

Food Safety Manual

For

Farmer Field Schools



A training reference guide on food safety in global FFS programmes



November 2010

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Introduction and Acknowledgements

This field manual was developed for the FAO Plant Production and Protection Division (AGP) in collaboration with the Food Safety and Quality Division (AGN) and three FAO regional Integrated Pest Management (IPM) programmes.

In the supply chain for fruit and vegetables there is an increasing pull for more attention to food safety. The three FAO Regional IPM Programmes are recognizing the need to respond to this demand and have initiated different activities to develop relevant Farmer Field School (FFS) training modules. As this area is still very much in development, it was recognized that IPM programmes could benefit from closer collaboration. The FAO Plant Production and Protection Division (AGP), in collaboration with the Food Safety and Quality Division (AGN), therefore organised a workshop in March 2010 to enable relevant experts from the three regional programmes to meet with food safety experts and to jointly develop this guide on the development of a food safety module for inclusion in the FFS curricula of IPM programmes. This process was coordinated by Harry van der Wulp and Anne-Sophie Poisot.

This manual was compiled on the basis of the expertise and global experiences of workshop participants, and of existing relevant references and training materials listed in Chapter 4 of Part I.

Contributions of Catherine Bessy, Marjon Fredrix, Alfredo Impiglia, Almalinda Morales-Abubakar, Jan Ketelaar, Anne-Sophie Poisot, Areepan Upanisakorn and Harry van der Wulp are gratefully acknowledged. These colleagues contributed information, training materials, and suggestions based on their technical expertise and field experience, reviewed this manual and offered suggestions for improvements. Much of the content of this manual is based on several decades of experience in implementing Farmer Field Schools in Asia, the Near East, and more recently, in West Africa.

The resulting manual is a team effort.

Frederike Praasterink
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October 2010

Why this Manual

Objective of the manual

In the supply chains for fruit and vegetables there is an increasing demand for more attention to food safety. Farmer Field Schools has proven to be a very effective method to incorporate food safety aspects into farming practices¹. This manual is a reference guide for the inclusion of Food Safety aspects in Farmer Field School (FFS) programmes. *Health* (consumer protection) is the main entry point for food safety in this manual. However, in some cases, marketing benefits could occur from improved food safety and quality.

This manual is written for managers of (national) IPM programmes, TOT master trainers and FFS facilitators.

How to use

This manual should be used as a source of information and inspiration. It is meant to be changed and adapted to the local situation by users. It is recommended to test and validate exercises with experienced FFS facilitators. Additional facilitator training on food safety issues will probably be necessary. An assessment of food safety issues at farm level or community level can be part of such training. Further feed-back from facilitators and farmers will help to adapt food safety modules or exercises to the local needs.

Content of the manual

Much of the content of this manual is based on field experiences from FFS programmes in Asia and West-Africa. Background information is used from various sources, listed in chapter 4, including ASEAN GAP training materials. However, any errors in this manual are our responsibility.

Part I of this manual provides practical information about food safety and a reference list for more detailed information. It also contains a section on how to incorporate food safety elements into existing FFS programmes.

Part II contains a number of exercises and special topics on food safety for FFS. These exercises can be used for inspiration, but need to be adapted to fit the crop and the local conditions.

The focus of this manual is on **pre-production, production, harvest and post-harvest on-farm.**

¹ The vegetable IPM Programme in Thailand has successfully introduced food safety aspects into FFS training since 2007.

Food Safety Manual for Farmer Field Schools

A training reference guide on food safety in global FFS programmes

Part I

Background information

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1 Introduction to Food Safety and GAP

1.1 What is Food Safety and why is it important?

Food Safety
is the absence of adverse health effects due to food contamination.

Food Safety is very important:

- **To protect consumer health**
(so that people do not get sick after eating contaminated food)
- **To gain market access**
(some national governments or retailers require food safety certificates; if farmers do not produce according to specific standards (e.g. maximum residue levels for pesticides), they cannot sell produce through those markets.)

Food safety hazards
are any chemical, biological or physical substance or property that can cause fruits and vegetables to become an unacceptable health risk to consumers.

Chemical hazards may include heavy metals or pesticide residues exceeding maximum authorized levels; biological hazards include pathogenic bacteria like *E. Coli* or *Salmonella* on the crop; physical hazards can be pieces of glass or stones in the product. In section 2.1 and 2.2 below more information is given about most hazards and how these can be prevented.

Information from the World Health Organization (WHO) in November 2009 showed that food borne diseases are much more intense than previously estimated: **some 1.2 million deaths every year** aged six and above in Southeast Asia and Africa. This is a three-fold increase in adult deaths than WHO believed was occurring world-wide! ²

There is a growing demand for high quality and safe food due to globalization of trade and markets (creating need for standardization of production and quality of food), changing life styles (more convenience food, and more consumption of meat and dairy) and a growing number of food safety outbreaks³.

Why are food safety outbreaks increasing?

- Increase in global trade
- New (convenience) products, such as fresh cut salads
- New production and conservation methods
- Organisms with different levels of virulence
- Introduction of new organisms into regions
- Changes in susceptibility of people



² <http://www.newsinferno.com/archives/13866>

³ Inspired on ASEAN GAP Training Course session 4, Food Safety Module (used for text box)

Case: acute mass poisoning with organophosphate Ethion

Mass poisoning occurred at a farm during a social ceremony in April 2005 in Magrawa, a village in India. A meal was served and children and male adults were the first to take the food. Within 2–3 hours, all nine adult males and six children who had taken the meal started complaining of severe abdominal pain, difficulty in respiration and many had diarrhea and vomiting. These effects were not observed among the people who did not consume this food. Of the fifteen affected people, ten died within 24 hours and the remaining five had to be hospitalized for varied durations. It was established that the food had been contaminated with Ethion, an organophosphate pesticides.

Organophosphate (OP) pesticides continue to be the most common type of pesticides involved in acute poisoning in countries like India and Sri Lanka. A large number of them, including Ethion, are registered for use in India. Ethion is a moderately toxic OP pesticide belonging to class II category by hazard, and approximately 3000–4000 metric tons of this pesticide is used annually in India.

Source: Dewan, Aruna, et al. Clinical Toxicology (2008) 46, 85-88

Some examples of large-scale food contamination and disease outbreaks⁴:

USA, Canada – 2004

Salmonella causes illness in 561 people. Contamination linked to tomatoes.



Philippines – 2006

Export consignment of mangoes halted in Japan due to insecticide residues above MRL

USA – 2006

3 deaths and over 200 people sick from eating fresh cut spinach contaminated with E. coli. Suspected cause is flooding of blocks or use of animal manure

India – 2006

High residues of heavy metals detected in vegetables grown in industrial areas

Turkey – 2006

Greenhouse production stopped due to barrels of toxic waste found buried on site

Australia – 1999

500 people sick from drinking unpasteurized orange juice contaminated with Salmonella. Traced to dip tank in packing shed.

Eating contaminated food can have an **acute** and/or a **longer-term effect**. Acute or immediate effect is when people get sick (e.g. vomiting, diarrhea) shortly after eating contaminated food. Longer-term (or chronic) effects can be related to a gradual build-up level of unhealthy substances in the body. When these levels become very high, people get sick and eventually may even die. Examples include residues of carcinogenic pesticides or chronic kidney disease due to cadmium. See box below.

Case: Cadmium chronic poisoning

Cadmium is a trace element that has been associated with various human health problems. Exposure to humans can be through respiratory track (e.g. cigarette smoke) and via gastrointestinal track (through food). The kidney is the main organ affected by chronic Cadmium exposure and this may lead to chronic kidney disease. Although Cadmium can be naturally present in the food plants, high levels in the food can be caused by cadmium-contaminated soil and water. Long-term exposure may lead to health problems.

Sources: 2010. Johri N, Jacquillet G, Unwin R. www.ncbi.nlm.nih.gov/pubmed/20355117 and Perilli P, Mitchell LG, Grant CA, Pisante M. www.ncbi.nlm.nih.gov/pubmed/20354761

⁴ Examples taken from ASEAN GAP Training Course, session 4 on Food Safety

1.2 What is the difference between food safety and food quality?

Food quality
is the combination of a product's characteristics valued by the consumer.
Food quality is subjective: it means different things to different people.

Quality may include nutritional facts (e.g. vitamin content), sensorial properties (e.g. taste, smell), appearance (e.g. colour, size, firmness, absence of bruises/damages), social considerations (e.g. traditions, food culture), convenience (e.g. preparation, shelf life, easy peeling) and food safety.



Food safety is a part of food quality

Most consumers buy food based on appearance, price and convenience. Food safety is often not specifically considered because *it is assumed by consumers that fruit and vegetables are healthy and safe to eat*. Unfortunately this is not always the case, as becomes clear from the examples of food safety incidents above.


A lot of what farmers can do to improve the safety of fruits and vegetables also helps improve the **quality**. For example, food safety *and* food quality are affected by:

- Seeds: good quality seeds, performance, variety demanded by the market
- Soils (or substrate, such as hydroponics): choice of field, soil preparation method
- Crop management: spacing, weeding, mechanical injury, etc
- Water: quantity, quality, irrigation techniques
- Fertilization: has strong influence on shape, shelf life, taste (e.g. sugar content of fruit). Using organic fertilizers does not necessarily result in good taste
- Diseases and pests: pesticide residues, insect parts. Selection of pest management approach (IPM, pesticide use) is important. Good looking produce versus chemical-free?
- Post-harvest handling: maturity stage, harvesting techniques and equipment, time of harvest, sorting and grading, washing prior to sale, etc
- Storage: conditions, length, use of preservation chemicals
- Transport: packaging quality, means of transport, etc

1.3 Who is responsible for food safety?

There has been a gradual shift from end-product inspection and testing to building safety and quality throughout the food supply chain. This is called the *food supply chain approach* and is popularly referred to as “farm to fork”. FAO defines food supply chain approach as “recognition that the responsibility for the supply of food that is safe, healthy and nutritious is shared along the entire food chain” – by all involved with production (e.g. farmers), processing, trade, transport and consumption. All players in the food supply chain are responsible and must share a common goal: ensure safe food at all steps of the chain.

Farmers have an important responsibility in food safety before and during production, harvest, post-harvest and storage on farm. However, food contamination can also occur further down the chain and that is -in most cases- beyond the responsibility of the farmer. See box below.

Step in the food supply chain	To be safe, food needs to be..... (for example)
 <p>Production</p> <p>Transport and processing</p> <p>Retail and storage</p> <p>Preparation</p> <p>Consumption</p>	<p>Properly produced by trained farmers (e.g. without too high pesticide residues)</p> <p>Properly transported and/or processed (e.g. not in trucks that also transport animals or pesticides),</p> <p>Properly stored (e.g. not in containers that were used to store chemicals, fertilizers, oil, or fuel),</p> <p>Properly prepared (e.g. no dirty hands, dirty utensils, dirty water when handling food at home but also in restaurants, hotels, etc)</p> <p>Properly consumed (e.g. not kept too long)</p>

Although *governments* are responsible for national food safety policies and their enforcement, all parties in the food supply chain need to ensure that they contribute towards producing a safe product.

Since contamination of food can occur at all steps in the food supply chain it is very important to make a good analysis of what farmers can do to prevent food safety hazards. Be critical and realistic on what farmers can do and consequently, what can be done on food safety in FFS training. When more prominent risks occur later in the food supply chain, partnerships⁵ could be relevant to assure food safety throughout the chain.

FFS training usually deals with the crop production phase. This is why the focus of this manual is on **pre-production, production, harvest and post-harvest on-farm**.

1.4 Good Agricultural Practices (GAP) and other food safety standards

Good Agricultural Practices (GAP)

GAP are practices that need to be applied on farms to ensure food safety during pre-production, production, harvest and post harvest. In many cases, such practices also help protect the environment and the safety of workers.

Examples of such good agricultural or farming practices are given in section 2.2 for each aspect of the production and post production process.

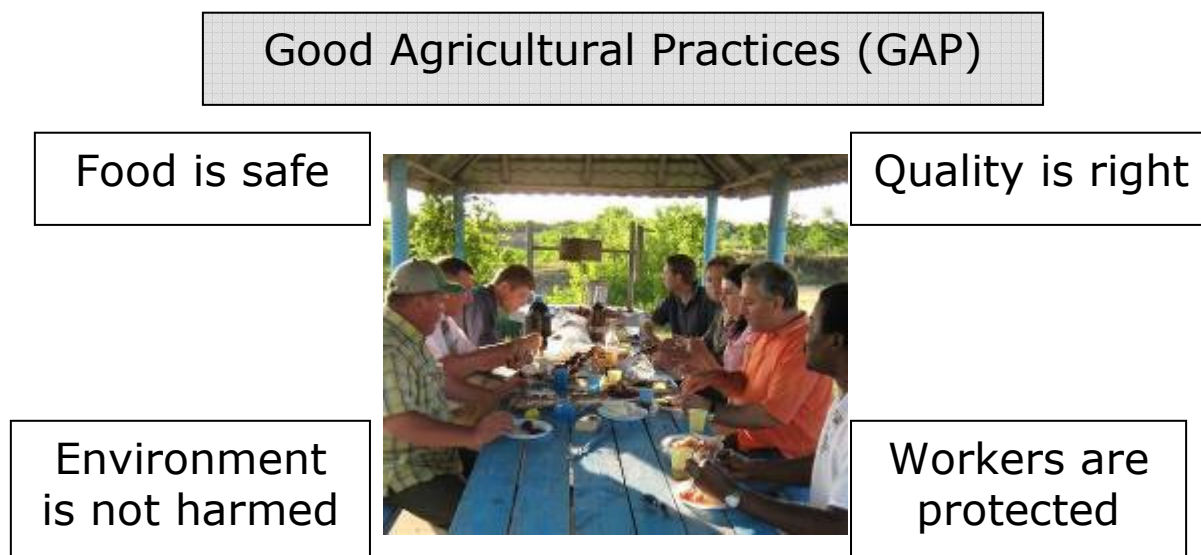
⁵ This often also means that farmers work together e.g. in associations, have longer-term marketing arrangements with middlemen or that farmers are contract growers for a processing factory. FFS can be a means to discuss this kind of cooperation among farmers.

GAP codes, protocols or standards are guidelines which have been developed in recent years by the food industry, exporters' or producers' organizations, governments or others, aiming to establish good agricultural practices at farm level for a range of crops. While food safety is a primary objective of most GAP codes, not all codes put equal emphasis on environmental protection and safety of workers. GAP standards are being set by both the private sector and by governments. Some examples are given below.

GLOBALGAP (previously called EurepGAP because it originated in Europe) is a private sector body that sets its own certification standards and procedures for good agricultural practices. GLOBALGAP was originally created by a group of European supermarket chains. GLOBALGAP is not an official government or EU standard. GLOBALGAP aims to increase consumers' confidence in food safety by developing good agricultural practices which must be adopted by producers if they want to sell to supermarkets or traders who require GLOBALGAP. The focus of GLOBALGAP is on food safety and traceability, although it also includes some requirements on worker safety, health and welfare, and some environmental criteria.

ASEANGAP was developed by the ASEAN Secretariat (with member country representatives and technical assistance from Australia) in preparation for a common market in 2015. It was launched in 2006 as a standard for good agricultural practices during the production, harvesting and post-harvest handling of fresh fruits and vegetables in the ASEAN region. Most ASEAN countries adhere to ASEANGAP when formulating their own national food safety and GAP standards.

The main principles of GAP are:



In many countries, public authorities and/or the private sector have developed their own sets of GAP standards. These are usually developed for export markets but can also be for domestic buyers. For example, India has IndiaGAP, Japan has JGAP, China has Green Food and ChinaGAP, Thailand has ThaiGAP (called Q-GAP), Kenya has KenyaGAP. A good overview of various regional and national GAP schemes is listed by FAO⁶.

In some countries, the GAP are voluntary standards while in other countries, these are mandatory. Example is Thailand: farmers *must* comply with the national GAP in order to sell their products in export markets. See box in section 1.6 below. In the vast majority of countries, the food safety component is regulated through criteria specific to the contaminant or hazard i.e. MRL (Maximum Residue Level) for pesticides; ML (Maximum Levels) for mycotoxins or other microbiological criteria; or criteria specific to a crop/commodity.

⁶ <http://www.fao.org/docrep/010/ag130e/AG130E12.htm>

Compliance with GAP standards is normally verified or certified by someone outside the farm, and in many cases farmers have to pay to be certified to a local food safety scheme, GAP standard or to GLOBALGAP. Therefore it is important for farmers to understand the cost of complying with each GAP standard and the potential benefits in terms of market access or prices. In addition to meeting the GAP standard, farmers or farmer groups would also need to be able to comply with the buyer's other requirements in terms of procurement, quality, volumes or terms of payment.

However, many countries with FFS programs do not have national GAP standards. Where no central regulations on food safety at farm level exist, it is all the more important to include this into FFS curricula.

All farmers should be encouraged to apply good agricultural practices that lead to food safety and quality on their farm. **Farmer Field Schools can help farmers understand, identify and apply the most appropriate practices in the local contexts.** But this does not mean that all farmers should be encouraged to be certified to a specific local GAP code or to GLOBALGAP. FFS facilitators can find more information about cost and benefits of GAP codes in their regions and help farmers understand what to do.

Make sure to know what food safety schemes or government standards exist in your region. These standards can be a good starting point for developing training sessions on food safety in FFS!

1.5 Does IPM lead to food safety?

IPM can contribute to food safety but does not automatically result in safe food. For example, when a fruit is IPM-produced with very little pesticides (no residues) but after harvest it is washed with unclean water, this fruit may still be unsafe to eat. Similarly, when only a few pesticides applications are made, but these are of the wrong type (highly toxic) or are made too close to harvest, residue problems may still occur.

IPM can be an essential first step to ensuring food safety but it should be much more than just addressing the pesticides residues issue. Integrated Production and Pest Management curricula of FFSs (which include improved agronomic practices in general) might help improve some aspects of product quality and food safety. But to deliver food safety and quality to the consumer, IPM must be **complemented by a systematic approach to what are called “good farming practices”** (or Good Agricultural Practices) which focus on improving food safety and food quality on farm, including hygiene during production, use of clean water and irrigation practices that minimize risks of contamination from water, preventing contamination from soil, good harvesting practices and more. This is why it is important to integrate food safety aspects into the curricula of FFS training programs.

