



Good Agricultural Practices (GAP) on horticultural production for extension staff in Tanzania

Training manual



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Good Agricultural Practices (GAP) on horticultural production for extension staff in Tanzania

Training manual

by

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Preface

This Manual is the result of collaboration between the technical staff in the Rural Infrastructure and Agro-Industries Division of FAO, the FAO Representation in Tanzania and the Ministry of Agriculture, Food Security and Cooperatives in Tanzania. It has been prepared in the context of the programmes of the FAO-Multi-donor Partnership Programme (FMPP) Component V – and the – ONE UN Joint Programme 1: Wealth Creation, Employment and Economic Empowerment.

A recent FAO assessment of the food safety and quality control system in Tanzania concluded that the system does not provide the level of consumer's protection necessary to ensure food safety for Tanzanians as well as concerning the competitive export market. Among contributing factors identified is the lack of good agricultural practices (GAP) awareness at the levels of government officials and private operators, such as food producers and processors, as well as a lack of an active consumer's organization that could advocate improvement of food safety (FAO, 2007). Awareness and skills that address the needs of improving production practices that incorporate GAP and good manufacturing practices (GMP) are essential to help producers ensure the safety of their produce. In order to reduce the contamination associated with production practices of fresh produce and promote market opportunities, FAO in partnership with the Government of Tanzania and the horticultural industry are devoting efforts to develop training materials and create awareness of GAP throughout the food chain.

This Manual aims to help create an awareness of the different aspects to be considered when implementing GAP. It is addressed to extension agents, the private sector and *junior* policy makers engaged in improving agricultural practices and ensuring food safety. Emphasis is placed on applying GAP and GMP throughout the food chain. The Manual is divided into four Chapters. Chapter 1 emphasizes the importance of good GAP in the horticultural supply chain. Chapter 2 provides an overview of the organizational strategies to enhance competitiveness in horticultural chains. Chapter 3 describes in detail the different elements of GAP. In Chapter 4 there are instructions for trainers on how to develop an effective training course. Annex 1 presents a number of additional resources related to quality assurance and certification systems on GAP.

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Acronyms

The following acronyms are used in this Training Manual for extension staff. All are identified when first introduced in the text but are also listed here for easy reference.

ASDP	Agricultural Sector Development Program
AVRDC	Africa Vegetable Regional Development Centre
BRC	British Retail Consortium
CAC	Codex Alimentarius Commission
CAN	Calcium Ammonium Nitrate
CBD	Coffee Berry Disease
CBO	Community-based organization
CCFH	Codex Committee on Food Hygiene
CCP	critical control point
CCPR	Codex Committee on Pesticide Residues
CIAA	Confederation of the Food and Drink Industries of the European Union
COAG	FAO Committee on Agriculture
DAFB	day after full bloom
DTIS	Diagnostic Trade Integration Study
EC	Emulsifiable concentrate
EPPO	European Organization for Plant Protection
EU	European Union
EUREP	European Retailer Produce Working Group
FLO	Fairtrade Labelling Organizations International
FPEAK	Fresh Produce Exporters Association of Kenya
GAP	Good agricultural practice
GDP	gross domestic product
GFSI	Global Food Safety Initiative
GMO	Genetic Modified Organism
GMP	good manufacturing practice
HACCP	Hazard Analysis Critical Control Point
ICS	Internal Control System
IH&RA	International Hotel and Restaurant Association
ILO	International Labour Organization
IMO	Institute for Marketecology Ltd, Switzerland
IPM	integrated pest management
IPPC	International Plant Protection Convention
ISO	International Organization for Standardization
JMPR	Joint FAO/WHO Meetings on Pesticide Residues

MRL	maximum residue limit
NGO	Non-governmental organization
NSGR	or MUKUKUTA – National Strategy for Growth and Reduction of Poverty
OSHA	Occupational Safety and Health Act
PHI	pre-harvest interval
PPE	personal protection equipment
PRA	Pest Risk Assessment
QA	quality assurance
QMS	Quality Management Systems
RPPO	Regional Plant Protection Organization
SARD	Sustainable Agriculture and Rural Development
SPS	Sanitary and Phytosanitary Measures
TA	Titrateable acidity
TACRI	Tanzania Coffee Research Institute
TBT	Technical Barriers to Trade
TFDA	Tanzania Food and Drug Authority
ToT	training of trainers
TPAWU	Tanzania Plantation Agricultural Workers Union
TPRI	Tropical Pesticides Research Institute
TSS:TA	Total soluble solids concentration and acidity ration
USFDA	United States Federal Drug Administration
WFSO	World Food Safety Organization
WG	Wet powders or granules
WHO	World Health Organization of the United Nations
WTO	World Trade Organization of the United Nations

Introduction

Good agricultural practices (GAP) are *Practices that address environmental, economic and social sustainability for on-farm processes and result in safe and quality food and non-food agricultural products.* (FAO COAG 2003 GAP paper). In simple language, GAP stands on four pillars (economic viability, environmental sustainability, social acceptability and food safety and quality).

In recent years, the concept of GAP has evolved to address the concerns of different stakeholders about food production and security, food safety and quality, and the environmental sustainability of agriculture. These stakeholders include governments, food retailing industries, farmers and consumers who seek to meet specific objectives of food safety, food production, production efficiency, livelihood and environmental benefits. GAP offers means to help reach those objectives.

POTENTIAL BENEFITS AND CHALLENGES RELATED TO GAP IN THE UNITED REPUBLIC OF TANZANIA

Potential benefits of GAP

- Appropriate promotion and adoption of GAP from farm to fork will help improve the safety and quality of food and agricultural products. In addition, producers and consumers will benefit from global markets and improve their livelihoods and the national economy as a whole.
- Adoption of GAP will help promote sustainable agriculture and contribute to meeting national and international environmental and social development objectives.
- Adherence to food quality and safety will protect people's health – an important factor in national development.

The benefits listed above are in line with relevant policies that elaborate the Tanzania Development Vision 2005, i.e.:

1. National Strategy for Growth and Reduction of Poverty (NSGRP or MUKUKUTA) of 2005 refers to poverty alleviation and food security as one of its core objectives.
2. The Agricultural Sector Development Program (ASDP) 2006 aims at creating an enabling environment for improving agricultural productivity and profitability and improving farm incomes, thereby contributing to reduction of poverty.

Challenges related to GAP

- Awareness is needed (by both producers and consumers) of “win-win” practices that will lead not only to improvements in terms of yield and productivity but also for the environment, health and safety of workers.
- More than two-thirds (74 percent) of the food processing plants in Tanzania are comprised of small micro-scale processors, and most of these do not have the system to ensure production of goods according to specified quality and safety standards (Sigonda 2008, Director Tanzania Food and Drug Authority –TFDA, Daily News, 29 June 2008).

- There is a high risk that small-scale farmers will not be able to access export market opportunities unless they are adequately informed, technically prepared and organized to meet this new challenge with Government and public agencies playing a facilitating role.
- In some cases, GAP implementation, and especially record-keeping and certification, will increase production costs. In this respect, harmonization of existing GAP related schemes and availability of affordable certification systems is needed to avoid confusion and higher certification costs.
- The country needs a proper policy and adequate resources to facilitate improvement of the food safety programme.

To respond to these challenges and opportunities, various technical, economical, social, infrastructural and institutional challenges need to be overcome in order to ensure food quality and safety to protect people's health and participate in the global economy.

Furthermore, there is a need to ensure participation of small-scale producers, processors, extension staff and retailers who are in the horticultural supply chain. Empowerment of these stakeholders within the framework of ASDP can enhance basic food quality standards that foster the health of all Tanzanians.

Background

A recent FAO assessment of the food safety and quality control system in Tanzania concluded that the system does not provide the level of consumer protection necessary to ensure food safety for Tanzanians or for the competitive export market. Among contributing factors identified is the lack of GAP awareness at the level of both government officials and private operators, such as food producers and processors, as well as a lack of an active consumer's organization that could advocate improvement of food safety (FAO, 2007). Awareness and skills that address the needs of improving production practices that incorporate GAP and good manufacturing practices (GMP) are essential to help producers ensure the safety of their produce. To reduce risks of contamination associated with production practices of fresh produce and promote market opportunities, FAO in partnership with the Government of Tanzania and the horticultural industry are devoting efforts to develop training materials and create awareness on GAP throughout the food chain. This is in line with the World Food Summit Plan of Action and the Millennium Development Goals to reduce hunger by half by 2015. The plan of implementation includes action to promote sustainable agriculture and natural resources management that contributes to food security, access to sufficient, safe and nutritious food, and improved livelihoods – particularly in reference to Chapter 14 of Agenda 21 on Sustainable Agriculture and Rural Development (SARD).

Emphasis is placed on promoting GAP in production and harvesting, GMP especially during post-harvest and Quality Assurance Systems such as Hazard Analysis Critical Control Point (HACCP) throughout the food chain and at the same time improving natural resource use, workers health and working conditions.

Objective

The objective of this intervention is to strengthen the capacity of the Government of Tanzania and the horticultural industry to promote the adoption of GAP, which will ensure food security, safety and quality for fresh fruits and vegetables. The implementation will be through capacity building by providing training and awareness

materials focusing on the practical application of GAP technical concepts within the framework of ASDP.

ABOUT THIS MANUAL

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

This Manual will:

- Provide a teaching tool to train extension staff, private sector, non-governmental organizations (NGO) and community based organizations (CBO), which will be conducting courses to facilitate the safe production, harvesting, handling, storage and transport of fresh fruits and vegetables for export and the local market.
- Serve as a resource for trainers preparing and conducting courses to assist those in the fresh produce industry with identifying and implementing appropriate measures to minimize hazards and maintain market quality. This will enhance further adoption of GAP and promote environmental sustainability and socially acceptable practices.

The materials in this Manual will provide guidance and not regulation and should be applied as appropriate food quality and safety to protect people's health and, where feasible, to individual fruit and vegetable operations.

The use of this Manual:

Principle information presented includes:

- GAP
- The importance of training in GAP
- Safety and quality of fresh produce
- Traceability
- Integration of small-scale farmers in the horticultural chain
- Marketing channels for horticultural produce
- Implementing an effective training course.

ADDITIONAL RESOURCES

Additional resources include relevant reference documents and information on obtaining additional resource material.

It is anticipated that the time required to present the information would be 5–7 days including a field-site visit. However, the background and needs of the course participants will determine how much time should be spent on each of the training modules. Logistic budget and schedules may dictate shorter or split sessions and the number of practical sessions that are included.

Because the interactive sessions with discussions, laboratory demonstrations and field visits are an important part of the training process, the number of participants needs to be limited to a manageable level for trainers and facilities.

Users of the Manual should be constantly alert for new information and technological advances that expand their understanding of those factors associated with GAP. Awareness of these advances will allow updating the recommendations and information contained in this Manual as appropriate to keep training content current.

Chapter 1

The importance of good agricultural practices (GAP) in the horticultural supply chain

Module 1

GAP for food safety

LEARNING OUTCOMES

- Participants understand the importance of food safety and regulation
- Participants understand the importance of implementing good agricultural practices (GAP) and good manufacturing practices (GMP) as important steps to reduce the impact of possible hazards throughout the production and distribution chain

INTRODUCTION

GAP concept

The concept of GAP evolved recently as a result of the big concern about food safety and quality, and the environmental sustainability of agriculture. GAP offers benefits to farmers and consumers to meet specific objectives of food security, food quality, production efficiency, livelihood and environmental protection. In a broad sense, GAP applies available knowledge in addressing environmental, economic and social sustainability for on-farm production and post-production processing, resulting in safe and healthy food and non-food agricultural products.

PRODUCE QUALITY AND SAFETY

Product quality is defined as the totality of characteristics of a product that bears on its ability to satisfy stated or implied needs. In other words, good quality exists when the product complies with the requirements specified by the client (van Reeuwijk, 1998). This means quality is a term defined by the consumer, buyer, grader or any other. Using these definitions, safety is a component of quality but safety is the most important component of quality, because a lack of safety can result in serious injury and even death for the consumer of the product.

