

# **IMPROVING THE SAFETY AND QUALITY OF FRESH FRUIT AND VEGETABLES: A TRAINING MANUAL FOR TRAINERS**



Copyright © 2002 University of Maryland. This work may be reproduced and redistributed, in whole or in part, without alteration and without prior written permission, for nonprofit administrative or educational purposes provided all copies contain the following statement: "© 2002 University of Maryland. This work is reproduced and distributed with the permission of the University of Maryland. No other use is permitted without the express prior written permission of the University of Maryland. For permission, contact JIFSAN, University of Maryland, Symons Hall, College Park, MD 20742

**IMPROVING THE SAFETY AND QUALITY  
OF FRESH FRUIT AND VEGETABLES:  
A TRAINING MANUAL FOR TRAINERS**

Table of Contents

**Introduction**

Table of Contents .....	i
Introduction .....	v
About This Manual .....	v
Acronyms.....	ix

**Principles**

**SECTION I. THE IMPORTANCE OF TRAINING FOR IMPROVING THE SAFETY AND QUALITY OF FRESH FRUITS AND VEGETABLES**

Module 1. Safety Hazards In Fresh Produce – Biological, Chemical and Physical.....	I-2
Module 2. Fresh Produce Safety and Consumer Health .....	I-13
Module 3. Impact of Produce Safety on Trade .....	I-18
References.....	I-22

**SECTION II. GOOD AGRICULTURAL PRACTICES**

Module 1. Soil and Water .....	II-3
Module 2. Organic and Inorganic Fertilizers .....	II-16
Module 3. Animal Exclusion and Pest Control .....	II-27
Module 4. Worker Health and Safety .....	II-39
Module 5. Harvesting and Cooling .....	II-50
References .....	II-63

**SECTION III. GOOD MANUFACTURING PRACTICES FOR HANDLING, PACKING, STORAGE AND TRANSPORTATION OF FRESH PRODUCE**

Module 1. Produce Cleaning and Treatment .....	III-2
Module 2. Packing, Storage and Transportation .....	III-15
Module 3. Equipment Cleaning and Sanitation .....	III-25
References .....	III-33

**SECTION IV. FOOD LAWS AND REGULATIONS**

Module 1. The U.S. Food Safety System.....IV-2  
Module 2. Investigating Foodborne Disease Outbreaks.....IV-9  
Module 3. International Food Laws and Regulations.....IV-16  
References .....VI-23

**SECTION V. FOOD SAFETY AND QUALITY ASSURANCE ISSUES**

Module 1. Safety and Quality Assurance .....V-2  
Module 2. Quality Attributes, Grades and Standards .....V-10  
Module 3. Quality Attributes and Spoilage .....V-18  
References .....V-25

**SECTION VI. DEVELOPING AN EFFECTIVE TRAINING COURSE**

Module 1. Planning for Effective Training: Identifying Needs  
and Setting Objectives .....VI-2  
Module 2. Preparing and Organizing the Training Content .....VI-9  
Module 3. Conducting and Evaluating the Course .....VI-18  
References .....VI-25

**Practical**

**Introduction** .....P-3  
**Experiments/Demonstrations**  
• Water as a Contamination Agent .....P-4  
• Product Integrity and Produce Contamination .....P-6  
• Handwashing .....P-8  
• Chlorine Concentration and Water Quality Management .....P-10  
• Fruit Spoilage .....P-13  
• Experiments Using Artificial “Germs”:  
    Handwashing .....P-15  
    How Germs are Spread - I.....P-16  
    How Germs are Spread – II .....P-16  
    Germs and Produce .....P-16  
• Fresh Produce Quality .....P-18  
**Discussion Questions** .....P-19  
**Problem Solving Exercises**  
    Traceback Investigation.....P-20  
    Planning for an Effective Training Course on GAPs: 3 Scenarios ....  
        .....P-22  
**Field Site Visit Guide** .....P-24

## **Additional Resources**

### **Part I. Foodborne Disease and Fresh Produce**

- Table 1 – Pathogens Associated with Fresh Fruits and Vegetables .Res-2
- Table 2 – Outbreaks of Foodborne Disease Associated with  
Fresh Fruits and Vegetables .....Res-6