1.6 Does more food safety lead to better marketing opportunities?

Important is that farmers first need to understand their potential markets (what do traders want? what does the consumer want?) and whether these require some certification on food safety. Is there a national scheme for food safety? Do retailers or other trade parties require certification? What are the conditions and what are the benefits?

Implementing activities to create more food safety and quality may be costly and cumbersome, both in terms of money and time (e.g. record keeping). Farmers will often only implement this when the price of products is good (cost-benefit) and/or to maintain market access. Often, training is necessary. See box below.

How Q-GAP certification lead to increased FFS participants in Thailand

Thailand is a food and agricultural products exporting country and aims to be recognized as the *Kitchen of the World!* In 2002, with the public sector's push for food safety, the Government of Thailand developed its Food Control System and Food Network and urged producers to comply with international standards (CODEX, IPPC, OIE). With growing concern for international trade, the Government declared 2004 as the Food Safety Year obliging every stakeholder involved in the process - from farm to table - to ensure safety for consumers and emphasized traceability to develop consumer confidence. The Q-mark was developed as an accreditation mark for safe and qualified products. GAP was recognized as the first step to food safety. When exports of coriander and okra were rejected in 2007, traced to an export company that had not passed Q-GAP certification, the Government gave instructions that all production should pass Q-GAP certification. Farmers then had to register and be trained in Farmer Field Schools on IPM and GAP. Upon passing inspection procedures for compliance with GAP standards, farmers receive GAP-certification that gives them access to both to domestic and export markets.

Source: Pers. comm. Ms A.L Morales-Abubakar, Thailand

Products from IPM farmers have often been produced with fewer pesticides than in conventional farming and with respect for environment and workers⁷. Some farmers sell their IPM produce as 'safe' or 'clean' vegetables. However, in many countries those safer food products can not be recognized by consumers or buyers since there is no official certificate or logo. In addition, most consumers buy products on the basis of quality attributes such as appearance, taste, shelf life, etc, *assuming* the food is safe. In order for safer produce to lead to better markets, produce would also have to display other quality attributes. It would therefore be useful if training programme for IPM farmers also integrate some quality matters.



Sales of "Safe Vegetables" in Vietnam
(photo courtesy Do Kim Chung, Vietnam)

A number of countries have come up with activities to promote IPM produce such as logos or labels (e.g. Jordan) or establishing direct sales to supermarkets or hotels. Some work, some don't. **There is no single answer to the question whether better food safety at production level leads to better marketing opportunities and better prices.** It just depends on the local conditions, so facilitators should help farmers understand local requirements for specific markets. In FFS training in West Africa, for example, food safety topics in the training are combined with market research activities.

Some examples on linking farmers to markets can be found on the FAO internet site⁸.

⁷Various references: i.e. Sette, William; Garba, Mohamed Hama, 2009, case study on IPM in West Africa. Multiple reports from the Near East IPM programme, including 2008-2009 country reports. See www.IPM-NearEast.com

⁸ For example this one-page case study on www.fao.org/ag/ags/subjects/en/agmarket/linkages/index.html

1.7 Is food safety important for ALL farmers?

From a public health perspective: yes!

ALL farmers must apply good farming practices to produce safe food. However, not all countries have good guidelines, certification and training programs and controls on food safety issues. And often, it is more difficult for small farmers to comply with good agricultural practices than it is for large farmers.

Facilitators should make farmers aware about the principle and concepts of food safety, understand main food safety risks in their community, and work with farmers in FFS to identify food safety risks and the most feasible practices to improve food safety.

This is why it is important that food safety is integrated into Farmer Field School training programs. See chapter 3 on how to do this.

2 Food Safety and Good Farming Practices on-farm⁹

In this chapter, background information is provided on the different types of food safety hazards that may occur, the cause of contamination and examples of good farming practices to prevent contamination. 'On-farm' means the production stage and post-harvest handling.

2.1 Types of food safety hazards

There are various types of food safety hazards: chemical, biological, physical and others. A number of examples of each hazard and possible causes of contamination are listed below.

2.1.1 Chemical hazards

Harmful chemicals at high levels have been associated with sudden or chronic illness and death. For example after eating food accidentally contaminated with pesticides or regularly eating food with high levels of pesticide residues.

In many developing countries, pesticides are a major food safety risk from fruit and vegetables, especially when chronic health risks from regular consumption of contaminated produce is taken into account.

Hazards	Causes of contamination (examples)
Pesticide residues in produce exceeding maximum residue limits (MRLs) ¹⁰	<ul style="list-style-type: none"> ○ Pesticide not approved for target crop ○ Poor quality pesticides (formulation not meeting specifications) ○ Incorrect mixing and applying higher than recommended dosages ○ Withholding period (pre-harvest interval) not observed ○ Application equipment faulty or not calibrated ○ Pesticide in soil from previous use ○ Dumping or accidental spillage of pesticide into soil or water source
Non-pesticide contamination such as lubricants, cleaners and sanitizers, paint, refrigerants, vermin control chemicals, fertilizers, adhesives, plastics	<ul style="list-style-type: none"> ○ Inappropriate chemicals used for cleaning and sanitation ○ Oil leaks, grease, paint on equipment in contact with produce (e.g. in the storage space on the farm) ○ Contaminated picking containers that previously were used to store chemicals, fertilizers, oil, fuel ○ Spillage of chemicals (lubricants, cleaners, vermin control chemicals) near produce and packing materials ○ Transportation vehicles contaminated
Heavy metal residues (cadmium, lead, mercury) in produce exceeding maximum levels	<ul style="list-style-type: none"> ○ Continued use of fertilizers (including compost) with high levels of heavy metals ○ Use of improper domestic compost containing batteries (cadmium, mercury) ○ Lead contamination from car exhaust fumes if farm is near busy road

⁹ Several text parts and tables have been taken from or edited from ASEAN GAP training materials, e.g. Session 7, Food Safety Hazards.

¹⁰ The codex MRL database : <http://www.codexalimentarius.net/pestres/data/index.html> is an internationally recognized source for information about MRLs. The generic trend is that national MRLs are aligned with the Codex MRLs, although discrepancies exist. However, specific markets may have their own requirements that complement Codex. Be sure to check this for your location/conditions.

	<ul style="list-style-type: none"> ○ High levels of heavy metal in irrigation water ○ High levels of heavy metals in soil naturally or from previous use or leakage from industrial sites ○ Use of contaminated water for irrigation
Natural toxins – allergens, mycotoxins, alkaloids, enzyme inhibitors	<ul style="list-style-type: none"> ○ Unsuitable storage conditions, for example: <ul style="list-style-type: none"> - humid storage space leading to mold on produce - storage of potatoes in light
Allergenic agents	<ul style="list-style-type: none"> ○ Traces of a substance that causes a severe reaction in susceptible consumers – for example sulphur dioxide used to prevent rots on grapes
Intentionally added substances	<ul style="list-style-type: none"> ○ Added colour, mineral oil, carbides (for ripening), preservatives, etc

2.1.2 Biological hazards

Microorganisms or microbes are small organisms that can only be seen through a microscope. Microorganisms are found everywhere in the environment. Fruit and vegetables contain a dynamic and diverse mixture of microorganisms. The produce we handle daily may contain as many as 100 million organisms per gram as normal inhabitants that do not affect the health of consumers.

Microorganisms can affect food in 3 different ways:

- Beneficial – act on food to produce desirable quality characteristics such as aroma, texture, microbiological stability – for example yeast and fungi for making yoghurt, beer and cheese.
- Spoilage – spoil the food by producing undesirable quality characteristics such as softening, bad odour and flavour – for example fruit rots.
- Pathogenic – affect consumer health – illness is either caused by the microorganism itself growing inside the human after eating (infection) or by toxins produced by the microorganism (toxic contamination).

The most common types of pathogenic microorganisms are bacteria, parasites and viruses.

Bacteria are the most common cause of food-borne illness. Bacteria require nutrients and appropriate environmental conditions to grow. They can grow rapidly in a very short time. In 7 hours, one bacterial cell can generate over a million cells!

Common pathogenic bacteria that have been linked to contamination of fresh fruit and vegetables are:

Bacteria	Some of the main disease symptoms related to food poisoning ¹¹ (note that this list may not be exhaustive)
<i>Salmonella species</i>	Gastroenteritis (crampy diarrhea, nausea, vomiting) and headache. Headache may come back a few weeks later as arthritis (joint pains). In people with impaired immune systems it can cause a life-threatening illness. Salmonella can be transmitted by undercooked foods such as eggs, poultry, dairy products, and seafood.
<i>Escherichia coli (E. coli)</i>	Causes moderate to severe illness that begins as large amounts of watery diarrhea, which then turns into bloody diarrhea. There are many different types of this bacteria. The worst strain can cause kidney failure and death (about 3%-5% of all cases). It is transmitted by eating raw or undercooked meat, unpasteurized milk or juices, or contaminated well water.
<i>Campylobacter species</i>	Causes mild illness with fever, watery diarrhea, headache, and muscle aches. Campylobacter is the most commonly identified food-borne bacterial infection encountered in the world. It is transmitted by raw poultry, raw milk, and water contaminated by animal faeces.
<i>Staphylococcus aureus</i>	Causes moderate to severe illness with rapid onset of nausea, severe vomiting, dizziness, and abdominal cramping. These bacteria produce a toxin in foods such as cream-filled cakes and pies, salads and dairy products.

¹¹ http://www.emedicinehealth.com/food_poisoning/page3_em.htm

<i>Listeria monocytogenes</i>	Listeria infection starts with headache, low-grade fever, muscle aches, nausea and vomiting and is often mistaken for a viral illness that will cure itself. It can cause encephalitis, meningitis, blood-borne infection, and accounts for about 28% of deaths due to food poisoning. Listeria is tough and can thrive even in the refrigerator. It is most commonly found in raw milk, soft-ripened cheeses and processed meats, but also in raw and smoked fish, poultry, fresh vegetables and ice cream.
<i>Bacillus cereus</i>	Causes mild illness with rapid onset of vomiting, with or without diarrhea and abdominal cramping. It is associated with rice (mainly fried rice) and other starchy foods such as pasta or potatoes.

Some bacteria can be found in the soil (*Listeria sp*, *Bacillus cereus*) and can contaminate crops through soil contact directly or through dirty containers and equipment. Other bacteria can pass through the intestinal tract of animals and humans and can contaminate fruits and vegetables through manure, contaminated water, and humans handling produce.

Parasites are organisms that live in another living organism, called the *host*. They are unable to multiply outside an animal or human host but can cause illness with only a low number of organisms. Fruit and vegetables can act as a vehicle to pass a parasite from one host to another – animal to human or human to human. Cysts, the dormant phase of parasites, can survive and remain infectious for up to seven years in the soil – for example *Giardia*. Water contaminated with faecal material, infected food handlers and animals in the field or packing shed can be vehicles for contamination of produce with parasites. Parasites most commonly associated with contaminated fruit and vegetables are:

Parasite	Some of the main disease symptoms related to food poisoning¹² (note that this list may not be exhaustive)
<i>Cryptosporidium</i>	Cryptosporidium symptoms including nausea, vomiting, fever, abdominal cramps and watery diarrhea.
<i>Cyclospora</i>	Common symptoms may include stomach cramps, nausea, vomiting, diarrhea, and fever. These symptoms can start soon after eating contaminated food or drinking contaminated water. Or they could appear a week to a few weeks later.
<i>Giardia</i>	<i>Giardia</i> causes an abrupt onset of abdominal cramps, explosive, watery diarrhea, vomiting, foul flatus, and fever which may last for 3–4 days.
<i>Helminthes (worms)</i>	While in the intestinal tract, <i>Helminthes</i> may cause abdominal pains, cramps and diarrhea. Fever and fatigue and dehydration may occur. At chronic infection, severe longer term effects such as liver problems may occur.

Viruses are very small and unable to reproduce outside of a living cell and do not grow in or on fruit and vegetables. However produce can act as a vehicle to pass viruses from animals to humans or from humans to humans. Low numbers of surviving viruses on produce can cause illness. Viruses that have been passed onto humans through contaminated produce are:

Virus	Some of the main disease symptoms related to food poisoning¹³ (note that this list may not be exhaustive)
Hepatitis A	Causes mild illness with sudden onset of fever, loss of appetite, and feeling of tiredness followed by jaundice, is a yellowing of the eyes and skin. It is transmitted from person to person by faecal contamination of food.
Norovirus	Noroviruses are a group of viruses that cause a mild illness (often termed "stomach flu") with nausea, vomiting, diarrhea, abdominal pain, headache, and low-grade fever. These symptoms usually resolve in two to three days. It is the most common viral cause of adult food poisoning and is transmitted from water, shellfish, and vegetables contaminated by faeces, as well as from person to person.

¹² http://www.emedicinehealth.com/food_poisoning/page3_em.htm

¹³ http://www.emedicinehealth.com/food_poisoning/page3_em.htm

Fungus/molds: in rare cases, food crops may be infected by toxins produced through a fungal infection. Aflatoxins for example are naturally occurring toxins produced by many species of the fungus *Aspergillus*. Aflatoxins are toxic and among the most carcinogenic substances known. Crops susceptible to *Aspergillus* infection include cereals, oilseeds, spices and tree nuts. The toxin can also be found in the milk of animals which are fed contaminated feed.

The risk of biological contamination varies with:

How the produce is grown

Produce that are grown in or close to the ground (carrot) have a higher risk than produce grown well above the ground (lychee).

Produce grown in frequent contact with water can have a higher risk – for example hydroponic production.

The type of produce surface

Produce with a large uneven surface (lettuce) have a higher risk than produce with a smooth surface (apple).

How the produce is consumed

Produce that is eaten raw (leafy vegetables) has a higher risk than produce that is cooked (potato).

Produce that have an edible skin (grape) have a higher risk than produce with an inedible skin (banana).

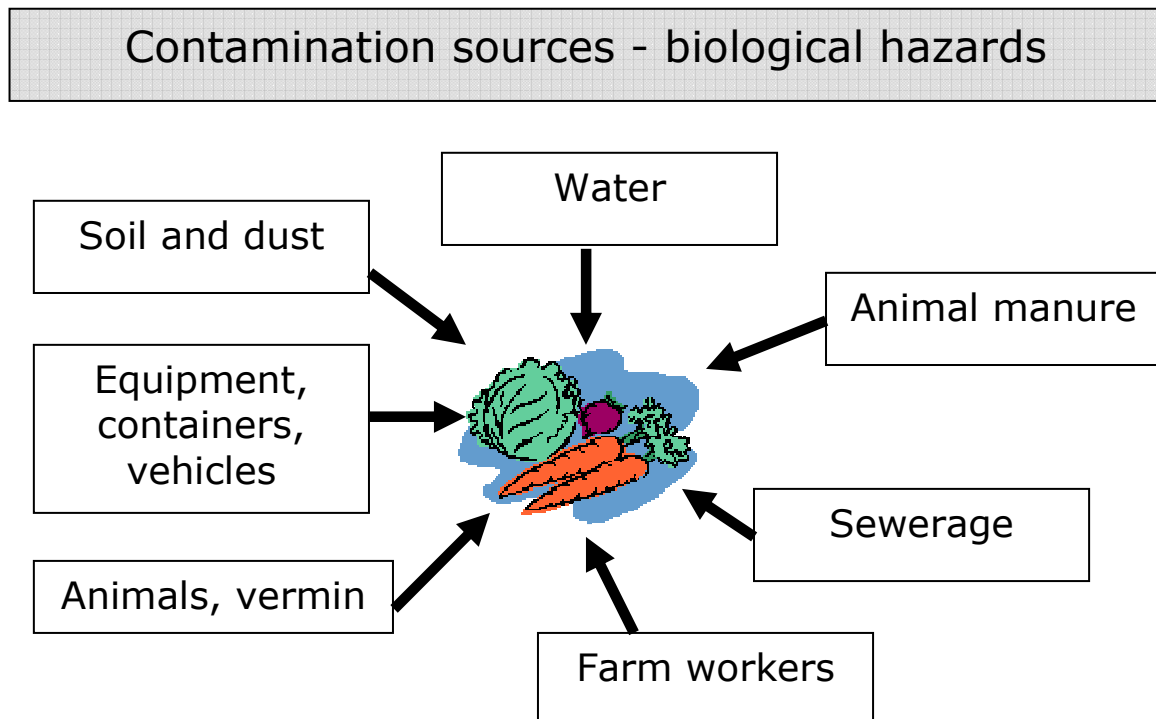


Eggplant



Cherry trees

Growing close to the ground is a higher food safety risk than way above the ground



2.1.3 Physical hazards

Physical hazards are foreign objects that can cause illness or injury to consumers. Contamination can occur during production and post-harvest handling. Types of physical hazards include glass, wood, metal, plastic, soil and stones, personal items like jewelry, hair clips, other like paint flakes, insulation, sticks, staples, weed seeds, toxic weeds.

