to the nervous system, symptoms such as headache, stiff neck, confusion, loss of balance, or convulsions can occur. |

[17] CDC, 2006: Bacterial Disease.

| Bacterial pathogen | Main characteristics and effect on human health |
|---|---|
| *Salmonella spp.* | *Salmonella* bacteria are the most frequently reported cause of foodborne illness. The bacteria live in the intestinal tracts of infected animals and humans. *Salmonellosis* is an infection causing diarrhoea, abdominal cramps and fever within 8 to 72 hours after ingestion of the contaminated food. |
| *Shigella spp.* | *Shigella* infections may be foodborne and are usually passed on fresh produce by improper hygiene of food handlers or contamination in fields due to infected human sewage and crop production water. Common symptoms of *Shigellosis* include diarrhoea, fever and stomach cramps starting 1-2 days after exposure. *Shigellosis* usually resolves in 5 to 7 days. |
| *Staphylococcus aureus.* | *S.* is the causing agent for the gastrointestinal illness referred to as *staphylococcus food poisoning.* It is caused by contamination of foods with bacterial toxins that are resistant to heat and therefore cannot be destroyed by cooking. *S.* is a common bacterium found on the skin and in the noses of up to 25% of healthy persons and animals. The most common cause of contamination with *S*I is improper hygiene during food handling. |

Bacteria reproduce easily and quickly if the environmental conditions meet their specific requirements for growth and reproduction, such as adequate nutrients, humidity, acidity, oxygen level and temperature.

**!**

Because some bacteria have very low infective doses, prevention of bacterial contamination is the most important control factor to enhance product safety. Also, it is essential to take action to assure that pathogens already present cannot reproduce and grow to hazardous levels.

If conditions are favourable, the generation time of bacteria can be as short as 15 – 30 minutes, allowing the population of bacteria to reproduce very rapidly. Under optimum conditions, a single cell could thus produce a population of over one million cells within 10 hours.

**!**

The two main strategies to prevent hazardous levels of bacterial contamination in fresh produce are:

1. Preventing bacteria from reaching the product surface and / or keeping their initial numbers low (prevention of contamination);
2. Ensuring that bacteria that have reached the product cannot grow (prevention of further growth).

**Viral hazards**

Viruses are very small organisms that are unable to reproduce and multiply outside a living cell and that cannot therefore grow on or inside food as bacteria do. However, raw fruit and vegetables may become contaminated by viral particles with exposure to contaminated water, soil, dust or surfaces. The virus could then infect the consumer of the product if it is consumed raw. The infective dose of most viruses is extremely small (sometimes as few as 10 viral particles), so prevention

of contamination is essential. The following table shows the main viruses reported to be associated with foodborne illnesses:[18]

| Viral pathogen | Main characteristics and effect on human health |
|---|---|
| ***Noroviruses*** | *Noroviruses* are a group of viruses that cause gastroenteritis. They are found in the intestines of infected persons, who can easily pass them on. The term *Norovirus* was recently approved as the official name for this group of viruses (other names that have been used include Norwalk-like viruses) The symptoms of *Norovirus* illness usually include nausea, vomiting, diarrhoea, stomach cramps, low-grade fever, chills, headache and muscle aches. The illness often begins suddenly, and the infected person may feel very sick. In most people, the illness is self-limiting and lasts for about 1 or 2 days. |
| ***Rotaviruses*** | *Rotavirus* is the most common viral cause of severe diarrhoea among children worldwide. The primary mode of transmission is faecal–oral. Because the virus is stable in the environment, transmission can occur through ingestion of contaminated water or food and contact with contaminated surfaces. The disease is characterized by vomiting and watery diarrhoea for 3-8 days, and fever and abdominal pain occur frequently. Adults can also be infected, though the disease tends to be mild. |
| ***Hepatitis A*** | The Hepatitis A virus can be transmitted from one infected person to another by contamination of food or water.[19] Foodborne cases of Hepatitis A are recognized to occur worldwide and can mainly be prevented by proper hygiene practices during handling of fresh food. |

[18] CDC, 2006: Viral Diseases.
[19] Clinical Infectious Diseases, 2004.

**!**

Viruses can pose serious health hazards in very low concentrations. Consequently, prevention of product contamination is essential during the production process:

- Proper sanitation and hygiene measures during food handling in agricultural and post-harvest operations;
- Proper washing and sanitizing of produce before final packing.

## Parasitic hazards

Parasites are organisms that derive nourishment and protection from other living organisms known as hosts. Parasites are of different types and range in size from tiny, single-celled organisms (protozoa**)** to larger multi-cellular worms (e.g. helminths). They may be transmitted from animals to humans, from humans to humans, or from humans to animals. Several parasites have emerged as significant causes of food- and waterborne disease. Parasites live and reproduce within the tissues and organs of infected human and animal hosts, and are often excreted in faeces. They may be transmitted from host to host through consumption of food or water, or by oral contact with infected surfaces. The following table lists some of the most prominent pathogenic parasites that can be associated with fresh produce.[20, 21]

[20] CDC, 2006: Parasitic Disease.
[21] FSIS, 2006: Foodborne Parasitic Disease.

| **Pathogenic parasite** | **Main characteristics and effect on human health** |
|---|---|
| ***Cryptosporidium parvum*** | The protozoan parasite that lives in the intestines of many herd animals, including cows, sheep, goats and deer. *C.* is a significant cause of water- and foodborne illness worldwide and leads to the disease *Cryptosporidiosis*, which is accompanied by watery diarrhoea, stomach cramps, upset stomach and slight fever. *C.* is passed on via the ingestion of food or water contaminated with *C.* oocysts (infective stage of the parasite). The oocysts are the environmentally resistant stage of the organism and are shed in the faeces of a host. |
| ***Cyclospora cayetanensis*** | The protozoan parasite that causes *Cyclosporiasis*, a parasitic disease about which little is known at present but which is increasingly reported to be associated with water- and foodborne intestinal diseases worldwide |
| ***Entamoeba histolytica*** | The protozoan parasite that causes *Amebiasis.* Food- and waterborne cases of *Amebiasis* are very common in developing countries. Symptoms are quite mild and include loose stools and stomach pain and cramps. *Amebic dysentery* is a severe form of *Amebiasis* associated with stomach pain, bloody stools and fever. |
| ***Giardia intestinalis (Giardia lamblia)*** | A protozoan parasite that lives in the intestines of infected humans or animals. *G.* is found in soil, water or surfaces that have been contaminated with faeces of infected hosts. It occurs in every region throughout the world and has become recognized as one of the most common causes of waterborne (and occasionally foodborne) illness. *G.* is protected by an outer shell and can survive outside the body for long periods of time. *G.* causes diarrhoeal illness (*Giardiasis*), typical symptoms being diarrhoea, stomach cramps and nausea. |

| **Pathogenic parasite** | **Main characteristics and effect on human health** |
|---|---|
| ***Toxoplasma gondii*** | The protozoan parasite that causes the disease *Toxoplasmosis*. *T.* can only carry out its reproductive cycle within members of the cat family. In this parasite–host relationship, the cat is the definitive host. The infective stage (oocyst) develops in the gut of the cat and then spreads to the environment via cat faeces, a common source of food and water contamination. *Toxoplasmosis* brings on "flu-like" symptoms. Infants may develop severe toxoplasmosis, which can result in damage to the eyes or brain. |

**!**

Parasites can pose multiple health hazards and diseases if ingested by humans. To prevent and minimize the abundance of parasites on fresh fruits and vegetables, the following strategies must be applied at all stages of production:

- No contact with water or soil contaminated with human or animal faeces;
- No contact of infected people as product handlers;
- Prevention of contact between animals (pests) and fresh produce.

*** GUIDING PRINCIPLES ***

**Microbial pathogens and fresh produce**

Microbial pathogens pose the greatest threat to the food safety of fresh produce. The following principles should be borne in mind in any horticulture operation:

- Once a product is contaminated, removing or killing the pathogens on the produce is very difficult;
- Accordingly, prevention of microbial contamination at all steps of operation is strongly favoured over treatment to eliminate any contamination that may have occurred.

## B. Chemical hazards

Chemicals and single substances can pose a serious health hazard to the consumer if they contaminate fresh fruit and vegetables in significant concentrations. Contamination may be caused by either naturally occurring substances or by synthetic chemicals that may be added or are present during agricultural production or post-harvest treatment and further processing.

| Naturally occurring chemical hazards | Potential health risks for humans |
|---|---|
| Allergens (e.g. weeds, peanuts) | Allergenic reactions |
| Fungal toxins (mycotoxins; e.g. aflatoxin) | Multiple poisonings (acute or chronic) |
| Phytohaemagglutinin | |
| Alkaloids | Multiple poisonings (acute or chronic) |

| **Added chemical hazards** | |
|---|---|
| Agrochemicals (pesticides and fertilizers) | Multiple poisonings (acute or chronic) |
| Toxic elements and compounds (e.g. lead, zinc, cadmium, mercury, arsenic, cyanide) | Multiple poisonings (acute or chronic) |
| Processing contaminants (e.g. lubricants, cleaning agents, sanitizers, coatings, paints, refrigerants and cooling agents, water / steam treatment chemicals, pest control chemicals) | Multiple poisonings (acute or chronic) |
| Persistent organic pollutants (POPs) are compounds that accumulate in the environment and the human body. Known examples are dioxins and PCBs (polychlorinated biphenyls). | Exposure to POPs may result in a wide variety of adverse effects in humans. |
| Agents from packing material (e.g. plasticizers, vinyl chloride, adhesives, lead, tin) | Multiple poisonings (acute or chronic) |

*** GUIDING PRINCIPLES ***

**Chemical hazards and fresh produce**

Chemicals, either naturally occurring or artificially added synthetic substances, can pose serious health hazards for consumers. In order to minimize risks of chemical contamination of fresh products, it is important to:

- Make minimal and correct use of chemical additives (e.g. agrochemicals, processing and treatment agents, packing additives, pest control agents, antibiotics);

- Prevent contamination during product handling and processing by identifying potential risks and implementing adequate proper practices and countermeasures.

## C. Physical hazards

Physical hazards may be introduced as foreign material into fresh fruits and vegetables at numerous points in the production chain. The following table lists some of the most common contamination materials and their sources.

| Material | Injury potential | Sources |
|---|---|---|
| Glass | Cuts and bleeding | Bottles, jars, light (bulbs), fixtures, utensils, gauges |
| Wood | Cuts, choking, infections | Field sources, pallets, boxes, materials |
| Stones | Choking, broken teeth | Fields, buildings |
| Insulation | Choking, cuts, infections | Building material |
| Plastic | Choking, cuts, infections | Packing, pallets, equipment |
| Personal effects | Choking, broken teeth, cuts | Employees |

*** GUIDING PRINCIPLES ***

**Physical hazards and fresh produce**

Foreign material in fresh produce can result in serious injury and illness for the consumer. Most of these physical hazards are related to poor handling practices during harvesting, washing, sorting and packing of products. To ensure the food safety of fresh produce, the following principles should be borne in mind:

- Identify possible physical hazards along the production chain (agriculture and post-harvest processes);
- Implement proper practices and countermeasures and create awareness and responsibility among workers.

## MODULE 2:
## Fresh Produce, Foodborne Diseases and Consumer Health

| | | |
|---|---|---|
| **Learning outcomes:** | Trainers gain an awareness of foodborne disease related to fresh produce and its consequences on consumer health. | |
| **Definitions:** | **Foodborne disease** | Diseases, usually either infectious or toxic in nature, caused by agents that enter the body through the ingestion of food. The causing agents (hazards) can be of different types (biological, chemical, physical). |

## A. Sources of foodborne disease: The role of fresh produce

Existing data on outbreaks and prevalence of foodborne diseases show that almost half of all foodborne diseases are caused by pathogenic micro-organisms. Bacteria are the predominant microbial causing agent for foodborne disease worldwide, with viruses and parasites both playing a minor role. The other main cause of all incidents stems from chemical substances, such as naturally occurring toxins (e.g. toxins from fungi and algae) or synthetic substances (e.g. agrochemicals). Physically induced foodborne illnesses are comparatively rare.

The fact that fresh produce is often consumed raw without any type of intervention that would reduce, control or eliminate pathogens prior to consumption heightens its potential as a source of foodborne illness. However, foodborne illnesses caused entirely by fresh produce make up only a relatively small percentage – estimated at 20 to 20 per cent – of all foodborne diseases.[22,23]

**!**

- The majority of foodborne diseases are associated with biological hazards (pathogenic bacteria) and chemical hazards (toxins originating from micro-organisms).
- Purely fresh-produce-associated foodborne disease outbreaks account for a relatively small percentage of all foodborne disease. Nevertheless, they still constitute a source of contamination and pose a serious threat to human health worldwide.

[22] WHO, 2002.
[23] CFSAN, 2004.

## B. Magnitude of foodborne disease

Foodborne diseases are a widespread and growing public health problem in developed and developing countries alike. Despite recent considerable efforts by governments and the food industry to implement food safety measures to prevent foodborne diseases, today they are considered to be emerging.[24]

- The global incidence of foodborne disease is difficult to estimate, but it has been reported that in 2000 alone 2.1 million people died from diarrhoeal diseases. A great proportion of these cases can be attributed to contamination of fresh food and drinking water. [25]
- In industrialized countries, the percentage of people suffering from foodborne diseases each year has been reported to be up to 30%. In the United States of America (USA), for example, around 76 million cases of foodborne diseases, resulting in 325,000 hospitalizations and 5,000 deaths, are estimated to occur each year.[26]
- While less well documented, developing countries bear the brunt of the problem due to the presence of a wide range of foodborne diseases, including those caused by parasites. The high prevalence of diarrhoeal diseases in many developing countries suggests major underlying food safety problems.