What are the quality attributes of fresh produce?

One way is to observe its characteristics as the product is encountered and consumed. Using this system, quality attributes are often classified as external, internal or hidden.

Quality attributes		
External	Internal	Hidden
Appearance (size, colour, gloss)	Taste	Wholesomeness
Feel	Odor	Nutritive value
Defects	Texture	Safety

The “hidden attributes” are more difficult for most consumers to measure or differentiate, but the perception of these contributes to the consumer’s decision to accept or reject and to differentiate food products. Hidden quality attributes include wholesomeness, nutritional value and safety of a product.

Safety differs from many other quality attributes because it is a quality attribute that is difficult to observe. A product can appear to be of high quality, i.e. well coloured, appetizing, flavourful, and still be unsafe because it is contaminated with undetected pathogenic organisms, toxic chemicals or physical hazards. On the other hand, a product that seems to lack many of the visible quality attributes can be safe.

HOW CAN GAP PROMOTE FOOD SAFETY?

There are many activities that take place as food products move from the farm to the table. These include activities related to production, harvesting, post-harvest operations, packaging, transportation, and storage. Implementing programs such as the use of GAP and GMP are important steps in reducing possible hazards associated with the produce throughout the production and distribution chain.

Food safety is defined as the assurance that the food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use.

(FAO/WHO, 1997)

The food chain approach to food safety and quality recognizes that the responsibility for the supply of food that is safe, healthy and nutritious is shared along the entire food chain – by all the operators involved in production, processing, trade and consumption of food.

Food safety is an obligation of all food sector operators (producers, processors, exporters, importers, etc.) to place on the market wholesome products that:

- comply with current requirements;
- do not have a harmful effect on consumer health;
- if defective, can be withdrawn from the market.

A specific version of GAP is applied within established codes of practices for food safety, under Codex Alimentarius, to minimize or prevent contamination of food. The Codex Alimentarius Commission (CAC) develops and adopts standards, guidelines and related texts on all aspects of food safety and quality reflecting consensus at an international level. Codex standards are reference points for developing and harmonizing national standards. Codex defines GAP in the use of pesticides to include “nationally authorized safe uses of pesticides under actual conditions necessary for effective and reliable pest control.” While the Codex Alimentarius specifically defines GAP in the context of the use of pesticides, the Code of Practice (General Principle Food Hygiene) and other more specific codes, address good practices in primary production as well as post-production processing.

Case study 1 – Worldwide cases of food-borne diseases

- About 840 million people do not have access to quality food.
- 1 500 million of cases of diarrhoea/year.
- Around 70 percent of annual cases of diarrhoea are caused by biological contamination.
- In developing countries, it has been estimated that annually over 1 500 million children under five years suffer from diarrhoea and over 3 million die as a result (WHO, 1999).

- **In Tanzania**, every year cholera outbreaks are reported in all major cities (Dar es Salaam, Arusha and Mwanza).

What can be done to ensure food safety?

The food safety policy – regulatory and private standards such as GLOBALGAP – are responses to the growing consumer concern for food safety, wholesomeness and origin.

This requires that at all pre-harvest and post-harvest stages to:

- Establish self-assessments and risk-control procedures (identify hazards and their causes, decide which threaten food safety and introduce control measures to avoid, reduce or eliminate them) based on the principles of the HACCP methods.
- Identify data to be recorded and ensure product traceability: to keep information on the product's background, destination and origin.
- Apply GAP at all pre-harvest stages.

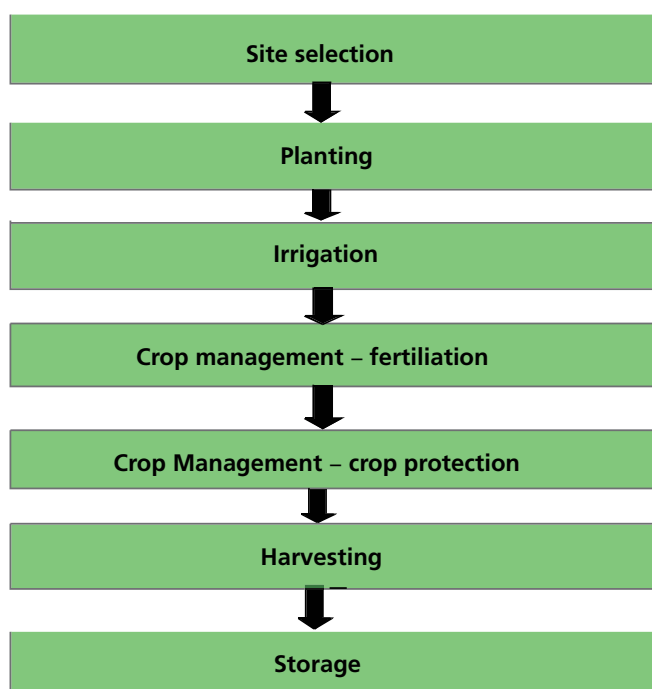
FOOD SAFETY MANAGEMENT

Product flow diagram

The product flow diagram describes the various stages, from primary production to distribution. The detailed analysis of the product flow is the first step for the construction of a food safety system. The product flow diagram (Figure 1) is the main tool in food safety; it is used to:

- evaluate potential risks and dangers at exactly where control actions are needed, as well as the critical control points;
- design top-to-bottom and bottom-to-top traceability schemes.

FIGURE 1
Typical production flow diagram for farm production



Hazards associated with production flow that could be harmful to the consumer

There are three main types of hazards associated with fresh produce:

- biological
- chemical
- physical

Biological hazards

Food-borne micro-organisms, such as bacteria, viruses and parasites, are often referred to as biological hazards (FAO, 1998). Some fungi are able to produce toxins and also are included in this group of hazards.

Micro-organisms able to cause human disease may be found on raw produce. Sometimes they are part of the fruit or vegetable microflora as incidental contaminants from the soil, dust and surroundings. In other instances they get introduced onto the produce through poor production and handling practices, such as the use of untreated manure, the use of contaminated irrigation water or unsanitary handling practices.

Pathogenic bacteria associated with fruits and vegetables include:

- *Salmonella*
- *Shigella*
- *Escherichia coli* (pathogenic)
- *Campylobacter* species
- *Yersinia enterocolitica*
- *Listeria monocytogenes*
- *Staphylococcus aureus*
- *Clostridium* species
- *Bacillus cereus*
- *Vibrio* species

Chemical hazards

Chemical contaminants in raw fruits and vegetables may be naturally occurring or may be added during agricultural production, post-harvest handling and other unit operations (FAO, 1998). Harmful chemicals at high levels have been associated with acute toxic responses and with chronic illnesses.

Examples of chemical hazards:

- pesticides
- fertilizers
- antibiotics
- heavy metals
- oils and grease

Physical hazards: foreign bodies

Examples of physical hazards include:

- residual soil and stones found on fruits and vegetable;
- packaging remaining from harvesting (wood, metal, etc.);
- packing materials and storage facilities, e.g. packaging plastics and cardboard;
- foreign matter collected during harvesting;
- glass and sharp objects;
- personal effects: jewels, hair, pens.

Illness and serious injuries can result from foreign material in produce; these physical hazards can result from poor practices during harvesting, washing, sorting and packaging operations (FAO, 1998). Filth and foreign matter in fruits and vegetables are listed in many instances among the main barriers to international trade.

Hazards

These may be introduced into fresh fruit and vegetable products at numerous points in the production chain as a result of bad agricultural practices.

How hazards find their way to produce

Microbiological	Risks	Reason for occurrence
• Slurry spread	• Pathogens present (or numbers too high)	• Contamination from livestock and human sewage during the growing season traceable to irrigation, soil, pesticide applications, flooding
• Manure	• E. coli	• Contamination by workers at harvest because of lack of personal hygiene or sickness
• Water	• Salmonella	• Poor quality control at harvest
• Staff	• Campylobacter	• Inadequate pre-harvest container and equipment cleaning
• Harmful and domestic animals	• Listeria	• Inadequate temperature control during storage
• Decaying matter	• Clostridium	• Poor stock management
• Parasitism	• Pseudomonas	• Lack of vermin control
• ...	• ...	• Poor waste management
Chemical hazards	Risks	Reason for occurrence
• Pesticides	• MRL exceeded	• Inappropriate use of pesticides leading to:
• Water	• Residues of non-approved pesticides	• Wrong pesticide selection
		• Incorrect dosage/concentration
		• Harvest interval not observed
		• Poor calibration of sprayer
		• Sprayer drift
		• Inadequate cleaning between uses
		• Contamination of produce due to pesticide storage conditions
		• Spillage of pesticides on produce
		• Use of contaminated water to mix spray
• Oils, grease and fuel	• Oils, grease and fuel contamination	• Inappropriate use of produce containers to store pesticides, fertilizers or oil
		• Fuel spillage onto ground or produce
		• Lack of inspection and servicing equipment
• Heavy metals	• Heavy metal residues	• Heavy metal residues in soil because of previous use
Physical hazards	Risk	Reason for occurrence
• Soil	Presence in finished products:	Harvested with the crop
• Machinery	• Soil and stones	• Dirty packaging materials
• Equipment and containers	• Metal	• Inadequate inspection of field equipment and packing facilities
	• Wood	• Inadequate maintenance of containers and machinery
	• Glass and plastic	• Discarded rubbish, e.g. bottles, cigarette butts
	• Knives	• Inadequate cleaning schedule
	• Plasters	
• Workers	• End product contains: jewellery and pieces of clothing	• Staff untrained in personal hygiene
		• Inappropriate working clothes

CONSUMERS NEED TO BE ASSURED THROUGH TRACEABILITY REGARDING PRODUCTS THEY EAT

Traceability food-safety approach

In the horticultural supply chain, consumers and other clients require:

- information on production of the product: where, when, how, with what components;
- respect for the technical specifications: adeptness, control, audits;
- crisis management: competence to find and withdraw defective or dangerous products from sales points;
- assurance that the company produces in a socially responsible way.

Traceability is the ability to trace the history, application and location of any entity by means of recorded identification.

FOOD SAFETY REGULATORY SYSTEM IN TANZANIA

The Tanzania Food and Drug Authority (TFDA) is charged with protecting consumers against food that is impure, unsafe, produced under unsanitary conditions or fraudulently labelled.

TFDA regulates both domestic and imported foods and has primary responsibility for enforcing Tanzania Food, Drugs and Cosmetics – Act 1 of 2003.

TFDA recognizes that food safety is an essential component of sustainable development, as it contributes to the promotion of public health, adequate livelihood, reduction of poverty through human productivity and reduced medical costs. TFDA has prepared a strategy to improve food-processing standards especially among the small holders and microscale processors. However, Tanzania is faced with many challenges regarding food safety, including lack of an appropriate policy, shortage of internationally accredited laboratories and overlapping laws. To address these issues, the institution has drafted the National Food Safety Policy that is expected for discussion by stakeholders in the near future. The proposed policy will modernize the existing food legislation to make it more coherent and to keep abreast of changing trends as well as provide greater understanding for consumers on the importance and access to safe food.

SUMMARY

1. Food safety is defined as the assurance that the food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use. Implementation of GAP and GMP are primary steps in reducing the risks associated with fresh fruits and vegetables.
2. A hazard is something that could cause harm to the consumer. There are three main types of hazards associated with fresh produce: Biological, Chemical and Physical.
3. Fresh fruits and vegetables may be vehicles for the transmission of parasites and viruses.
4. Micro-organisms able to cause human disease may be found on raw produce. In other instances they are introduced into food through poor production and handling practices, such as the use of untreated manure, the use of contaminated irrigation water or unsanitary handling practices.
5. Chemical contaminants in raw fruits and vegetables may be naturally occurring or may be added during agricultural production, post-harvest handling and other unit operations.