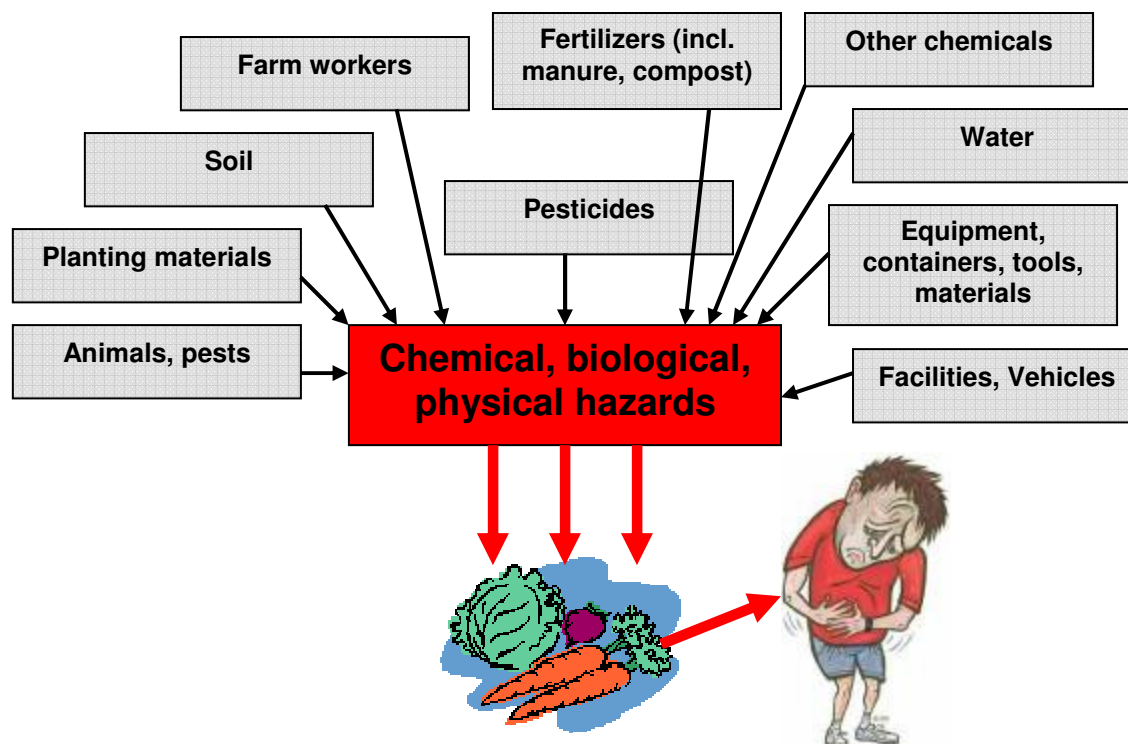
Hazard	Causes of contaminations (examples)
Foreign objects from the environment – soil, stones, sticks, weed seeds	<ul style="list-style-type: none"> ○ Harvesting of ground crops during wet weather ○ Dirty harvesting and packing equipment, picking containers, packaging materials ○ Stacking of dirty containers on top of produce
Foreign objects from equipment, containers, buildings and structures – glass, wood, metal, plastic, paint flakes	<ul style="list-style-type: none"> ○ Broken lights above packing equipment and areas where produce is exposed ○ Damaged picking containers, harvesting and packing equipment, pallets ○ Inadequate cleaning after repairs and maintenance
Foreign objects from human handling of produce – jewelry, hair clips, personal items, staples used for closing packaging	<ul style="list-style-type: none"> ○ Careless or untrained staff ○ Inappropriate clothing

2.1.4 Other hazards

Potential food safety hazard may also occur through application of technologies of which the hazards may not yet be fully understood (e.g. genetically modified plants or nano-technology. Research is still ongoing to better understand the hazards associated with this.

2.1.5 Sources of contamination of food

Below, the main sources of contamination that cause food safety hazards are summarized.¹⁴



2.2 Doing a food safety hazard analysis

Obviously, not all sources of contamination are applicable to all farms. This is why it is important to do a good hazard analysis to identify the main sources of food safety risks. When it is clear what kind of sources of contamination exist that can cause food safety problems, it becomes easier to identify what can be done to avoid contamination of food.

A number of exercises and activities to do a hazard analysis are listed in part 2 of the Food Safety Manual for FFS. Methods include structured participatory discussions with farmer groups, field visits and interviews, and participatory mapping of a farm or of a community.

Facilitators or national IPM programme coordinators might need to get help from a local food safety expert to make a comprehensive hazard analysis for the crops and selected locations where the programme works. When possible, facilitators should be involved in doing this analysis in order to improve their skills. Then a participatory hazard analysis can be done as an exercise with the FFS group, as a basis to identify good practices that can be tried in the FFS.

- See exercises in part 2 of the Food Safety Manual for FFS (chapter 2: Analysis of food safety hazards and good farming practices).

¹⁴Picture from: <http://www.diseasencure.com/s.jpg>

2.3 Good Farming Practices to manage food safety¹⁵

Activities that are done to produce safe food are called *good farming practices* or *good agricultural practices (GAP)*. Good farming practices reduce or eliminate food safety hazards.

Good farming practices need to be followed at all stages of crop production, from planning and field preparation, to planting, crop management, harvesting and post-harvest processing, transport and storage. All people working at the farm are involved and should be aware of their responsibilities in producing safe food. Training of farmers and farm workers may be necessary.

A number of good farming practices to avoid food safety hazards for important sources of contamination are listed below.

Please Note: The practices listed below are based on material from 'official' GAP schemes that are mainly aimed at commercial producers and/or export markets. This text is included to provide a fairly complete overview of GAP principles as a background. This is supplemented by Annex 2, which provides examples of hazards and good farming practices for a number of cropping stages or farm operations that are at the level of small-scale farmers and are based on FFS field experiences.

Facilitators are encouraged to prepare a set of good farming practices with farmer groups according to annex 2 but use the information below to make sure not to miss important hazard-reducing practices! Also see exercises in part 2, chapter 2.

For preparation of actual FFS training modules, the latter may be more relevant. Since most FFS programs follow the cropping cycle, it would make sense to add food safety elements to FFS sessions according to cropping stages. A number of structured learning exercises can be done with farmers to list and practice good farming practices applicable to a specific crop and location. It is important to be very practical and work with those practices that are relevant to the farmers.

Facilitators can help the FFS group to prioritize food safety hazards and select good farming practices that are appropriate and locally feasible.

- See exercises in part 2 of the Food Safety Manual for FFS (chapter 2: Analysis of food safety hazards and good farming practices).

2.3.1 Site history and management

Food safety hazard: Chemical and biological contamination of produce from previous use of the site or from sources of contamination outside the site.

Good farming practices:

- The risk of contaminating produce from chemical and biological hazards present in or near the site is assessed for each horticultural activity and a record is kept of any significant hazards identified.
- Where a significant risk of chemical or biological contamination has been identified, either the site is not used for horticultural production or remedial action is taken to manage the risk.
- If remedial action is required to manage the risk, the actions are monitored to check that contamination of the produce does not occur.



Discarded pesticide bottles near a vegetable field are a food safety hazard

(<http://cnreviews.com/wp-content/uploads/2009/07/china-farm-pesticides-trash-alex-hofford.jpg>)

¹⁵ The content of paragraphs 2.3.1-2.3.8 is largely based on ASEANGAP training materials, e.g. session 13 on GAP to manage food safety.

- The location of any sites identified as unsuitable for horticultural production is recorded.
- Farm animals are excluded from entering the site for 3 months before planting and during crop production, particularly for crops grown in or close to the ground.

2.3.2 Planting materials: seeds, varieties or rootstocks

Food safety hazard: Chemical contamination of produce from pesticides used during production of planting material.

Good farming practices:

- Using certified / good quality seeds or planting material if possible (*special consideration should be given to the advantages and disadvantages of the use of GMO seeds, when applicable!*)
- A record is kept of the name of the supplier of planting material and the date of purchase.
- If planting material is produced on the farm, a record is kept of any chemical treatments used

2.3.3 Fertilizers and soil additives

Food safety hazard: Chemical and biological contamination of produce from fertilizers and soil additives applied directly to the soil or growing medium or through irrigation systems or foliar spraying.

Good farming practices:

- The risk of chemical and biological contamination of produce from the use of fertilizers and soil additives has been assessed for each horticultural activity and a record is kept of any significant hazards identified.
- Where there is a significant risk of contamination of produce from heavy metals, fertilizers or soil additives measures are taken to minimize uptake.
- Where there is a significant risk of biological contamination of produce from organic materials, measures are taken to manage the risk.
- Untreated organic materials are not applied in situations where there is a significant risk of contaminating produce.
- Where an organic material (e.g. organic fertilizer) requires treatment on site before use, the date and treatment method is recorded.
- Composting sites are located and constructed in a manner to prevent contamination of production sites and water sources.
- Where an organic material requires treatment before purchase, documentation is obtained from the supplier specifying that the material has been treated to minimize the risk of contaminating produce.
- Organic materials (untreated or treated) are not applied where direct contact with the edible part of the crop can occur.
- Human sewage is not used for production of fresh agricultural produce.
- Fertilizers and soil additives are stored and disposed of in a manner that does not present a risk to contaminating produce.
- The application of fertilizers and soil additives is recorded, detailing the name of the product/ material, date, treatment location, quantity applied, application method and operator name.



2.3.4 Irrigation water

Food safety hazard: Chemical and biological contamination of produce from contaminated water used for irrigation.

Good farming practices:

- The risk of chemical and biological contamination of produce from water used for irrigation is assessed for each horticultural activity, and a record is kept of any significant hazards identified (for example: risk of fecal contamination of water when used from rivers also used as sewerage).
- Where water testing is locally available and required to assess the risk of produce contamination, tests are conducted at a frequency appropriate to the conditions impacting on the water supply and the horticultural activity, and a record of test results is kept.
- Where the risk of chemical and biological contamination is significant, either a safe alternative water source is used or the water is treated and monitored and a record is kept of the monitoring results.



Empty bottle of Lannate (methomyl) floating in an irrigation canal

Photo courtesy Harry van der Wulp

2.3.5 Pesticides

Chemical food safety hazard: Chemical contamination of produce with pesticides above maximum residue levels (MRLs) during storage, application, and disposal of pesticides used for crop protection.

Good farming practices:

- Where possible integrated pest management systems and non-chemical products are used to minimize the use of chemicals.
- Farm managers and workers have been trained to a level appropriate to their area of responsibility for pesticide application.
- Pesticides used are approved for the target crop, are applied according to label instructions or a permit issued by a government authority
- Pesticides are applied at an appropriate frequency and dosage to prevent overuse and to prevent residue levels in the produce exceeding the MRL.
- For produce that is exported, approval of the chemical for the crop concerned and the related MRL in the destination country are checked prior to use.
- In general pesticides should not be mixed. In exceptional cases mixtures can be used only when chemicals are compatible and the risk of excessive residues is low.
- Withholding periods (pre-harvest intervals) between pesticide application and harvest are strictly observed.



Boots used for pesticide spraying are placed in the kitchen, where food is prepared (photo courtesy Do Kim Chung, Vietnam)

- Pesticide application equipment (such as backpack sprayers) is calibrated at least annually and regularly maintained in effective working condition.
- Equipment is cleaned after each use and washing waste is disposed off in a manner that does not present a risk of contaminating produce or water sources.
- Left-over application mixes are disposed off in a manner that does not present a risk of contaminating produce or water sources.
- All chemicals are stored in a structurally sound, secure area according to label directions, and in a location to minimize the risk of contamination of sites, water source, packaging materials and produce.
- Chemicals that are unusable or no longer approved are disposed off in legal off-farm areas or are isolated from other chemicals and clearly identified.
- The application of chemicals is recorded for each crop, detailing the chemical used, application date, treatment location, application rate, application method, withholding period, and operator name.
- A record of chemicals purchased is kept, detailing chemical name, place of purchase, date received, quantity purchased, and expiry or manufacture date.
- For large scale growers producing for export markets: An up to date list of chemicals approved for use on the produce grown on the farm/ sites is kept and utilized to guide pesticide selection.
- If chemical residues in excess of the MRL are detected, the crop is quarantined and the cause of the contamination is investigated and actions are taken to prevent re-occurrence.



Biological food safety hazard: Use of biologically contaminated water to prepare pesticide dilutions

2.3.6 Harvesting and handling produce

Equipment, materials and containers:

Food safety hazard: Chemical, biological, and physical contamination of produce from inadequate use, cleaning and maintenance of equipment, materials and containers.

Good farming practices:

- Equipment, containers, work surfaces and materials that contact produce are made of substances that are non-toxic.
- Containers previously used for storage of waste, chemicals, and other dangerous substances are clearly identified and not used for holding produce.
- Equipment is regularly maintained and cleaned to minimize contamination of produce.
- Harvest and packing containers and materials are stored in separate areas to chemicals, fertilizers and soil additives and measures are taken to minimize contamination from vermin.
- Harvest and packing containers are checked for soundness and cleanliness before use and cleaned or discarded as required.
- After packing, containers are not placed in direct contact with soil and water.



Buildings and structures:

Food safety hazard: Chemical, biological, and physical contamination of produce from inadequate construction and maintenance of buildings and structures.

Good farming practices:

- Buildings and structures used for growing, packing, handling and storage are built in areas not prone to environmental contamination (e.g. flooding or toxic emanations), away from industrially polluting sites, adequately enclosed to keep out animals and constructed and maintained to minimize the risk of contaminating produce.
- Grease, oil, fuel, and farm machinery are segregated from handling, packing and storage areas to prevent contamination of produce.
- Septic, waste disposal and drainage systems are designed and constructed to minimize the risk of contaminating the water supply.
- Lights above areas where produce and packing containers and materials are exposed are either shatter proof or protected with shatter proof covers or in the event of a light breaking, exposed produce is rejected and equipment and packing containers and materials are cleaned.
- Where workshop equipment is located in the same building as handling, packing and storage areas, the equipment is screened with a physical barrier or it is not operated during packing, handling, and storage of produce.
- Area for vehicles to be provided so that product not contaminated

Cleaning:

Food safety hazard: Chemical, microbial, and physical contamination of produce from inadequate cleaning of equipment, containers, and materials and areas where produce is packed, handled and stored.

Good farming practices:

- Instructions are prepared and followed and monitored for cleaning of equipment, containers, and materials that contact produce and areas where produce is packed, handled and stored. Cleaning schedule to be prepared
- Appropriate cleaning chemicals (and if appropriate, disinfectants specific to surfaces or equipment) are used to minimize the risk of chemical contamination of produce.
- Records of cleaning are maintained

Animals and pest control:

Food safety hazard: Biological contamination of produce from vermin infestation and animals and chemical contamination from vermin control chemicals.

Good farming practices:

- Measures are taken to minimize the presence of vermin in and around handling, packing and storage areas.
- Measures are taken to discourage the roosting of birds above handling, packing and storage areas.
- Domestic animals are excluded from areas where produce is handled, packed and stored.
- Baits and traps used for vermin control are located, maintained and regularly checked to prevent chemical contamination of produce and packing containers and materials, and the location is recorded. Bait maps should be placed at convenient locations.

Produce treatment:

Food safety hazard: Chemical contamination of produce above maximum residue levels (MRLs) during storage, application, and disposal of chemicals applied after harvest.

Good farming practices:

- Chemicals applied after harvest, including pesticides and waxes, other treatments such as sulphites, carbides, etc are approved for the produce and are applied according to label directions or a permit issued by a government authority.
- For produce that is exported to another country, approval of the chemical and the MRL in the destination country are checked prior to use.
- Equipment used to apply chemicals is regularly cleaned, calibrated and maintained in effective working condition.
- Surplus application mixes and washing waste are disposed off in a manner that does not present a risk of contaminating produce.
- All chemicals are stored in a structurally sound, secure area according to label directions, and in a location to minimize the risk of contamination of sites, water sources, packaging materials and produce and in demarcated areas. Chemicals should be appropriately labeled.
- Chemicals that are unusable or no longer approved are disposed off in legal off-farm areas or are isolated from other chemicals and clearly identified.
- The application of chemicals is recorded for each produce, detailing the chemical used, application date, batch of produce treated, application rate, application method, and operator name.
- A record of chemicals purchased is kept, detailing chemical name, place of purchase, date received, quantity purchased, and expiry or manufacture date.
- An up to date list of chemicals approved for application to produce after harvest is kept.
- If chemical residues in excess of the MRL are detected, the produce is quarantined and the cause of the contamination is investigated and actions are taken to prevent re-occurrence.

Water use:

Food safety hazard: Chemical and biological contamination of produce from contaminated water used after harvest for handling, washing, and treatment of produce.

Good farming practices:

- The risk of chemical and biological contamination of produce from water used after harvest for handling, washing, and treatment of produce is assessed, and a record is kept of any significant hazards identified.
- Where water testing is required to assess the risk of produce contamination, tests are conducted at a frequency appropriate to the conditions impacting on the water supply and the type of produce, and a record of test results is kept.
- Where the risk of chemical and biological contamination is significant, either a safe alternative water source is used or the water is treated and monitored and a record is kept of the monitoring results.
- Final wash water applied to the edible parts of produce is equivalent in quality to potable water standard (WHO guidelines or country requirements, suitable for drinking).



Washing vegetables in pond with rubbish everywhere
(photo courtesy Do Kim Chung, Vietnam)

Personal hygiene:

Food safety hazard: Biological contamination of produce from poor personal hygiene and inadequate facilities.

Good farming practices:

- Instructions, preferably written, on personal hygiene practices are provided to farm workers to cover use of protective clothing, finger nails cut short and kept clean, sores/wounds/cuts covered with waterproof dressing, use of perfumed creams or powders avoided.
- Farm workers are trained in personal hygiene practices and a record of training is kept where possible.
- Toilets and hand washing facilities are readily available to farm workers.
- Workers are aware that specific diseases (diarrhea, infected wounds) may cause the contamination of food if they are in direct contact with the final fresh product. So if workers are sick, they should be allowed to work on other activities without prejudice for them.
- Medical check ups may be carried out at periodic intervals and records maintained

2.3.7 Storage and transport

Food safety hazard: Chemical, biological and physical contamination of produce from inadequate storage and transport.

Good farming practices:

- Packed containers are not placed in direct contact with soil.
- Where pallets are used, they are checked before use for possible contamination from soil, chemical spills, foreign objects and vermin infestation. If unsuitable they are rejected, cleaned or covered with protective material.
- Transport vehicles are checked before use for cleanliness, foreign objects, and vermin infestation, and cleaned if there is a significant risk of contaminating produce.
- Produce is stored and transported separate from goods that are a potential source of chemical, biological and physical contamination (beware of previous goods or inputs being transported in the same container or vehicle).



“Safe vegetables” with bar code for the market
(photo courtesy Do Kim Chung, Vietnam)

2.3.8 Farm Management

Good farming practices:

- Farm workers are trained in their area of responsibility relevant to good agricultural practices and a record of training is kept, when possible.
- Packed containers are clearly marked with an identification to enable traceability of the produce to the farm or site where the produce is grown.
- A record is kept of the date of supply and destination for each batch of produce.
- Where produce is identified as being contaminated or potentially contaminated, the produce is isolated and distribution prevented or if sold, the buyer is immediately notified.
- The cause of any contamination is investigated and actions are taken to prevent re-occurrence and a record is kept.
- All practices are checked at least once each year to ensure they are done correctly and actions are taken to correct any deficiencies identified.
- A record is kept of practices checked and any corrective actions taken.
- Records required demonstrating good agricultural practices are kept for a minimum period of at least the production and marketing of the crop or for a longer period if required by legislation.