**!**

Foodborne diseases are widespread all over the world and are today considered to be emerging despite recent efforts in the field of food safety measures. Foodborne diseases pose a considerable threat to human health and the economy of individuals, families and nations. Their control requires a concerted effort on the part of the three principal partners, namely governments, the food industry and consumers.

[24] WHO, 2002.
[25] WHO, 2002.
[26] WHO, 2002.

## C. Effects on consumer health

The effect of foodborne disease on human health very much depends on the constitution of the affected persons. Highly susceptible individuals, such as infants, children, elderly, pregnant women or persons with affected immune system (e.g. HIV), are the most affected, and foodborne disease can lead to serious consequences, including death.

**!**

The most common effects of foodborne disease include:

- Vomiting and nausea;
- Gastroenteritis and diarrhoeal diseases;
- Non-intestinal diseases (e.g. neurodiseases, premature labour and stillbirth).

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*** WEB INFO ***

**Additional information and documentation on Chapter II**

| | | |
|---|---|---|
| US Food and Drug Administration (FDA) Center for Food Safety and Nutrition (CFSAN) | Official website | http://www.cfsan.fda.gov |
| US Centers for Disease Control and Prevention (CDC) | Official website | http://www.cdc.gov |
| US Department of Agriculture Food Safety and Inspection Service (FSIS) | Official website | http://www.fsis.usda.gov |
| World Health Organization of the United Nations (WHO) | Official website | http://www.who.int/topics/foodborne_diseases/en/ |

| | | |
|---|---|---|
| US Food and Drug Administration (FDA) Center for Food Safety and Nutrition (CFSAN) | Information on chemical food contamination | http://www.cfsan.fda.gov/~lrd/pestadd.html |

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CFSAN 1998: Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables. Guidance for Industry. Center for Food Safety and Applied Nutrition (CFSAN), U.S. Department of Health and Human Services, Food and Drug Administration, October 1998.
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Improving the Safety of Fresh Fruit and Vegetables 2005: Edited by W. Jongen, Wageningen University,
The Netherlands. ISBN 1 85573 956 9.

University of Maryland 2002: Improving the Safety and Quality of Fresh Fruit and Vegetables:
A Training Manual for Trainers, University of Maryland, Symons Hall, College Park, MD 20742.

WHO 2002: Facts Sheet N° 124: Foodborne Diseases Emerging.

WHO 2002: Facts Sheet N° 237: Food Safety and Foodborne Illness.

# CHAPTER III

# GOOD AGRICULTURAL PRACTICES

## Introduction

The concept of good agricultural practices (GAPs) has evolved in recent years in the context of a rapidly changing and globalizing food economy and as a result of multiple concerns about food production and security, food safety and quality and the environmental and social sustainability of agriculture[27]. Broadly defined, a GAP approach applies recommendations and available knowledge to addressing environmental, economic and social sustainability for on-farm production and post-harvest processes resulting in safe and healthy food.

However, the term good agricultural practice connotes different meanings and implications. For this manual, the term is used as a formally recognized terminology in international regulatory frameworks in association with codes of practice to minimize and prevent the contamination of food and thus to enhance the safety of food in agricultural production.

The use of good agricultural practices in the production of fresh fruit and vegetables is essential to prevent pathogen contamination. When implementing GAPs in field operations, key areas of concern are amongst others the use of land, soil and water in an integrated and risk-sensitive approach as well as control of wildlife and pests, proper worker hygiene, sanitation, harvesting and cooling practices.

The following modules provide an introduction into all these operational steps and the GAPs associated with each. These modules will not cover every detail of each operation, but rather give the reader an up-to-date

[27] FAO, 2003.

overview of the most important and crucial practices when dealing with fresh fruits and vegetables in agricultural operations.

## MODULE 1:
## Soil and Water

| | |
|---|---|
| **Learning outcomes:** | Trainers are able to identify and estimate the potential for produce contamination due to current and prior use of soil. |
| | Trainers are able to recognize the potential for contamination of fresh fruits and vegetables associated with water use and quality. |

### A. Soil

Agricultural land and land that has been used for activities other than agriculture can be contaminated by pathogenic organisms or toxic chemical substances. Studying the prior use of land is important in order to identify potential hazards for future horticulture activities. Also, failure of prior users of land for agriculture to follow GAPs can entail a risk of contamination as well as present improper activities by neighbouring operators. It is therefore important to obtain information about previous use of land where agricultural production is to take place. Based on this information, land-specific risks for fresh produce contamination can be identified and prevented accordingly.[28]

[28] EUREPGAP, 2004.

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**Prior use of cultivated land**

Identify possible sources of microbial and chemical contamination associated with prior use of land: [29]

- For animal feeding or domestic animal production;
- As a waste disposal site (garbage or toxic industrial waste);
- As a sanitary waste management site;
- For mining activities, oil or gas extraction;
- For former agricultural activities;
- Prior use of adjacent land and neighbouring areas (risk of cross-contamination);
- History of flooding in area of concern.

Main sources of soil-associated hazards and their potential for contamination of fresh produce:

| Potential hazard | Risk of contamination of fresh produce in agricultural production |
|---|---|
| Prior land use for animal feeding or domestic animal production | Contamination of produce by pathogens found in the intestinal tract of animals. Magnitude of risk is related to the time that has passed since the land was used for animal production. The risk of contamination also depends on site-specific conditions such as temperature, sunlight, precipitation and relative humidity. |

[29] University of Maryland, 2002; CFSAN, 1998.

| Potential hazard | Risk of contamination of fresh produce in agricultural production |
|---|---|
| Prior land use as a waste disposal site (garbage or industrial waste) | Contamination of produce by toxic substances, decomposing organic matter, faecal material and pathogenic micro-organisms. The risk of contamination depends on the time lag between former use and present contents of the disposal site. |
| Prior land use as a sanitary waste management site | Contamination of produce by pathogenic micro-organisms. Depending on the time lag between former use and management of site, the pathogen load can be extremely high. |
| Prior land use for mining and oil/gas extraction | Contamination of soil and produce by heavy metals and toxic hydrocarbons. Proper soil analysis is strongly recommended if ground history indicates high risk due to improper former site management. |
| Prior land use for agricultural activities | Contamination by residues due to former improper production practices such as organic and non-organic fertilizing (microbial loads or chemical residues) or improper use of agrochemicals, which can cause serious long-term chemical hazards. |
| Land use of adjacent sites | Prior use of adjacent land as one of the above mentioned potential hazards can influence the present site by cross-contamination (e.g. water drainage, subterraneous water flow and surface run-offs). |
| History of flooding | Hazardous contaminants can be deposited at the site by heavy flooding (e.g. toxic waste, faecal matter, dead animals). |

*** GOOD AGRICULTURAL PRACTICES ***

**Current use of adjacent land and area**

The risk of produce contamination at the production site can be influenced by activities in the neighbouring area:

- Check current use of land and activities in the neighbouring area and assess risk of cross-contamination;
- Contamination can reach produce through multiple means, including water drainage and run-offs, subterranean water flow (water wells), wind erosion and transport by workers, animals, vehicles and equipment;
- It may be necessary to create physical barriers to prevent cross-contamination (e.g. water diversion channels, wind erosion protection).

## B. Water

Water as a carrier or living environment for a number of pathogenic micro-organisms, such as bacteria, viruses and parasites, poses one of the greatest threats to food safety. Water use in crop production involves numerous field operations, including irrigation and application of pesticides and fertilizers. Water of inadequate quality has the potential to be a direct source of contamination as well as a vehicle for spreading localized contamination in the field and in facilities used for post-harvest processes.

*** GOOD AGRICULTURAL PRACTICES ***

**Importance of quality of crop production water**

Wherever water comes into contact with fresh produce, its quality may directly determine the potential for persistent pathogen contamination. Consequently, ensuring proper quality of crop production water on site is the key to safe production of fresh fruits and vegetables.

Common sources of water for crop production include:

- Surface water: Rivers, channels, lakes, reservoirs, swamps and open tanks
- Ground water: Water from wells (open and capped)
- Public water: Public water systems provided by municipalities

Surface water can be exposed to temporary or intermittent contamination, which can be caused by human and animal waste, sewage water and industrial waste discharges, water from lots set aside for animal production, or other sources of contamination such as surface run-offs. Surface water generally flows some distance before it reaches the crop. It is therefore important to identify upstream sources of contamination. Elimination of contaminated water flows may involve modifications of the water's route or the introduction of intervention methods such as filters.

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**Surface water for crop production**

- Identify the source and distribution of surface water used for crop production;
- Identify the topography of the landscape and its effects on water flow and rainfall patterns in the region;
- Estimate the potential for sources of pathogens or contaminants in the affected area;
- Prevent crop production water from becoming contaminated by human or animal faeces;
- Check water sources shared with grass lots, animal feed lots and dairy farms;

- Check water sources potentially affected by deposition of human faeces and provide field workers with properly constructed and maintained restrooms or sanitary facilities;
- Prevent uncontrolled access of animals and humans to crop fields, water sources and related areas;
- Avoid storage of manure and biosolids near water bodies and crop fields;
- Check if adjacent field operators are using untreated animal or human manure as fertilizer;
- Check uncontrollable wildlife vectors within the crop production area.

It is generally believed that ground water is less susceptible to contamination than surface water since ground water loses much of its microbial load and organic compounds after filtration through rock and clay layers of the soil. Under certain conditions, however, ground water may be contaminated by either surface water or persistent chemicals and other substances infiltrating the soil.

Proper planning, instalment and maintenance of wells are essential to prevent contamination of crops by using polluted ground water. Prevention of well contamination begins with appropriate placement and instalment of the well. Required well distance from sources of contamination depends on many factors:

- Geologic formation and characteristics of related aquifers;
- Direction and characteristics of water flow;
- Effect of well pumping on ground water movement;
- Susceptibility of the site to flooding.

Moving wells away from a source of contamination may reduce the chance of pollution but will not guarantee that wells are safe. Contaminants can come from great distances, depending on aquifer and well characteristics.

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**Proper instalment and maintenance of wells** [30]

- Choose appropriate sites for well placement: always locate wells away from sources of contamination (e.g. sewage and waste disposal sites, septic tanks, feed lots, manure piles, dumps or landfills, chemical or fuel storage sites);
- Always site wells in areas free of flooding (floodwater may carry contaminant loads);
- Plan surface drainage away from wells;
- Place wells above areas of contamination (e.g. disposal sites and landfills);
- Maintain wells properly and keep the surrounding area clean;
- Avoid handling with agrochemicals in the vicinity of wells;
- Check older wells for proper functioning and water quality.

In addition to the water quality, other factors impact on the risk of produce contamination. The severity of the hazard resulting from poor water quality will depend on the type and amount of micro-organisms in the water, their capability to reproduce and survive on the produce, the degree of contact between the water and the produce, and the characteristics of the produce itself.

| Factor of influence | Means of influence on the level of produce contamination |
|---|---|
| Type of crop | Fruits and vegetables with large surface areas (e.g. leaf vegetables) or those with rough surface structures allowing pathogens to adhere easily are at greater risk. |

[30] Engel et al. 1998.

| Factor of influence | Means of influence on the level of produce contamination |
|---|---|
| Crop development stage | If contamination occurs near harvest time, the risk of contamination is greater. |
| Time lag between contact with water and harvest | The risk of hazardous contamination is significantly greater near harvest time. |
| Use of water in harvest and post harvest practices | If produce are contaminated via harvest or post-harvest product handling practices, the risk of contamination is especially high. |

The majority of hazards introduced to fresh produce by contaminated water stem from crop irrigation. As irrigation plays an important role in developing cultivable land and ensuring successful harvest results, the implementation of proper site-specific irrigation practices is vital in order to prevent produce contamination while at the same time achieving good harvest results. Irrigation methods are selected according to the environment, water source, climate, soil characteristics, type of crop and related costs.[31]

[31] University of Maryland, 2002.

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**Sound irrigation practices**

The type of irrigation system is important for food safety since it determines the amount of contact between the irrigation water and the edible produce. The following principles should be considered and observed:

- Generally, the water in direct contact with the edible part of the crop should be of higher quality than irrigation water that has minimal or no contact with edible parts;
- If water quality is unknown or cannot be controlled, irrigation practices that minimize contact between water and produce should be implemented (e.g. trickle irrigation);
- The use of high-quality water is especially important in the case of irrigation methods that allow considerable contact between water and edible produce (e.g. surface flow and sprinkle irrigation);
- The closer to harvest irrigation occurs, the greater the chance for survival of pathogens and the presence of residual chemicals (e.g. pesticides) on the produce. Consequently, the use of high-quality water prior to harvesting is of paramount importance.