6. Foreign materials in produce can cause serious illness and be injurious. These physical hazards can result from poor practices during harvesting, washing, sorting and packaging operations.
7. Training of producers in GAP at every level of the production chain and education of consumers is the key element in reducing hazards associated with fresh fruits and vegetables.
8. TFDA regulates both domestic and imported foods and is charged with protecting consumers against food that is impure, unsafe, produced under unsanitary conditions or fraudulently labelled.

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Module 2

GAP to improve market access

LEARNING OUTCOMES

Participants understand the importance of promoting GAP for both quality assurance and market access to improve country economy and producers' livelihoods

INTRODUCTION

Globalization brings new opportunities for food producers, along with new challenges to meet growing demands for quality and food safety. Capturing new opportunities to export high-value horticultural products will require producers to manage safety from farm to table and to meet increasingly stringent food-safety standards in import markets. Successful performance in export markets has the potential for substantial gains from trade, as well as generating income in the rural sector in the United Republic of Tanzania, but at the same time, it requires new and different kinds of market coordination. The public sector can play a role in improving food safety and quality to meet export-market standards, and addressing domestic issues of consumer safety at the same time.

WHAT CAN BE DONE TO COMPLY WITH FOOD SAFETY STANDARDS?

Capacity building at macrolevel

Extension agents should be trained in:

- GAP basic principles
- Integrated Pest Management (IPM) and integrated crop management
- European Union/United States/Japan food regulation and market
- Requirements for exports /SPS/TBT agreement
- Packaging and post-harvest technologies
- Traceability procedures
- GAP auditing
- Market information systems.

Capacity building at farmer level

Farmers need to be trained in:

- Pesticide management
- Traceability and record-keeping
- Farm business management skills
- Environmentally and socially sound practices
- Basic food hygiene and sanitation
- Post-harvest management.

CASE STUDY 1 – KENYAGAP (KENYA)

KenyaGAP is a national standard for fresh produce based on the principles of GAP, HACCP, principles for food handling and marketing, as well as on local regulations and international conventions ratified by the Government of Kenya. KenyaGAP was

TABLE 1
Kenya export of fresh produce and global ranking

Country	Area (ha)	Export (tonnes)	Export US\$ million	Share in agricultural trade (%)
South Africa	483 303	2 373 539	1 546.2	45
Chile	420 753	2 750 651	2 190.1	44
Kenya	308 380	192 086	272.2	17
Malaysia	320 000	731 180	241.2	2.2

Source: FAOSTAT, 2006

developed through private-sector initiatives and is owned and maintained by the Fresh Produce Exporters Association of Kenya (FPEAK).

By adopting GAP and complying with food safety and quality, Kenya is among the leading African countries exporting fresh produce (Table 1).

HOW CAN TANZANIA BENEFIT FROM ADOPTING AND PROMOTING GAP?

The agricultural sector is central to the Government of Tanzania's objectives of achieving sustained economic growth and reducing poverty. Horticulture and floriculture are emerging non-traditional exports in Tanzania. According to Tanzanian industry data 2004/05, (Table 2), such exports amounted to around US\$28 million or around 1.1 percent of total exports. While this is small compared to total exports, it is one of the few exports that have increased its share in total exports since the mid-1990s. Given Tanzania's strength in this area, there is certainly potential for expansion of these exports if GAP is adopted and promoted with other infrastructures.

EXAMPLE OF FRESH PRODUCE EXPORTED FROM TANZANIA

Raspberry

There has been a significant investment in a raspberry export project (Kilihortex). This project hopes eventually to export 200 tonnes of fruit per year to northern Europe (with an estimated FOB value of US\$1 million per year).

Mangoes

The Association of Mango Growers is making an effort to develop the exports market, targeting the Near East and Asia regional markets.

TABLE 2
Tanzania export of horticulture and floriculture to Europe: industry estimates (2004/05)

	Industry (2004/05)	
	Volume (tonnes)	Value ('000 US\$)
Cut roses	3 250	12 675
Other flowers	500	1 268
Cuttings	929	7 605
Fruits and vegetables	2 400	5 760
Vegetable seeds		1 000
Total	7 079	28 308

Source: Tanzania diagnostic trade integration study (Tanzania_DTIS_ Vol. 2. November, 2005)

Regional markets

Regional exports – in particular exports to Kenya – constitute another significant outlet for Tanzania's horticulture exports, in addition to Europe; export to Kenya are mainly oranges, onions and tomatoes.

The vegetable industry is now established as a small player in the European Union market, with a narrow base of vegetable exports – mainly green beans

with some mangetout (or snow peas) and baby corn. Plans are underway for vegetable exporting companies to invest in cold chain facilities as part of a strategy to expand and increase production.

From the information provided above, exports of fruits and vegetables make up a significant percentage of export income in Tanzania. Thus, assuring the acceptability of these products to importing countries should be a major economic consideration. In addition, it is important to keep in mind that fruits and vegetables are produced for domestic consumption as well as for export. Therefore, the production of safe products is important for the health and welfare of the people within Tanzania as well as for potential export revenue.

Countries importing food products and non-food from Tanzania have strong economic reasons for demanding safe and quality products. Unsafe imports may pose a threat to the health and safety of their consumers. Detention and/or rejection of unsafe products and decreased consumer confidence in a product or in a country's ability to produce safe products will lead to major losses of revenue and will have adverse effects on poverty reduction and sustainable economic growth.

SUMMARY

1. Food and agricultural production plays an important role in the economy of Tanzania.
2. Exports of horticultural produce is making up a significant percentage of the export income of Tanzania.
3. Unsafe exports may pose a threat to the health of people consuming the product and will result in a significant economic loss for Tanzania.
4. Capturing new opportunities to export high-value horticultural produce will require producers to manage safe food from farm to table and to meet increasingly stringent food-safety standards in import markets.
5. The public sector can play a role in improving food safety and quality to meet export-market standards and at the same time address domestic issues of consumer safety.
6. Capacity building at both macrolevel and farmers' level is needed for Tanzania to comply with food safety standards.
7. Infrastructures, such as laboratories, GAP auditors and market requirement information, are critical for food safety standards compliances and market access.

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Chapter 2

Organization strategies to enhance competitiveness in horticultural chains

Module 1

Understanding modern horticultural supply chains

LEARNING OUTCOMES

The learner should:

- Develop an appreciation of the supply chain as a mechanism for delivering horticultural produce that meets market requirements
- Develop an appreciation of key role players in supply chains and their functions
- Develop an appreciation of how the consumer drives modern supply chains

INTRODUCTION

Market liberalization and growth in international trade have created export opportunities within the horticultural sectors of many developing countries. At the same time, rapid urbanization and income growth in these countries have led to increased consumption of horticultural produce, thereby expanding opportunities for small-scale producers, packing houses and other stakeholders in the horticultural sector. Tapping into these market opportunities is, however, dependent upon their ability to meet a plethora of stringent requirements.

Produce destined for export must comply with the sanitary and phytosanitary (SPS) regulations of importing countries. It must also comply with private-sector standards and codes of practice, which have been put in place by importers and multiple chain supermarkets in order to respond to consumer requirements. Fresh produce sold in local format markets and in supermarkets must also satisfy consumer requirements for safety and quality. Coupled with these exigencies for produce safety and quality, are requirements for guaranteed supplies and consistent volumes of a variety of fresh produce items.

Fresh produce can no longer, therefore, be taken to the market on the off chance that it will be purchased. Access to markets requires that produce be supplied through market-driven systems in which market requirements known prior to production are used in specifying input quality as well as production practices and post-production handling.

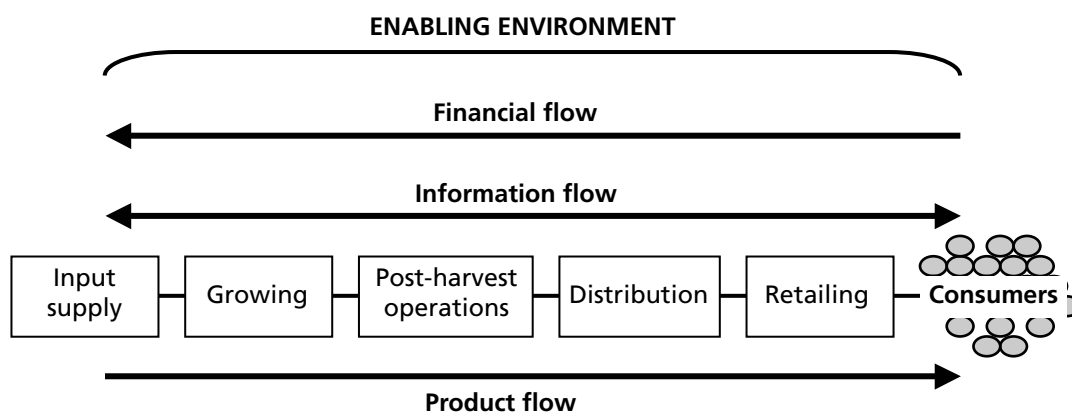
This module discusses the horticultural supply chain, a systemic structure involving the participation of various stakeholders and which provides the coordination and flexibility required to respond to market requirements for fresh horticultural produce effectively and efficiently.

(Adapted from *Horticultural Chain Management for Eastern and Southern Africa – Theoretical Manual*; FAO and Commonwealth Secretariat – March 2008.)

THE HORTICULTURAL SUPPLY CHAIN

The horticultural supply chain refers to the entire vertical chain of activities from the supply of input (seed, fertilizer, chemicals and so on) through production, post-harvest operations, distribution and retail (Figure 1).

FIGURE 1
Key elements of the supply chain for horticultural produce



Adapted from *Horticultural Chain Management for Eastern and Southern Africa – Theoretical Manual*; FAO and Commonwealth Secretariat– March 2008.

Key stakeholders within horticultural supply chains

The *consumer* is the ultimate buyer and/or end-user of produce in horticultural supply chains. A consumer may be a business, a household or an individual.

Consumer within the chain refers to business within the chain that has direct dealings with each other. Packing houses, for example, are the customers of growers of horticultural produce, while retail stores are customers of packing houses.

Flows with the modern supply chain that govern optimal functioning

As shown in Figure 1, three major flows within horticultural supply chains govern their optimal functioning:

- **Product flow:** Fresh produce flows in one direction through the chain, starting with input supply and ending at the retailer, who makes the final product available to consumers.
- **Financial flow:** Financial flow takes place in the opposite direction of produce flow, whereby payments go to suppliers as produce moves downstream (from the producer through the various customers within the chain) towards consumers. Financial flow is generated through the willingness of the consumer to pay for produce that meets his/her requirements.
- **Information flow:** Information flows in both directions throughout the supply chain. Market information on consumer requirements, as well as information about what is demanded by customers at successive steps of the chain, travels upstream (from the retailer through the various customers to the producers), while information about supply conditions and product attributes travels downstream. Information flow is very important in coordinating activities at the different steps of the chain in order to assure that these activities satisfy market requirements. It facilitates planning and coordination of supplies and therefore helps to minimize losses. Information related to the identity of produce (for example, origin, variety, orchard block from which harvested), treatment at the pack house and handling (for example, the temperature and relative humidity during distribution) through

the chain can be recorded and stored at the different steps of the chain. Stored data is used in providing traceability (tracing and tracking of produce) in the chain. Stored data may also serve during later verification of compliance with protocols, such as those related to the application of GAP and GMP.

The enabling environment

An enabling environment consists of those factors external to the chain that impact upon optimal functioning of the chain. Elements of the enabling environment include:

- enabling policies and regulations;
- an infrastructural support base to facilitate chain operations;
- business development support services, which include:
 - banks that provide loans;
 - companies that provide market information;
 - equipment hire services;
 - logistics companies that transport and/or store produce;
 - trainers and technical assistance providers.