3 Incorporating food safety issues in FFS programs

3.1 When would it be useful to include food safety in FFS?

Although food safety is an important production aspect for all farmers at all times, there may be situations where there is a clear and urgent need to train farmers in food safety. For example, high risk situations like using waste water for irrigation, pesticides stored next to water canals, farm animals in a vegetable production field or use of fresh manure - all this could be sources of contamination resulting in unsafe food and leading to human health risks.

Another reason may be market-driven, as in Thailand (see box in section 1.6). Thai farmers have better market access and slightly higher prices when they have an official food safety certificate to prove that they have been trained in using GAP. Farmer Field Schools provide this GAP training, in addition to the 'regular' training on crop production and protection. Other examples on linking farmers to markets can be found on the FAO internet site¹⁶. If market access is the objective, in addition to food safety it will be useful to also include in the training how to improve food quality based on the requirements of the targeted markets.

A few considerations for inclusion of food safety into FFS programs:

- **Food safety hazard analysis:** A good analysis of the local food safety situation ("hazard analysis") is very important to identify food safety risks. There are various methods for this. See 2.2 above.
- **Existing food safety schedules:** an assessment of the local situation with regard to existing rules, regulations, and different kinds of schemes (government policies, trade requirements) that might be in place should be part of the analysis made by the FFS Programme.
- **Additional training for FFS facilitators** on food safety may be necessary! It is recommended to include food safety issues in all future **Training of Trainers**.

3.2 How to include food safety in FFS?

There are various ways of incorporating food safety topics into the curriculum of an FFS. Some need to be done by (experienced/trained) facilitators before start of the FFS. Others can be done during the FFS with farmers. All can be done in a participatory way, with and by farmers, guided by facilitators.

Common steps are

- Awareness raising on food safety
- Doing a location-specific hazard analysis: sources and routes of contamination
- Identifying good farming practices to avoid contamination
- Addressing food safety issues at every production step

For existing FFS programs wanting to give more attention to food safety issues, it is recommended to look at the 'typical' FFS schedule and discuss (for example in a training of trainers) where obvious anchor points are for food safety. Then identify approaches on *how* to deal with food safety at every step in the FFS schedule. Part 2 of this manual contains a number of practical exercises for FFS to highlight or emphasize food safety in common farming practices.

- An example of how to integrate food safety aspects into a 'typical' FFS curriculum is listed in Annex 3.

¹⁶ For example this one-page case study on www.fao.org/ag/ags/subjects/en/agmarket/linkages/index.html

Since most FFS programs follow the cropping cycle, it makes sense to add food safety elements according to cropping stages and associated farm practices. This is also integrated in the table in annex 3.

- [An example of food safety hazards and good farming practices for typical cropping stages is given in Annex 2.](#)

In addition, emphasizing food safety can also effectively be done by¹⁷:

Baseline survey / Hazard analysis

Usually when planning farmer training in an area, a baseline survey is done during which the main crops, main problems, etc are identified. Food safety aspects can be included in the baseline survey. This allows the FFS to address location-specific food safety risks as indicated by the survey and by farmers' priorities.

- [See Annex 1 for an example of a baseline survey form that includes food safety questions.](#)

A baseline survey that includes interviews and visits to farmers, community health centres, pesticide shops, markets will help identifying priorities and entry-points for curriculum development. Include home visits to see how people deal with garbage, storage of chemicals, sprayers, with sanitation facilities like toilets, etc. Such visits can also be part of an FFS activity, for example in Part 2 exercise 2.4 (field visit) or 2.6 (community mapping).

- [See Part 2 exercise 2.4 for an example of a visit by the FFS group.](#)

Household or Community mapping

Making a map of one household and include the 'risk areas' or mapping a complete village could give insight in where contamination may come from. After initial awareness on what is food safety and the kinds of hazards that may cause contamination of food, the FFS group could go on a visit to one farmer to map the location and identify possible food safety hazards.

- [See Part 2 exercises 2.5 and 2.6 for an example of how this could be done.](#)

Cropping calendar exercise

This exercise looks at all farming practices in the sequence of the growing season. For every step in this cropping cycle, food safety hazards and sources of contaminations can be identified and discussed with farmers so that practices to avoid food contamination can be done or tested in FFS.

- [See Part 2 exercise 2.2 for an example.](#)

Special Topics

Many FFS have sessions on 'special topics', which are determined by the current situation and the priorities of the FFS farmers. It would be good to deal with food safety in a special topic, preferably early in the growing season. Special topics are especially useful for raising awareness on what is food safety and how to prevent contamination.

Several exercises in Part 2 of this manual can be used as special topics.

- [See Part 2 exercises 1.1, 1.2 and many others.](#)

Agro Ecosystem Analysis (AESA)

Once farmers are aware of the importance of food safety, questions can be added to the AESA e.g. by asking what certain management practices would mean for food safety. AESA should not only be used to analyse production and protection issues but also be employed to assess potential food safety

¹⁷ Contributions from Thailand and Vietnam FFS programs.

hazards and used to generate recommendations for prevention activities. Important is to do this systematically during the whole cropping season, including post-harvest on farm.

For example, when discussing organic fertilization, the risk when using fresh manure can be discussed (may cause biological contamination of the crop - see sections 2.1.2 above). When discussing irrigation, talk about the source and quality of the water and how it is used (irrigation, cleaning products after harvest, etc).

➤ [See Annex 4 below for more examples of additional AESA questions.](#)

4 Reference List

Various materials have been used as references to compile this manual, including those listed below, which are herewith gratefully acknowledged. Other information sources, such as literature or internet sites, are listed as footnotes in the texts and therefore not further specified in this chapter.

ASEAN-GAP Training Course

Managing food safety on fruit and vegetable farms – poster

Session 4: Food safety module (ppt)

Session 7: Produce quality module (ppt)

Session 12: Main points raised (ppt)

Session 6: How can quality be lost after harvest? (document)

Session 7: Food safety hazards (document)

Session 8: Sources of contamination from food safety hazards (document)

Session 13: Good agricultural practices to manage food safety (document)

International GAP standards and national training materials

- ASEAN-GAP

- GLOBALGAP

- ASEAN-GAP Lao training: selected examples of exercises

- Thailand food safety training materials

Annex 1 - Baseline Survey form for FFS in vegetable production¹⁸

Date: Interviewer: Soil type in the production area:

Village: Commune District..... Province:

Describe the location of the proposed FFS plot (e.g., near to an industrial site? near the highway? near to a garbage dump?

Can animals in the neighbourhood get into the proposed FFS plot or other plots around?

What is the source of irrigation for the plot?.....

Is it possible to state something about the cleanliness of the water?

Has the water been tested and to what standards – records of the same?

I. Background Information

Name: Sex..... Age..... Education..... Family status..... Labor.....

II. Production Implementation

1. Type of vegetable and production area:

Dry Season				Wet Season		
No.	Crop	Land cultivation (ha)	Month of planting	Crop	Land cultivation (ha)	Month of planting
1						
2						
3						

2. Major crop cultivation (Crop grown for studying in FFS or the crop the same family with FFS)

Season	Name of crop	Variety name	Land area	Seed use/land area	Type of variety	Seedling age (day)	Month of planting
Dry							
Wet							

3. Cultivation method: Dry: Planting Direct seedling Wet: Planting Direct seedling

4. Planting

Season	No. of seed / hill	Row spacing	Hill spacing	Furrow	Bed height	No. of plowing	No. of harrowing
Dry							
Wet							

5. Fertilizer application

Dry season			Wet season		
Type of fertilizer	Time of application	Quantity	Type of fertilizer	Time of application	Quantity

Will compost be used? Who prepared the compost and how was it prepared?

How do you know that the compost was mature?

.....

¹⁸ This form is used in FFS programs in Cambodia and can be used as an example. The form has been slightly modified by the FAO/editor team to include a few extra food safety questions.

Annex 2 - Good farming practices per cropping stage for FFS

Cropping stage, food safety hazards and examples good farming practices that avoid food safety problems¹⁹. More examples can be taken from section 2.2 on site history.

Note: such table can also be made with an FFS group (see exercise 2.2 in Part 2). The next step is to identify HOW to deal with a good farming practice. Is it a priority? Does it need a special topic to create awareness? Is it something that can be added to AESA? Should a field study be done? Cost - benefits? Etc.

stage	hazards	good farming practices
Select and prepare site	<ul style="list-style-type: none"> previous contaminations, e.g. pesticide heavy metals (can be characteristic of soil or coming from outside), dioxins close to traffic zone might lead to lead contamination previous dump of chemicals or other waste (including batteries...) quality and availability of water sources; include upstream inventory of possible pollutants (livestock, hospitals, heavy industry, etc) presence of animals in the site (domestic, wild) - may cause biological contamination e.g. through manure previous cropping history - with reference to potential presence of moulds that could lead to mycotoxin contamination irradiation sources 	<ul style="list-style-type: none"> not dumping empty packaging materials of pesticides, or batteries crop selection based on assessment of risk – e.g. don't grow leafy vegetables (eaten raw and large leaf surface) if close to a road with heavy traffic (change the crop) select vegetables that need to be cooked (microbial); grow vegetables that are not close to the ground like beans (splashing soil may cause contamination) find another field (extreme cases...) fence the field, or avoid entry of animals into the field especially during the period before you will start growing the crop (2-3 months might be good time..) if suspicion exists of contamination of pesticides or heavy metals --- have a soil analysis done explore whether you can find other water sources, for example water harvesting avoid areas that get flooded
Planting	<ul style="list-style-type: none"> contaminated seed? if seed is contaminated with mould then you might get mycotoxins later (cereals) pesticide treated seed? as long as seed is treated according to rules, then it should not be an issue. monoculture can enhance risks of moulds smuggled, uncontrolled planting materials might lead to new problems poor quality seed leads to problems later on that might trigger off more pesticide use seedlings from an outside nursery might have problems like for example unripe compost used for production 	<ul style="list-style-type: none"> selection of a suitable variety to avoid problems later on seed treatment if done properly, and based on actual need crop rotation using seeds and planting materials from reliable sources
Irrigation	<ul style="list-style-type: none"> source of water (microbial contaminations that might be managed, while chemical contamination might be more difficult to manage) how the water source is used/managed at the local level (some practices might enhance risks of contamination, like washing pesticide containers, animals in the water, sanitation practices in the area, etc...) 	<ul style="list-style-type: none"> filtering water, decanting sedimentation ponds (film Ghana)²⁰ avoid splashing when you water the plant, especially close to harvest use watering methods like drip irrigation, furrow irrigation water harvesting clean tanks, maintain them, same for pipes to remove slime and dirt choice of materials when you invest in

¹⁹ This table was developed during the Food Safety Workshop at FAO Rome, March 2010.

²⁰ See reference section - at FAO a film on water management to avoid food safety problems is available.

	<ul style="list-style-type: none"> • kind of material used for irrigation -- local materials like pipes might be unclean and cause contaminations • method of watering can increase or decrease risks • timing of watering (not during hot periods --- microbial, cracking, etc) 	<ul style="list-style-type: none"> • irrigation system – easy to clean etc • farmer indicators – validate them and see how they can be actually used • drainage system • water treatment?? • water analysis • irrigating close to harvest --- several considerations: food safety vs economics...
Fertilization	<ul style="list-style-type: none"> • use of fresh manure and compost that is not mature • excessive use of nitrogen fertilizers (nitrates, esp on leafy vegetables) • excessive use of plant hormones?? • use of poor quality fertilizers (chemical) that do not meet standards and have impurities • pre-harvest intervals for manure not respected • plant residues of previous crop could pose a risk for moulds and then later mycotoxins • fermented materials and molasses as fertilizers – might be contaminated by microbes (often used as foliar application) • night soil (human excrements) if not used well 	<ul style="list-style-type: none"> • use matured manure and compost – check out what would be best practices for the specific locality • incorporating manure into soil to avoid direct contact with plants • put manure on the soil when crop is already established, not on the crop • respect pre-harvest intervals for manure and chemical fertilizers – determine locally what that would be • locate compost heaps in order to minimize contamination from run offs (e.g. not uphill from the field) • procure the fertilizer from reliable sources • prevent animals entering in the field before harvesting • cover compost heaps to keep out vermin and flies
Pest and Disease Control	<ul style="list-style-type: none"> • pesticides not registered, not authorized for the crop, not properly labelled • use of expired and obsolete pesticides • calendar spraying • overuse • overdosing/poor calibration • storing pesticides near food and water sources • dumping empty cans in the water • washing equipment in water • recycling containers for food stuff and water storage • mixing cocktails of pesticides • pre-harvest intervals not respected • botanicals if not used properly 	<ul style="list-style-type: none"> • IPM • respect recommended doses • field sanitation • field monitoring • proper handling, storage and disposal • selection of pesticides – only pesticides registered for this crop, the least toxic as possible, spot application when possible - know the risks • farmer training on pesticide related risks • alternatives to chemical pesticides – biopesticides, botanicals, biocontrol, agronomy, etc • know and respect pre-harvest intervals when using pesticides
Weed control	<ul style="list-style-type: none"> • toxic plants that occur as weeds in the field might be harvested with the crop (e.g. belladonna) • herbicides – see above all related to pesticides • thorny weeds 	<ul style="list-style-type: none"> • remove toxic plants as soon as possible – good weed control • herbicides – see above
Harvest	<ul style="list-style-type: none"> • damage to crop that may induce bacterial and/or fungal growth • timing of harvest • maturity of the crop according to end-use • contaminated containers • inappropriate containers • no separating of damaged and rotten produce • inappropriate handling (dirty hands and tools, not putting things on the soil, etc) 	<ul style="list-style-type: none"> • hygiene for harvesters/workers – washing hands (following all etiquette), not coughing and sneezing, clean toilets (far from the field) • select proper time for harvest – time of the day • harvest according to proper maturity stage • clean containers, tools, select proper containers • don't overload containers • handle with care, don't throw (even small bruises might cause premature rot) • don't mix things of different origins • separate produce from soil, e.g. use plastic sheets

		<ul style="list-style-type: none"> • keep harvested produce far from sources of contamination incl pesticides, animals and children • store the materials used for harvesting away from sources of contamination
<p>Washing and cleaning</p> <p>(as a special topic in the FFS)</p>	<ul style="list-style-type: none"> • use of contaminated water for washing produce • use of contaminated tools for cleaning • dirty hands • improper washing and cleaning techniques, and sequence of techniques • clothing to be changed as needed • putting washed produce on the floor, mixing washed and unwashed 	<ul style="list-style-type: none"> • know the source of the water you use – final rinsing water should be clean • boil the water if it is used for washing the crop (if there is only one source for water....) • follow proper sequence for washing produce • use clean tools • define in what situation it is needed/preferable for the produce to be washed or not (if it might create new contaminations) • chlorine?
<p>Grading and Packing</p>	<ul style="list-style-type: none"> • mixing 'bad' produce with 'good' produce • dirty packing material • inappropriate packing material • inappropriate handling that might cause injuries • poor hygiene of workers • exploding light bulbs in the packing place • proper removal of waste that results from grading • rodents and vermin in the grading place, other sources of contamination in or around the grading place 	<ul style="list-style-type: none"> • grading and sorting • place where you grade should be away from sources of contamination, and kept free from sources of contamination • workers' hygiene, washing hands • protection of light bulbs – where appropriate • don't place packed containers on the floor; proper handling of packing material • clean material for packing • rodent and vermin control plans that do not create new problems for food safety – use bait maps • regular cleaning of walls, floor, roof • regular disposal of waste
<p>Storage</p>	<ul style="list-style-type: none"> • not appropriate storage conditions (temperature, humidity, etc) • mixing toxic and edible products in storage, or storing them close to each other • physical hazards from storage facilities – roof parts etc • rodents and vermin • chemicals to enhance storage life and to protect against post-harvest problems 	<ul style="list-style-type: none"> • proper temperature and humidity, good ventilation • regular maintenance of buildings and structures • good methods to manage the stored products (e.g. first in first out, etc); logistics and record keeping • clean the storage room regularly • use only authorized products for post-harvest issues, use them properly, BUT avoid whenever possible, explore other ways to protect against post-harvest losses • clearly identify separate edible products and chemicals and animal contaminants/products • use clean materials, use them properly • store away from walls
<p>Transport</p>	<ul style="list-style-type: none"> • dirty transport • inappropriate transport – linked to produce and distance • mixed transport of animals, agr produce, chemicals et and humans • overload – physical injuries • poor hygiene of transporters and transport workers • place produce on the ground when loading and unloading • produce is not sufficiently protected • mixing produce between different places of origin 	<ul style="list-style-type: none"> • use clean and appropriate transport means, check what was transported previously (i.e. manure, pesticides) • cold storage, refrigerated transport depending on produce and conditions • hygiene of transporter and workers • appropriate handling practices • protection of the produce to circumstances • suitable ventilation/ aeration techniques

<p>farm workers</p>	<ul style="list-style-type: none"> • poor personal hygiene • human diseases • inadequate handling of crop/produce, causing injuries to the produce • insufficient knowledge, awareness on personal hygiene, handling of crops, harvesting techniques 	<ul style="list-style-type: none"> • training on personal hygiene, handling of crops, harvesting techniques etc • wash hands after doing things that might cause contamination – toilet, animals, chemicals, waste, rubbish etc • do not harvest when sick when having infectious diseases like hepatitis a; cuts and sores should be covered • no spitting smoking • wearing a head cover • do not wear jewellery
<p>tools and equipment</p>	<ul style="list-style-type: none"> • lack of toilets and washing, hygiene facilities • dirty or badly maintained equipment all along production and harvesting process • cleaning of certain equipment in certain ways and places – pesticide sprayers.... • inappropriate storage of equipment, dirty place... 	<ul style="list-style-type: none"> • toilets and other hygiene facilities available • access to some clean water when needed • cleaning of materials and equipment • use non-toxic materials • storage away from sources of contamination --- see above • proper use of tools and equipment • proper maintenance – right way and right time • don't put tools on ground before using • calibration of measuring devices

Annex 3 - Integration of Food Safety aspects into the FFS curriculum²¹

Note: this table is an example that can be used for inspiration on how to integrate food safety into an FFS curriculum, based on experiences from the Asia IPM Programme. However, not all subjects and methods are applicable for all crops in all conditions. It is important to select and modify those that apply to your specific conditions.