## MODULE 2:
## Organic and Inorganic Fertilizers

| | |
|---|---|
| **Learning outcomes:** | Trainers know about potential produce-contamination risks associated with fertilizing practices in horticulture operations and are aware of proper management practices to control such risks;<br>Trainers are especially aware of microbial contamination risks for fresh produce induced by organic fertilizing practices. |

| | | |
|---|---|---|
| **Definitions:** | Organic fertilizer | Natural fertilizer consisting of organic matter that serves as the nutritional basis for micro-organisms that live in the soil. These transfer organic matter into inorganic substances that serve plants as nutrients. |
| | Inorganic fertilizer | Fertilizers consisting of inorganic matter that directly serve plants as nutritional elements. Most inorganic fertilizers are produced synthe-tically. |

Fertilizing practices are associated with multiple risks for produce contamination in the field, the greatest hazards stemming from organic fertilizers consisting of animal manure or human biosolids.

### A. Organic fertilizers

Organic fertilizers are derived from plant material, animal manure or human organic waste. Properly treated, such material can provide an effective and safe fertilizer for agriculture operations. The main sources for organic fertilizers are:

- Animal manure;
- Post-harvest plant material;
- Organic waste;
- Human waste (biosolids or sludge).

Untreated, improperly treated or re-contaminated manure or biosolids used as fertilizers pose multiple risks for contamination of fresh produce:

- Contamination by pathogenic micro-organisms derived from animal/human faecal material;
- Chemical hazards posed by heavy metals or toxic organic compounds that may be part of input materials.

**!**

If animal manure and human biological waste intended for use as fertilizers are not treated appropriately, the risk of serious microbial produce contamination can be extremely high.

Potential risks can be significantly reduced by following good agricultural practices in mainly two areas of focus[32]:

– Focus 1: Treatment procedures in order to reduce the potential pathogenic microbial load in manure or biosolid waste;

– Focus 2: Prevention of direct or indirect contact between organic fertilizers and produce.

[32] CSFAN 2004.

**Focus 1: Treatments to reduce pathogen levels**

Treatments that may be used for the reduction of pathogen loads in organic materials can be divided into two groups:

- **Passive treatments** rely on the passage of time in conjunction with environmental factors, such as temperature, sunlight and humidity. These factors encourage the decomposition and ageing of organic material and, given enough time, eventually lead to a reduction of pathogenic micro-organisms.
- **Active treatments** generally involve more intentional management and higher input of resources than passive methods. Active treatments include pasteurization, heat drying, anaerobic or aerobic digestion, alkali stabilization or combinations thereof.

Active treatments are clearly favoured over passive ones since they offer much faster turnover rates and higher temperatures within the decomposition process, thereby allowing for maximum, efficient destruction of pathogens. Composting is a very common and well-established active treatment method for manure and biosolid waste.

**!**

Composting is a natural fermentation process by which organic material is decomposed and broken down into stable humus by micro-organisms such as bacteria and fungi. This heat-generating process eliminates much of the microbial pathogenic load within a few days and significantly reduces contamination risks by organic fertilizers.

Composting includes specific management of organic matter in order to create optimum conditions for the growth of beneficial micro-organisms (e.g. aeration of piles, monitoring of temperature and humidity). Composting should not be confused with simpler passive treatments such as ageing, which require more time to reduce microbial hazards.

*** GOOD AGRICULTURAL PRACTICES ***

**Proper composting procedures**

- Composting microbes are aerobic and thus require oxygen. Regular aerating of compost piles allows for maximum growth of microbes and rapid turnover of the composting process.
- Keep moisture levels in compost piles between 40 – 60 %.
- Aim at temperatures above 55°C in compost piles. The heat speeds up the decomposition process as well as the elimination of pathogens.
- The composting process is completed when the pile stops heating.
- Keep a complete record of composting procedures (origin of material, volume, date and duration of compost process, treatments applied, temperatures achieved and number of days above 55°C).
- Keep this record to verify that appropriate composting procedures have been applied.

## Focus 2: Prevention of produce contamination during handling and application

Contamination of fresh produce by pathogenic micro-organisms derived from organic fertilizers can occur in numerous ways and can affect the edible product either directly (e.g. by application of contaminated fertilizer on the edible crop) or indirectly (e.g. by cross-contamination of produce by infected soil that has been fertilized). Good agricultural practices should be followed in order to minimize risks of such produce contamination.

*** GOOD AGRICULTURAL PRACTICES ***

**Sound practices for manure and biosolids prior to treatment**

- Always store untreated manure and human biosolids separately from treated manure and keep them separate from crop production or post-harvest handling areas.
- Use barriers or physical containments to prevent contamination of production areas by run-offs, subterranean water flows or wind spreads from untreated manure storage areas.
- Prevent contamination of surface and ground water by untreated manure / biosolids by means of lined storage floors (e.g. cement or clay lining).
- Use adequate covering to protect untreated manure piles from rainfall and wind drift.
- Clean all equipment that has been in contact with untreated manure (e.g. tractors, tools) prior to access to crop production areas.
- Do not allow personnel handling untreated manure or biosolids access to crops without proper hygiene.

**Sound practices for storage**

- Always keep treated manure covered and away from waste and garbage to prevent recontamination by birds, rodents or wind drift.
- Separate the storage area for organic fertilizers from the crop production, post-harvest processing and packing areas.
- When purchasing manure and organic fertilizers, always obtain a specification sheet from the supplier containing information about the sources of raw material and methods or treatment.

**Sound practices for application of organic fertilizers**

- Never use untreated animal manure or human biosolids as fertilizer in horticulture.
- Apply properly treated organic fertilizers in the pre-planting or early crop-growing stages.

- Do not apply organic fertilizer near crop maturity or harvest time.
- Apply organic fertilizer near the roots and cover with soil; do not apply directly on edible parts of crop.
- Allow maximum time between application of organic fertilizers and harvest of crop.
- Prevent application of fertilizers on fields adjacent to crop fields due to harvest (wind drift and run-offs).
- Keep a complete record of application procedures (amount used, type of crop and fertilizer, place and date of application, method of application, person responsible for application).
- Keep this record to verify that appropriate steps were taken to ensure the food safety of produce.

## B. Inorganic fertilizers

Most inorganic fertilizers are chemically synthesized in industrial plants and are obtained commercially. Since inorganic fertilizers do not contain any organic matter, they do not carry microbial pathogens and thus pose no microbial threat to fresh produce. Due to the chemical process of synthesis, some inorganic fertilizers may contain heavy metals as by-products that can negatively affect soil fecundity and result in long-term accumulation, eventually also leading to uptake by plants. When applying inorganic fertilizers in the field, it is therefore important to correctly follow the given instructions.

# MODULE 3:
# Animal Exclusion and Pest Control

| | |
|---|---|
| **Learning outcomes:** | Trainers are aware of and understand the potential food safety risks associated with animals and pests in the crop production area and adjacent lands.<br><br>Trainers know about recommended good agricultural practices for pest control and safe handling procedures for pesticide use. |

## A. Animal exclusion

All animals, including vertebrates such as mammals, birds, reptiles, amphibians, as well as arthropods such as insects and spiders, can be considered as vehicles for contamination with pathogenic microbes and thus pose a biological threat to fresh produce. Pathogenic micro-organisms are found in animal skin, hair and feathers or live within animals' respiratory and gastrointestinal systems.

Faeces are the leading animal source of pathogens. However, since animals are in close contact with soil, excrements and water, they can also easily pick up microbial contaminants on their body surface (e.g. hide, paws, and hair).

In addition to contamination risks via the microbes transmitted, animals can further negatively affect product quality by spoiling it or by physically harming and damaging the product. Such damage may then lead to spoilage and contamination of produce by a variety of organisms.

**!**

All animals are a potential source of produce contamination or spoilage. They should therefore be excluded from access to crop fields and kept away from post-harvest processing and packing areas. Domestic and farm animals pose as great a threat as wild animals and thus need to be dealt with similarly. The main sources of contamination by animals are faecal matter containing pathogenic microbes as well as pathogenic micro-organisms that are harboured by animal skin, fur and feathers.

*** GOOD AGRICULTURAL PRACTICES ***

**Keeping animals out of production areas**

- Keep livestock and domestic animals near horticulture operations confined in pens or yards or exclude them by proper fencing or other physical barriers from agriculture production fields.
- Do not allow domestic, livestock or wild animal access to production facilities (storage rooms, processing and packing areas and machinery).
- Do not allow field workers to bring their pets (e.g. dogs or cats) into the operation areas.
- Dispose of dead animals on the farm promptly and properly via burial or incineration.
- Keep adjacent land and areas surrounding the fields cleared as strips of "animal-free areas" (e.g. by keeping the grass short, cleaning all garbage and removing unused or old equipment).
- Limit free availability of water within the production area to a minimum. Since animals are attracted by water, water tanks, storage containers, ponds or channels should be covered or fenced.

## B. Pest control in agricultural operations

### Integrated pest management (IPM)

Producers should critically evaluate the need for any pesticide application and whenever possible use alternative methods of pest control. Integrated pest management (IPM) is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices. IPM programmes use current, comprehensive information on the life cycles of pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means and with the smallest possible threat to people, property, and the environment.[33] IPM takes advantage of all appropriate pest management options including, but not limited to, the judicious use of pesticides.

IPM is not a single pest control method, but rather a series of pest management evaluations, decisions and controls. In practising IPM, growers who are aware of the potential for pest infestation follow a four-step approach:

### Step 1: Set of action thresholds

Before taking any pest control action, IPM first sets an action threshold, a point at which pest populations or environmental conditions indicate that pest control action must be taken. A single pest sighting does not always mean that control is needed. Determining the level at which pests become economic threats is critical to guide future pest control decisions.

[33] US EPA, 2004.

**Step 2: Monitor and identify pests**

Not all insects, weeds and other living organisms require control. Many organisms are innocuous, and some are even beneficial. IPM programmes work to check for pests and identify them accurately so that appropriate control decisions can be made in conjunction with action thresholds. Such monitoring and identification remove the possibility that pesticides may be used when they are not really needed or that the wrong kind of pesticide will be used.

**Step 3: Prevention**

As a first line of pest control, IPM programmes work to manage the crop, lawn, or indoor space to prevent pests from becoming a threat. In an agricultural crop, this may mean using cultural methods, such as rotating between different crops, selecting pest-resistant varieties and planting pest-free rootstock. These control methods can be very efficient and cost-effective and entail little to no threat to people or the environment.

**Step 4: Control**

Once monitoring, identification and action thresholds indicate that pest control is required and preventive methods are no longer effective or available, IPM programmes then evaluate the proper control method for both effectiveness and risk. Effective, less risky pest control methods are chosen first, including highly targeted chemicals, such as pheromones to disrupt pest mating, or mechanical control, such as trapping or weeding. If further monitoring, identification and action thresholds indicate that less risky controls are not working, additional pest control methods would be employed, such as targeted spraying of pesticides. Broadcast spraying of non-specific pesticides is a last resort.

**Proper use of pesticides**

Pesticides are toxic substances of mostly synthetically origin used in pest control. They are used to protect growing crops from harmful insects or competitive weeds, to prevent stored products from being affected by animals, to control household pests and nuisance insects, or to eliminate potential vectors of diseases.

Classification of pesticides usually refers to the type of pest they are targeting for control:

- Insecticides: Eliminate insects
- Rodenticides: Eliminate rodents
- Fungicides: Eliminate fungi
- Herbicides: Eliminate weeds

**!**

Pesticides can be extremely harmful to both humans and the natural environment. They may represent a chemical hazard for consumers when fresh produces are accidentally contaminated by pesticides. Consequently, pesticides have to be applied, handled and stored carefully by well-trained personnel.

If a pesticide is to be applied, sound practices are mandatory. Observation of good agricultural practices generally refers to proper use of pesticides, and more specifically to safe handling and application practices in horticulture operations for fresh fruits and vegetables.[34]

[34] FAO, 2002.

*** GOOD AGRICULTURAL PRACTICES ***

**Proper selection of pesticides**

- Only use pesticides for crops for which they have been officially and specifically registered.
- Never use unauthorized pesticides or other agrochemicals of which you are unsure.

**Sound storage and handling of pesticides**

- Keep the amount of stored pesticides to a minimum. Only store what you need during the growing season.
- Keep pesticides separately and closed off from unauthorized entry (e.g. children, workers or animals).
- Make sure the floor of the storage area is leak-proof (danger of infiltration into soil and ground water).
- Keep storage area away from all water sources and sinks (immediate contamination risk).
- Pesticides need to be clearly labelled and stored in appropriate containers.
- Never transport pesticides and food (or harvested crops) in the same vehicle.

**Proper application of pesticides**

- Read and follow instructions for application of any pesticide carefully before using the product.
- Consider and follow information given on restriction of use, application rates, approved doses, number and interval of applications.
- Follow label instructions for mixing, loading and handling as well as actual conditions of use.
- Carefully calculate the amount of pesticide needed for a specific site / crop.
- Always use water free of microbial pathogens to prepare the pesticide.

- Check proper functioning of spraying equipment regularly in order to prevent over- or under-treatment.
- Regularly clean all spraying and handling equipment to prevent cross-contamination.
- Post warning signs on fields that have been treated with pesticides to prevent workers or visitors from coming into contact with toxic chemicals.

**Sound disposal of pesticides**

- Check product label for instructions or restrictions on pesticide disposal.
- Empty pesticide containers should be washed several times, and the rinse water can be applied to crops.
- Rinsed containers can be returned to the supplier or disposed of appropriately (e.g. at sanitary landfills).
- Do not dispose of pesticide containers in unused wells or near water sources and sinks.