Consumers, the driving force of the horticultural supply chain

Value-creating activities are applied within horticultural supply chains to impart attributes that are of value to – and which are demanded by – the final consumer. Urban consumers, for example, prefer horticultural produce that is uniform in size and colour and that is attractively presented in unitized packing. The success or failure of a horticultural supply chain is ultimately determined by the degree to which produce satisfies consumer requirements for quality and safety. It is these preferences of consumers that drive modern horticultural supply chains. Consumer demands define the quality of production inputs as well as production, post-harvest and distribution practices. Information flow up and down the chain is, therefore, a crucial element in meeting consumer requirements.

Each participant in the chain requires its upstream producer to supply produce that will allow it to meet the requirements of the downstream customer. This is applied until the end of the chain, where retailer provides produce that satisfies consumer requirements. Thus, by delivering value to its customer, each supply chain partner effectively delivers value to the final consumer.

A packing house, for example, requires growers to supply fruits of the appropriate quality that will allow it (the packing house) to grade, treat and package the produce to meet the needs of retailers. These retailers will, in turn, supply fruits that meet the needs of consumers.

Value chains

A value chain is a particular form of supply chain that is created when chain partners have a shared vision and common goals that aim to meet specific market objectives and consumer needs. The value chain may encompass the entire spectrum of the supply chain, from customer to producer. It is differentiated from a generic supply chain by the following characteristics:

- Participants in the value chain have a long-term strategic vision.
- Participants recognize their interdependence and are disposed to work together to define common objectives, share risks and benefits, and make the relationship work.

- Participants have a shared commitment to control product quality and consistency..
- Participants have a high level of confidence in one another, which allows greater security in business and facilitates the development of common goals and objectives.

Horizontal and vertical coordination within value chains

Horizontal coordination refers to coordination among entities operating at a particular link of the value chain, for example, a group of farmers supplying fruit to a particular packing house.

Vertical coordination refers to the synchronization of activities at successive stages of the chain, from input supply, through growing, harvesting, packing house operations and distribution to retailing.

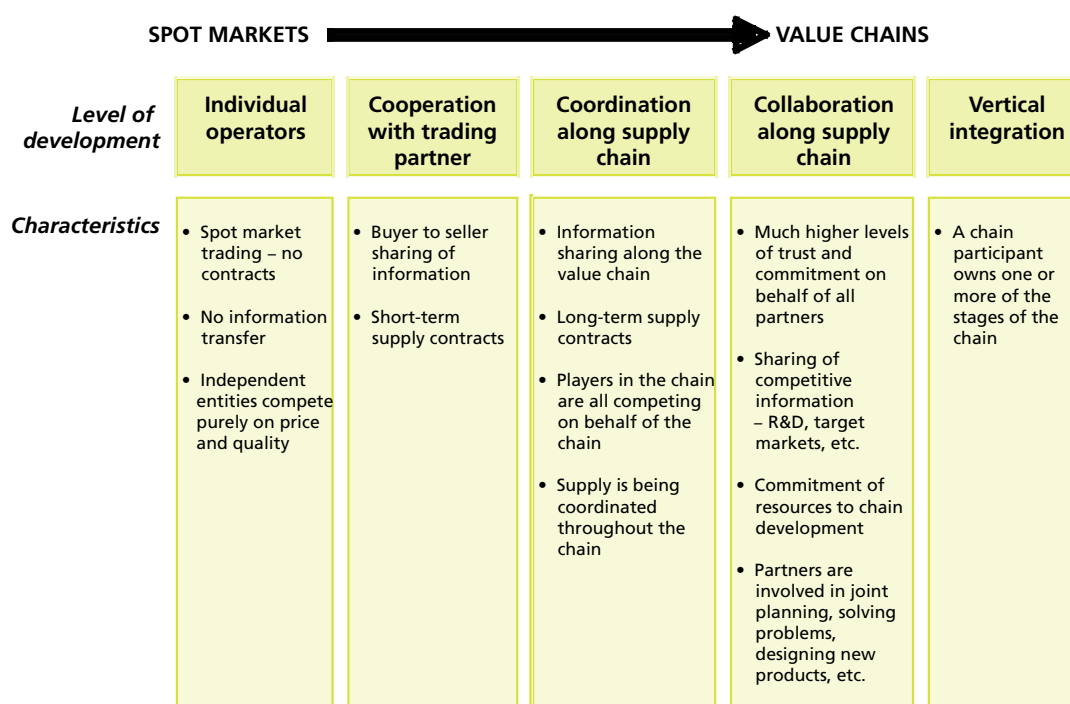
Range of vertical coordination possibilities in supply chains

The continuum of coordination possibilities in a supply chain ranges from spot-market transactions on one extreme to vertical integration on the other (Figure 2).

Spot-market transactions are transactions that involve independent buyers and sellers who have no long-term relationship. Resources move between the parties involved as a result of price signals alone.

Vertical integration is a form of vertical coordination in which a firm, such as a supermarket, a commercial supplier or a multinational, owns one or more of the stages

FIGURE 2
Levels of development in the supply chain



Source: Adapted from *Horticultural Chain Management for Eastern and Southern Africa – Theoretical Manual*; FAO and Commonwealth Secretariat – March 2008.

of the chain. It represents the greatest degree of control that a firm can gain over the output from a chain partner.

Ownership ensures complete power over decisions regarding product attributes, location and timing of delivery.

In between the extremes of spot-market transactions and vertical coordination lay various coordination possibilities, including contracts and joint ventures.

Time frame

The duration of the lecture and discussion is one hour.

The duration of the practical exercise is around two hours.

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Module 2

Integration of small farmers into horticultural chains¹

LEARNING OUTCOMES

The learner should:

- Develop an appreciation of modalities for increasing market access for small-scale farmers through horizontal and vertical coordination mechanisms
- Develop an understanding of contract farming arrangements for small-scale farmers

INTRODUCTION

Many small-scale farmers in Tanzania are unable to satisfy market requirements for horticultural produce in importing countries and in urban centres within the country. This is owing to the small size of their operations, poor organization, use of low technologies, dependence on unskilled labour, lack of capital and poor support services.

For many commercial entities (such as packing houses, exporters and supermarkets), the prospect of working with a multitude of individual small farmers raises concerns about communication, management, quality, reliability of supply and transaction costs.

This Module discusses coordination mechanisms through which small farmers can overcome these impediments, better satisfy the requirements of packing houses, supermarkets and other companies, and thereby become integrated into modern horticultural supply chains.

HORIZONTAL COORDINATION THROUGH THE FORMATION OF FARMER GROUPS

Horizontal coordination of farmers entails the formation of a group, association or other collaborative structure through which information, inputs, technical and quality assistance, and various other needs may be accessed. As an organized group, small-scale farmers can work together to function such as larger businesses and thus offer many of the advantages of a larger operation. These advantages include:

- improved access to credit, training and business services;
- improved access to technology and equipment through shared resources;
- increased efficiencies and economies of scale through collaborative production and marketing, reduced transaction costs, and bulk purchases of raw materials and contracted services;
- collective knowledge of markets, production standards and customer requirements;
- pooled creativity for developing innovative products and services;
- reduced costs/risks for the development of new products and services;
- improved ability to avoid oversupply and a resulting decline in prices;
- collective efforts to overcome shared obstacles;

¹ Adapted from *Horticultural chain management for Eastern and Southern Africa –Theoretical manual*; FAO and Commonwealth Secretariat– March 2008.

- an improved market position, with increased production capacity, a broader range of produce offerings and a more diversified skill set.

Horizontal linkages are not limited to farmer groups. They can be formed, and are beneficial, at all levels of the supply chain. Small packing house operations in a given setting could, for example, form such a group. Horizontal linkages may emerge because of collaboration among concerned parties (e.g. participating farmers) or may be fostered by an external party (e.g. an NGO).

VERTICAL COORDINATION THROUGH CONTRACT FARMING

One vertical coordination option that is suited to the integration of small-scale farmers into horticultural supply chains is contract farming.

Contract farming

According to Eaton and Shepherd (2001), contract farming can be defined as: “an agreement between farmers and processing and/or marketing companies for the production and supply of agricultural produce under forward agreements, frequently at predetermined prices”. The arrangement also invariably involves the provision of a degree of production support by the purchasing company, through, for example, the supply of inputs and the provision of technical advice to the farmers.

The basis of such arrangements is a commitment on the part of the farmer to provide a specific commodity in quantities and at quality standards determined by the company and a commitment on the part of the company to support the farmer’s production and to purchase the commodity.

Contract farming schemes typically involve the provision of inputs (seeds, fertilizers and pesticides) on credit by the company, often with extension advice, but may also included a range of other services such as ploughing and crop spraying. Costs are recouped when the produce is sold.

Advantages of contract farming for the small farmer

The prime advantage of a contractual agreement for farmers is that the purchasing company will normally undertake to purchase all produce grown within specific quality and quantity parameters. Additional advantages include:

- provision by the purchasing company of basic inputs (seeds and fertilizers), production services (field preparation, harvesting, spraying, etc.) and a wide range of managerial, technical and extension services;
- access to credit, either advanced, arranged or facilitated by the purchasing company;
- access to appropriate technology and opportunities to upgrade agricultural commodities for markets that demand high quality;
- transfer of skills and knowledge (e.g. record-keeping, improved methods of applying chemicals and fertilizers, knowledge related to quality and the requirements of export markets);
- guaranteed and fixed pricing structures, as prices are fixed in advance;
- access to reliable markets, which would otherwise be inaccessible to small farmers.

A well-organized contract farming scheme can therefore provide the right incentives and forward and backward linkages required for small farmers in developing countries to participate in modern horticultural supply chains successfully.

Models of contract farming

Some of the most widely used contract farming models includes:

- **Centralized model or “outgrower scheme”:** This model involves a centralized packing house exporter buying from a large number of small farmers.
- **Nucleus estate model:** This model is similar to that of the centralized model, except for the fact that the company also manages a central estate or plantation.
- **Multiparty model:** This model involves statutory bodies and private companies jointly participating with farmers.
- **Informal model:** This model applies to individual entrepreneurs or small companies, which normally make simple, informal production contracts with farmers on a seasonal basis.

COMBINING VERTICAL AND HORIZONTAL COORDINATION: CONTRACT FARMING INVOLVING FARMER GROUPS

Vertical coordination through contract farming and horizontal coordination through the formation of farmer groups often work best together, with farmer groups contracting with companies that supply them with a range of services, within a suitable framework such as an out-grower model.

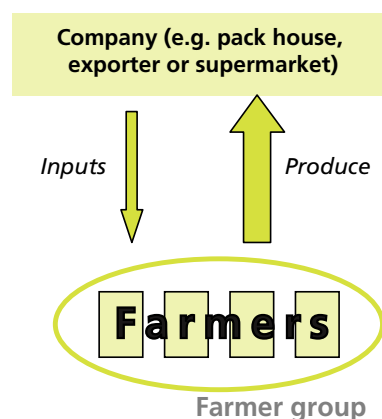
Contract farming involving farmer groups increases access to new market opportunities. When dealing with a purchasing company, the negotiating strength of a farmer group is greater than that of its constituent individual members. Companies prefer working with farmer groups because group liability for credit reduces lending risks, while economies of scale reduce transaction costs.

Generalized model for contract farming involving farmer groups

In order for a company to contract small-scale fruit and vegetable growers in a particular setting, extension agencies, NGOs, development agencies or the company itself should assist growers in forming a group if one does not exist or assist in improving the cohesiveness of existing groups (e.g. by training growers on group forming skills, formally registering the group and providing literacy and numeracy training).

Small-scale growers are better placed to deal with exporters, supermarkets and other larger companies when they coordinate among themselves within such a group. A group can better comply with contractual requirements of the company than its individual members, and serves as a convenient organizational unit around which the company can coordinate procurement of produce and provide inputs, credit and technical assistance to the growers (Figure 1).

FIGURE 1
Generalized model for contract farming involving a farmer group



Source: Adapted from *Horticultural Chain Management for Eastern and Southern Africa – Theoretical Manual*; FAO and Commonwealth Secretariat – March 2008.