Content area	When	How	Question(s) to add
I. Community mobilization and social preparation	2-3 months before season starts to introduce FFS programme to the community		
1. Community, environmental and household mapping		<ul style="list-style-type: none"> - Transect walk, informal interviews and community meeting - See detailed procedure in Part 2 exercise 2.5. - Information is presented to community - Plans are developed by the community to address the problems identified 	<p>Source: pesticide shop owners and sellers Information: location in relation to residences, water sources, food shops Questions: Are there any food shops near pesticide shops? Are the pesticide shops also selling food stuff? What implications would this have on food safety?</p> <p>Source: house owners Information: drinking and cooking water and food storage Questions: Are pesticides kept near water or food storage areas? Why is this dangerous?</p> <p>What would happen if anyone, especially children, accidentally drink the contents of the bottles because they are in soft drink containers? How can accidents like these be avoided?</p> <p>Source: house owners and farmers Information: disposal of pesticides and containers Questions: Describe what recycled pesticide containers are used for. Why should they not be used for keeping water or food?</p> <p>Source: By-standers (other family/community members and other agriculture and non-agriculture populations) Information: agriculture and non-agriculture populations affected by pesticides Questions:</p>

²¹ Table courtesy Ms Dada Morales-Abubakar, May 2010

			Are vegetables washed in the river where pesticide containers are cleaned? How will this affect the consumer? What happens to the fish in the river where pesticide residues flow to? What does this mean for people who will eat the fish from the river?
II. Pre-FFS activities			
<ul style="list-style-type: none"> • Location selection • Participatory Needs and Opportunity Assessment • Participant selection • Baseline survey²² 	After communities have agreed to engage in FFS programme and have identified priorities for FFS curriculum	IPM Trainers, local leaders and farmer representatives carry out the process	
III. FFS proper			
1. Field preparation (learning plot) <ul style="list-style-type: none"> • Crop and field study topic selection • Design of experiments • Field selection • Setting up of study • Observation criteria • Weekly data collection and analysis • Weekly reporting and data presentation • End-of-season report 	During 1 st season (initial) FFS	Procedure for designing field studies Food safety components can be integrated in the field selection – e.g. see section 2.2.1 on ‘ <i>Site history and management</i> ’	
2. Agro-ecosystem analysis (AESA) <ul style="list-style-type: none"> • Concept of agro-ecosystem • Functions of organisms in the ecosystem • Outline and format of AESA • Procedures on how to collect, summarize, analyze and present AESA results and reach consensus for field management decisions/actions (weekly) 	During 1 st season (initial) FFS	- Add food safety question to AESA questions and discussion	Questions that may be added to AESA <i>Note: these are general questions for any vegetable crop and assumptions for days after transplanting: crop-specific questions need to be added.</i> 0. Seedling preparation Describe the location of the seedbed. What happens if the seedling is prepared on contaminated soil? I. 5-7 days after transplanting If watering is to be done, what is the irrigation source? What happens if contaminated water is used for irrigation? II. 14 days after transplanting If fertilization is to be done, what fertilizer will be used? What is the source of and is the fertilizer of good quality?

²² See example of baseline survey form in annex 1.

			<p>Describe fertilizer of good quality. If compost is used, it is mature compost? What happens if the compost is not mature enough?</p> <p>III. 21 days after transplanting If contaminated water has to be used, what application method should be used? How should watering be done?</p> <p>IV. 28 days after transplanting If there are symptoms of diseases on some plants, what do you do? How do you dispose of infected plants that are removed?</p> <p>V. 35 days after transplanting What options can you use to reduce pesticides? Do you use bio-pesticides? If so, do you make them yourself? How can you be sure that the bio-pesticides that you produce are not toxic?</p> <p>VI. 42 days after transplanting Can animals go into the vegetable fields/plots? What implication does this have on food safety?</p> <p>VII. 49 days after transplanting What happens if a farmer is sick and still works in his field? What are the basic hygiene practices that a farmer should observe? What implication does this have on food safety?</p> <p>VIII. 56 days after transplanting What happens if there is excessive use of nitrogenous fertilizer? What are the advantages and disadvantages of using growth hormones on vegetables?</p> <p>IX. 63 days after transplanting Why is it important to keep a record of all inputs and activities on the production of the vegetable? When is the last time fertilizer and/or pesticides should be applied on the crop before they are harvested?</p> <p>X. 70 days after transplanting What equipment will be used for harvesting the vegetables? Are these used for other farm operations? What are the implications for food safety?</p> <p>XI. 77 days after transplanting</p>
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			<p>What is the source of water that will be used for washing vegetable produce? What containers will be used to carry the produce from the field and for the keeping? What will happen if containers of produce are placed on the ground?</p> <p>XII. 84 days after transplanting Where are the produce kept after harvesting? Why is it important to have a separate place for packing vegetable produce? Why should the packaging area be protected from birds, rats and other animals? How can the shelf life of vegetables be prolonged? Why is this important? Why should you carry or not carry pesticides (gas, oil or other agricultural machineries) on the vehicle used to transport vegetables?</p>
<p>3. Safe vegetable production</p> <ul style="list-style-type: none"> • Production standards: <ul style="list-style-type: none"> ○ Concept of production standards ○ Standards for safe vegetable production issued by MARD ○ Distinction between organic, green label, safe vegetable standards • Safe vegetable production: <ul style="list-style-type: none"> ○ Conditions for safe vegetable production ○ List of permitted, restricted and banned pesticides • Marketing and certification: <ul style="list-style-type: none"> ○ Safe vegetable marketing ○ Certification ○ Procedures for labelling 	<p>During 1st season (initial) FFS</p>		<p>How do you select the vegetable you will produce? (Ask the question until you get several different answers. Explain that the need of each customer is always different.) Can you produce to meet the criteria and requirement of all customers? (Explain that this is very difficult and this is the reason that there are “standards” that are accepted by all customers.) What are these standards? (List some then group participants and ask them to add some more based on national standards.) Discuss differences between safe and organic products or other standards like green label products. (Summary all standards that have been discussed: what are the same? what are different?) How do you produce safe products? (Use answers to item no.4) Discuss about dangerous pesticides and give the list of banned pesticides to participants. Where do you sell your products? What criteria does the buyer use to buy your products? Do you know where the middle man sells your products? Do you know the Q-GAP label? Do you know that Exporters should sell only certified (labeled) products? Do you know how to get the label (certification)? What practices should you use in your farm to pass the certification?</p>
<p>4. Environmental Impact Quotient (EIQ)</p> <ul style="list-style-type: none"> • Concept of EIQ • EIQ components/formula • EIQ practice exercises • EIQ and pesticide selection • EIQ for IPM impact evaluation • Design EIQ training content 	<p>During 1st season (initial) FFS</p>		<p>EIQ is a method to measure the environmental impact of pesticides. The method evaluates the toxicity of the active ingredient of each pesticide and its effect on eight environmental factors identified by farm workers, consumers and pest management practitioners. The EIQ value is used to calculate the Field EIQ value of the pesticide at a dosage applied to the field. The potential impact of a pesticide is measured as toxicity multiplied by exposure. The topic and practice exercises are presented in the FFS in several sessions and uses data of pesticide use in IPM and FP field studies to show differences in pesticide impact on the environment comparing the two management practices.</p>

<p>5. Special Topics</p> <ul style="list-style-type: none"> • Soil ecology <ul style="list-style-type: none"> ○ Healthy soil ○ Water holding capacity 	During 1 st season (initial) FFS		
<ul style="list-style-type: none"> • Plant physiology at different growth development stages 	During 1 st season (initial) FFS		
<ul style="list-style-type: none"> • Disease management: <ul style="list-style-type: none"> ○ Disease triangle ○ Categories of diseases (above ground versus soil-borne) ○ Management strategies 	During 1 st season (initial) FFS		
<ul style="list-style-type: none"> • Fertilization <ul style="list-style-type: none"> ○ Macro- and micronutrients; conversion from nutrient content to fertiliser dose ○ Composting ○ Timing of fertiliser application, especially last application before harvesting 	During 1 st season (initial) FFS	<p>Setting up of an additional study/experiment on composting in the 1st season FFS</p> <p>Study to be established at the same time (i.e., at the beginning of the season) as other field studies</p> <p>See sample study design on composting in Part 2 exercise 3.2.</p>	<p><i>Composting</i></p> <p>What happens if the temperature in the compost heaps does not go up? What implications will this have for food safety if the compost is applied in the crop? Describe the location of the compost heaps. What implication would it have for food safety if they were constructed near sources of drinking water or uphill from the field?</p> <p><i>Pre-harvest interval</i></p> <p>When will the plant need fertilizer? Which stage of the plant needs more fertilizer? Young plant or old plant? If the plant needs fertilization for growth, what will happen if you provide more fertilizer after the plant has stopped growing? If the fertilizer is not used by the plant but remains inside the plant, will they be useful for humans who eat the plants? If there are fertilizers inside vegetables, would you want to eat them? Would you think those vegetables are of good quality?</p>
<ul style="list-style-type: none"> • Pesticides <ul style="list-style-type: none"> ○ Kinds of pesticides and Understanding pesticide labels ○ Effects of pesticides on human health ○ Household storage and disposal of pesticides ○ Effects of pesticides on insect pests and natural enemies ○ Timing of last pesticide application before harvest (Pre Harvest Intervals) 	During 1 st season (initial) FFS	<p>Special topic on <i>Household Storage and Disposal of Pesticides</i>; See exercises 2.5 and 3.1 in Part 2 of this manual.</p>	<p><i>Household Storage and Disposal of Pesticides</i></p> <p>Note that the whole exercise and questions are related to food and drinking water safety</p>
<ul style="list-style-type: none"> • Biological control agents <ul style="list-style-type: none"> ○ Concept of biological control ○ Compare biological control with chemical control ○ Biological control agents used in 	During 1 st season (initial) FFS		

<ul style="list-style-type: none"> vegetable production: <ul style="list-style-type: none"> ▪ BT: effect of sunlight on BT, feeding capacity of infected caterpillars, how to use effectively, ▪ NPV and other biopesticides: collect in nature, describe symptoms ▪ Parasitoids (Ds, Dc for Lam Dong, Di for HCMC): life cycle, parasitisation capacity, environmental conditions, conservation methods, rearing and release 			
<ul style="list-style-type: none"> • Disease chambers <ul style="list-style-type: none"> ○ Disease epidemiology ○ Disease herbarium 	During 1 st season (initial) FFS		
<ul style="list-style-type: none"> • Absorption of Pesticides by Plants (<i>Roots and Plant Vessels</i>) 	During 1 st season (initial) FFS	Special topic See detailed procedures in exercise 3.1 in Part 2 of this Manual	<i>Absorption of pesticides by plants (Roots and Plant Vessels)</i> Where do the systemic pesticides go after being absorbed by the plants? What happens if people eat rice or vegetables with systemic pesticides?
<ul style="list-style-type: none"> • Life cycles and food webs 			
<ul style="list-style-type: none"> • Economic threshold <ul style="list-style-type: none"> ○ "Risk analysis" ○ Limitations of economic threshold level 	During 1 st season (initial) FFS		
<ul style="list-style-type: none"> • Farm economic analysis 	During 1 st season (initial) FFS		
6. IPM folk media			
7. Field Day <ul style="list-style-type: none"> • Presentation of FFS results • Planning for post-FFS activities • Generating local government support for local IPM programmes 			
IV. Post-FFS/follow-up activities			
1. Special Topics			
<ul style="list-style-type: none"> • Existence of Micro-organisms in the Soil 	During 2 nd season (follow-up) FFS	Special topic See detailed procedures and discussion questions in exercise 1.4 in Part 2 of this Manual	<i>Existence of Microorganisms in the Soil</i> What happens during harvesting and farmers put the produce directly in contact with the soil? What does this imply for food safety?

Annex 4 - Additional AESA questions to help discuss food safety

Topic	AESA questions
Select and prepare site	<p>What was previously grown? Is there information about previous pesticide and fertilizer use? Is there soil analysis done? What is the surrounding of the site (highway, etc - possible contaminations) Are there any animal farms close to your field? Have you ever checked your soil? Do the plants in our field grow well? Do animals come freely on this site/plot? when?</p>
Planting	<p>Why this variety? Why did you buy the seed in that store or from that farmer? How did you store your seed? How was your seed bagged? Where did you buy your seed? Is the seed treated with pesticide coating? Does this variety sell well on local markets?</p>
Irrigation	<p>What is the source of water for irrigation? Do animals drink from the source of irrigation for crops? Did you see plant residues in or around the irrigation source? Did you see farmers cleaning pesticide sprayers in the irrigation source? Do people have toilets near around? How do you water the plants? What water do you use? where do you get it for watering? Are compost heaps established near the irrigation source?</p>
Fertilization	<p>Is fresh manure used? Why can this be a hazard for food safety? How is this compost prepared? When was this compost made? where did you buy? What fertilizer do you use? if chemical, how do you apply and dose it? How do you prepare your compost? Do you use animal manure as a fertilizer? How do you apply it? What is the basis for fertilization?</p>
Pest and Disease Control	<p>What are pesticide residues? What is problem with pesticide residues? How do you get pesticide residues on your crop? What can you do to prevent or reduce pesticide residues? Where and how do you store agro-chemical (pesticides, fertilizer including rodent control production)? What pest control methods do you use? What happens with empty pesticide containers?</p>
Weed control	<p>How do you control weeds What kind of herbicide you use? When did you last spray herbicides? How do you control weeds? Can this affect safety of food?</p>
Harvest	<p>What can cause crops to spoil faster after harvest? How do you see it is spoiling? How can you avoid or slow the spoiling? What packaging do you use when harvest? Could this packaging damage the crop? When do you harvest? time of the day, maturity level</p>
Washing/cleaning	<p>Where is this water coming from? Could it be polluted by chemicals, manure, etc?</p>
Grading and Packing	<p>What packing materials do you use? how do they influence produce? Who does grading and packing? How do they do it? Do you remove the rotten produces? why/why not?</p>
storage	<p>Do you spray something on products to prolong shelf life? Where do you store? near/with chemicals? in your home?</p>
Transport	<p>How long does produce needs to be transported? What can cause crops to spoil fast during transport? How can you avoid/slow this?</p>

Food Safety Manual for Farmer Field Schools

A training reference guide on food safety in global FFS programmes.

Part II

Exercises on food safety for farmer training programmes

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Introduction to Exercises

This manual presents a range of exercises that address the KEY concepts of food safety to be used in Farmer Field Schools and participatory farmer training programmes.

The exercises in this manual complement the manual “Food Safety Guide for Farmer Field Schools part 1” which contains background information about food safety and suggestions on how to incorporate food safety topics into existing FFS curricula.

Both manuals are written for managers of (national) IPM programmes, TOT master trainers and FFS facilitators.

How to use

Exercises from this manual should be used for inspiration, to be tried out and elaborated with (experienced) FFS facilitators, and adapted to the local situation. Exercises are meant to be changed so that they become effective training tools for specific situations. Some exercises are comparable: a different procedure to obtain the same objective: raising awareness on food safety, or identifying methods to prevent food contamination. ***This means the exercises are not a fixed sequence that must be followed!*** Upon reading, facilitators can select and modify the exercise(s) that fits best their group and conditions.

Facilitators will need some (refresher) training to effectively integrate food safety into FFS. It would be useful to collect some local materials on food safety, and schemes with food safety component that are operated in the area. For example, ASEANGAP materials for production of fresh fruit and vegetables. See reference list in part 1.

Several exercises can be used as special topics: a separate session of 1-2 hours during a regular FFS meeting. Others are activities that can be done separately, or even before the FFS starts.

Some exercises can be done in one session, other exercises will require some preparations and results can be observed after some days, e.g., growth of micro-organisms (exercise 1.3) or increase in the temperature in a compost heap/pile (exercise 3.2).

Selecting a Food Safety Module for your FFS

Food Safety in a minimum scenario is:

1. one or two special topics on raising awareness on food safety (e.g. exercise 1.1 and/or 1.2 and 2.2). Do this early in the FFS cycle (e.g. at the second meeting)
2. integrate food safety questions into AESA (see Annex 4 in Part 1) e.g. by asking at recommended farming practices: ‘how does that affect food safety?’ ‘how can food contamination be prevented?’

When food safety issues are amongst the urgent topics in your situation, more attention is needed by selecting a range of topics and exercises that emphasize food safety and good farming practices. A baseline survey including food safety aspects is recommended (Part 1 Annex 1). It would be good to have a few special topics on awareness raising early in the FFS cycle followed by a field visit (exercise 2.4) or a mapping exercise (exercise 2.5) to help make a good hazard analysis early in the season. Then select a number of exercises that help clarify food safety at different activities in the cropping cycle (see chapter 3).

Main types of exercises

This manual contains a range of exercises, several of which are field-tested in specific countries or regions (but not in others) and some of which are part of existing training materials such as ASEAN-GAP. Main types are:

1. *What is food safety / raising awareness on food safety*

Learning objectives:

- Improve understanding on food safety
- Knowledge on the types of contamination that can occur – microbial, physical and chemical
- Why it is important to avoid contamination, or to keep it below certain levels
- General understanding of how contamination could be avoided

2. *How to make a hazard analysis and identify good farming practices*

Learning objectives:

- Understand local food safety requirements (e.g. national standards or certification schemes)
- Define when and where contamination might occur with a focus on activities that the FFS participants can directly influence/manage – field selection, water source, production, harvest, storage, etc.
- Identify ways and practices to avoid contamination

3. *Exercises at each step (or key steps) of the production process (inc. pre/post production)*

Learning objectives:

- Better understanding on food safety at different steps in production
- How to practically implement food safety into common farming practices

1 Raising awareness on food safety

1.1 What is Food Safety and why is it important?²³

Farmers produce food on the farm, to consume in their family or to sell in the market. Many families will eat some of the food produced, and sell the rest. People want to eat healthy and safe food. We all know from our own experience, or from stories we hear, that sometimes we get sick after eating certain food. Even if the food looked and smelled ok, people still get sick. This food was unsafe to eat, because it had some contamination. In this exercise we will discuss more on food safety, and the kind of contamination that can make food unsafe to eat.

Objective

The objective of this exercise is to increase the understanding on food safety, the kind of contamination that can make food unsafe, and how this contamination can occur during production and/or harvesting.