**Training of staff**

- All personnel on the farm handling and applying pesticides should be aware of the associated hazards.
- Thorough and regular training of workers is mandatory, and also includes proper use of application devices and safety equipment such as air masks and gloves.

**Documentation and records**

- The handling of pesticides should be fully documented by the person responsible.
- For each pesticide used in the operation, there should be a technical data sheet available including permission for use issued by an authorized organization.
- Keep a pesticide record sheet for documentation of all activities (crop data, type of pesticide used, place and date of applications, dosage, time before harvest, person in charge of application).

**Pesticide residuals on fresh produce**

High levels of pesticide residues on crops can be a health hazard to consumers. To regulate pesticide residues, a legal limit known as the maximum residue limit (MRL) has been developed for each substance. This limit provides reasonable assurance that no adverse effects on consumer health result over a lifetime of dietary exposure.

**!**

The maximum residue limit (MRL) is the maximum concentration of pesticide residue that is legally permitted to remain on or in a crop in commerce. Compliance with MRLs is mandatory for credibility and reliability as producers and exporters of fresh fruits and vegetables in international markets.

## C. Pest control in fresh produce operations

In fresh produce operations, the term "pest" applies to all organisms that can contaminate fruits and vegetables during field production, packing, storage and distribution. This includes animals such as rodents and birds or smaller animals like insects (e.g. cockroaches and flies).

**!**

Good sanitation is the key to animal and pest control in produce production and handling areas. All areas where produce is grown and handled should be kept clean and free of garbage or other waste.

In addition to proper cleaning, the implementation of a pest control programme allows a systematic approach to prevent produce contamination risks posed by pests.

*** GOOD AGRICULTURAL PRACTICES ***

**Pest control programme in fresh produce operations**

- Regularly check and inspect all facilities and identify situations of pest outbreaks or animal contamination.
- Schedule these inspection activities on a regular basis and make sure that they take place.
- Identify type of pests, sources of origin and quantify their numbers.
- Implement a facility maintenance programme to repair / remove places where pests might settle.
- Choose countermeasures that are approved for specific use in fresh fruit and vegetables units.
- Keep record of all inspections performed and prevention / corrective actions taken.
- Regularly verify effectiveness of countermeasures taken.

## MODULE 4:
## Worker Health and Hygiene

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|---|---|
| **Learning outcomes:** | Trainers know about the relationship between worker health and food safety.<br><br>Trainers know the essential practices for worker hygiene. |

## A. Importance of worker health

Ensuring workers' health increases employee productivity and supports the prevention of produce contamination by microbial pathogens transmitted by sick or injured persons. Thus, preserving good and stable worker health is a key element for food safety and the long-term economic success of operations.

**!**

Good worker health stands for better productivity and greater food safety within the operation. Efforts should be focused on (1) providing workers with a sound and safe working environment and health programme in order to prevent diseases; and (2) dealing adequately with sick or injured workers in order to prevent pathogen contamination of produce or disease transmission to other persons.

## B. Worker hygiene

Proper hygiene procedures are a crucial element of food safety in every fresh produce production operation. Therefore, proper practices need to be established and included in hygiene and health training programmes for all employees. Depending on employees' functions, responsibilities and areas of activity, the level of knowledge and awareness will vary accordingly. Key areas of consideration for worker hygiene are the following:

- First aid and injuries;
- Hand washing and personal hygiene;
- Dealing with sick workers;
- Drinking water.

The importance of food workers clearly understanding and practising proper hygiene cannot be overemphasized. Workers can unintentionally contaminate fresh produce, water supplies and handling equipment and

transmit diseases to other workers or consumers. Proper hygiene practices also need to be followed by any visitors, inspectors or maintenance workers from outside the facility.

*** GOOD AGRICULTURAL PRACTICES ***

**First aid and injuries**

- Exposed wounds pose an immediate threat of contamination and must be taken care of immediately.
- First aid kits for proper treatment of injuries should be available at all work sites.

**Proper hand washing**

- Make sure hands are washed frequently and after any potential contamination.
- Correct washing procedures include applying soap on wet hands, scrubbing of whole hand during a minimum of 20 sec., rinsing with water, drying with paper towel and turning off knob with towel.
- Train and regularly check all employees in hand-washing procedures.

**Proper personal hygiene**

- Regular bathing or showering, washing hands, keeping nails clean and short;
- Use of toilets, also on field sites;
- Wearing of clean cloths and hairnets.

**Sick workers**

- Workers showing signs of sickness (e.g. diarrhoea, vomiting, dizziness, fever, abdominal cramps) should be assigned to activities that do not involve contact with fresh produce.
- Sick workers should strictly follow proper hygiene in order to prevent contamination / transmission.

- Employees should be trained to recognize symptoms of diseases and report them to supervisors.

**Drinking water**

- Water for consumption by workers needs to be potable and of good quality at all work sites.
- Ensuring workers free access to proper drinking water prevents diseases and eventual contamination risks.

## C. Sanitary field stations

Workers in the field should have access to proper sanitary facilities in order to prevent risks of serious microbial produce contamination. Any inadequate or improper accessible facility poses a threat to contamination of soil, water, crops and the workers themselves. The following practices should be considered:

*** GOOD AGRICULTURAL PRACTICES ***

**Basic requirements for sanitary field stations**

- Place toilets away from crop fields and water sources and a maximum 400m away from the work area.
- Connect toilet to an evacuation or sewage system and regularly maintain the outlet system.
- Make the facility easily accessible to all workers and permit use of toilets whenever necessary.
- Install an adequate number of toilets – minimum 1 toilet per 20 workers of the same sex.
- Sanitation stations need to be in proper and clean condition. Equip with clean water, soap and paper towels.

# MODULE 5:
# Field and Harvest Sanitation

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|---|---|
| **Learning outcomes:** | Trainers know the basic principles of food safety measures that have to be applied in the field during harvesting and post-harvesting activities. |

## A. Harvest process

Maintaining safe, high-quality produce with an adequate shelf life depends on both the pre-harvest factors presented in Modules 1 - 4 in this chapter and the measures taken when harvesting the product. Specific food safety hazards may occur during harvesting through contamination of produce by soil, water, workers and harvesting equipment or through physical damage to the products by handling equipment. The following GAPs should be respected in order to prevent produce contamination or damage during harvesting.

*** GOOD AGRICULTURAL PRACTICES ***

**General considerations**

- All surfaces and implements that touch fresh produce must be treated as food contact surfaces.
- Clean and sanitize all food contact surfaces such as harvest equipment, containers, boxes and bins prior to use.
- Check harvest storage facilities for pests and clean them prior to use.
- Ensure that all harvest workers, including external contractors, adhere to established food safety practices.
- Remove as much soil and dirt as is practicable before the product leaves the field.

**Manual harvesting**

- Proper hygiene and hand washing is key to prevent contamination through contact with workers' hands.
- Prevent any physical damage to produce by harvesting tools and equipment.

**Mechanical harvesting**

- Handle machinery properly to prevent physical damage to produce.
- Make sure that no produce is left within the machinery after the harvest process and clean accordingly.

**Equipment handling and maintenance**

- Use and maintain harvesting equipment appropriately and keep it as clean as possible.

## B. Post-harvest water

Water is used in a number of post-harvest activities, e.g. in dump tanks and hydrocoolers, as a mixing agent for post-harvest treatment with waxes or fungicides or simply as a washing and rinsing agent. In order to reduce the risk of produce contamination, proper water quality is essential in all post-harvest activities. Pathogens present on freshly harvested fruit and vegetables can accumulate in water handling systems, as a result of which such post-harvest water can contaminate other products. When using water in post-harvest treatment procedures, the following practices should be kept in mind.

*** GOOD AGRICULTURAL PRACTICES ***

**Post-harvest water**

- Water used for post-harvest processes must be safe and sanitary (pathogen-free).
- Do not use untreated or not sanitized water (e.g. water from rivers or ponds) for post-harvest treatment.
- Routinely inspect and maintain all equipment for sanitizing process water (e.g. filters, chlorine injectors).
- Water sanitation may involve addition of a sanitizing agent such as liquid chlorine or sodium hypochlorite.
- Change water in product holding tanks or hydrocoolers frequently.
- Filter or change water used for washing frequently and prevent saturation with organic solids from the soil.
- Clean and sanitize all water contact surfaces regularly.

## C. On field cooling

As highly perishable commodities, fruits and vegetables are extremely sensitive to high temperatures. Consequently, specific heat reduction and on-site cooling practices can significantly enhance the quality and shelf life of freshly harvested produce. There are various basic principles that can be followed:

- Minimization of exposure to high temperatures and sunlight by means of night or early morning harvesting;
- Shading and ventilation of harvested products on site;
- Active cooling by water or ice in tanks.

The benefits of immediate cooling after harvest for fresh produce are multiple:

- Reduction of field heat lowers respiration and ethylene production rates;
- Minimization of spoilage, limitation of microbial growth and reduction of water losses.

*** GOOD AGRICULTURAL PRACTICES ***

**On field cooling**

- Do not leave freshly harvested produce in direct sunlight.
- Prevent contamination by bird droppings if shading harvested produce under trees.
- When cooling products on site in water tanks, make sure water and ice is well sanitized and of proper quality.

## D. On field packing

Some products, such as grapes and berries, are not washed and further processed prior to packing. They are packed in the field after harvesting. Field packing generates a situation where contamination can easily occur.

*** GOOD AGRICULTURAL PRACTICES ***

**On field packing**

- Make sure that all workers strictly follow good hygiene and sanitation practices.
- Containers and all packing material should be handled with care and kept clean from dirt and contaminants.

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*** WEB INFO ***

**Additional information and documentation on Chapter III**

| | | |
|---|---|---|
| Good agricultural practices (general information) | Joint Institute of Food Safety and Applied Nutrition GAP Training Programme | www.jifsan.umd.edu/GAPs_train_the_trainer.html |
| General information on pesticides | US Environmental Protection Agency (EPA) | www.epa.gov/pesticides/about/types.htm |
| | FAO Pesticide Management | www.fao.org/ag/AGP/AGPP/Pesticid/default.htm |
| MRL for pesticides | MRL Pesticide List of Codex Alimentarius Commission (CAC) | www.codexalimentarius.net/mrls/pestdes |
| EU pesticides MRL | EU Official Information | www.ec.europa.eu/food/plant/protection/pesticides/index_en.htm |
| Proper and safe handling of pesticides | International Code of Conduct on the Distribution and Use of Pesticides (FAO 2002) | www.fao.org/ag/agp/agpp/Pesticid/Default.htm |

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University of Maryland 2002: Improving the Safety and Quality of Fresh Fruits and Vegetables:
A Training Manual for Trainers, University of Maryland, Symons Hall, College Park, MD 20742.

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(http://www.epa.gov/pesticides/factsheets/ipm.htm)

# CHAPTER IV

# GOOD MANUFACTURING PRACTICES

## Introduction

Like good agricultural practices (GAPs), the concept of good manufacturing practices (GMPs) has been developed in recent years in the context of increasing public awareness and importance of food safety, food quality and the environmental and social sustainability related to it. GMPs are based on the same principles as GAPs, and their implementation relies on identification of food hazards and definition of the measures appropriate for their prevention and control. GMPs include practices focused on the prevention and control of hazards associated with the fresh fruit and vegetable post-harvest chain, ensuring a safe and wholesome product.

The following modules provide an introduction into all operational steps of fresh fruit and vegetable processing until final shipping and the GMPs associated with each. These modules will not cover every detail of each operation, but rather give the reader an up-to-date overview of the most important and crucial GMPs.

**!**

Proper quality of all processing water that contacts fresh produce during cleaning, grading, cooling and application of surface treatments is widely recognized as the principal key to ensure food safety.

# MODULE 1:
# Produce Cleaning and Treatment

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| **Learning outcomes:** | Trainers are aware of recommended cleaning procedures and understand the safety considerations for water used in cleaning processes.<br><br>Trainers have a basic understanding of proper use of sanitizing agents for reduction of microbial contamination on fresh produce. |

Even if agricultural operations employ good agricultural practices, it is inevitable that fresh produce will have micro-organisms on its surface when it is brought into facilities for further processing. To what extent some of those microbes are pathogenic largely depends on factors such as the commodity itself and the agricultural practices used. In many instances, outgrowth of microbial contaminants does not take place until conditions are appropriate. Thus, reducing the number of contaminants by washing or cleaning and sanitizing before the product is finally packed helps to further reduce contamination risks.

**!**

Washing, cleaning and sanitizing procedures prior to packing reduce the number of potential pathogenic micro-organisms on fresh produce and thus prevent foodborne diseases. However, they are no substitute for proper prevention of microbial contamination through implementation and observance of GAPs.

The method of treatment for cleaning depends on produce's ability to tolerate water:

- Soft tissue and delicate commodities with large water-adhering surface areas such as berries and grapes do not tolerate water. They are "dry-cleaned" using air blowers or vacuum methods.