### **Part II. FDA Publications**

- The Guide to Minimize Microbial Food Safety Hazards for  
Fresh Fruits and Vegetables - In Brief .....Res-10
- Farm Investigation Questionnaire .....Res-14
- Do Your Own Establishment Inspection – A Guide to Self Inspection  
for the Smaller Food Processor and Warehouse .....Res-25
- Guidance for Industry: Reducing Microbial Food Safety Hazards for  
Sprouted Seeds .....Res-36
- FDA Publishes Final Rule to Increase Safety of Fruit and  
Vegetable Juices .....Res-39

### **Part III. Disinfecting Contaminated Wells .....Res-41**

### **Part IV. Composting Facility .....Res-43**

### **Part V. Storage Conditions for Fruits and Vegetables .....Res-46**

### **Part VI. Fundamentals of HACCP .....Res-48**

### **Part VII. Choosing the Correct Training Aids .....Res-60**

### **Part VIII. Glossary of Terms .....Res-64**

### **Part IX. Where to Find Additional Information .....Res-68**

## **Introduction**

The health benefits associated with regular consumption of fresh fruits and vegetables have been clearly demonstrated and encouraged by national and international nutrition and health authorities. However, increased consumption of these products has been associated with an increased proportion of reported outbreaks of foodborne illness that can be traced to fresh produce. Recent outbreaks of foodborne illness, such as those in the U.S. involving *E. coli* O157:H7 in lettuce and *Salmonella* in cantaloupe, and the fact that most fresh produce is not processed, a step which generally reduces or eliminates pathogens, have raised concerns regarding the potential safety of fresh fruits and vegetables.

### **Background**

In 1998, the U.S. Food and Drug Administration (FDA) and U.S. Department of Agriculture (USDA) issued the document "Guidance for Industry -- Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables." This document, referred to as the Guide, addressed microbial food safety hazards and good agricultural and manufacturing practices (GAPs and GMPs) common to the growing, harvesting, cleaning/washing, sorting, packing, and transporting of most fruits and vegetables sold to consumers in an unprocessed or minimally processed (raw) form. This voluntary, science-based guidance was designed to be used by both domestic and foreign fresh fruit and vegetable producers to help ensure the safety of their produce. The voluntary guidance is consistent with U.S. trade rights and obligations and does not impose unnecessary or unequal restrictions or barriers on either domestic or foreign producers.

That same year, the Food and Agriculture Organization of the United Nations (FAO) in conjunction with the Institute of Food Science and Engineering, University of Arkansas (IFSE/UA) initiated plans to develop a regional training course for Mexico and Central America on quality assurance and safety of fresh produce. The Government of Guatemala hosted a planning Workshop for this training in Guatemala City in December 1998. The 10-day FAO Regional Training Course took place in June 1999 at the School of Tropical and Humid Agriculture (EARTH) and was hosted by the Government of Costa Rica. The participants at both the planning workshop and the training course indicated a 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 will:

1. Provide a teaching tool to train trainers who will be conducting courses to facilitate the safe production, handling, storage, and transport of fruits and vegetables produced in countries exporting to the United States and elsewhere
2. Serve as a resource for trainers preparing and conducting courses to assist those in the produce industry with identifying and implementing appropriate measures to minimize risks of microbial contamination while also reducing other hazards (chemical and physical) and maintaining market quality

The information and recommendations presented expand on the Guide and the material developed for the Regional course in Costa Rica. 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**

Information presented includes:

Principles – science-based information regarding elements of produce safety and quality. Topics included are:

- The importance of training for improving the safety and quality of fresh fruits and vegetables
- Good agricultural practices (GAPs)
- Good manufacturing practices (GMPs) for handling and packing
- Quality and phytosanitary issues for fresh produce
- Safety hazards and quality attributes of fresh produce
- Developing an effective training course

Practical - materials to accompany and complement lectures. Included are experiments/demonstrations, discussion questions, problem solving activities and a Field Site Visit Guide. Volume II of this manual contains commodity specific case studies that provide an opportunity for participants to apply material learned to actual agricultural situations.

Additional Resources- includes relevant reference documents and information on obtaining additional resource material.

Although background data and examples have been specifically targeted to Latin America and the Caribbean, the recommendations contained in this manual are globally applicable and independent of location or agricultural and industrial circumstances. For use in other regions, presentation style and teaching resources may vary, depending upon cultural and political circumstances.