Materials & Time needed

Paper, marker
Duration 1 hour

Procedure

- Start with the introduction, and ask the FFS participants whether they have experienced falling sick after eating food that seemed to be ok. Why do they think that happened? Take note of the answers.
- Then try to analyze/categorize the possible causes of the food being unsafe: microbiological, chemical? Ask where the contamination might have occurred – in the field already? In storage? During preparation of the food? For this exercise, focus is on contamination that occur in the field, during harvesting and storage, not so much during the preparation.
- Split up in smaller groups, and ask each group to discuss the following questions, for about 15-20 minutes

Discussion

- When you are growing vegetables or fruits for the market, do you do the same things as when growing vegetables and fruits for your family? If yes, why. If no why?
 - If you spray a pesticide, what does it mean for food safety? Can you eat the fruit immediately after spraying? What after 10 days? How do you know when you can eat it?
 - What can happen if you put human manure on the field?
 - Where does your irrigation water come from? What water do you use to wash products after harvest? Is the water clean? Would you or your family drink this water as it is? Who controls the quality of the water?
 - How do you think contamination of food can happen in the field? during harvest? What could you do about it?
- Then ask each subgroup to give feedback on the questions, and discuss with the whole group. Summarize what the groups think food safety is, and what kind of contamination can occur, and general ideas to avoid contamination.

Note – if the facilitator thinks that some basic concepts like microbiological contamination are not understood, some small exercises can be initiated that would demonstrate/make visible development of microbiological contamination. One could bring some examples of rotting fruits, or vegetables as well and ask how these start.....

²³ Source: Marjon Fredrix, FAO/AGP 2008

1.2 Food Safety hazards²⁴

This is another exercise to raise awareness on food safety. Note that this exercise can be done in different ways (procedure). Consider which one is most suitable in your conditions.

Objectives

- Farmers understand that food safety is important to protect consumer health and gain market access,
- Farmers understand that there are 3 types of food safety hazards – chemical, biological, physical

Materials and time needed

Flip charts and marker pens

Takes about 45 minutes

Procedure**

1. Group work

- Ask farmer groups to list down on cards / paper what food safety is in their opinion.
- Stimulate sharing of specific experiences about food safety, e.g. when somebody got sick after eating food. Or if someone ever found strange objects in their food (e.g. stones, cockroaches)?
- Then discuss what can cause food to be unsafe and who is responsible.
- Summarize experiences on a flip chart.

2. Presentation

After this discussion and sharing of experiences, a presentation can be given on why food safety is important, examples of food safety outbreaks in the region, the costs of a food safety outbreak (e.g. in terms of physical health but also on economics of individuals, companies, government or society), and the 3 types of food safety hazards (chemical, biological, physical)²⁵.

Alternatively, the procedure can be followed in another sequence²⁶:

1. Presentation (20 minutes)

- Facilitator explains what a food safety hazard is, why food safety is important, examples of food safety outbreaks in the region, the costs of a food safety outbreak, and the 3 types of food safety hazards.

2. Exercise (20 minutes)

- The following questions can be asked either after each type of hazard is presented on a flip chart or after all of the flip charts are presented.
- Ask the farmers to identify the types of chemicals that are used on their farm that may be a potential chemical hazard.
- Ask the farmers to volunteer any examples of where family or friends have become sick from pathogenic micro-organisms (germs). Discuss what may have caused the illness and try to relate causes to possible biological contamination of fruit and vegetables.
- Ask the farmers to identify possible physical hazards on their farm.

3. Summary of main points (5 minutes)

- food safety is important to protect consumer health and gain market access,
- food safety outbreaks in the region have been traced back to fruit and vegetables as a possible source of contamination. There are 3 types of food safety hazards – chemical, biological, physical.

²⁴ Modified from: “Managing food safety and postharvest quality of fruits and vegetables” Training farmers in Lao PDR, July 2006.

²⁵ This procedure is followed in Thailand FFS programs as well as in West Africa.

²⁶ This procedure is followed in Lao PDR.

1.3 What is a micro-organism: flour tests

Micro-organisms or microbes are small organisms that can only be seen through a microscope. Micro-organisms are found everywhere in the environment, also in the air, on your skin, in the soil. Many micro-organisms are beneficial but some can cause food spoilage. There are also micro-organisms that cause diseases, either caused the micro-organism itself growing inside the human after eating (infection) or by toxins produced by the micro-organism (toxic).

When you eat food contaminated with pathogenic micro-organisms, a common reaction of the body is vomiting or diarrhoea. See section 2.1.2 in Manual Part 1 for more information about micro-organisms.

Objective

Better understanding about what micro-organisms are and how they can be spread.

Materials and time needed

Some wheat flour
Paper and markers
Duration 1 hour

Procedure

Ask the participants to share events where they got sick after eating food (or remember them from a previous discussion on food safety). Discuss what could be the cause of becoming sick, how did the food get unsafe? Explain that one cause can be the presence of pathogenic micro-organisms in the food. Discuss how this contamination could occur, how did that micro-organism get into the food? List suggestions from the group onto a large paper. Summarize main sources of contamination, such as water containing microbes and contact with human or animal manure. To visualize bacterial spread select one (or more) of the below explained flour tests:

Tests with flour²⁷:

1. Two participants are asked to put their hands in wheat flour. Then they go shake hands other participants: they also get flour on their hands. Microbes are exactly the same thing, but unfortunately we can not see them!
2. Another variation with the flour exercise with focus on personal hygiene. Beforehand, put flour on doorknob of toilet. Let one FFS participant go to the toilet and then wash his/her hands after using the toilet. Put flour again on the doorknob and get ask another volunteer to go to the toilet. The second participant should NOT wash his/her hands. The whole group observe the traces of flour on the hands of the 2 volunteers.
3. Similarly, you can put some flour on the floor (select a clean area with dark color, inside or outside) and ask somebody to walk through this flour and onwards. We can see the flour spread by the shoes. Microbes, including soil-borne diseases, can be spread by workers walking through the field and by soil attached to your shoes or slippers! Also when rain splashes on the soil, it can cause soil (with 'flour' = microbes) to get onto the plants and cause food unsafety!
4. Comparable with no.3: add flour to a watering can filled with water, then water the crop or the produce : flour ends up every where like microbes from dirty water. Then you can illustrate safer watering techniques such as: do not splash waste water on the leaves if possible but water at the foot of the plant (though it is not always possible. best would be drip irrigation or furrow irrigation!)

Summarize main contamination sources and discuss how to prevent microbial contamination of food.

Discussion

- How can water affect food safety?
- How can personal hygiene affect food safety?
- When during the cropping cycle is water used? (irrigation, but also mixing pesticides, washing products, for washing of farm workers, etc)
- What can be done to prevent contamination?

²⁷ These (or comparable) tests are done in FFS in West Africa; the near East and Asia.

1.4 Existence of micro-organisms in soil²⁸

This is an exercise about biological contamination of food through soil.

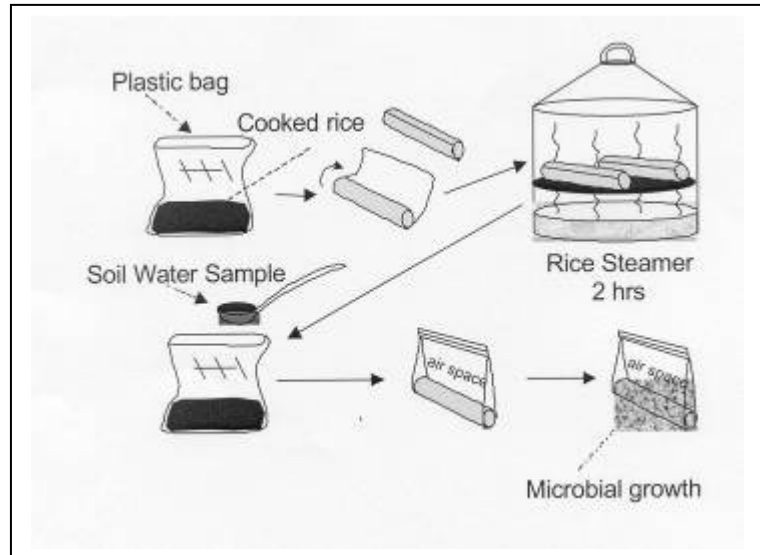
Microbial contamination can occur as a result of soil contaminating the produce or improper use of containers. For example, sometimes, containers are placed directly on the ground after they have been packed. However, it is difficult for farmers to understand the presence of micro-organisms in the soil because they cannot be seen. The following exercise will help farmers understand why it is important to apply good farming practices, such as not putting vegetable produce on the ground and using clean containers, to ensure food safety.

Objectives

- Visualize microbial growth
- Discuss the importance of good farming practices to avoid contamination through soil and ensure food safety

Materials

- 50 g boiled rice
- 100 ml polyethylene bag
- Sterile water
- Steamer (Note: Ordinary covered pots can be used as steamers.)
- Soil microbial solution (see below for the process of preparation)



Procedure

1. Prepare the nutrient medium for the microbes (for two treatments). Each group should prepare two plastic bags or transparent glass bottles (with covers) which can be put in a double boiler for steaming. To do this, put 50 g boiled rice into a 100 ml transparent bottle and seal it. Within 24 hours, sterilize each bottle (nutrient medium) twice for 20 minutes each by steam-heating. After cooling down, the white sterile medium is ready to use
2. Set up two treatments by applying micro-organisms from the following sources:
 - T1: soil microbial solution. This is done by first mixing 50 g of field soil with 50 ml sterile water. Stir the suspension and then let the soil settle for 10 minutes. Take 10 ml of the liquid and pour on the sterile rice medium.
 - T2: control. Only sterile rice medium. No microbial growth is expected in the control treatment.
3. Leave the closed bottles at room temperature for approximately seven days.
4. Microbial growth will become visible on the surface of the rice medium within 24 hours. A slimy lawn of various colours indicates bacterial growth, whereas fungi appear to produce dry mycelia growing in the air, best describable as a layer of fine cotton fibres.

Discussion

1. Describe observations from the treatments.
2. Where did the growth come from?
3. What effect would these micro-organisms have on vegetable products? Why?
 - What happens during harvesting and farmers put the produce directly in contact with the soil? What does this imply for food safety?

1.1.1 ²⁸ Adapted by ALCMorales-Abubakar from Richard Sikora's Soil Nutrients and Soil Health in Lowland Rice Production

1.5 Analysis of farming practices, harvesting and market preparations²⁹

Objective

This exercise builds on the basic understanding of food safety and contamination initiated in earlier exercises (e.g. 1.1 or 1.2). The objective is to analyze what farmers are doing during the production of the crop and when harvesting and preparing for the market, and how these practices can influence food safety, in particular contamination. This exercise will then also identify ways to avoid contamination during production and harvesting stages.

Materials and time needed

Paper, markers

Duration 1.5 hours

Procedure

- Start with a quick reminder of the first exercise on food safety and contamination, by asking a few questions such as: what is food safety? How can food be contaminated?
- Explain the purpose and procedure of the exercise: working in small groups, each group will draw/list practices during the cropping season, during harvesting and preparation for the market. Each group will mark with an arrow activities that can cause contamination, and indicate what type of contamination it is (microbiological, chemical).
- Discuss how the contamination happens, and summarize on the paper.
- Then discuss how to avoid contamination – what to change to improve, and summarize on the paper. Also ask each group to mention things they do not know exactly (for example, maybe there is no information on water quality...).
- Then ask groups to present their finding to the big group, and discuss.
- Summarize main actions that you can take to reduce contamination.

Discussion

- What contamination can happen during the field stage? During harvesting and preparation? What are the most important ones, and the most dangerous ones?
- When you harvest your products do you need to wash them before you can send them to the market? What water do you use? Is that clean? What about the harvesters – do you ask them to clean their hands?
- For microbiological contamination: what can we do to reduce them? In the field? during harvest?
- For pesticide contamination: what can we do to reduce them? In the field? During harvest?
- What is the pre-harvest interval? Is it the same for all pesticides? Where can you find the information?
- Are you keeping records of all the things that you do in the field and at harvesting? Can you always remember how many days it was when you last sprayed pesticides when you are ready to harvest? Can good records help you to improve food safety? Can they help you to show inspectors what you do for food safety?

Note: this exercise provides an overview of what kind of contamination might occur, and when. Link other exercises you do in the FFS with food safety as well. For example, if you discuss on pesticides ask some questions on food safety. If some things are not very clear to the FFS group, select some exercises that will illustrate the weak points (e.g. toxicity classifications of pesticides; pre-harvest intervals – different for different pesticides, should be on labels, etc).

See also Part I: Annexes 2 and 4.

²⁹ Source: Marjon Fredrix, FAO/AGP 2008

1.6 Food Safety requirements in the area³⁰

Objective

In your area there might be specific standards/requirements with regard to production practices and food safety. This can be GAP schemes, promoted by the government or the private sector. There can be national GAP schemes, or international ones focussing on meeting export requirement. Or other schemes like organic agriculture. If such schemes operate in the area this exercise will assist the FFS in defining the requirements of the particular scheme, how these relate to food safety concerns, and how to meet the requirements. That is the objective of this exercise.

This exercise is optional – it is up to the facilitators and farmers to judge whether it is relevant. If there is a scheme in the area, and none or only some of the FFS participants have joined yet for several reasons, it can be an interesting exercise. If all farmers are already part of it, then maybe there is no need for the exercise. If there are no existing schemes in the area, probably the improvements identified in exercises 1.1, 1.2 and 1.5 are the best you can get.....

For this exercise you might want to invite a resource person who is very familiar with the scheme.

In addition, there might be interest for food safety in the conventional domestic market independent of any certification. Certifications are not relevant for all farmers. An alternative would be to invite in the FFS a hotel owner, upmarket restaurant owner, exporter, caterer, a trader who is (really) dealing with safer produce etc so they can explain why food safety is important to them and what they consider to be “safe food”.

Materials and time needed

Paper, markers, information materials of the particular GAP scheme, or any other scheme or certification programme in the area. An expert on the scheme. Or another resource person about food safety (hotel owner, restaurant, etc).

Duration 1-2 hours, depending on the particular scheme.

Procedure

- Build on and use the outputs of exercise 1.2, when field and harvesting practices were identified.
- Start adding the requirements of the scheme in a summary drawing based on exercise 1.2 – do this by asking questions if the farmers already have some experience with the scheme.
- After finishing the requirements have a general discussion (see discussion questions).
- Summarize and conclude what can be next steps forward. Provide contacts as and when needed.

Discussion

What are you already doing that is in the requirements? What not? Why or why not?

What is easy to adapt? What is difficult?

What are the advantages to meet the requirements of the scheme? What are disadvantages?

Do you know of other schemes, such as organic farming?

If you have not joined the scheme yet, what are the next steps to do?

³⁰ Source: Marjon Fredrix, FAO/AGP 2008

1.7 Regional or Local forces driving demand for food safety³¹

This exercise is an alternative to exercise 1.6 above.

Objective

Farmers are aware of local (own area or national) or regional (international) driving forces increasing demand for fruit and vegetables that are safe to eat and the right quality

Materials and time needed

Flip charts and markers

Takes about 35 minutes.

Procedure

1. Presentation (10 minutes)

- Explain the local or regional forces driving demand for fruit and vegetables that are safe to eat and the right quality, such as:
 - Changes in consumer lifestyles
 - Income growth
 - Growth in supermarkets
 - Increased tourism
 - More people travelling
 - Increase in imports and exports
 - Development of infrastructure – roads, for example
- Discuss why food safety and post-harvest quality are important (talk about consumers, international and local trade, what other countries are doing). Highlight that government requirements for food safety and hygiene are increasing and retailers are increasingly demanding assurance for food safety and quality. The impact of government and retailer requirements is that fruit and vegetables must be safe and the quality right.

2. Discussion (20 minutes)

- Small group discussion – 10 minutes
 - Split the farmers into 3 groups with one trainer per group.
 - Ask the farmers to identify the changes that are occurring in their area that are impacting on food safety and quality of fruit and vegetables. The information is recorded on large sheets of paper.
- Large group discussion – 10 minutes
 - One farmer from each group presents summary with assistance from trainer.

3. Summary of main points (5 minutes)

Emphasize that changes in consumer lifestyles, retailing, trade and tourism are driving the demand for fruit and vegetables to be safe and the right quality.

³¹ Source: “Managing food safety and postharvest quality of fruits and vegetables” Training farmers in Lao PDR, July 2006.

2 Analysis of food safety hazards and good farming practices

2.1 Identifying sources of contamination³²

Objective

To identify possible sources of contamination on a farm, it is necessary to first identify the activities done during a cropping cycle and then list the inputs necessary for those activities. An input is something that is necessary for an activity to occur. For example: an activity is irrigation, and water is the input that is needed. The objective of this exercise is to identify main sources of contamination from food safety hazards.

Materials and time needed

Paper, markers

Duration 1.5 hours

Procedure

- This exercise can be done in small groups as a working session, or in a large group as a discussion session.
- First, groups list all activities that are done during the production of a crop until it leaves the farm (alternatively, other steps can be added until the produce is consumed, i.e. goes from 'farm to fork' in which case distribution and retail need to be added to the table below).
- Once all agree on those activities, discuss what inputs are needed to do the activities. Examples in the table below. List everything on a big poster.
- Once the inputs are agreed upon, the facilitator asks which of those inputs can be a source of contamination from food safety hazards. List them separately, or mark inputs already listed with a different colour.
- At the end of the session the facilitator emphasizes the main sources of contamination and summarizes the discussion. See Part 1 of this manual (chapter 2) for background information.

Activity during cropping cycle	Inputs needed	Sources of contamination
Select and prepare site	Soil, fertilizers, soil additives, fumigants, herbicides, equipment	Soil Manure, etc
Planting / sowing	Planting materials or seeds, equipment	
Irrigation	Water, equipment	
Fertilization	Chemical fertilizers, organic fertilizers, compost, soil additives, water, equipment	
Pest and disease control	Insecticides, fungicides, water, equipment	
Weed control	Herbicides, equipment	
Crop management (pruning, etc)	Tools, equipment	
Harvest	Picking containers, equipment, people	
Washing & cleaning	Water, sanitizers, equipment, people	
Grading and packing	Equipment, picking and packing containers, people	
Storage	Storage space, packing materials/containers	
Transport	Vehicle	

Discussion

- Why can an input be a source of contamination?
- How does the contamination occur? (*you can add a column to the table above with this question because it helps to identify ways to avoid contamination*)
- How can a contamination be avoided?
- Who should be involved to avoid contamination?