- All other products that tolerate water are washed or rinsed with water.

| ! Hazards associated with produce cleaning and sanitizing ! | |
|---|---|
| Biological | Microbial contamination of produce by contaminated process water |
| Chemical | Chemical contamination of produce by chemicals (e.g. sanitizing agents and additives) |

Sanitizing produce after cleaning and washing helps to further reduce and eliminate micro-organisms. Sanitizing involves the use of chemical substances (e.g. chlorine solutions) and must be properly handled. The use of sanitizing agents is not a substitution for the GAPs presented in Chapter II; rather, they are used as an additional measure to minimize the threat of microbial hazards to fresh produce.

Commonly used sanitizers for treatment of fresh fruit and vegetables include:

- Halogens (e.g. chlorine, chlorine dioxide, iodine, bromide);
- Ionic compounds (e.g. trisodium phosphate TSP, quaternary ammonium compounds, organic acids);
- Active oxygen compounds (e.g. hydrogen peroxide, peracetic acid, ozone);
- Irradiation and pulsed light treatments (e.g. ionizing radiation, UV light, infrared);
- Hurdle technology (multiple above-mentioned procedures that supplement and enhance each other).

The effectiveness of each individual method of sanitization is influenced by many factors, including water temperature, pH, contact time, organic matter content and surface morphology of the produce.

*** GOOD MANUFACTURING PRACTICES ***

**Harvest containers and receiving area**

- Remove as much dirt as practicable from harvest containers, trailers and boxes between harvest uses.
- This should be done outside the cleaning and packing facility and isolated from water source for processing.
- Containers that have been in direct contact with soil should be specifically marked and should not enter the receiving or packing area at any time.
- Use a second set of containers and handling boxes inside the facility and mark them specifically.

**Proper cleaning procedures step by step**

1. Remove soil and dirt by dry-cleaning (brushing or air blowers).
2. Initially wash with water to remove surface dirt (or dry-clean for delicate commodities).
3. Wash with sanitizing agent (usually chemical disinfectant).
4. Perform a final rinse with water.

**Principal focus: Quality of washing and processing water**

- Process and washing water must be free of microbial pathogens.
- Recycled water should be treated and maintained in proper condition.
- To ensure better product quality, keep water temperature low.
- Monitor temperature and quality of process water and keep it under control.

**Correct sanitizing procedures**

NOTE: Sanitizing agents can only reduce microbial contaminants, not completely eliminate them.

- Follow sanitation standard operating procedures (SSOP) if applicable and implemented.

- Remove all dirt and soil prior to sanitizing (any organic particles will reduce sanitizing efficiency).
- Only use sanitizers that are officially registered for the intended use and method of application.
- Strictly follow the manufacturer's instructions and verify expiration date of product.
- Keep process water for sanitizing clean and free of organic matter (e.g. by filtration).
- Application of sanitizers must be documented (type of agent, doses, date etc.) and kept for records.

## MODULE 2:
## Cooling Procedures

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|---|---|
| **Learning outcomes:** | Trainers know about potential food safety hazards related to produce cooling in processing of fresh fruits and vegetables.<br><br>Trainers are able to follow and consider GMPs in produce cooling. |

Immediately after harvest, fresh produce temperature can be high. To extend the shelf life of fresh produce and to sustain quality of fruits and vegetables, products are generally cooled within 24 hours after harvesting. Cooling also helps to inhibit the growth of pathogenic bacteria in fresh produce.

In the cooling process, excessive heat is removed from the product by a cooling medium, in most cases by air, water or ice. For the commercial cooling of fresh fruits and vegetables, many different cooling methods are available. Regardless of the cooling method, care must be taken to ensure that the cooling medium does not contaminate the product.

It is important to know the principles of each cooling method in order to be able to identify potential hazards associated with them. The most common cooling methods for fresh produce include:

| | |
|---|---|
| Room cooling | Heat is transferred from the produce to cold air being circulated around stacked containers or pallets of produce in a closed room. The cooling rate is slow. The cooling process can be speeded up by additional air circulation or ceiling jet cooling. |
| Forced air cooling | Similar to room cooling, but the cold air is actively forced to move through the containers of produce, providing greater air circulation resulting in faster cooling. |
| Hydro-cooling | Heat is transferred from the produce to cold water that is showering or rinsing down over the product. The cooling rate is rapid. Can only be applied to water-tolerating commodities. As cooling water is recirculated, proper sanitation is critical. |
| Package icing | Cooling is facilitated by direct contact of produce with ice. Ice is crushed or flaked and packed over the product. Provides fast initial cooling, but cooling rate slows down as ice melts. Only applicable with commodities that tolerate direct contact with ice (e.g. root and stem vegetables). Proper quality of ice is critical. |
| Vacuum cooling | Cooling occurs from vaporization of water in the produce that is placed in an airtight vacuum chamber. As the heat energy needed for vaporization is taken from the produce itself, the produce cools down. Primarily used for leaf vegetables. Produce loses weight by water vaporization. Maintaining proper water quality is crucial. |

| ! Hazards associated with cooling procedures ! | |
|---|---|
| Biological hazards | Air cooling methods<br>Air and vacuum cooling present the lowest risks. Air can serve as a transmitting agent for pathogenic microbes that are introduced into the cooling system from outside. |
| | Water cooling methods<br>Water and ice cooling methods feature the higher risk of contamination. Water and ice must be of potable, microbial-free quality and stored under sanitary conditions. |
| Chemical hazards | Produce contamination by refrigerants, cooling and sanitizing agents |

*** GOOD MANUFACTURING PRACTICES ***

**Proper air cooling procedures**

- Maintain sanitary conditions in the facility, especially in the air source area (no dust, chemicals or waste).
- Exclude animals and locate compost storage and waste deposits far from the air source area.
- Properly maintain the air system and change filters regularly.
- Keep inside of cooling room clean and in sanitary condition.
- Prevent dripping of condensed or evaporated water on produce.
- Prevent chemical contamination of produce by refrigerants (leaky cooling systems).

**Proper water and ice cooling procedures**

- Water and ice for cooling must be free of pathogenic microbes (potable quality).
- Regularly perform microbial testing of water used for cooling and icing.
- Ice must be produced from sanitized water and stored under sanitary conditions.
- Cooling water that is being recirculated must be sanitized (e.g. by chlorine).
- Frequently check chlorine concentration in cooling water and replace accordingly.
- Place water settling and filters in the cooling water system to remove organic material.
- Regularly replace cooling water that is being recirculated as cooling agent (daily at a minimum).
- Frequently clean and inspect cooling equipment and maintain properly.
- Prevent chemical contamination of produce by refrigerants (leaky cooling systems).

## MODULE 3:
## Packing, Storage and Transportation

| | |
|---|---|
| **Learning outcomes:** | Trainers are aware of potential food safety hazards during packing, storage and transportation of fresh produce and understand the basics of proper practices and countermeasures to reduce such risks. |

### A. Packing and storage

Well-designed, properly operated packing facilities can help reduce pathogen contamination and minimize chemical and physical hazards associated with packing and storage activities. Lapses in facility and

system management have the potential to amplify local contamination, broadly redistribute pathogens or other contaminants, and create new hazards within the production environment.[35]

| ! Hazards associated with packing and storage ! | |
|---|---|
| Biological hazards | Microbial contamination of produce due to improper design, maintenance and cleaning of processing and storage facilities and equipment as well as unsafe handling practices and insufficient worker hygiene |
| Chemical hazards | Contamination of fresh produce by processing additives, lubricants and machinery oils, agents from packing material and adhesives, cleaning, sanitizing and pest control agents |
| Physical hazards | Introduction of foreign material into fresh produce during product handling |

Packing and processing facilities may differ in their design due to specific local needs and type of commodities that are handled and processed for shipment. Regardless of the size of the operation, good manufacturing practices are essential to prevent the physical facility and its equipment from becoming a source of microbial, chemical and physical contamination and to ensure consistent quality of fresh produce. The following GMPs give an overview of key factors that need to be considered in this regard.

[35] University of California, 2004.

*** GOOD MANUFACTURING PRACTICES ***

**Sanitary design and construction considerations**

- Facilities should be designed and constructed for easy cleaning and sanitation procedures;
- Building should be screened with barriers to exclude all animals and pests;
- All windows should be closed or covered with mesh;
- Packing and storage areas should be separated, with handling performed by different personnel;
- Lights need to be covered with protection screens to prevent produce contamination via broken glass;
- All floors should be built with a slight slope to avoid water accumulation in processing areas;
- All buildings require a proper, functional sewage system to prevent water accumulation.

**General principles for all facilities and equipment**

- All packing and storage areas are to be kept free of harvest residues, chemicals and waste materials;
- All facility sectors are to cleaned regularly, with removal of all visible debris, dirt and waste;
- Comprehensive sanitation standards operating procedures (SSOP) and maintenance programmes should be implemented and integrated pest management (IPM) should be in place;
- Equipment and machinery that come in contact with produce should be kept as clean as is practicable;
- All equipment and utensils should be checked to verify proper functioning and prevent loose parts from falling off;
- All paint used on machineries, walls and ceilings needs to be approved for food processing. Painting that falls off should be removed and renewed. Rust on metal parts should be removed and further rusting should be prevented;

- Avoid oil leaks and over-lubrication. Use only food-grade oil and lubricants on machinery;
- Introduce a comprehensive machinery and equipment cleaning and maintenance programme.

**Packing procedures**

- Design and maintain packing surfaces and equipment to minimize produce damage and maximize accessibility for cleaning and sanitizing;
- Establish routine cleaning and sanitizing programmes for all food contact surfaces;
- Clean and sanitize packing area at the end of each working day.

**Containers and handling boxes**

- Containers and boxes should be made of non-toxic materials and constructed with a view to easy cleaning;
- Repair or discard damaged containers and handling boxes;
- Always clean pallets, containers and boxes before use;
- Do not use fresh produce boxes and containers for other items, such as tools, lunch or combustibles;

Use separate containers (by specific labelling or colouring) for transport of produce before and after washing.

**Storage of packing material**

- Storage area must be kept clean, dry and free of trash, pests and animals;
- Storage area should be well separated from areas with hazardous material (e.g. chemicals, compost);

Store unformed or empty containers and packing material off the floor and protect them from contamination

**Storage of fresh produce**

- All rooms and chambers should have accurate recorded temperature and humidity control;

- Adjust and regulate temperature and humidity according to a commodity's specific requirements;
- Store fresh products in a clean location using an organized system based on codes and inventories;
- Keep containers and boxes off the floor and provide enough space in between containers and wall for air circulation and ease of access for cleaning and pest inspections.

## B. Transportation

Operators and food handlers involved in the transport of fresh produce are encouraged to scrutinize product transportation at each level in the system, which includes transportation from the field to the cleaning, cooling and packing facility, and on to shipment for export or distribution to market terminals. Proper transport of fresh produce helps reduce the potential for microbial contamination and produce spoilage due to hazardous transporting practices.[36] To ensure the success of management programmes and proper practices for transport of fresh produce that is designed to deliver safe food to the consumers, it is essential to create active awareness among the personnel involved in produce shipment and transportation.

| ! Hazards associated with transport of fresh produce ! | |
|---|---|
| Biological hazards | Microbial cross-contamination of produce during loading and unloading |
| Chemical hazards | Contamination or cross-contamination during transport process |
| Physical hazards | Introduction of foreign material or damage to produce during transport |

[36] CFSAN, 1998.

*** GOOD MANUFACTURING PRACTICES ***

**Proper transport of fresh produce**

- Use only containers or trailers that are explicitly for transport of food only;
- Inspect transportation vehicles and trailers for cleanliness before loading and insist on trailer or container clean-out if necessary;
- Transportation units should be dry and not have condensation water;
- Hermetic sealing of transport units is highly recommended to avoid pest access and contamination;
- If a container has previously been used for transport of hazardous commodities such as meat, eggs or fish, make sure the container has been thoroughly cleaned and disinfected prior to loading with fruits or vegetables;
- Ideally, a container should be sanitized after each load;
- Maintain proper temperature to ensure produce quality and safety;
- Make sure that produce is loaded carefully in order to minimize damage to produce;
- Ensure that transporters maintain integrity of the lot identification and traceback system in use;
- Make sure that all personnel involved in the loading / unloading process practise proper hygiene.

**Considerations for refrigerated transportation**

- Refrigeration and humidity control units should be checked for proper functioning before each trip;
- Make sure temperature and humidity are set according to specific commodity requirements;
- Minimize time between removal from cooling storage and loading into refrigerated container;
- Allow for proper air circulation within the transportation unit by proper stacking;

- Prevent produce contamination by condensation water from refrigeration units;
- Maintain temperature and humidity control during transport and record all data;
- Provide drivers and personnel handling the loading process with regular temperature control training.

## MODULE 4:
## Waste Management, Cleaning and Sanitation

| | |
|---|---|
| **Learning outcomes:** | Trainers know about sound practices for trash and waste handling.<br><br>Trainers are aware of proper cleaning and sanitizing practices for facilities, machinery and equipment and sanitation standard operating procedures (SSOPs). |

### A. Waste management

Trash and waste products from fruit and vegetable processing operations can be a source of microbiological contamination. Decomposing organic matter can serve to spread micro-organisms around the facility and generate offensive odours, thereby attracting insects or other pests bearing pathogenic organisms. The following GMPs should be observed for the daily management of waste and trash in a food processing facility.