BOX 1
Case study

Kathiriti-Kanjau Horticultural Growers in Kenya is a registered farmer group founded in 2001 with a membership of 27 farmers. Recognizing that the function of brokers was to assemble lots for exporters, and that they could achieve such lots by pooling produce, the farmer group was formed out of a desire to eliminate brokers and deal directly with exporters. Contractual arrangements between the farmer group and exporters resulted in higher returns to farmers as compared to the broker market. The contracts between the farmer group and the exporters require the farmer group to supply specified volumes of produce on a weekly basis, depending on the market season, while exporters provide seeds on credit with an agreement to purchase produce outputs and recover their costs from the sales proceeds of the farmer groups.

Source: Faida MaLi

TIME FRAME

The duration of the lecture and discussion is one hour.

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Module 3

Traditional and modern marketing channels¹ for horticultural produce in Tanzania

LEARNING OUTCOMES

The learner should:

- Develop an understanding of marketing channels and intermediaries involved in traditional and modern horticultural supply chains in countries of the Eastern and Southern Africa region.

INTRODUCTION

Horticultural produce in the United Republic of Tanzania is moved from production areas to consumers via a number of different channels. This module will briefly describe the main local, regional and international marketing channels and intermediaries involved in horticultural supply chains in Tanzania.

MARKETING CHANNELS FOR HORTICULTURAL PRODUCE IN THE REGION

Horticultural produce from Tanzania is sold to local, regional and international markets. The main marketing channels are depicted schematically in Figure 1.

Horticultural produce is marketed to rural and informal urban markets through traditional supply chains; these are largely supply driven, with relatively little coordination. Marketing channels for formal and export markets, on the other hand, make use of well-coordinated modern supply chains, which are driven by consumer requirements.

Marketing channels for rural consumers in the region

Producers of horticultural crops can, in general, access nearby rural consumers easily through informal transactions involving sales in the farmgate or village market centre. The smallest rural markets are informal and are held periodically at an appropriate location in the village. These are in close proximity to production areas, so the produce is transported to market by head-load, bicycle or animal portage. Direct transactions between farmers and consumers often take place.

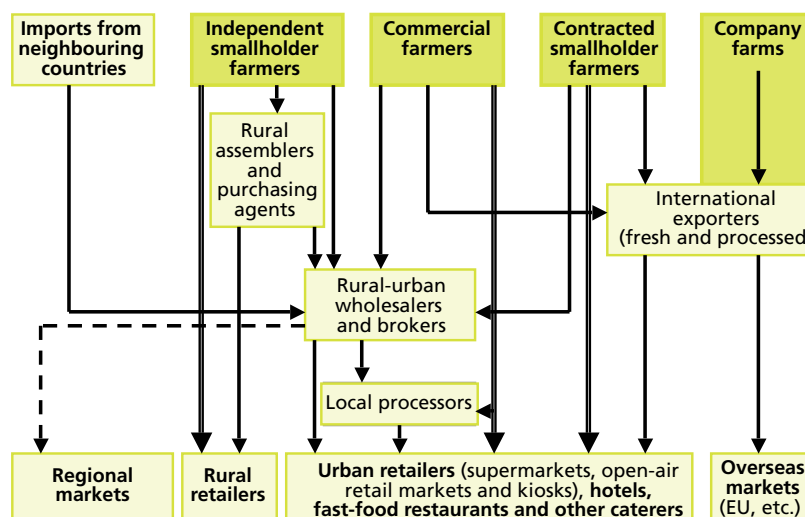
Larger rural markets may be registered and supported by the local government. These may also be periodic and are likely to be outfitted with permanent stalls where traders sell to consumers and other traders. These markets draw farmers from further distances, so that produce is transported to market by minibuses and small trucks.

Marketing channels and key stakeholders in urban areas

Produce is moved from rural to urban areas through a chain of intermediaries, which may include assemblers, brokers, wholesalers and retailers.

¹ Adapted from *Horticultural Chain Management for Eastern and Southern Africa – Theoretical Manual*; FAO and Commonwealth Secretariat– March 2008.

FIGURE 1
Marketing channels for fresh produce in Tanzania



Source: Adapted from *Horticultural Chain Management for Eastern and Southern Africa – Theoretical Manual*; FAO and Commonwealth Secretariat – March 2008.

Assemblers and wholesalers

Assemblers and wholesalers supply produce to urban markets after purchasing it directly from farmers or from rural markets. Produce is transported either by minibus (for small quantities) or truck (for larger quantities).

Common brokers

Commission brokers, acting on behalf of large and long-distance trades, play an important role in sourcing supplies and in organizing procurements into economical loads. These individuals also play an important role in marketing, especially given the wide-ranging agro-ecological zones within the region, the geographical distribution of production and the small sizes of farms.

Terminal wholesale and semi-wholesale markets

Terminal wholesale and semi-wholesale markets are located within or near to major cities and may be supplied by purchasing/assembly centres in rural areas or directly from farms, particularly those in peri-urban areas. Produce is supplied either by agents, traders or by farmers themselves. As shown in Figure 1, above, wholesalers and brokers in districts generally source produce from different farmers in the districts in order to supply the urban retail market.

Informal retailers

Informal retailers include small-scale traders operating in traditional open-air retail markets or makeshift sheds and stands in high-density residential areas, on pavements in busy urban streets or in door-to-door hawking in residential areas. Although primarily involved in retailing, informal markets – also referred to as farmer's markets – may have a semi-wholesale function, particularly if farmer trading takes place in those markets.

Formal retailers

Formal retail markets include supermarkets, convenience stores and small retail shops. Small retail shops – also known as urban self-service stores, urban countertop stores, “corner” shops and roadside stands, depending on their particular operation – supply produce in the vicinity of the home of the consumer. These establishments generally procure their produce supplies from wholesale markets.

Supermarkets also procure their produce supplies from wholesale markets, although the leading supermarket chains will often by-pass wholesale markets and rely primarily on brokers and on direct procurement arrangements with contracted commercial farmers and organized small- and medium-sized farmers.

The formal retailers may also source produce from distant sources, requiring the operation of modern logistics and cold chains.

MARKET CHANNELS FOR EXPORT

Conveying produce to export destinations also requires the operation of modern supply chains and cold chains. The channels used vary widely, but can be classified into roughly three categories according to the degree of vertical co-ordination:

- **Vertically integrated exporters:** These are exporters who grow produce on their own farms, arrange shipping to overseas destinations and even distribute the goods to supermarkets and wholesalers in foreign markets.
- **Exporters who consolidate produce grown under contract directly:** This category includes exporters who obtain produce from contract farmers. In a majority of cases, larger or medium-scale farmers supply exporters directly on contract. In a few cases, a number of small farmers may also supply produce to exporters on contract (Figure 1).
- **Exporters who consolidate produce procured by brokers:** In this case fresh produce is sourced through brokers, who in turn consolidate produce from farmers in spot market transactions, or alternatively through farmer groups to ensure the minimum standard of quality that will attract exporters or traders.

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Chapter 3

GAP for fresh produce

Module 1

Site selection and land preparation

LEARNING OUTCOMES

- Participants understand the guidelines for site selection and land preparation, which are agronomically and environmentally appropriate
- Participants understand the hazards associated with land history
- Participants understand the importance of environmental protection during land preparation

INTRODUCTION

GAP adhere to appropriate soil management as an important tool to maintain and improve soil productivity, and should aim to improve the availability and plant uptake of water and nutrients. Activities such as replenishing soil organic matter and soil moisture and minimizing soil erosion are fundamental for sustainable agricultural production. Soil management is generally undertaken at farm or field level but it affects the surrounding area or nearby water catchment site because of water runoff and sedimentation.

GAP IN SITE SELECTION

Key considerations in selecting site for growing fresh produce

- Does the area chosen lend itself to labour-intensive cultivation methods?
- Are erosion control measures needed?
- Is irrigation necessary for reliable vegetable production?
- Is there a regular need for drainage and flood control?
- Is the area subject to build-up of pests and diseases?
- What is its land history?

Considerations on cultivation methods

- Use of hand labour or animal draft is usually more appropriate for smallholders than mechanical cultivation, because the resources and skills required for labour-intensive technologies are generally available to them.
- If mechanization is needed for any stage of the production process (e.g. for early land preparation to ensure timely planting), less heavy machinery should be considered through a contracting company, an entrepreneur or perhaps a producers' cooperative. If the services cannot be provided, the area should not be chosen.

Considerations on erosion control

- If the terrain is steep or exposed and the soils are liable to erosion, physical anti-erosion structures (bunds, terraces, grass strips, wind break, etc) must be put in place.
- The land-use system should be designed to strengthen soil structure and avoid leaving the surface exposed to wind and rain at times of highest risk.

- If the farmers' fields are in a block, cooperative action may be needed for construction and maintenance of storm drains, wind breaks, etc.
- If any of these anti-erosion measures are not feasible, the area is unsuitable for intensive smallholder horticultural production and should not be chosen.

Considerations on irrigation

- If rainfall is regularly insufficient for target yields, a reliable and affordable source of supplementary water for irrigation must be developed.
- Gravity flow or flood irrigation is usually more manageable for smallholders than sprinkler or drip irrigation.
- Water conservation measures can reduce or even eliminate the need for supplementary irrigation.
- If affordable irrigation and water conservation methods are not feasible, the area is unsuitable for vegetable production and should not be chosen.

Considerations on flood control

- If the area is subject to flooding, drainage and flood, control measures must be put in place.
- Joint action between neighbours is usually needed. If this is not considered feasible, the area may be unsuitable for intensive vegetable production.

Considerations on pests and diseases

- Crops that are new to an area are likely to be initially free of pest and disease attack, but the threat will build up quickly with continual cultivation.
- Preventing build-up of pests by crop rotation and biological or integrated methods of control is preferable, where feasible, to chemical control.
- Risks of pesticide residue are particularly critical with food products. If chemical applications are unavoidable and cannot be reliably controlled and traced, the area is likely to be unsuitable for production of domestic and export horticulture.

Considerations on land history

It is necessary to identify possible sources of microbial and chemical contamination associated with the prior use of land that it is being used for agricultural production. Such information for prior use of land can be obtained through interviews with prior owners, a review of municipal permits or village government and from other sources (Box 1).

As already stated, prior use of the land for animal feeding or domestic animal production and the presence of barns or farm animals a short distance from the cultivation site increase the risk of contamination of fruit and vegetables with pathogens commonly found in the intestinal tract of animals. It is also important to evaluate drainage systems and water currents flowing near these areas, which will help determine the potential for contamination. In some instances it may be necessary to create physical barriers or channels to divert water, which may carry contamination from the animals.

When the land has been used for garbage disposal or as a waste management site, it may contain decomposing organic matter and perhaps, faecal material. The soil may also contain harmful chemicals or toxic contaminants. Land that has been used for mining or petroleum extractions can be contaminated with heavy metals or hydrocarbons; it is recommended to carry out analysis of toxic substances in the soil.

BOX 1 Cultivated land information

Important information that needs to be obtained about the history of the land includes if the land has been used:

- ✓ For animal feeding
- ✓ For domestic animal production
- ✓ As a garbage or toxic-waste disposal site
- ✓ As a sanitary waste-management site
- ✓ For mining activities, oil or gas extraction
- ✓ For the disposal of incinerated material, industrial waste or if mineral residues exist on the site

For barns and/or if farm animals are being produced on land adjacent to or a short distance from the cultivation site.

Other information that should be obtained includes if the land has:

- ✓ Experienced any serious flooding
- ✓ Been treated in an uncontrolled manner with organic or inorganic fertilizers and/or pesticides

Heavy flooding also can increase the sources of contamination. Water runoff can introduce pathogens and chemical contaminants from farther regions. When there is concern about the safety of the growing site, microbiological analyses after a contamination has occurred (e.g. flooding or runoff) may assist in identifying contamination. It is also important to obtain the prior and present user of adjacent land, to identify the potential danger of the contamination and take necessary measures to prevent contamination of the fresh produce.