As training needs vary by country, the time frame for training and the extent of training will also vary. It is anticipated that the length of time to present the Principles and Practical information will be 5-7 days with the inclusion of a field site visit. The backgrounds and needs of the course participants will determine how much time should be spent on each of the training modules. Logistics, budget, and schedules may dictate shorter or split sessions and the number of Practical activities that are included. Since interactive sessions with discussions, lab demonstrations, field visits, and case studies are an important part of the training process, the number of participants needs to be limited to a manageable level for trainers and facilities.

Included throughout the Principles section are suggestions for information that may be highlighted as visuals. These are intended as suggestions for visuals, not as actual visual masters. Depending on the amount of material to be presented, the type of visual aids to be used, and the size of the training group, the trainer may choose to present each as a single visual or as multiple slides, overheads, charts, or posters.

The Practical section of the manual includes activities to involve participants in the training. Use of these activities will enhance training of trainers by complementing lecture material and by providing the participants with ideas for activities to enrich their own training efforts. Suggestions for activities related to training topics are included at the beginning of each of the training modules. Trainers of trainers are encouraged to use as many of these as time and resources will allow.

In Volume II, the commodity specific case studies allow participants to apply the recommended GAPs and GMPs in examples relevant to Latin America and the Caribbean. These case studies have been developed with direct input from producers in the region to ensure that topics and presentation are appropriate. They are intended to build understanding and awareness of practices that may be presented to individual growers, packers, and shippers for consideration and incorporation into their own operations.

Users of the Guide are reminded of several important considerations in applying its recommendations. These considerations also are important for those using this manual:

- 1) The manual focuses on microbial hazards for fresh produce. It addresses in only the broadest terms other areas of concern to the food supply or the environment (such as pesticide residues or chemical contaminants). When providing recommendations to growers, packers, and shippers it is important to encourage them to apply the techniques that are most appropriate for reducing hazards in their individual operations. They should also strive to establish practices that do not inadvertently increase other risks to the food supply or the environment (e.g., excessive packaging or improper use and disposal of

antimicrobial chemicals).

- 2) This training 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.
- 3) This training manual provides broad, scientifically-based principles. Trainers should encourage operators to use the information to help assess microbiological hazards within the context of the specific conditions (climatic, geographical, cultural, economic) that apply to their own operation and implement appropriate and cost effective risk reduction strategies.
- 4) Users of the manual should constantly be alert for new information and technological advances that expand the understanding of those factors associated with identifying and reducing microbial food safety hazards. Awareness of these advances will allow updating the recommendations and information contained in this manual as appropriate to keep training content current.

## **ACRONYMS**

The following acronyms are used in this manual. Each is identified when first introduced in the text but are also listed here for easy reference.

**APHIS** – Animal and Plant Health Inspection Service/U.S. Department of Agriculture

**CAC**- Codex Alimentarius Commission

**CCP** – Critical Control Point

**CDC** – U.S. Centers for Disease Control and Prevention

**CFR** – Code of Federal Regulations

**CFSAN** – Center for Food Safety and Applied Nutrition/U.S. Food and Drug Administration

**CODEX ALIMENTARIUS** – a code of food standards for all nations

**CSREES** – Cooperative State Research, Education and Extension Service/U.S. Department of Agriculture

**EPA** – U.S. Environmental Protection Agency

**FAO** – Food and Agriculture Organization of the United Nations

**FDA** – U.S. Food and Drug Administration

**GAPs** - Good Agricultural Practices

**GATT**- General Agreement on Tariff and Trade

**GDP**- Gross Domestic Product

**GMPs** - Good Manufacturing Practices

**HACCP** - Hazard Analysis Critical Control Point

**IFSE** – Institute of Food Science and Engineering/University of Arkansas

**IPM** – Integrated Pest Management

**JIFSAN** – Joint Institute of Food Safety and Applied Nutrition/University of Maryland

**MAQ** – Minimum Acceptable Quality

**PAHO** – Pan American Health Organization

**OSHA** – Occupational Safety and Health Administration

**SOPs** – Standard Operating Procedures

**SPS** – Agreement on Sanitary and Phytosanitary Measures

**SSOPs** – Sanitation Standard Operating Procedures

**TBT** – Agreement on Technical Barriers to Trade

**USDA** – U.S. Department of Agriculture

**USDA-AMS** – USDA's Agricultural Marketing Service

**WHO** – World Health Organization of the United Nations

**WTO** – World Trade Organization of the United Nations