*** GOOD MANUFACTURING PRACTICES ***

**Proper trash and waste handling**

- Designate a specific confined area well outside the processing facility for the temporary holding of all waste;
- Design this area for easy cleaning and to prevent accumulation of residues and bad odours:
- Place trash and waste containers conveniently inside all operations sectors of the facility. They should be properly labelled and suitable for tight closure;
- Remove all trash and waste products on a frequent basis and include waste collection procedures in daily cleaning activities;
- Train all staff to make sure that waste collection procedures are correctly followed and properly handled;
- Separation of organic and inorganic waste material with proper recycling is recommended.

## B. Cleaning and sanitation

To reduce the risk of produce contamination within the processing facility, strict cleaning and sanitizing procedures must be followed in all handling facilities and sectors, with all equipment, machinery, utensils, tools and containers. All surfaces that come in contact with fruits or vegetables during all stages of production must be properly cleaned and sanitized on a regular basis.

### Cleaning procedures

Proper cleaning involves the use of both physical methods, such as scrubbing, as well as chemical methods, such as the application of detergents to remove dirt, dust, food residues and other debris from surfaces. These methods may be used separately or in combination.

| | |
|---|---|
| **Physical methods:** | Cleaning tools such as sponges, brooms, scrapers, scrubs and pressure water guns |
| **Chemical methods:** | Different types of detergents (alkaline, acid, abrasive, non-abrasive) |

A detergent is a chemical agent that reduces the surface tension of water, thus helping particles become dislodged from surfaces and suspended in water. By rinsing with water, the particles can be washed away. A good detergent should have complete and rapid solubility, be non-corrosive to metals, feature good moistening action, offer good dispersion or suspension and rinsing properties, and show germicidal action. When selecting a detergent, it is important to know what surface material it will act on and which material it will remove. The following table offers some recommendations.[37]

| **Type of surface** | **Recommended detergent** | **Frequency of use** |
|---|---|---|
| Stainless steel | Alkaline, non-abrasive<br>Acid, non-abrasive | Daily<br>Weekly |
| Metals (copper, aluminium, galvanized surfaces) | Moderately alkaline agents with corrosion inhibitors | Daily |
| Wood | Detergents with surfactants | Daily |
| Rubber and plastics | Alkaline agents | Daily |
| Glass | Moderately alkaline agents | Daily |

[37] University of Maryland, 2002.

| Type of surface | Recommended detergent | Frequency of use |
|---|---|---|
| Concrete floors | Alkaline | Daily |

*** GOOD MANUFACTURING PRACTICES ***

**Proper cleaning**

Cleaning tools are necessary to clean effectively. However, cleaning tools can be a major source of biological hazard when not handled properly:

- Always rinse and sanitize all cleaning tools after use;
- Replace cleaning tools regularly to avoid growth of microbes on their surfaces.

## Sanitizing procedures

Proper cleaning procedures cannot guarantee the reduction of micro-organisms, but they can minimize the formation of biofilm. To eliminate micro-organisms, all food contact surfaces must be treated with sanitizing agents, also referred to as disinfectants. Proper sanitizing or disinfection procedures result in a 99.9% reduction of representative populations of microbes.

**!**

Sanitizing is *not* a substitute for proper cleaning procedures. Organic and inorganic matter on surfaces negatively affects the germicidal action of many sanitizers. All food contact surfaces must be cleaned prior to sanitizing to remove dirt, dust, food residues and biofilm.

When selecting a sanitizer for certain food contact surfaces, the following considerations should be borne in mind: [38]

- Type of equipment and kind of surface being sanitized;
- Water hardness;
- Sanitizing equipment available;
- Effectiveness of sanitizing agent against certain pathogens;
- Effectiveness under practical conditions.

The following table gives an overview of the most common types of sanitizers for use on food contact surfaces:

| **Type of sanitizing agent** | **Product properties** | **Important notes** |
|---|---|---|
| Chlorine and chlorine compounds | Broad action spectrum<br>Rapid and effective effect<br>Inexpensive<br>Highly corrosive to metals<br>Can bleach equipment | – Concentration of free residual chlorine (proper handling required) is essential for effectiveness;<br>– pH, temperature and organic load negatively affect activity of chlorine;<br>– Proper rinsing after treatment strongly recommended. |
| Iodine compounds (iodophores) | Wide spectrum of action<br>Also effective against yeasts and moulds<br>Active in acid range (pH 2-5) | – Iodophores lose effectiveness in the presence of a high organic load or > pH 7 |

[38] University of Maryland, 2002.

| Type of sanitizing agent | Product properties | Important notes |
|---|---|---|
| Quaternary ammonium compounds (quats) | Selective for some type of bacteria<br>Low corrosiveness and non-toxic<br>Good detergent characteristics<br>Tend to adhere to surfaces | – Not effective against some bacteria (e.g. *E. coli*);<br>– Quats are not compatible with soaps or anionic detergents;<br>– Thorough rinsing recommended. |
| Strong acids | Considerable antimicrobial activity | Prevent contamination with food;<br>Thorough rinsing after treatment. |
| Strong bases | Considerable antimicrobial activity | Prevent contamination with food;<br>Thorough rinsing after treatment. |

*** GOOD MANUFACTURING PRACTICES ***

**Handling and use of sanitizing agents**

- Storage of sanitizers must be separated from fresh produce and packing material;
- Carefully follow specific handling and usage instructions for each product;
- Employees must wear goggles, gloves and protective clothing when using alkaline or acid agents;
- As sanitizers are classified as pesticide agents, country-specific regulations for proper disposal should be followed;

- Regularly train employees and operators on safe handling and preparation practices.

**Water quality for sanitizing agents**

Water is the main component of sanitizing solutions and its properties can influence effectiveness of treatment:

- Water for sanitizing treatment must be of good quality;
- Do not use water with organic load, turbidity and pathogens present.

**Mixing of sanitizing agents**

Sanitizing agents have different chemical properties and can react spontaneously if mixed:

- Different sanitizing agents should not be mixed because dangerous reactions may occur;
- Avoid mixing acid and alkaline agents (abrupt neutralization reaction can result in toxic fumes);
- Never mix acid agents with hypochloric solutions (can result in toxic chlorine gas).

## Sanitation standard operating procedures (SSOPs)

Good manufacturing practices in cleaning and sanitation often involve a systematic approach to the repetitive actions that need to be performed within an operation. With the establishment of sanitation standard operating procedures (SSOPs), each cleaning and sanitation task performed within the product flow is described in detail. The SSOP approach offers higher awareness, guarantees that all activities are being performed properly, and facilitates daily discipline and training of personnel.[39]

[39] FAO, 2004.

*** SANITATION STANDARD OPERATING PROCEDURES (SSOPs) ***

SSOPs for fresh produce operations usually include the following:

- Description of activity to be performed;
- Place, frequency and time (duration) of performance;
- List of equipment, utensils and cleaning / sanitizing agents needed;
- Definition of personnel responsibilities;
- Description of every step necessary for proper performance of the procedure.

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*** WEB INFO ***

**Additional information and documentation on Chapter IV**

| | | |
|---|---|---|
| Food and Agriculture Organization of the United Nations (FAO) | Food Safety and Quality of Fruits and Vegetables Official website | www.fao.org/ag/agn/food/food_fruits_en.stm |
| Integrated crop and pest management (ICM and IPM) | Guidelines for vegetable crops, Cornell University | www.nysaes.cornell.edu/recommends/ |

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FAO 2004: Improving the quality and safety of fresh fruits and vegetables: A practical approach. Manual for Trainers. Food Quality and Standards Service. Food and Nutrition Division. FAO Rome, 2004.

University of California 2004: Key Points of Control and Management of Microbial Food Safety for Growers, Packers and Handlers of Fresh Consumed Horticultural Products. Prepared by Trevor V. Suslow, Dept. of Vegetables Crops, University of California

University of Maryland 2002: Improving the Safety and Quality of Fresh Fruits and Vegetables:
A Training Manual for Trainers, University of Maryland, Symons Hall, College Park, MD 20742.

# CHAPTER V

# PRINCIPLES AND PRACTICES OF FOOD SAFETY MANAGEMENT

## Introduction

The assurance of the safety and quality of the food supply has traditionally been a prerogative of governments through the development of regulations and inspections. However, due to a number of global food safety incidents during the 1990s, consumer and retailer trust in the capacity of official regulators to guarantee food safety has declined. In response, the private sector (especially retailers) has moved to develop more specific and sophisticated systems of food safety assurance in order to guarantee safety and traceability of products and processes.[40]

Today, the world's food industry is confronted and somehow confused with an increasing number of mostly private standards for food safety and quality assurance. Those standards somehow include different aspects and components of quality and food safety management and also differ in their scope, some standards applying to farming operations, some only to processors and others to all food operations. In addition, the geographic scope of these standards is often limited, since most private standards tend to be recognized by buyers or retailers from specific countries only. This situation makes it rather difficult for food producers aiming at broader market access, since the diverse requirements often result in duplication of processes and costs for food safety management and certification procedures. This chapter aims at

[40] FAO, 2006.

clarifying the actual situation by offering a short introduction to the major, well-established food safety management systems.

## MODULE 1:
## Food Safety Management and Existing Certification Programmes

| | |
|---|---|
| **Learning outcomes:** | Trainers know about the main food safety management system and are informed about the most important, well-established food safety management certification programmes and initiatives. |

### A. Benchmark model of the global food safety initiative (GFSI)

The global food safety initiative (GFSI) was launched by food retailers as a means to respond to the proliferation of diverse standards. GFSI was created in 2000 by the Global Food Business Forum (CIES), a network of 350 retailers and food suppliers in 150 countries representing 65% of global food retail revenue. GFSI has implemented and maintains a scheme to benchmark private food safety standards. The GFSI benchmark model serves as an "equivalency framework" by outlining key elements that a food safety standard should contain: [41]

- A quality management system (QMS) applied to food safety (e.g. based on the ISO 9000 standard);
- Implementation of prerequisite food safety programmes such as GAPs, GMPs and GHPs;
- A HACCP-based system in accordance with, or equivalent, the Codex standard.

The requirements of this benchmark model are flexible given the variations within the different standards. A standard benchmarked and

[41] FAO, 2006 and GFSI, 2004.

approved by the GFSI should theoretically be recognized by all participating retailers around the world. Nevertheless, some GFSI-approved standards have not yet been mutually recognized by different retailers today.

## B. Existing food safety management and certification programmes

The following table offers an overview of the major international food safety management systems and programmes. They have mainly been developed and adopted by the private industry. For comparison, the four main characteristics are described for each programme. In the following Modules 3 and 4 of this chapter, some of these private certification programmes are further introduced.[42]

| Standard | Geographical range | Operators | Scope | Acceptance |
|---|---|---|---|---|
| ISO 22000 | International | All operators | QMS and HACCP | In progress |
| BRC Global Food* | UK and Scandinavia | Only manufacturing (food industries) | QMS, HACCP, GMP | Majority of UK and Scandinavian retailers |
| IFS* | Germany and France | Only manufacturing (food industries) | QMS, HACCP, GMP | Majority of French and German retailers |
| SQF* | USA and Australia | Primary producers (SQF 1000)<br>Food industries | QMS only | Numerous US and Australian retailers |

[42] FAO, 2006 (adopted).

| Standard | Geographical range | Operators | Scope | Acceptance |
|---|---|---|---|---|
| | | (SQF 2000) | | |
| EUREPGAP* | EU and Switzerland | Primary producers (GAP) | GAP and principles of HACCP | Numerous European retailers |
| Dutch HACCP Code* | The Netherlands | All operators (primary producers not mentioned) | QMS and HACCP | Dutch retailers |

* Benchmarked by GFSI.

As this overview shows, these standards differ significantly with regard to geographic range, intended operators and scope of provision as well as final market acceptance. Each of the above-mentioned standards has its own specific body of requirements, which sets it apart.

All private food safety management programmes are intended to be used in business-to-business relationships and are therefore not directly visible for the consumer in the form of a product label. In most cases, buyers from retailers or wholesalers require certification from the product seller for the standard concerned, which attests to compliance with the food safety management system in place.

## MODULE 2:
## HACCP Principles

| | |
|---|---|
| **Learning outcomes:** | Trainers know about the HACCP system and scope of use within the fresh produce sector and are able to validate its potential benefits for any fresh produce operation. |

The system of HACCP (Hazard Analysis of Critical Control Point) is a science-based, systematic tool for identifying and evaluating hazards that are significant for food safety and for establishing systems of control and measures to ensure food safety. The official version of the HACCP method was first published in 1993 by the Codex Alimentarius Commission (CAC), and has served as a reference for all legislation and food safety management systems based on HACCP. The CAC recommends the implementation of HACCP principles for food hygiene as a mean to enhance food safety. HACCP focuses on prevention rather than relying mainly on end-product testing. HACCP can be applied throughout the food chain – from primary production to final consumption. Its implementation should be guided by scientific evidence of risks to human health.[43]

Today, the concept of HACCP is present worldwide and has become a requirement for international food trade. Yet implementing HACCP in a fresh produce operation will not solve all food safety problems. Ideally, a HACCP program should be integrated with effective prerequisite programmes such as GAP, GMP and GHP.[44]

HACCP is compatible with other quality management systems, such as the ISO 9000 series (where it is the practice of choice for food safety management within the system), as well as with private industry standards such as the British Retail Consortium (BRC) or EUREPGAP (see following Modules in this Chapter).