³² This exercise is based on ASEAN GAP training materials: session 8 Sources of contamination from food safety hazards.

2.2 Identifying food safety hazards and good farming practices

In this exercise builds on from exercise 2.1 above. A systematic list of good agricultural practices that avoid contamination of food products is developed in a participatory way. These good agricultural practices are related to the cropping cycle. This exercise also gives examples of activities that can be done during AESA. Make sure to incorporate some questions about food safety in AESA at relevant times in the cropping cycle. Also see Part 1 of this manual, annex 4.

Materials and time needed

Paper, markers
Duration 2 hours

Procedure

- Depending on the group size this exercise may be done in small groups, or in one large group.
- Groups discuss what kind of food safety hazards exist at a number of cropping stages. Select a specific crop, e.g. a fruit or a vegetable. For every hazard, a good farming practice is identified that would avoid that food safety problem.
- When small groups are used, each stage in the cropping cycle is presented by one small group and the other group can add activities.

Cropping stage	Food safety hazard	Good farming practice
Select and prepare site		
Planting		
Irrigation		
Fertilization		
Pest and Disease Control		
Weed control		
Harvesting		
Washing/cleaning (can be a special topic in the FFS)		
Grading and Packing		
Storage		
Transport		
Other inputs that may cause food safety problems		
farm workers		
tools and equipment		

An example of how this table could look can be found in annex 2 of the Food Safety Manual part 1.

Discussion

- When you have carefully avoided food safety problems at the early crop stages, is it still necessary to do it at later stages? Why, or why not?
- Is it sufficient to do one good farming practice to avoid a food safety hazard, or do we need to do several practices? Why?

2.3 Photo presentation of food safety hazards³³

Objective

Visualize food safety hazards and discuss how to handle in a particular situation to prevent contamination of food.

Materials and time needed

Computer, beamer, photos of relevant situations
Duration 1 hour (depending on number of photos)

Procedure and questions for discussion

This needs proper preparation time and might be more feasible in a Training of Trainer context: the facilitator either prepares a PowerPoint presentation with pictures of specific situations on-farm where food safety risks are shown, or prints are made of such photo's. For example: a plot with factory nearby; water sources; spilled pesticide bottles in a field; or the use of fresh animal manure in leafy vegetables; harvested plot with waste; crops being cleaned; compost heap with garbage like medicine bottles or batteries, etc.

The photos are shown to participants. The following questions are asked:

- What type of risk can we see in this picture?
- How can we deal with this situation?
- What would be the consequences of taking action to prevent food unsafety? (e.g. costs, training needed, etc)

At the end of the photo presentation and discussion, the facilitator summarizes the risks and ways to handle.

³³ Modified from Thailand training on Good Agricultural Practices

2.4 Field Visit - looking for food safety hazards³⁴

For this to be an effective exercise, the facilitator(s) should pre-visit farms and fields to determine whether the selected plots are good examples with clearly identifiable hazards.

Objective

The farmers will observe examples of sources of contamination from food safety hazards during production and post-harvest handling on farm, which will reinforce awareness on the importance of food safety and on practical ways to avoid contamination.

Materials and time needed

- Food Safety checklist (see below)
- Clipboards and pens
- Transport to farms

Field trip: preparation time 30 minutes (in previous FFS session); the field trip itself excluding travel time approx. two to three hours depending on the number of farms visited. Summarizing observations and discussing results: 1 hour.

Procedure

1. Preparation for field trip – presentation + previewing checklists
2. Field trip – observe and discuss sources of contamination
3. Observations from field trip – group discussion about observations

1. Preparation for field trip

- Explain the purpose for the field visit and the ground rules.
- Explain the itinerary and administrative arrangements.
- Give each farmer a food safety checklist (below) and explain how to use it. Highlight that they can add extra items to the checklist.
- Allow 10 minutes for the farmers to read the checklist.

Ground rules when visiting each location:

- Stay out of the way of workers.
- Obey signs or instructions, if present.
- Do not touch produce unless given permission.
- Avoid misunderstandings due to questions, comments or gestures made to the management, supervisors or workers.
- Observe and do not comment or criticise.

2. Field trip

- If possible visit 2-3 farms that differ in farm size, types of fruit and vegetables grown, and production systems.
- At each farm, you may have to divide the farmers into smaller groups to observe practices and conditions.
- Encourage the farmers to use the checklist and look for sources of contamination from food safety hazards.
- At the end of each visit, have a group discussion about what they observed using the checklist as a guide. One trainer leads the discussion and another trainer records the key points raised.

3. Observations from field trip (this can be in a next FFS session or at the end of all field visits)

- Explain that the purpose of the field trip was to observe examples of sources of contamination from food safety hazards during production and post-harvest handling on farm.
- Present a summary of the key points raised during the field trip discussions.

³⁴ Modified from training material Lao PDR “Managing food safety and post-harvest quality of fruit and vegetables. Training farmers in Lao PDR” exercise 9, July 2006.

- Ask the farmers to list on their food safety checklist any sources of contamination they observed and measures needed to prevent or reduce the contamination. Encourage the farmers to use the key points from the field trip discussions. Allow 10 minutes for individual thinking. The farmers can work in groups of 2-4 if they wish.
- Group discussion – select volunteers to provide examples of sources of contamination they observed and measures needed to prevent or reduce the contamination. Records the information on large paper sheets. Reinforce the 10 major sources of contamination.

Food safety checklist

Farm: _____ **Location:** _____

Produce grown: _____ **Date of visit:** _____

Practices and conditions	Comments
Agrochemicals	
Are pesticides stored in a secure area away from produce and containers, packaging and equipment that contacts produce?	
Are pesticides stored in original containers with readable labels?	
Are pesticides approved for use on the crops grown?	
Other chemicals (non-agrochemicals)	
Are fuel, oil, and grease stored away from produce and containers, packaging and equipment that contacts produce?	
Soil and growing media	
Is the soil likely to be contaminated with persistent chemicals, heavy metals or germs that will make people sick?	
Is the area prone to flooding with contaminated water (e.g. presence of polluting industries or slaughterhouse) nearby?	
Could there be other sources of contamination of the soil? If yes, specify.	
Fertilisers and soil additives	
Is animal manure applied before or after planting the crop?	
Are any measures taken to reduce the risk of germs contaminating produce from use of fertilisers and soil additives?	
Water use	
What operations on the farm use water and what is the source of water?	
Is there any risk of water being contaminated with germs that may cause contamination of produce?	
Farm workers	
What type of toilet and hand washing facilities are provided for workers?	
Are there any instructions given to workers on personal hygiene standards?	

Practices and conditions	Comments
In a situation where the workers would touch the final product (like sorting or washing operations, and if it is a fresh product): are there any specific instructions about staying away from the final product if workers are suffering from diarrhea or infected wounds?	
Animals and pests	
Are any grazing or domestic animals present where the crops are grown, harvested or packed?	
What measures are taken to prevent rats, mice, and cockroaches from contaminating produce and containers, packaging and equipment that contacts produce?	
Equipment, containers and materials	
What types of tools, containers, materials and equipment are used for harvesting and packing produce?	
Are equipment, containers, and materials used for harvesting and packing free of stones, wood splinters, metal fragments, glass, and animal faeces?	
How often are harvesting tools, containers and equipment cleaned and what method is used?	
Packing and storage facilities and transport vehicles	
Is produce packed on the floor or tables or benches?	
Are containers or packages holding produce stacked on the ground?	
Is there any risk of physical hazards falling from the roof or walls of structures into containers or packages holding produce?	
Are vehicles used for transporting produce also used for carrying animals, manure, fertilisers, and chemicals? If yes, is the vehicle cleaned before transporting produce?	
Other comments	

NOTE: if a photo camera is available, pictures can be taken from good or bad examples of food safety / hazards. These pictures can be shown at the next FFS or TOT session for easy reference to situations and how to avoid contamination of food.

Also see exercise 2.3.

Discussion: observations from the field trip

- Did you observe any potential sources of contamination from food safety hazards?
- What measures would you suggest to prevent or reduce the risk of contamination?

Sources of contamination from food safety hazards	Measures to prevent or reduce the risk of contamination

2.5 Community, environmental and household mapping³⁵

In order to further raise awareness about food safety and identify factors that may cause contamination of food (or environment, or human health!) it can be very useful to make an analysis of the situation in a community. In some countries, such mapping is an activity in a Pesticide Risk Reduction Programme, as it often concentrates on pesticides. This activity can also be done only at household level. See exercise 2.6 below.

At community level, include local leaders, farmers, pesticide sellers, representatives from social organizations (e.g., Women's Union, Farmer's Union, Youth Union, etc.), local environment agency, as well as pesticide inspectors. The public health sector (hospitals or health centers) can also be a good source for information about food poisoning cases (or pesticide poisoning cases).

This mapping activity that is used to collect baseline data can also be used as a method to raise community awareness and motivate community action. The following table summarizes the source and type of information suggested to be collected. **Note that questions should be added / removed to make sure it applies best to your conditions!**

Table: Community, Environmental and Household Mapping Information

Source	Method	Information / observation	Analysis and Presentation
Pesticide shop owners/sellers	Interview and observation	<ul style="list-style-type: none"> - kinds of pesticides - classes of pesticides - storage - handling - sources of pesticides - location in relation to residences, water sources, food shops, schools, etc. -shopkeeper's knowledge on pesticides, risk reduction techniques, regulations, etc. 	<ul style="list-style-type: none"> - List down kinds of pesticides available; emphasize those that are banned and/or belong to WHO Hazard Class I - Describe handling of pesticides and use of protective equipment by sellers - Describe exposure of family members who use shops as residence, if applicable - Make a map of the community and indicate location of pesticide shop; indicate movement of pesticide from the shop to the community - Make an analysis of the risks from the pesticide shop to food safety, for example: <ul style="list-style-type: none"> • Are there any food shops near pesticide shops? • Are the pesticide shops also selling food products? • What implications would this have on food safety? - If a camera is available, photographs may be taken and shown to the community.
House owners	Interview and observation	<ul style="list-style-type: none"> - pesticide storage (inside the house, in the yard, in animal shelter, etc.) - storage of tank - leaking pesticide containers - pesticides in original containers with proper labels - Place of storage of drinking and cooking water and food storage 	<ul style="list-style-type: none"> - For each household, draw a household map to indicate where pesticides are kept and analyze the situation, for example: <ul style="list-style-type: none"> • Are pesticides accessible to children or farm animals? • Are pesticides kept near water of food storage areas? • Why is this dangerous? - Summarize information for all houses

³⁵ Modified from Thailand FFS exercises - courtesy Dada Morales

House owners/farmers	Interview and observation	<ul style="list-style-type: none"> - location of water source - location of drinking water - place for storing food - place for preparing food - place for eating - place for children to play in - place for keeping animals - place for keeping spray equipment - place for keeping pesticides - place for disposing of pesticide containers - were any containers leaking? - pesticides containers recycled and used in the homes or sold - are there pesticides that are not in their original containers? 	<p>observed on one household map</p> <ul style="list-style-type: none"> - Describe how pesticides are stored, e.g., in soft drink bottles hanging on the walls or ceiling or ground-level and accessibility to children. For example: <ul style="list-style-type: none"> • What would happen if anyone, especially children, would accidentally drink from those bottles because they think it is a soft drink? • How can those accidents be avoided? - If a camera is available, photographs may be taken and shown to the community - Describe how pesticide containers are disposed of, e.g., are they buried, burned, left lying around, etc. - Describe what recycled containers are used for, - If a camera is available, photographs may be taken and shown to the community.
By-standers (other family/community members and other agriculture and non-agriculture populations)	Interview and observation	<ul style="list-style-type: none"> - distance of houses to fields - agriculture and non-agriculture populations connected by water - for humans, vulnerability of groups, e.g., women and children - routes of exposure for agriculture and non-agriculture populations - women washing clothes used by applicator - children playing in the field or bathing in the canals/rivers, etc. - people catching fish for food - animals drinking from water source 	<ul style="list-style-type: none"> - Include information in map of the community and describe. For example: <ul style="list-style-type: none"> • Are pesticide application equipment and containers washed in the river? • What happens to the fish in the river where pesticide residues flow to? • What does this mean for people who eat the fish from the river? • What other contamination can one get from using river water, for instance for washing vegetables? - If a camera is available, photographs may be taken and shown to the community.

2.6 Household mapping³⁶

This is an exercise on household practices of storage and disposal of pesticides. Questions on food safety can easily be added. See also Annex 4 in Manual Part 1 for examples of guide questions.

Farmers and their families may be indirectly contaminated from pesticides through unsafe household storage and disposal practices. They can reduce risks of pesticide poisoning through proper household storage and disposal of pesticides.

Materials and time needed

Household maps, pens, flipchart paper, markers

Duration approx. 2-3 hours, depending on distance to household

Procedure

Carry out observations in farmer households. The number of households should be determined by the community. Observe if:

- Pesticides are stored in the same room as where food is being prepared or stored? Water is distributed or stored?
- Pesticides are stored at ground level, accessible to children?
- Pesticides are stored at ground level, accessible to farm animals?
- Pesticide containers are leaking?
- Pesticides are not in their original containers with proper labelling?
- Pesticide containers are used for water or food storage?
- Used pesticides are not buried as a means of disposal?

Answer the following questions (yes/no) for each household. Use the household maps/diagram below to mark pesticide storage and disposal sites as safe or unsafe.

Storage:

- a. Is pesticide storage child-safe?
- b. Does pesticide storage prevent drinking and cooking water contamination?
- c. Does pesticide storage prevent food contamination?
- d. Is pesticide storage farm animal safe?

Disposal:

- e. Is pesticide disposal child-safe?
- f. Does pesticide disposal prevent drinking and cooking water contamination?
- g. Does pesticide disposal prevent food contamination?
- h. Is pesticide disposal farm animal safe?

Tally the results on a master list (number and %)

Discuss why the answers are 'no' picture by picture. Define with group what constitutes unsafe storage and disposal.

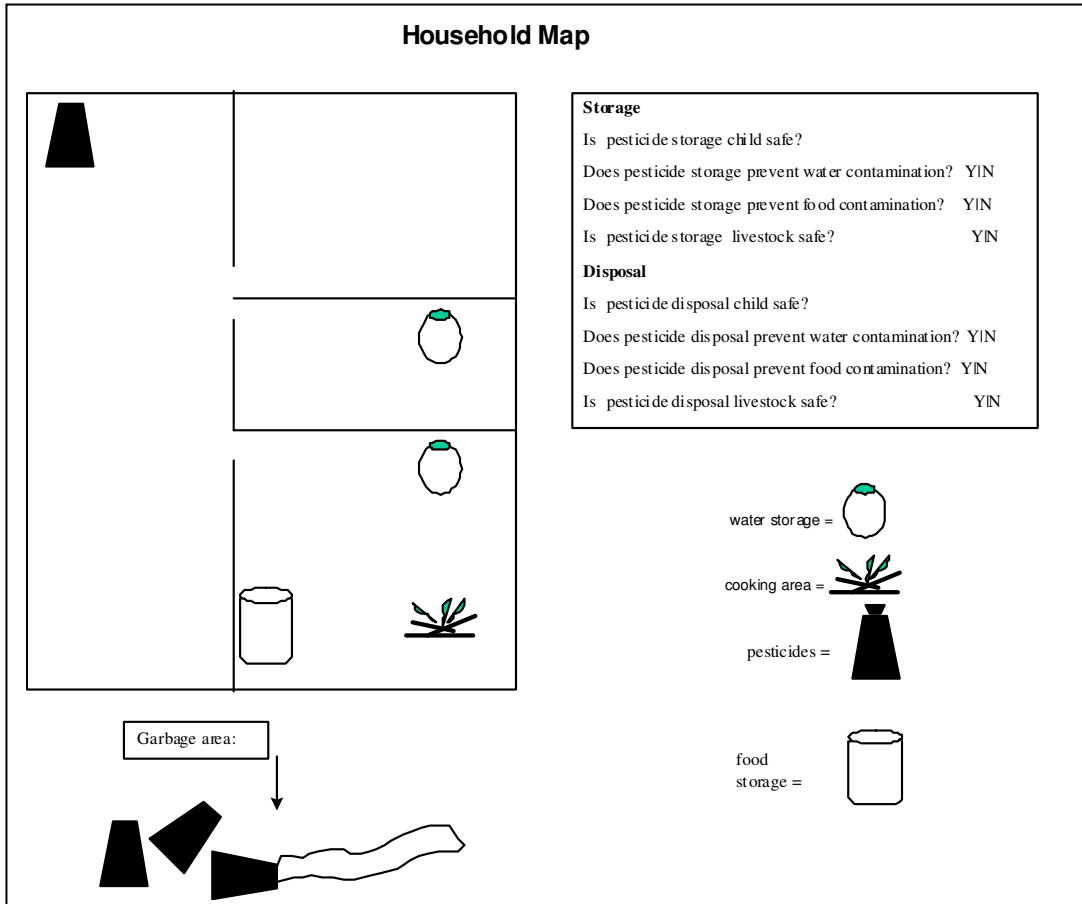
Data analysis and presentation: The same household map/diagram used for collecting information may be used to present the results of the exercise. Alternatively, the information may be presented in a table. Information on the following should be presented:

- homes with pesticide storage that is not child safe
- homes with pesticide storage that is not farm animal safe
- homes with pesticide storage that potentially contaminates food
- homes with a pesticide storage that potentially contaminates water
- homes with pesticide container that is leaking
- homes with pesticides not in their original container with proper labelling
- homes with pesticide containers used for water or food storage
- homes that do not bury pesticide containers after use

³⁶ Modified from training materials by ALCMorales-Abubakar, based on H. Murphy, Guide for Farmer-to-Farmer IPM Health Studies

Sample Data Collection/Presentation Format: Example of a Household Map

When drawing a map like this: make sure to indicate where the house is!



3 Food safety exercises at key steps of the production process

In part 1 chapter 2, a large number of good farming practices to ensure food safety (also called GAP, Good Agricultural Practices) are listed for important activities during crop production. For a number of these good farming practices, exercises can be done to demonstrate the importance of food safety for that activity. However, often other factors also influence decision making: for example, water of unreliable quality may affect food safety, but without water, yields will be lower. It is always a critical balance.