Considerations on previous crops in rotation

Crop rotation plays an important part in the health of the crop, which may be susceptible to *Fusarium* and root knot nematode and other soil-borne pests and diseases. For example: Beans should not follow crops that are hosts to pests and diseases that attack beans (Table 1); in particular, other legume crops such as runner beans should be avoided.

In between the bean crop, a minimum of one and preferably two “recommended crops” should be grown to actively manage soil health and optimize bean yields. Yields of beans will decline if no rotation is practiced. Poor rotation will also build up levels of pests and diseases in the soil, which may be difficult to “remove” by the use of chemical treatments. Crop rotation is the most cost-effective means of maintaining soil health and crop yields (Table 1).

TABLE 1
Example of crop rotation in beans

To be avoided as preceding crops	Not useful as preceding crop	Recommended as preceding crop
Beans, peas, potato, African eggplant, melon, cucumber, watermelon, lettuce and okra	Ground nuts, pepper, lettuce, carrot, onion and garlic	Cereals (maize, sorghum, millet, fodder, grass) cabbage, kale, sukumawiki, cassava, sweet potato

Case study 1 – Deforestation in Tanzania and environmental consequences

In Tanzania, 2 percent of forest area is lost per year and the data show an increasing trend. Land clearing accounts for 40 percent of deforestation. Clearing continues today because of poorly designed land laws that do not address encroachment and structural adjustment's impact on input pricing. The net effect is that farmers cannot expand their production by intensification, but only by clearing more land. Extraction of wood products is responsible for the remaining 60 percent of deforestation. Most of this is fuelwood, but some is the result of tobacco farming and commercial logging. Sixty-three percent of farmers interviewed for this study indicated that erosion was a serious problem. The causes of erosion are land clearing, poor farming practices and cultivation of erosive crops. Cropping patterns have also changed because of adjustment. Tanzania experienced a 17 percent increase in land planted with cash crops. About 80 percent of this increase consists of highly erosive crops.

Source: *Case Study for Tanzania* in Reed, David, ed., *Structural Adjustment, the Environment and Sustainable Development* (London: Earthscan, 1996): 107–127.

ENVIRONMENTAL GUIDELINES

Tanzania Environmental Act 2004, **GLOBALGAP**, and the individual codes of practice provide guidelines that spell out the actions required to ensure that agricultural production has a positive environmental impact, including conservation of soil, water and genetic resources, and protection of forests, water sources, air quality and natural habitats.

Environmental protection consideration when selecting a site

- Locations where intensive cultivation could cause soil erosion or contamination of water resources must be avoided.
- Areas that are important for retention of threatened plant or animal species or natural habitats should not be disturbed.

GAP IN LAND PREPARATIONS

Any land preparation methods should take into consideration adoptive methods that ensure soil conservation, water resource management and environmental conservation.

Depending on availability of resources and crop requirement, and landscape, soil preparation may be mechanized or non-mechanized.

Terracing the field

On slope land that is liable to wash away in heavy rains – especially when the soil is bare – terraces should be constructed to prevent this soil erosion. Terraces are more effective if the strip of vegetations is left at the edge of the terrace, and the runoff water is channelled across the slope instead of shooting quickly down the slope. Growing cattle folders on this strip on the edge the terrace is common practice

Tillage – Field preparation

- Excessive disturbance of the existing soil layers should be avoided during tillage to prevent the bringing to the surface of the poorer layers more likely to cause

asphyxia and colonized by different micro-organisms as well as soil erosion. Soil preparation should enable the root system to spread to a depth of 40 to 60 cm for shallow root crops to ensure good water and mineral supply to the plant (loose, fine soil). Any ploughing should be performed once a year and be completed before cropping by levelling and finer loosening, for example, by two runs of an offset plough set at a depth of 15 to 25 cm.

- Organic, lime or lime-magnesium enrichment agents are applied before ploughing so that they are turned in evenly.
- Good soil levelling prevents the accumulation of water that could asphyxiate the plants or cause the spread of diseases. The field should be perfectly level and not too stony. Choose well-oriented flatland, preferably next to a watercourse to make watering easier. Avoid depressions that can be flooded and that can cause asphyxiation during the rainy season.
- Ridging (performed by machine at 1.2 m intervals) or shaping (by hand) is performed in case of furrow irrigation. The ridges should be regular, 30–35 cm high and 25–30 cm wide at the top, which will be levelled off.
- The fields must be fenced to prevent livestock from entering. It is not advised that livestock should be allowed to graze the crop residues (they can bring weed seeds or spread nematodes).
- The false sowing technique can be used to reduce the number of weed seeds in the soil before planting. This consists of full preparation of the soil as for sowing and then watering to cause weed seeds to germinate. These are then eliminated by hoeing or chemical weed killer.

Hoeing

- At a certain time of plant growth, hoeing may be required for aerating the soil and weeds management; hoeing must be very shallow to avoid damaging roots near the surface.

Mulching

Mulching is the protective layer of material that is spread on top of the soil between crop plants. Mulches can be decaying weeds, grass, rotten manure or compost. Mulches have many benefits, they:

- protect the soil from erosion;
- reduce compaction from the impact of heavy rain;
- conserve moisture, reducing the needs of the irrigation;
- prevent weeds growth;
- maintain soil temperature;
- keep fruits and vegetables clean;
- prevent disease spores splashing up on to the crop;
- break the cycle of some pests that pupate in the bare soil, for example leaf miners.

SUMMARY

The land-use methods, which are agronomical and environmentally appropriate, are basic tools for GAP; horticultural producers should consider the following, when selecting land for cultivation:

1. It is necessary to identify possible sources of microbial and chemical contamination associated with the prior use of land when selecting land for agricultural production.
2. The land use system chosen should be designed to strengthen soil structure and avoid leaving the surface exposed to wind and rain at times of highest risk.
3. If the area is subject to flooding, drainage and flood control measures are needed.
4. Excessive disturbance of the existing soil layers should be avoided during tillage to prevent the bringing to the surface of the poorer layers more likely to cause asphyxia and colonized by different micro-organisms as well as soil erosion.
5. When the land has previously been used for garbage disposal or as a waste management site,, it is recommended to carry out analysis of toxic substances in the soil.
6. If the area is subject to build-up of pests and diseases, plant protection measures have to be taken to prevent pests and diseases build-up.
7. Areas that are important for retention of threatened plant or animal species or natural habitats should not be considered for agricultural productions.

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Module 2

Maintaining soil fertility

LEARNING OUTCOMES

- Participants understand agricultural practices that are related to soil fertility improvements.
- Participants understand best practices in handling and application of fertilizers.

INTRODUCTION

GAP related to soil fertility improvement include maintaining and improving organic matter, appropriate crop rotation, manure application, rational mechanical and conservation tillage, maintaining soil cover, minimizing soil erosion losses by wind and water, and application of organic and inorganic fertilizers in amount and timing, and by methods appropriate to agronomic, environment and human health requirements.

GAP TO MAINTAIN SOIL FERTILITY

Maintaining soil organic matter through mulching and allowing plant stalks to rot in the field

- Higher organic matter in the soil creates porous soil and improves the aerations.
- Organic matter improves soil moisture.
- Soil organic matter acts as buffer against adverse environmental effects such as higher temperature and drought.

Disturb the soil as little as possible during land preparation

- Minimum tillage, zero and conservation tillage are possible solutions in land preparation to maintain soil fertility.

Crop rotation

- Planting crops with different requirements in rotation, such as leguminous and cereals, also intercropping deep-rooted crops with shallow-rooted ones, e.g. sorghum and sun hems.

Aerate the soil

- Aeration – by double digging, adequate ground cover and mulching – provides both soil micro-organisms and plant roots with much-needed oxygen to breathe.

Provide drainage

- Too much water can cause serious damage to the soil and plants; by applying mulching, adding humus to the soil and ridging can help prevent water logging.

Protect the land from soil erosion and degradation

Practices that can help to protect against soil erosion and minimize the loss of topsoil are strongly encouraged such as:

- terracing;
- conservation tillage;
- planting bunch grasses;
- planting tree hedges and shelter belts;
- planting perennial crops such as fruit trees with cover crops.

Application of compost, manure and inorganic fertilizer in correct amounts and timing and by methods that are appropriate to agronomic and environmental requirements

FERTILIZER

Fertilizers are natural or synthetic substances that are added to the soil or plants to provide them with nutrients necessary for plant development. The use of fertilizers is a common practice to increase soil fertility and consequently the quantity and quality of fruits and vegetables.

Categories of fertilizers

Depending on the source of materials, fertilizers can be divided into two categories:

- organic fertilizer
- inorganic fertilizer

Organic fertilizers

Raw materials used for the production of organic fertilizers in Tanzania include:

- animal manure
- post-harvest material
- organic waste

INORGANIC FERTILIZERS

Composting

To convert organic waste into safe fertilizers (compost), practices should be followed to reduce the presence of pathogenic bacteria. Composting is a natural, biological process by which organic material is broken down and decomposed. The heat produced by the micro-organisms during the composting process not only contributes to their own growth, but also speeds up the decomposition process and helps in killing pathogenic micro-organisms.

Hazards associated with animal manure

When animal manure is used for fertilizers without proper treatment, there is danger of contamination of fruits and vegetables with pathogenic bacteria. These bacteria can cause gastrointestinal and other illnesses in humans.

Human and animal faecal materials are important sources of microbiological contamination of produce. Organisms linked to these sources include *Salmonella*, anaerobes such as *Enterococcus*, and other intestinal bacteria. One of the most infectious organisms prevalent in animal manure is *E. coli* O157:H7 that usually derives from the faecal material of ruminants such as cows, sheep and deer. Other significant hazards found in human and animal faecal material includes *Cryptosporidium*.

GAP in the management of organic fertilizers

To assure that pathogenic micro-organisms do not reach fruits and vegetables and, ultimately the consumers, it is necessary to follow certain practices when manufacturing organic fertilizers, during their application and during harvest. These include:

- The location for storage and treatment of animal manure should be away from the produce production areas.
- Barriers or some type of physical containment should be used as part of the manure storage areas to prevent contamination of produce or production areas by pathogens spread by rain wash, subterranean water flow or wind spread from the stored manure.
- Contamination of groundwater supplies can be minimized if animal manure is stored on a cement floor or in special holes lined with clay.
- Manure piles should be covered with plastic or other materials and/or stored under a shed because rainfall on manure piles can result in runoff containing pathogenic bacteria that can contaminate fields, equipment, etc.
- The minimum distance from the manure storage facility to the production field depends on many factors, such as the configuration of the plantation fields, land slope, existing barriers to entrap water and the possibility of bacterial spread by wind or rain.
- Treated manure should be kept covered and away from waste and garbage to prevent recontamination by birds or rodents.

Note

The use of untreated animal manure (without composting) in the production of produce results in a greater risk of contamination than treated manure and is **NOT** recommended!

Precautions for the application of organic fertilizers

- ✓ Only properly treated organic fertilizer should be applied during pre-planting or in the early stages of growth of the plant. It should be applied near the roots and covered with soil.
- ✓ Organic fertilizers should **NOT** be applied when the fruit or vegetable is nearing maturity or harvest.
- ✓ Maximum time should be allowed between the application of organic fertilizers and harvest of the product.
- ✓ It is also suggested that crops on adjacent fields be grown in a way that organic fertilizers are not applied near a field that is already cultivated or near its harvest time.

Record-keeping to ensuring traceability

- Ensure that records of composting condition for manure and bedding are in file.
- Always keep a detailed record of compost use.

Livestock health

The health of livestock kept at the farm should be constantly checked and monitored in consultation with a veterinary officer to prevent an outbreak of diseases, which in turn may contaminate fresh produce in nearby farm. Always separate new animals from older animals and restrict domestic animals from production fields and irrigation facilities.