Any HACCP system is capable of accommodating change, such as advances in equipment design, processing procedures or technological developments. While the application of HACCP to food safety is considered in this module, the concept can applied to other aspects of food quality accordingly.

[43] Codex Alimentarius, 2003.
[44] EU, 2005.

The HACCP system consists of seven principles, which are briefly introduced in the following table. These principles are to be followed step by step when establishing HACCP in an operation.

| **HACCP principle** | **Required activities** |
|---|---|
| 1. Conduct a hazard analysis | – List all potential hazards for each step of production.<br>– Analyse each identified hazard and assess its risk to food safety.<br>– Identify measures of control for each relevant hazard. |
| 2. Determine critical control points (CCPs) | – Determine points where control is applied to address critical hazards. |
| 3. Establish critical limits (CLs). | – Specify and validate (measurable) critical limits for each CCP. |
| 4. Establish a system to monitor control of CCP. | – Monitor each CCP relative to its critical limit (CL).<br>– Make process adjustments when a CCP tends towards its CL. |
| 5. Define corrective action to be taken when monitoring indicates that a particular CCP is not under control. | – Corrective action must be taken whenever CCP deviations occur.<br>– Such action must ensure that the CCP has been brought under control. |
| 6. Establish procedures for verification to confirm that the HACCP system is working effectively. | – Verification and monitoring procedures are used to determine if the HACCP system is working properly. |
| 7. Establish appropriate documentation for all procedures and records. | – HACCP procedures need to be documented accurately and efficiently. |

*** HACCP GUIDING PRINCIPLES ***

- Successful HACCP implementation requires the full commitment and involvement of management and the workforce. Responsibility should be positioned within the general management. [45]
- Elaboration of the HACCP system requires multidisciplinary expertise (e.g. agronomy, veterinary health, food technology, public health, medicine, microbiology, production process, engineering, chemistry).
- Regular training and awareness-building of personnel in HACCP principles and provision of clear working instructions and procedures are essential elements for successful implementation.
- Cooperation and joint training between primary producers, industry and trade groups are of vital importance.

**!**

The use of the HACCP system in agricultural production is somehow limited. When fruits and vegetables are to be consumed fresh, there are no steps that can eliminate or reduce biological hazards to acceptable levels once contamination has occurred. Basically, controlling contamination through application of GAP and GMP is the only way to reduce such hazards.[46]

Although HACCP has limited usefulness in agricultural production of fruits and vegetables, hazard analysis is a useful process for reducing hazards when produce is processed, since there are steps in the production chain where hazards can be minimized.

[45] Codex Alimentarius, 2003.
[46] University of Maryland, 2002.

# MODULE 3:
# ISO Standards for Quality and Food Safety Management: ISO 9000 and 22000

| | |
|---|---|
| **Learning outcomes:** | Trainers know about the requirements and scope of ISO 9000 and ISO 22000 standards. |

The International Organization for Standardization (ISO) is a worldwide body that develops many different kinds of standards for the industry. The vast majority of ISO standards are highly specific to a particular product, material or process. However, some ISO standards, such as ISO 9000, are known as "generic management system standards", which means that they can be applied to any organization, administration or business entity independent of the type of product or service they provide. The following table offers an overview of the most prominent and important ISO standards for the food industry:

| ISO standard family | Content and scope |
|---|---|
| ISO 9000 | Quality management system (QMS) |
| ISO 14000 | Environmental management systems |
| ISO 22000 | Food safety management systems |

## ISO 9000: Quality management

The ISO 9000 family of standards represents an international consensus on good management practices for quality assurance within any business operation. The ISO standard 9001:2000 can be certified by an external authorized agency and replaces the old version 9001, 9002 and 9003 with one single standard.

Today ISO 9001:2000 is the best-known internationally established standard for quality assurance systems.[47] Basically, ISO 9000:2000 lays down a set of standardized good management practices for quality management systems. It defines what requirements quality systems must meet but does not dictate how they should be met within a specific organization. This "generic" system leaves great scope and flexibility for implementation in different business sectors and business cultures as well as different national cultures.

**!**

Compliance with ISO 9001:2000 provides customers with assurances that a company has developed quality management procedures for all aspects of its business and adheres to them. ISO 9001:2000 can assure quality of products but does not necessarily provide for food safety, except when the system is combined with food safety management systems, such as GAP, GMP, GHP and HACCP.

Many organizations decide to implement ISO 9001:2000 and obtain registration because it assures customers that the company has a good quality management system (QMS) in place. An organization with an effective QMS will typically meet customer expectations better than an organization without an effective QMS.

## ISO 22000: Food safety management

ISO standard 22000:2005 "*Food safety management systems – Requirements for any organization in the food chain*" was published in 2005 and is a new international standard designed to ensure safe food supply chains worldwide. The standard has been developed in close cooperation with the Codex Alimentarius Commission. It is basically

[47] ISO, 2006.

designed around the HACCP method of CAC and ensures, via the inclusion of system elements, the proper conditions for HACCP implementation.[48]

ISO 22000, backed by international consensus, harmonizes the requirements for systematically managing safety in food supply chains and offers solutions for good practices on a worldwide basis. ISO 22000 is therefore designed to allow all types of organization within the food chain to implement a food safety management system. These range from feed producers, primary producers, food manufacturers, transport and storage operators and subcontractors to retail and food service outlets – together with related organizations such as producers of equipment, packaging material, cleaning agents, additives and ingredients.

The objectives with ISO 22000 can be summoned as following: [49]

- Harmonization of national and private standards for food safety assurance;
- Simplification of companies tasks and certification bodies accreditation;
- Worldwide accessibility and acceptance for all participants of global food chain.

While ISO 22000 can be implemented on its own, it is designed to be fully compatible with ISO 9001:2000, and companies already certified to ISO 9001 can extend this to certification to ISO 22000. With a view to facilitating effective implementation of ISO 22000 in a given food operation, ISO has published a guideline that supports and gives guidance for implementation (ISO/TS 22004:2005 Food Safety Management Systems – Guidance on the application of ISO 22000:2005).

[48] ISO Management Systems, 2005; and Pro Cert, 2005.
[49] Pro Cert, 2005.

**!**

Compliance with ISO 22000:2005 provides customers within the food supply chain with assurances that the food operation in question has implemented a systematic food safety management system based on the principles of HACCP and its prerequisite programmes, GAP, GMP and GHP.

The principles of ISO 22000:2005 are based on the general ISO Quality Management Standard 9001:2000 and involve food safety issues for all types of food organizations within the global food supply chain.

For fresh produce food operators, ISO 22000 offers a holistic approach to food safety because it also involves the implementation of good management practices in agricultural and manufacturing activities and proper implementation of hygiene practices.

**SUMMARY: ISO STANDARD 22000**

| | |
|---|---|
| Standard-setting body | International Organization for Standardization (ISO) |
| Scope and objectives | – Establishment of a single internationally recognized standard for food safety;<br>– ISO 22000 applies to all food operators including primary producers. |
| Provisions | – Implementation of general food safety management;<br>– System based on management responsibility and resource management;<br>– Implementation of prerequisite programmes (GAPs, PMPs, GHPs);<br>– Implementation of HACCP and traceability system;<br>– Validation, verification and improvement procedures. |

| SUMMARY: ISO STANDARD 22000 | |
|---|---|
| Market penetration in 2006 | Due to the recent launch (late 2005), market penetration cannot yet be assessed. |

## MODULE 4:
## Private Industry and Retailer Standards

| | |
|---|---|
| **Learning outcomes:** | Trainers know about requirements and scope of the different food safety management standards and certification programmes adopted by private industry and food retailers. |

### A. The international food standard (IFS)

The international food standard (IFS) was set up in 2002 by the German retail association HDE and was joined by the French retail association FCD in 2003. The IFS is a food safety and quality management protocol based on HACCP that is designed for producers of all kind of food products. The IFS was specifically established as a retailers' standard dedicated to food manufacturing suppliers for private label products in order to ensure food safety at all levels of the manufacturing supply chain. The IFS does not cover primary production in its requirements; rather, it only comes into force when product handling starts. [50]

[50] IFS, 2006.

| SUMMARY: INTERNATIONAL FOOD STANDARD (IFS) | |
|---|---|
| Standard-setting body | German and French retail associations (HDE and FCD) |
| Scope and objectives | – IFS applies to food manufacturers and processors only;<br>– IFS is aimed at suppliers of private label food products |
| Provisions | – Management of the quality system;<br>– Implementation of HACCP system based on Codex Principles;<br>– General good manufacturing practices (GMPs) |
| Market penetration in 2006 | Almost all French and German retailers request IFS certification, as do some retailers from Austria, Switzerland, Italy and Poland. |

## B. Safe quality food (SQF) standard

The safe quality food (SQF) standard was originally established by the Western Australian Department of Agriculture in 1996. After its launch, the SQF standard caught the attention of the Food Marketing Institute (FMI), a US-based retail association. In 2003, worldwide ownership of SQF was transferred to FMI and is now managed by FMI's SQF Institute. [51] The FMI comprises more than 1500 US and international retail and wholesale companies that account for 75% of all US domestic retail revenues.

[51] SFQ, 2006.

The SQF programme is intended to deal with comprehensive food safety management. However, in comparison to other standards such as IFS, BRC or ISO 22000, it only specifies requirements for quality management systems and does not include good practices or HACCP plans. The SQF is designed for all types of food products and all types of suppliers; the SQF 1000 Code applies to primary producers; while the SQF 2000 Code applies to food industry suppliers.

| **SUMMARY: SAFE QUALITY FOOD (SQF)** | |
|---|---|
| Standard-setting body | Safe quality food institute (SQFI) |
| Scope and objectives | - Complete food safety management;<br>- SQF 1000: Primary producers;<br>- SQF 2000: Food industry. |
| Provisions | - SQF mainly deals with quality management systems;<br>- GAPs as a prerequisite programme for SQF 1000 (no specifications);<br>- GMPs as a prerequisite programme for SQF 2000 (no specifications);<br>- Establishment of food safety plan based on HACCP (no specifications). |
| Market penetration in 2006 | Most American retailers and global retailers request or support SQF certification. |

## C. BRC global standard – food

The BRC Global Standard – Food is a private food safety standard elaborated and adopted by the British Retail Consortium (BRC), a trade association representing the whole range of retailers in UK. In 1998, the British Retail Consortium, responding to industry needs, developed and

introduced the BRC Food Technical Standard for use in evaluating manufacturers of retailers' own brand food products.

In a short space of time, this standard has become invaluable to other organizations across the food sector. The BRC food standard was and still is today regarded as a benchmark for best practice in the food industry. The fourth version of the BRC normative document, published in January 2005, has been in effect since July 2005.

The objective of the BRC Global Standard – Food is to specify the safety, quality and operational criteria required of a manufacturing organization to supply food to UK retailers, their suppliers or other standard users. The standard does not apply to primary production or distribution and storage activities. The BRC Global Standard - Food deals with quality management systems and HACCP, but also establishes general good manufacturing practices for food safety.

The majority of UK and some Scandinavian retailers will only consider doing business with food suppliers who have gained certification to the appropriate BRC Global Standard.

**SUMMARY: BRC GLOBAL STANDARD - FOOD**

| | |
|---|---|
| Standard-setting body | British Retail Consortium (BRC) |
| Scope and objectives | - Food safety and quality management system for food manufacturers |
| Provisions | – Adoption and implementation of HACCP;<br>– Implementation of an effective quality management system (QMS);<br>– Implementation of GMPs and GHPs;<br>– Control of factory environmental standards, products, processes and personnel. |

| SUMMARY: BRC GLOBAL STANDARD - FOOD | |
|---|---|
| Market penetration in 2006 | All major UK and Scandinavian retailers only source food from BRC-certified suppliers. BRC is increasingly viewed as a benchmark for best practices in food manufacturing, so some international operators are also requiring BRC certification from suppliers. |

## D. EUREPGAP

EUREPGAP is a private sector body that sets voluntary standards for the certification of agricultural products around the globe. EUREPGAP started in 1997 as an initiative by retailers belonging to the Euro-Retailer Produce Working Group (EUREP). Today, EUREPGAP is an equal partnership of agricultural producers and retailers who want to establish certification standards and procedures for good agricultural practices (GAPs).[52] EUREPGAP management and normative documents are hosted and owned by FoodPLUS, a non-profit organization.

EUREPGAP is a pre-farm-gate-standard, which means that the certificate covers the process of the certified product from before the seed is planted until it leaves the farm. It is a business-to-business label and is therefore not directly visible for consumers. The EUREPGAP standard is primarily designed to maintain consumer confidence in food quality and food safety. Other important goals are to minimize detrimental environmental impacts of farming operations, optimize the use of inputs, and ensure a responsible approach to worker health and safety.

[52] EUREPGAP, 2006.

EUREPGAP is a means of incorporating integrated pest management (IPM) and integrated crop management (ICM) practices into the framework of commercial agricultural production. Adoption of IPM and ICM is regarded by EUREPGAP members as essential to the long-term improvement and sustainability of agricultural production. EUREPGAP support the principles of HACCP and encourages its use.