For some activities, exercises are listed in the sections below. For others, there are no existing exercises, but suggestions on what can be done are listed in the table below.

Facilitators should discuss and decide with the farmer group what the priorities on food safety are and how to deal with this in the FFS training. Not all the topics listed below need to be dealt with in separate exercises. Facilitators can select appropriate ones and modify to local conditions.

Key activities during crop production	Food Safety Hazard	Exercises ³⁷
Site history and management	Chemical and biological contamination of produce from previous use of the site or from sources of contamination external to the site.	A possible training exercise would be to collect soils with animal excreta and allow participants to see how bacteria and other organisms grow on the soil as a result of contamination from animal manure.
Planting materials (seeds, varieties, rootstocks)	Chemical contamination of produce from pesticides used during production of planting material.	See under pesticides
Fertilization and soil additives	Chemical and biological contamination of produce from fertilizers and soil additives applied directly to the soil or growing medium or through irrigation systems or foliar spraying.	Concepts such as the need to establish a secure compost tank/pit/pile so as not to cause pollution or contaminate the production site and water source should be addressed. See 3.2 below. Another concept that could be addressed is the practice of using daily waste in fresh vegetable production. An exercise for this could be to use daily waste and monitor how organisms grow on the vegetables and cause contamination.
Irrigation water	Chemical and biological contamination of produce from contaminated water used for irrigation. The same applies to contaminated water used to spray pesticides and/or used for cleaning the produce after harvest.	If facilities are available, an analysis could be done to provide information on the level of micro organisms in the water A possible training exercise will be to sterilize a medium (e.g., boiled rice) and pour irrigation water on the medium and observe the growth of organisms . (This needs to be tested first!) There may be other information about water management, e.g. documentary or DVD (e.g. at FAO office Rome)

³⁷ Options for exercises: input from Almalinda Morales-Abubakar, FAO RAP

Pest, Disease and weed control (pesticides and agro chemicals)	Chemical contamination of produce above maximum residue levels (MRLs) during storage, application, and disposal of pesticides used for crop protection	Many exercises exist in regular IPM FFS programmes on dangers of pesticide usage. It is recommended to add a few questions on food safety. Another option is exercise 3.1 below.
Harvesting and handling produce:		
<ul style="list-style-type: none"> ○ Equipment, materials, containers 	Chemical, biological, and physical contamination of produce from inadequate use, cleaning and maintenance of equipment, materials and containers.	If facilities are available, swabs can be taken from containers that have not been cleaned and observations can be made using microscopes to show presence of micro-organisms. To illustrate why containers should not be placed directly on the ground after they have been packed, exercise 1.3 on how to show the existence of micro-organisms in the soil can be done.
<ul style="list-style-type: none"> ○ Buildings and structures 	Chemical, biological, and physical contamination of produce from inadequate construction and maintenance of buildings and structures.	
<ul style="list-style-type: none"> ○ Washing/cleaning (water use) 	Chemical, microbial, and physical contamination of produce from inadequate cleaning of equipment, containers, and materials and areas where produce is packed, handled and stored.	See above 'irrigation water'
<ul style="list-style-type: none"> ○ Animal and pest control 	Biological contamination of produce from vermin infestation and animals and chemical contamination from vermin control chemicals.	
<ul style="list-style-type: none"> ○ Personal hygiene 	Biological contamination of produce from poor personal hygiene and inadequate facilities.	Various exercises exist with flour – see exercise 1.3 for details.
<ul style="list-style-type: none"> ○ Product treatment (after harvest application) 	Chemical contamination of produce above maximum residue levels (MRLs) during storage, application, and disposal of chemicals applied after harvest.	See under pest control above
Grading and Packing		A field walk (see 2.4 above) would be a useful exercise. Observations may be taken on such items as birds/fowl and animals going into the packing area.
Storage and Transport	Chemical, biological and physical contamination of produce from inadequate storage and transport.	A visit to a warehouse of grains and taking samples from various stocks (e.g., stocks kept for a long time, newly delivered stocks) and doing a visual observation of the grains as well as bringing samples to a laboratory to evaluate for aflatoxin content.
Record Keeping		See 3.4 below

3.1 Other methods to demonstrate chemical contamination (pesticides)

Pesticides can enter the plant through the leaf tissue (and the human body through the skin!). While the intention of pesticide use is to reduce pests and diseases, too high residues on or in the crop may cause food safety hazard. Consumption of pesticide residues on food can be extremely dangerous and may lead to vomiting, stomach cramps, headaches, and even death by poisoning. For many pesticides, a MRL (Maximum Residue Level) has been defined: the maximum amount of pesticide that is 'permitted' as a residue on a fruit or vegetable (usually in ppm - parts per million, mg/kg).

Using IPM techniques can be helpful to reduce the amount of pesticides used. In addition, most pesticides have a withholding time. This is also called the Pre-Harvest Interval (PHI) and is the number of days that you should wait after spraying before you can harvest the crop. In this withholding time, (most of) the pesticide has broken down or is washed off. The PHI (number of days) should be mentioned on the label.

In many cases you cannot see if there is a pesticide residue still on a fruit or vegetable. However, if you don't see it, that does not mean it is not there.... just as we have seen with the microbes (exercise 1.3)!

These are a few simple methods to visualise this³⁸:

Test with cream: bring body lotion or cream and put a bit of cream on the hand of a participant. Initially, the cream can be seen as a white patch. But after a while, you cannot see the cream anymore because it is absorbed by the skin. The same applies for some pesticides: pesticides may be absorbed into your skin but also into a vegetable or fruit, causing potential health hazard.

Test with ink or oil-based paint: put ink or paint on a person's hand: when you wash it immediately, there is already a stain left on the hand. After it has dried, washing the spot is even more difficult: a more intense coloured spot remains. This can also happen with pesticides: when they are spilled on the skin pesticides penetrate quickly. Delaying washing will increase the amount of pesticides that can penetrate. This applies both for human safety but also for food safety

Test with tissue paper: Layers of tissue paper on which a coloured solution is brought. The colour can spread through various layers of the tissue paper, just like pesticides can penetrate through layers of human skin and through plant tissue. Even if you wash your skin, or wash the product on the surface, the pesticide may have already penetrated into deeper layers of the product or your skin.

***Please note: this Food Safety Manual does not provide additional exercises to demonstrate the dangers of pesticides.
This is an important part of FFS programs already!***

³⁸ These methods were demonstrated during a regional workshop in 2005 by a IPM master trainer Mr. Youssri from Egypt

3.2 Effect of different techniques on composting³⁹

This is a field study from the IPM programme in Vietnam. It is a 'common' study, aimed at improving the composting process, and not particularly targeted to food safety. However, food safety questions have been added in the discussion section, to mark how food safety can be integrated into existing training materials and to provide broader discussion about the food safety aspects of using compost.

3.2.1.1 Introduction

In Vietnam, farmers practice either the “hot” or the “cold” method for preparing compost. “Cold” compost is normally prepared in a pit in the ground. Ideally, pits are used during hot weather to reduce evaporation, but during the rainy season it may lead to water logging problems. In Vietnam, however, where a lot of confusion about composting exists, pits are normally used for keeping animal manure and night soil until it is applied in the field as fertilizer, whether composted or not. The “cold” process of composting happens/proceeds without oxygen. Due to the lack of oxygen, microorganisms are not able to “burn” (oxidize) the organic matter and therefore the temperature of the organic matter does not increase (hence the term “cold” composting). The result is a rotting process that does not kill weed seeds and disease pathogens in the compost.

“Hot” compost is normally prepared above the ground. In the “hot” process of composting, oxygen is present for the microorganisms to be able to digest the organic matter, which leads to the increase in temperature (hence the term “hot” composting) and eventually the decomposition of the organic matter. The result of a good “hot” composting process is compost that is free from disease pathogens and weed seeds. However, a large volume of the organic material is lost in the process.

Adequate supply of air to all parts of the compost may be achieved by laying sticks at the bottom and putting air passages in the heap at the time of building it. Natural movement of air in the process of turning is also important. (Turning also breaks up larger pieces of materials and exposes surfaces for organisms to break down.) Air flow removes carbon dioxide and water that are produced in the process of composting. However, air flow also removes heat by evaporating moisture, hence it becomes necessary to check and replenish the water content. In this study, farmers will experiment with different techniques in order to identify one with the “best” product that they can use in future field studies on using compost as a strategy for disease management, weed management and soil improvement (not fertilizer).

Objectives:

Explain the role of oxygen in the composting process
Compare compost from different composting structures
Become aware that compost can affect food safety

Materials:

Area for study: 20m²

For composting: whatever plant material is locally available for compost, like water hyacinth or residues of crops in the bean family, crucifers, etc., animal manure, urea, rice straw ash or lime, water, materials to cover the pile with (like banana leaves or mud 2 – 5 cm thick), bamboo poles for aeration and posts

Plastic twine

Equipment: shovels, watering cans, thermometers

Procedure

1. The study is set up with three treatments as follows: (See instructions on how to set up heaps below.)
 - T1 – WITH OXYGEN: plant material + animal manure
 - T2 - WITHOUT OXYGEN: plant material + animal manure

1.1.2 ³⁹ Source: Almalinda Morales, materials from Vietnam FFS programme. Adapted from Living Soils: Training Exercises for Integrated Soils Management compiled and edited by Dr. William Settle

- T3 (“DESTRUCTIVE” TREATMENT)⁴⁰ - WITHOUT OXYGEN: plant material + animal manure + lime (or ash) + superphosphate (Using superphosphate is a Vietnamese practice)

Each treatment will have two replications.

Assign treatments randomly to plots of 3m² or about a total of 20m².

Preparing the compost

1. Collect vegetable residues or rice straw or cut succulent weeds from roadside areas, and/or find banana leaves or just about any other leafy materials. Chop these up with a large knife to accelerate the breakdown process.
2. Collect cow dung (chicken and pig dung can also be used – these are higher in N, but also have more odor).
3. Gather all the materials in one spot near the field and close to a source of water.
4. Lay out an area about 1.5 X 1.5m.
5. Cut up branches of woody plants or some sticks and lay these out on the ground as the bottom layer of the heap for aeration. Begin constructing the heap with a layer of vegetation about 20 cm in the bottom; and then a layer of 5 cm manure, then a second layer of vegetation; then a sprinkling of lime; vegetation; manure; vegetation; lime; etc., until you have reached the top (about 1m).
6. After every layer of vegetation, tamp down the vegetation in order to compress the pile (not too much).
7. After every few layers, sprinkle a few litres of water on the pile to make the material damp, but not soaking wet.
8. For Treatment 1, after the layers are completed, thrust a pole down to the bottom of the pile in 4 to 6 locations in order to create air channels to the centre of the pile. Cover the top with a layer of banana leaves, coconut fronds, or a 2 – 5 cm layer of mud to keep rain from soaking the pile.
9. For Treatment 2, after the layers are completed cover the heap with a 15 – 20 cm layer of mud to prevent air flow. Keep in this manner until the end of the study period.
10. Treatment 3 (“destructive treatment”) will be used to check for observations and data collection for Treatment 2, as necessary. To do this, after the layers are completed, thrust a pole down to the middle of the pile in 4 to 5 locations to put in thermometers for monitoring temperature. At the top end of the poles, put wires for suspending thermometers attached to plastic string. Cover the top of the poles with transparent plastic for monitoring temperature daily.
11. For Treatment 3, after the layers are completed cover the heap with a 15 – 20 cm layer of mud to prevent air flow. Each time observations are taken, make sure to seal off the heap with a 15 – 20 cm layer of mud on areas where observations were taken and the crust was broken.
12. For Treatment 1, monitor the pile weekly and add water as needed. If the center of the pile becomes dried out, white and “chalky”, it means more water is needed. (The moisture must be such that one can take a handful of the material and it may be squeezed without crumbling but no water should come out.)
13. For all treatments, measure temperature daily.
14. For Treatment 1, when the temperature goes up to at least 65°C and then goes down to about 25°C - 30°C, turn the pile, bringing the outside materials to the centre and the centre materials to the outside.
15. Turning should be done at least once when the temperature has gone down, but it would be better to do it twice. If the temperature no longer goes up significantly, there is no more need to turn the compost.
16. If dung is not available, you will need to layer the pile with urea instead. (See Treatment 1.)

The pile will be completed when the compost is of a dark brown, crumbly consistency, with the odor of fresh earth and when the temperature has cooled down to 25°C - 30°C. This may take three months, depending on the climate. This will not be the case for the anaerobic heaps.

⁴⁰ The “destructive treatment” is meant for taking observations on moisture, smell, and appearance of fungus in the anaerobic treatments. The rationale for setting up this treatment is to allow participants to take observations without disturbing the real treatments. The process of taking observations, i.e., breaking the mud crust, will mean that oxygen will come in contact with the compost heap and therefore affect the experiment. To avoid this, the “destructive treatment” is set up. The final results will be observed using the real treatments at the end of the season.

Sampling:

Daily, take the temperature and record it.

Weekly, check and describe moisture, smell, and appearance of fungus (Use the “destruction treatment” to obtain data for Treatment 2).

Results:

1. Plot temperature for each treatment
2. Describe the changes in the moisture for each treatment over time
3. Describe the changes in the smell of each treatment over time
4. Describe the densities and varieties of fungus observed for each treatment over time

Discussion:

1. What were the main differences between the treatments? (Explain in terms of moisture, smell, occurrence of fungus.)
2. In which treatment did the temperature rise earliest? Explain what could have caused this. What is happening in the compost heap that causes temperature to rise?
3. Which treatment reached the highest temperature? Explain what could have caused this. What happens to the materials in the compost heap when temperature goes up?
4. Why does the volume of the compost decrease? Is this good or not? Why or why not?
5. What is the function of water in composting? What is the function of oxygen?
6. Why do we have to mix/turn compost?
7. How can composting be used as a disease management and soil improvement strategy?
8. Discuss farmers' local practices for preparing compost. How can these be improved?

Discussion with focus on food safety:

9. What happens if the temperature in the compost heaps does not go up?
10. What implications will this have for food safety if the compost is applied in the crop?
11. What implications does the application method for compost have on food safety? Why?
12. Describe the location of the compost heaps. What implication would it have for food safety if they were constructed near sources of drinking water?

3.3 Roots and Plant Vessels⁴¹

Similar to exercise 3.2 this too is a 'common' study, aimed at showing how systemic pesticides work. In order to discuss the relation between (systemic) pesticides and food safety, a few questions have been added in the discussion section. Note that other exercises used in FFS can also be slightly modified in order to discuss food safety aspects. See part 1 chapter 3 for more suggestions on how to do that.

Introduction

Fertilizers and systemic insecticides, such as methamidophos, are often applied to rice and vegetable crops. How do these nutrients and insecticides get into the plant and then move through the plant?

To enter the plant, the chemicals must be dissolved in water. Without water, the compounds will not be able to move either in the soil from the surface to the roots, or from the soil into the roots. Once the chemical are dissolved in the water, they are absorbed into the plant with the water. Once the chemicals are inside the plant, they can move to other parts of the plant through a system of hose-like vessels between the roots and the top of the plant. Water moves up these vessels and sugars move down the vessels.

After the systemic insecticide moves to the leaves of a plant, water from the vessels is exuded each evening. This is the small droplet of water found on the tips of the leaves early in the morning. This drop of water on each leaf contains the systemic pesticide. The drop falls onto the ground (or water in case of rice). The drop of water often falls on natural enemies or natural enemies drink from the drop of water.

Objectives

1. Understand and explain how systemic insecticides move through a plant.
2. Understand why insects sucking or chewing on vessels are controlled by systemic insecticides.

Materials and time needed

Water, red ink or dye, 2 cups per group, plants and 2 straws

Duration 120 minutes (Not whole time is used - best to run the exercise while doing another activity.)

Procedure and questions for discussion

1. Go outside by group and find many kinds of plants including rice seedling, kangkong, celery, grasses and other plants.
2. Add water to the 2 cups and place several drops of the red food colouring. The water should be dark red.
3. Place the plants in the cups with the stems in the cups. Also place the straws in the cups. One straw should be flattened first. Place the plants in a bright place.
4. Wait 90 minutes and observe the plants. What has happened to the colour of the leaves? How has the red coloring moved in the plants?
5. What do you think happens with rice/vegetables when systemic insecticides are used?
6. Where is the insecticide in the plant? What kind of insects suck on the fluid in the plant vessels?
7. What kind of insects chew on the plant vessels? What about insects that feed on the leaf edge?
8. Do they also feed on the main vessels?
9. What happens after the solution reaches the tip of the leaf? Have you noticed the water on the leaf tips in the morning? Where does this water come from and what does the solution contain? How might the solution effect natural enemies in the field? How about farmers walking in the early morning field?
10. Where do the systemic pesticides go after being absorbed by the plants?
11. What happens if people eat rice or vegetables with systemic pesticides? How can one make sure that food is free from very high levels of pesticides?

⁴¹ Adapted by ALCMorales-Abubakar, FAO Thailand

3.4 Record Keeping⁴²

In many FFS curricula, record keeping is a common part of the training, for example to do an economic analysis of comparative field studies (IPM versus Farmers Practice).

One of the requirements of many schemes on Good Agricultural Practices is that records should be kept by the farmer for traceability purposes. These records can be different from records now used in FFS. For example, records of use of pesticides and agro-chemicals should be kept, as well as data on pest survey and management practices. Do check what the requirements are for your region!

Objective of this exercise is to raise awareness on the importance of record keeping and discuss how to do this.

Materials and time required

Posters and markers

If available, record keeping forms of regional/national GAP schemes

Duration: about 1 hour

Procedure

1. The facilitator explains that record keeping is an important element of good farming practices. In some situations it is necessary to keep records even for several years (e.g. GLOBALGAP).
2. Participants discuss experiences and problems with record keeping
3. Besides the existing record keeping method, facilitator asks participants to come up with different forms.
4. When there are a few options for forms, the group selects the best format for their conditions.

Discussion

- What is the aim for record keeping?
- What things should be recorded?
- What could be a good format in order to consequently make records?
- Who checks the farm records?
- How long should records be kept?
- Where to keep those farm records?

⁴² Several exercises exist on the importance of record keeping. This one is from Thailand training materials on Good Agricultural Practices.