GAP in the management of inorganic fertilization

Inorganic fertilizers are obtained via commercial chemical processes. Although the products themselves are generally not a source of microbial contamination, care should be taken to assure that contamination is not introduced through the use of contaminated water to mix the products or unclean equipment used in their application.

GENERAL REMARKS

Fertilizer applications must be planned with precision so that the dosage of each nutrient is appropriate to actual conditions in each field (this requires a soil analysis every three years). Records should be kept of any soil analysis undertaken that justifies fertilizer applications in order to comply with commercial referential. The crop's requirements will be established as accurately as possible to avoid any excess.

KEY QUESTIONS ON FERTILIZER USE**What type of chemical fertilizer is appropriate for use?**

- Only reputable suppliers should be used.
- Chemical fertilizer composition should match the actual requirements of the crop based on soil analysis.

What quantity of fertilizer should be applied?

- A soil balance sheet approach should be used, based on requirements of the crop, past cropping history and current nutrient status of the soil – check soil analysis records.

How should fertilizers be applied?

- Smallholders can apply fertilizers by hand close to the take-up point of the roots.
- Fertilizers should be worked into the soil to avoid leaching or runoff.
- Large single doses should be avoided, as uptake is generally improved and leaching reduced when smaller doses are applied at intervals.
- Wear gloves during the application of fertilizers and remember to wash hands after application.

When should fertilizers be applied?

- Basal dressings, where required, should be applied at seed bed preparation time.
- Top dressings should be applied only when the plant can take them up.
- Fertilizers should not be applied during periods of heavy rain, waterlogging or unusual climatic conditions when the dangers of leaching or other barriers to immediate take-up are high.

Fertilizer storage

- Fertilizers should be stored separately from food, seeds, pesticides and animal feeds.

- Store should be dry and secured by padlock.
- Fertilizer store should be appropriately positioned to reduce the risk of contamination of water source.

Organize full traceability of fertilizer application

It is important to organize full traceability of fertilizer applications. The following information, at the least, needs to be recorded for each application:

- Name of producer/or person responsible for application
- Farm number and size (ha)
- Date of application
- Type of fertilizer
- Origin of fertilizer
- Quantity applied
- Method of application

Environmental protection guidelines regarding soil fertility management

- Fertilizer policy must maximize the use of organic manures and avoid mineral contamination of soil or water supplies.
- All agrochemicals used are approved by national and international legislation and are applied using industry recommended techniques.
- Surplus agrochemicals and used containers must be stored or disposed of in ways that protect soil, water and biological habitats.
- Crop residues are used or disposed of in ways that strengthen natural habitats.

Case study 1 – Kenya peas growers Mr Maina Kanene and his wife Perris Wangui, GLOBALGAP certified

“The first thing we do when we buy new inorganic fertilizers is to store them in a specially built store. Our store is divided into two: a segment for inorganic fertilizer and other segment for the chemicals, they remain inside until use.

We make organic fertilizer or compost. Every so often we gather manure and waste feeds or fodder and compost it in a heap with other waste foliage, fire ash and so on until it has broken during the land preparation. Used this early it has plenty of time for any disease causing matter it may contain to break down fully. This reduces the contamination risk to the crops. The technical assistant makes risk assessment on manure or compost and advises us whether to use or not.

It is very important to use the appropriate fertilizer and know when to use it so that one gets the best produce and best return on investment.”

Source: Bridging the GAP; supporting smallholders in Kenyan export horticulture – Voice from the field: www.wrenmedia.co.uk; January 2007

SUMMARY

1. GAP related to soil fertility improvement include maintaining and improving organic matter through:
 - appropriate crop rotation;
 - manure application;
 - rational mechanical and conservation tillage;
 - maintaining soil cover to minimize soil erosion losses by wind and water;
 - application of organic and inorganic fertilizers in amount and timing and by methods appropriate to agronomic, environmental and human health requirements.
2. Fertilizers are natural or synthetic substances that are added to the soil or plants to provide them with the nutrients necessary for plant development.
3. When animal manure is used for fertilizer without proper treatment, there is danger of contamination of fruits and vegetables with pathogenic bacteria.
4. Fertilizer applications must be planned with precision so that the dosage of each nutrient is appropriate to actual conditions in each field (this requires a periodic soil analysis).
5. It is important to organize full traceability of fertilizer applications. The following information, at the least, needs to be recorded for each application:
 - Name of producer/or person responsible for application
 - Farm number and size (ha)
 - Date of application
 - Type of fertilizer
 - Origin of fertilizer
 - Quantity applied
 - Method of application

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Module 3

Water resources and irrigation practices

LEARNING OUTCOMES

- Participants understand the importance of sustainable and cost-effective methods of applying and managing irrigation water.
- Participants should be able to recognize the potential for produce contamination associated with water quality and use practices.

INTRODUCTION

Agriculture carries a high responsibility for the management of water resources in quantitative and qualitative terms. Careful management of water resources and efficient use of water for rainfed crop and pasture production, for irrigation where applicable, and for livestock are criteria for GAP. Efficient irrigation technologies and management will minimize water and will avoid excessive leaching and salinization. Water tables should be managed to prevent excessive rise or fall.

GAP RELATED TO WATER USES

Managing water resources efficiently entails a number of key operations

- Maximize water infiltration and minimize unproductive efflux of surface water from watersheds.
- Manage ground and soil water by proper use, or avoidance of drainage where required.
- Improve soil structure and increase soil organic matter content; apply production inputs, including water or recycled products of organic, inorganic and synthetic nature by practices that avoid contamination of water resources.
- Adopt techniques to monitor crop and soil water status, accurately schedule irrigation and prevent soil salinization by adopting water-saving measures.
- Establish permanent cover, or maintain or restore wetlands as needed.
- Manage water tables to prevent excessive extraction or accumulation, and provide adequate, safe and clean watering points for livestock.
- Introduce, where appropriate, a system of water rights and volumetric delivery for greater efficiency in water use.

To guarantee reliable and economically viable crop yields, application of irrigation water to supplement natural rainfall is frequently needed. However, water is a costly input, often in short supply and not always of the desired quality. Hence, particularly with resource-poor small farmers, it is essential that sustainable and cost-effective methods of applying and managing irrigation water are adopted, and that the quality of the water applied and its impact on soil and crop water balances is carefully monitored.

KEY ISSUES TO CONSIDER WHEN APPLYING AND MANAGING WATER RESOURCES

- **Water quantity:** application of only the quantity actually required for optimal crop growth. Many irrigation systems apply more water than the plant or the soil can absorb, leading to waste of a scarce resource, drainage problems and unnecessary expense.
- **Water quality:** ensuring that the chemical content of the water applied does not lead to soil salinity or affect the quality of the irrigated crop.
- **Application method:** choice of a method of applying water to the crop that is low-cost and easily managed by small-scale growers.
- **Drainage method:** avoiding risks of water-logging and, wherever feasible, recycling the use of excess irrigation water.
- **Water charges:** establishing a method of charging water users, this is both equitable and provides farmers with an incentive to use water sparingly.
- **Irrigation management:** instituting a system of water and irrigation management that involves farmers and ensures efficient water use and irrigation system maintenance.

Legal framework to consider when applying and managing water resource in Tanzania

Sustainable management of irrigation water requires the user to comply with the legal framework current in place within the irrigation scheme. Some district councils have already introduced water user charges as the district revenue or for irrigation system maintenances, some have maintained customary law on land and water management such as the Ndung'u Case study below. The legal framework enables the villages to form a "village irrigation committee" chaired by an irrigation committee chairman. The committee is responsible for all issues related to irrigation, including water charges, maintenance of irrigation canal and settling water disputes.

- National Water Policy of 2002. The new Water Policy aims to develop a comprehensive framework for sustainable development and management of the nation's water resources.
- Water Utilizations (Control and Regulation) Act, 1974. Various subsidiary legislation made by local district council to regulate water resources and water for irrigation.
- Customary Law on land and water management.

Case study 1 – Interactions between traditional and modern water management systems in Tanzania

Irrigation Project vs Customary Law (changes on Land and Water Management, Ndung'u, Pangani Basin Same District in Kilimanjaro Region)

The village of Ndungu is situated in the local government ward of Ndung'u of Same District. The village enjoys year-round irrigation water. Paddy is grown twice a year. Irrigation water sustaining economic activities in Ndung'u flows from a number of rivers and streams.

Traditionally, land in Ndung'u was owned under customary arrangements, including in the areas covered by the irrigation project. There are several cases of customary owners leasing their irrigated blocks to others. Conflicts over land between owners and outsiders were non-existent because ownership was in accordance with customary arrangements, which were well established. The conflicts over land were restricted to relatives competing over inherited parcels or tenant failing to comply with applicable agreement. These conflicts were referred to traditional bodies known as *kitala*.

With intervention of statutory laws, projects and other institutions, land disputes are now referred to irrigation project leadership. If the project leadership fails, dispute will be taken before the *Baraza la Ardhi la Kijiji*. Land within irrigation areas are divided into blocks under block leaders. Resolution of disputes within irrigation area will involve irrigation block leaders. A new hybrid of customary system with strong dosage of mainstream values is in place. This hybrid came in the form of the subsidiary legislation made by the Same District Council under Local Government (District Authorities) Act, 198210 to regulate irrigation agriculture in Ndung'u area of Same District. The by-laws cover the Mkomazi River Valley area of Ndung'u designated as a project area for purposes of agricultural development. Mkomazi River is a controlled water source under the Water Utilization (Control and Regulation) Act, 1974. The Same District Council is product of another piece of legislation regulating local governments in Tanzania. Ndung'u Irrigation project extracts water from Mkomazi River under a water rights issued by the Pangani River Basin. The project has taken the control of a number of facilities that were constructed over land and water sources occupied and used under customary law of the Wapare people. Existing land and water tenure system were as a result of the project divided into blocks forming: (i) main and secondary drains from Mkomazi River and their related structures; (ii) main and secondary irrigation canals, intake weir, water gates and other related structures; (iii) tertiary irrigation canals and drains; (iv) flood dikes, gates and other installations for prevention of flood; (v) water course and related structures; and (vi) trunk road, main and secondary farm road, warehouse, residential quarters and any utility designated for residential or infrastructural purposes.

Source: *Formalization of Water Rights and its Implications for Equitable Sharing of Water Resources in Tanzania* (Ibrahim H. Juma and Faustin P. Maganga) 2004

Analysis

Water resources in Ndung'u village is managed under the new hybrid of a customary system that is operating effectively, under legal framework of Water Utilization (Control and Regulation) Act, 1974 and Same District Local Government (District Authorities) Act, 198210, to regulate irrigation agriculture in Ndung'u area of Same District.

WHAT YOU SHOULD KNOW ABOUT AGRICULTURAL WATER QUALITY

During agricultural production of fruits and vegetables, water is used for numerous activities in the field, including irrigation and pesticide and fertilizer application. Other water uses during produce handling include cooling, washing, waxing and transportation. In addition to activities where water comes in direct contact with produce, field and packing shed workers use water for drinking and hand washing (Box 1).

Case study 2 – Managing water resources effectively

Kenya bean and pea farmer, Mr Daniel Kaarie, member of Muringa Horticulture Group

“One of the most important things training has taught us is how to regulate crop moisture by choosing what kind of irrigation to use at a specific time.

For instance, when we are top dressing the crop with the CAN (calcium ammonium nitrate) fertilizer, we use overhead irrigation sprinklers to dissolve the fertilizer and spread it through the soil. Then we switch to drip irrigation so that every plant gets all the moisture – with fertilizer – it requires from the soil around it.”

Source: *Bridging the GAP; supporting smallholders in Kenyan export horticulture* – Voice from the field: www.wrenmedia.co.uk; January 2007

Box 1

Water used in agricultural activities can be contaminated with pathogenic bacteria that may cause severe health problems to consumers, and in severe cases can cause death.