Farmers applying for EUREPGAP certification should be able to demonstrate their commitment to:

- Maintaining consumer confidence in food quality and safety;
- Minimizing the detrimental impact on the environment while conserving nature and wildlife;
- Reducing the use of crop protection products;
- Improving the efficiency of natural resource use;
- Ensuring a responsible attitude towards worker health and safety.

| **SUMMARY: EUREPGAP** | |
|---|---|
| Standard-setting body | EUREP and FoodPLUS |
| Scope and objectives | - Promotion of good and environmentally sound agricultural practices;<br>- Restoration of consumer confidence in food safety;<br>- Promotion of sound animal welfare and worker health programmes. |
| Provisions | - Implementation of GAPs and promotion of IPM and ICM;<br>- Quality management issues such as traceability and record-keeping;<br>- Risk assessment according to HACCP principles. |

| SUMMARY: EUREPGAP | |
|---|---|
| Market penetration in 2006 | Various European retailers and private trading companies are asking for EUREPGAP certification, while others support the EUREPGAP initiative. The EUREPGAP standard on fruits and vegetables has become the most commonly used and established standard since it was first introduced. |

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*** WEB INFO ***

**Information and documentation on Chapter V**

| | | |
|---|---|---|
| International Organization for Standardization (ISO) | Official website | www.iso.org |
| The Food Business Forum (CIES) and the Global Food Safety Initiative (GFSI) | Official website | www.ciesnet.com |
| International food standard (IFS) | Official website | www.food-care.info |
| British Retail Consortium (BRC) | Official website | www.brc.org.uk/standards/index.htm |
| Safe Quality Food Institute (SQFI) | Official website | www.sqfi.com |
| EUREPGAP | Official website | www.eurepgap.org |

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# CHAPTER VI

# FOOD LAWS AND FOOD SAFETY REGULATIONS

## Introduction

In recent years, world food primary production, manufacturing and trade have been profoundly altered by the adoption of international agreements, regulations and standards that have provided a precise framework for global food supply chains and trade by defining the rights and obligations of all participating partners. The globalization process and the internationalization of food production and trade, further facilitated by international agreements on trade, have emphasized the need for harmonization of food laws and regulations in order to ensure that food is safe for consumers, prevent spread of diseases among animals and plants, and ensure fair practices in global food trade. Today, the production and trade of food is regulated within a framework of international and national agreements, laws and regulations. This chapter offers an overview of the most important international agreements that affect world food production and trade, as well as international and national regulations regarding food safety systems and export market access to US and EU countries.

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## MODULE 1:
## International Food Laws and Regulations

| | |
|---|---|
| **Learning outcomes:** | Trainers will gain insight into international agreements and regulations that affect production and trade of food and into the main institutions involved. |

## A. Agreements of the World Trade Organization (WTO)

The establishment of the World Trade Organization (WTO) during the Uruguay Round of Multilateral Trade Negotiations in 1994 marked the conclusion of two binding agreements regarding world agricultural production and food trade:

- The Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement); and
- The Agreement on Technical Barriers to Trade (TBT Agreement).

### Agreement on the Application of Sanitary and Phytosanitary Measures (SPS)

The SPS Agreement regulates the conditions under which national regulatory authorities may set and enforce health and safety standards that affect trade. It applies to any measure, regardless of its specific form, which aims to protect consumers and animals from food- and feedborne risks and consumers, animals and plants from pest- or disease-related risks.[53]

The Agreement basically ensures that all measures established by national governments are consistent with requirements prohibiting arbitrary or unjustifiable discrimination in trade. It further requires all member countries to base the adoption of national measures on international guidelines and standards issued by the following international institutions, where they exist:

- Food safety: Codex Alimentarius Commission (CAC)
- Plant health: International Plant Protection Convention (IPPC)
- Animal health: World Organization for Animal Health (OIE)

[53] UNCTAD, 2005.

Member countries are allowed to adopt stricter measures than those recommended by CAC / IPPC / OIE if there is sufficient scientific justification for doing so or if the level of safety afforded by CAC / IPPC / OIE regulations is inconsistent or not appropriate with the general level of protection in the country concerned.[54]

**Agreement on technical barriers to trade (TBT)**

The TBT Agreement was established with the objective of preventing the use of national or regional technical requirements or standards in general as unjustified barriers to trade.[55] The TBT Agreement covers standards relating to all types of products, including agricultural products and foods. Not covered are food standards and issues related to sanitary and phytosanitary measures, which are covered by the SPS Agreement.

**!**

Within the framework of international food regulations concerning human, animal and plant health as well as food- and feed-safety and trade-related issues, the two WTO Agreements on SPS (Sanitary and Phytosanitary Measures) and on TBT (Technical Barriers to Trade) play a key role in providing the basis for all national and international regulations, standardization and harmonization efforts.

## B. Codex Alimentarius Commission (CAC)

The Codex Alimentarius Commission (CAC) was created in 1963 by FAO and WHO to develop food standards, guidelines and related texts, such as codes of practice under the Joint FAO/WHO Food Standards Programme. The main purposes of this Programme are protecting

[54] UNCTAD, 2005; FAO, 2000.
[55] FAO, 2000.

consumer health and ensuring fair trade practices in the food trade, and promoting coordination and harmonization of all food standards work undertaken by international governmental and non-governmental organizations.[56] Codex normative texts fall into three groups:[57]

| | |
|---|---|
| **Codex standards** | Codex standards usually relate to product characteristics. They can be general standards that apply to all product groups (e.g. maximum residue limits, or MRLs) for pesticides or veterinary drugs) or commodity standards that are specific to certain foods (e.g. fruits, milk, poultry) |
| **Codex codes of practice** | Codex codes of practice define proper practices for production, processing, manufacturing, transport and storage of food that are deemed essential to food safety. |
| **Codex Guidelines** | Guidelines can be principles that set out policy in certain key areas or interpretative directions for the understanding of these principles or for the interpretation of the provisions of the Codex general standards. |

To date, the CAC has developed and adopted more than 250 Codex standards, 60 Codex codes of practice and 60 Codex guidelines. All national regulations that are consistent with the CAC meet the requirements of the SPS and TBT Agreements. Thus, the Codex standards play a key role in the harmonization of national food safety standards and have become global reference points for consumers, food industries, national food agencies and the international food trade.

[56] CAC, 2006.
[57] CAC, 2005.

## MODULE 2:
## EU Food Safety System

| | |
|---|---|
| **Learning outcomes:** | Trainers know about the system and policies of EU food safety and food law. |

The central goal of the European Commission's food safety policy is to ensure a high level of protection of human health and consumer interests in relation to food, taking due account of diversity, including traditional products, while ensuring the effective functioning of the internal market.

The EU Commission's guiding principle for food safety, which was first set out in the year 2000 in its *White Paper on Food Safety*[58], is to apply an integrated approach from farm to table covering all sectors of the food chain, including feed production, primary production, food processing, storage, transport and retail sale.[59] Today, the EU food safety system is based on three pillars of this "farm-to-fork" strategy:

- Legislation on the safety of food and animal feed;
- Sound scientific advice on which to base decisions;
- Enforcement and control.

### General Legislation

The general principles of EU food safety are set out in a regulation adopted in 2002 and often known as the *General Food Law*. Under this law, it became compulsory from 1 January 2005 for food and feed businesses to guarantee that all foodstuffs, animal feed and feed ingredients are traceable right through the food chain. Separate, updated hygiene rules came into effect on 1 January 2006.

[58] EU, 2000.
[59] EU, 2006a.

The General Food Law is supplemented by targeted legislation on a raft of food safety issues, such as use of pesticides, food supplements, colourings, antibiotics and hormones in food production, and products in contact with foodstuffs, such as packaging; and by stringent procedures on release, marketing, labelling and traceability of crops and foodstuffs containing genetically modified organisms (GMOs). The basic rules apply to all food and feed.

**Rapid alert system for food and feed (RASFF)**

In order to spot food and feed risks effectively, the EU further operates a rapid alert system. Every EU government has an early warning system to detect when feed or food could be unsafe and therefore expose consumers to the risks of illnesses such as salmonella. It alerts the Commission, which is the hub of an EU-wide notification system.

Warning bells also sound when banned substances are identified or legal limits for high-risk substances have been exceeded. These substances may be veterinary medicine residues, food colourings known to be carcinogenic or naturally occurring toxic moulds. The system deals with several hundred alerts on immediate risks each year.

What happens depends on the type of risk. It may be enough to stop a single batch, or it may be necessary to stop all shipments of a particular product from the farm, factory or port of entry. Products already in warehouses and shops may be recalled. Sometimes every shipment from one suspect source is tested for some months. In emergencies, the European Commission can step in directly to protect public health rather than waiting to consult EU governments.

**Sound scientific foundations: The EU Food Safety Authority (EFSA)**

Science is the essential foundation on which the EU bases its decisions on any part of the food chain. The European Food Safety Authority (EFSA) in Parma, Italy, plays a central role in this. EFSA has a wide brief. It can look into all stages of food production and supply, from primary production to the safety of animal feed through to the supply of

food to consumers. Its brief also extends to the properties of non-food and feed GMOs and to nutrition issues.

## MODULE 3:
## US Food Safety System

| | |
|---|---|
| **Learning outcomes:** | Trainers know about the system and policies of US food safety assurance. |

The food safety system in the United States is based on strong, flexible, science-based laws and on industry's legal responsibility to produce safe foods. Federal, state, and local authorities have complementary and interdependent food safety roles in regulating food and food processing facilities. The system is guided by the following principles:

- Only safe and wholesome foods may be marketed.
- Regulatory decision-making in food safety is science-based.
- The government has enforcement responsibility.
- Manufacturers, distributors, importers and others are expected to comply and are liable if they do not.
- The regulatory process is transparent and accessible to the public.

Food safety issues, regulations and law enforcement in the US are facilitated by various governmental bodies and institutions. The following table lists the principal federal regulatory organisations responsible for assuring US food safety:[60,61]

[60] US FDA and USDA, 2000.
[61] National Food Safety Programme, 2006.

| **Regulatory body** | **Main responsibilities** |
|---|---|
| Department of Health and Human Services (DHHS) of the US Food and Drug Administration (USFDA) | Assurance that all other products than meat, poultry and eggs are safe, wholesome and accurately labelled (e.g. fruits and vegetables).<br>FDA is responsible for assuring that all FDA-regulated imported goods meet US requirements for safety and quality. |
| Food Safety and Inspection Service (FSIS) of the U.S. Department of Agriculture's (USDA) | Assurance that meat, poultry, and egg products are safe, wholesome and accurately labelled |
| Animal and Plant Health Inspection Service (APHIS) of the USDA | Protection against plant and animal pests and diseases |
| Environmental Protection Agency (EPA) | Protection of public health and the environment from risks posed by pesticides and promotion of safer means of pest management |
| US Centers for Disease Control and Prevention (CDC) | Science-based support of the main US agencies responsible for enforcement of food safety (e.g. USFDA and FSIS) |

Regarding the import of food into the US market, the main responsible and acting body is the US Food and Drug Administration (USFDA). As a result of the events of September 11 2001, FDA must now include in its import agenda the detection of terrorist acts and other acts of intentional adulteration and/or tampering.

The Bioterrorism Preparedness and Response Act of 2002 required FDA and US Customs and Border Protection (CBP) to jointly develop

regulations pertaining to (1) registration of food and animal feed facilities; (2) prior notification of imported food shipments; (3) establishment and maintenance of records; and (4) administrative detention of suspect shipments. [62]

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*** WEB INFO ***

**Additional information and documentation on Chapter VI**

| | | |
|---|---|---|
| Codex Alimentarius Commission (CAC) | Official website | www.codexalimentarius.net |
| International Portal on Food Safety, Animal and Plant Health (IPFSAPH) | Official website | www.ipfsaph.org |
| International Plant Protection Convention (IPPC) | Official website | www.ippc.int |
| World Organization for Animal Health (OIE) | Official website | www.oie.int |

[62] CFSAN 2006: Registration of Food Facilities.

*** WEB INFO ***

**Additional information and documentation on Chapter VI**

| | | |
|---|---|---|
| World Trade Organization (WTO) | Official website | www.wto.org |
| World Health Organization (WHO) | Official website | www.who.int |
| EU Health and Consumer Protection General Directorate | Official website | www.ec.europa.eu/dgs/health_consumer/index_en.htm |
| EU Food Safety Programme | Overview | www.ec.europa.eu/food/index_en.htm |
| EU Food Safety Programme: From the Farm to the Fork | Official website | www.ec.europa.eu/food/food/index_en.htm |
| EU export helpdesk for developing countries | Official website | www.export-help.cec.eu.int/ |
| EU rapid alert system for food and feed (RASFF) | Official website | www.ec.europa.eu/food/food/rapidalert/index_en.htm |
| International food safety authorities network (INFOSAN) | Official website | www.who.int/foodsafety/fs_management/infosan/en |

*** WEB INFO ***

**Additional information and documentation on Chapter VI**

| | | |
|---|---|---|
| US Government food safety information | Official website | www.foodsafety.gov |
| US National Food Safety Programme | | www.foodsafety.gov/~dms/fs-toc.html |
| US Centers for Disease Control and Prevention (CDC) | Food Safety Office of CDC | www.cdc.gov/foodsafety |
| US Food and Drug Administration (USFDA) | Food Defence and Terrorism (Bio-Terrorism Act) | www.cfsan.fda.gov/~dms/defterr.html |
| USFDA Center for Food Safety and Applied Nutrition (CFSAN) | Registration for food facilities | www.cfsan.fda.gov/~furls/ovffreg.html |

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