It can be a source of and vehicle for biological hazards such as:

Enterohemorrhagic and Enterovirulent	
<i>Escherichia coli</i>	<i>Salmonella spp.</i>
<i>Vibrio cholera</i>	<i>Shigella spp</i>
<i>Cryptosporidium parvum</i>	<i>Gardia lamblia</i>
Toxoplasma gondii	
<i>Cyclospora cayetanensis</i>	Hepatitis A virus

The chances of contamination of fruits and vegetables with micro-organisms present in water can increase depending on factors such as:

- product growth stage;
- type of crop;
- time between water application and harvest;
- water and product handling practices.

For example: Fruits and vegetables with large surface areas, such as leafy vegetables, or those where the surface structure allows pathogens to adhere easily, are at a greater risk of contamination from water. This risk can be further increased when the contact with contaminated water takes place near harvest time or during post-harvest handling

How does agricultural water become contaminated?

Usually, water for agricultural uses comes from:

- surface sources such as rivers, streams, and reservoirs;
- groundwater from wells (open or capped);

- public water systems, such as those provided by towns or other municipalities.

Surface water can be exposed to temporary or intermittent contamination. This contamination can come from raw human and animal wastes, sewage water discharges, and water coming from adjacent lots dedicated to animal production, or other contamination. Surface water generally flows some distances before it reaches the crop. It is important to identify upstream sources of contamination to this flow. Elimination of this contamination may involve modification of the water's route or the introduction of prevention of contamination methods, such as filters (Box 2).

Box 2

Water used in agricultural activities can be contaminated with pathogenic bacteria that may cause severe health problems to consumers, and in severe cases can cause death.

It can be a source of and vehicle for biological hazards such as Enterohemorrhagic and Enterovirulent.

Enterohemorrhagic and Enterovirulent	
<i>Escherichia coli</i>	<i>Salmonella</i> spp.
<i>Vibrio cholera</i>	<i>Shigella</i> spp
<i>Cryptosporidium parvum</i>	<i>Gardia lamblia</i>
<i>Cyclospora cayetanensis</i>	<i>Toxoplasma gondii</i>
<i>Norwalk virus</i>	Hepatitis a virus

Pesticide handling in the vicinity of wells may result in chemical contamination of groundwater. The location of wells should be considered when mixing, applying, storing and disposing of pesticides. Vegetation or other barriers should be established as guard zones to help limit contact between the chemicals and water sources (Nesheim, 1993).

IRRIGATION PRACTICES

The common methods used in irrigation are:

- surface (furrow or flood);
- overhead (sprinklers);
- trickle (drip or buried);
- microsprinklers.

The type of irrigation system chosen is important to product safety because this determines the amount of contact between the irrigation water and the produce. Where water quality is unknown or cannot be controlled, growers are advised to consider irrigation practices that minimize contact between water and the edible portion of the crop.

Hazards associated with irrigation practices are influenced by:

- water source and quality;
- amount of water applied;
- irrigation program;
- irrigation method – degree of contact with the edible portion of the fruit or vegetable;

- soil drainage properties;
- time to harvesting date.

The closer to harvest irrigation occurs, the greater the chance for survival of pathogens and for the presence of residual chemicals on the produce. Irrigation methods, such as

BOX 3

Summary of GAP to prevent contamination of water sources

- ✓ Identify the primary and secondary sources of water, and be conscious of sources for possible pathogen contamination.
- ✓ Identify sources of water shared with grass-lots, feed-lots and dairy farms.
- ✓ Take necessary measures to prevent animal access to crop fields, water sources and other related areas.
- ✓ Be aware of uncontrollable wildlife vectors and treat water accordingly.
- ✓ Identify if any adjacent fields are using untreated animal manure as fertilizer.
- ✓ Avoid manure storage near the crop fields.
- ✓ Identify topography of the landscape, its effect on water flow and the rainfall pattern of the region.
- ✓ Provide maintenance to water storage tanks.
- ✓ Periodically verify water quality by submitting samples for microbiological testing. Tests for standard indicators of faecal pollution, such as *E. coli*, can be performed but do not necessarily indicate the absence of protozoa and viruses.

the drip system, where the contact between water and plant is minimized, are generally less likely to lead to fresh produce contamination (Box 3).

What to consider when planning irrigation

Water requirement

- On sandy soils, irrigation should be more frequent than on heavier soils.

Water quality

- Avoid saline water, which will cause an immediate drop in yield. Avoid irrigating directly with chlorinated water.

Watering regularity

- From the moment of emergence, the plant must never be subjected to water stress. The emergence and flowering/pod formation stages are particularly sensitive.

Frequency of irrigation

- To encourage the establishment of the root system, do not water too often until the crop has begun to put down roots (to encourage deeper rooting).
- To avoid root collar diseases, irrigation should be prudent and not excessive in sandy soil.

Timing of irrigation

- With spray or row irrigation, water in the morning to reduce the risk of prolonged

BOX 4**Agricultural water microbiological testing procedures**

- ✓ Microbiological testing is used to track safety, not for daily monitoring activities.
- ✓ It is important to document the frequency and results of each water test for comparison purposes. Changes may help identify problems.
- ✓ These records would become very important in the event of a microbiological outbreak investigation.

Pathogenic micro-organisms that can contaminate drinking water include:

- ✓ *Escherichia coli* (*E. coli*); *Salmonella*; *Shigella* spp.
- ✓ Hepatitis A and Norwalk viruses.
- ✓ Parasites such as *Giardia lamblia*, *Cryptosporidium* and *Cyclospora cayetanensis*.

high relative humidity on leaves and root collar (risk of rust, *Rhizoctonia*, *Sclerotium*, *Sclerotium anthracnose*, blight and *Pythium*), and avoid water stress in very hot weather. With sprinkle irrigation, do not irrigate after applying a foliar treatment (Box 4).

Regular water test should be in place to ensure that drinking water is free from any faecal coliform bacteria and *E. coli*, if the test is positive; an investigation of the water treatment and distribution system is advised.

In Tanzania urban and rural areas, water should be boiled or treated with *Water Guard* or chlorine, as precaution. To prevent contamination, it is important that water used for hand washing should be of drinking water quality (Box 5).

Case study 3 – Importance of water quality in agricultural production

Farmer Gerald Wanjohi Kibichi, who grows 30 acres of French beans, says:

“Water is a very important element of hygiene, so all the water I use in the farm and in the grading shed is treated with *Water Guard*. In this farm, I maintain four water cans. HW1 is set at the grading shed; HW2 at the toilets, HW3 at the chemical store and the HW4 is the portable one that I carry to the farm during picking. For instance, somebody can sneeze necessitating the need to wash hands.”

Source: *Bridging the GAP; supporting smallholders in Kenyan export horticulture* –
Voice from the field: www.wrenmedia.co.uk; January 2007

BOX 5**Precautions for handling drinking water in the fields and packing areas**

- ✓ Water supply systems should be in good condition, and operating properly requires constant monitoring.
- ✓ Water should be stored in clean, previously sanitized containers and tanks.
- ✓ Water containers should be washed and sanitized on a daily basis.
- ✓ Water storage containers should be closed at all times.
- ✓ Containers should be kept away from the sun and excessive heat.
- ✓ Disposable cups should be provided and each person should use a different cup.
- ✓ Frequent microbiological and physical evaluation should be performed on drinking water when the water is being stored or treated on-site.
- ✓ Simple organoleptic evaluations (color, odour and taste) of water should be performed as part of the daily monitoring procedures.
- ✓ If any of the water quality tests indicate the quality is not adequate, the water should be replaced to reduce the chances of infection and the proper authorities should be notified of the problem.

Because chlorine can cause skin irritation after extended exposure, the use of protective equipment is recommended. To treat produce surfaces, chlorine is commonly used at concentrations of 50–200 ppm with a contact time of 1–2 minutes. In rural area, *Water Guard*, which is readily available in the market, is recommended.

SUMMARY

1. Every time water comes in direct contact with fruits or vegetables, the possibility of contaminating the produce with pathogens exists. This includes water used for produce production activities such as irrigation and chemical application, fresh produce washing, in packaging facilities and during transportation:
 - It is important to identify source and distribution of water used;
 - Be aware of current and historical use of land.
2. Water destined for agricultural production can easily get contaminated with human and/or animal faeces. It is important to keep animals and children out of the fields and to provide field workers with properly constructed and maintained restrooms or mobile sanitary units.
3. Consider practices to minimize contact of the edible portion of fresh produce with contaminated irrigation water. Where water quality is good, risk is low regardless of irrigation method.
4. Maintain water quality, such as by periodic testing for microbial contamination.
5. Antimicrobial chemicals, such as chlorine or *Water Guard*, may help minimize the potential for microbial contamination to be spread by processing water; levels of antimicrobial chemicals should be routinely monitored and recorded to ensure they are maintained at appropriate levels.

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Module 4

Seed, crop selection and seedlings production

LEARNING OUTCOMES

- Participants understand the importance of selecting suitable seeds and crops suitable for growing condition and that comply with market requirement.
- Participants understand the importance of using pure certified seed for obtaining the quality and uniformity of product which the market demands.
- Participants understand key questions on suitability of crop for small-holder production.
- Participants understand seedling nursery management.

INTRODUCTION

The use of pure certified seeds and rootstock is essential for obtaining the quality and uniformity of the product that the market demands. The main consideration should focus on selecting the crops that are most suitable for production and of course the demands of the market – there is no point in producing something unless someone wants to buy it.

SEED SELECTION

Selection of seed and rootstock is the critical step in GAP in obtaining the quality, high yield and uniformity of the product that the market demands.

What to consider when selecting seeds

- Use pure certified seed for obtaining the quality and uniformity of product that the market demands.
- Small-scale farmers should form growers groups to access credit to purchase seeds and other inputs or make necessary arrangements to produce their own certified seed under seed production schemes.
- Remember that traceability of the product can only be assured when the source of seed used is known and controlled by the company that purchases the farmers' crop.

It is therefore necessary that the company, which contracts smallholders to grow a particular crop, supplies them with certified seed ahead of the recommended planting date.

The low-input variety is usually preferable for small-scale farmers, as it exposes them to less financial and biological risk.

Other considerations are:

- If there is a choice between varieties with early and late planting and harvesting dates, the one that fits best into the smallholders' farming system (i.e. does not compete with other crops for land or labour at planting, weeding and harvesting time) should be selected.

- Contract farmers should be guaranteed seed quality and compensated if the seed supplied is mixed or if the germination rate is poor.
- The arrangement for the up-front cost of seed or seedlings is recommended if appropriate, and producers can repay when crop is sold, but farmers should make a contribution so that they value it more highly.

The choice of variety arises from a compromise between the expectations of producers, distributors and consumers. It takes into account such varied features as agronomic characteristics, resistance to various pests, storage and transportation capability, sensory and visual qualities, market niche, etc.

Crop selection

The main consideration in selecting the crops that are most suitable for production is of course the demands of the market – there is no point in producing something unless someone wants to buy it. However, among crops for which there is a sure demand some require agronomic practices or environmental controls that make them particularly suitable, or particularly unsuitable, for smallholder producers.

For example:

- Crops that are produced using agronomic techniques with which small-scale farmers are already familiar (e.g. green beans, baby corn) are less likely to present difficulties than crops that are completely new to an area as indicated in Case study 1 and 2 in this module.
- Crops that make full use of family labour and do not require large amounts of purchased inputs are more manageable for smallholders than crops that are best suited to mechanical cultivation and that need heavy applications of agrochemicals.
- Crops whose planting, weeding and harvesting dates come at periods of peak labour demand for other activities in the smallholder year (e.g. food crop planting, weeding or harvesting) are more difficult to fit into the smallholder farming system than crops whose peak labour needs come at an “off season period” in the smallholder year.

BOX

Case study 1 – Suitable crop selection

A horticultural export company in Tanzania contracted farmers on the fertile, well-watered lower slopes of Mount Kilimanjaro to grow fresh green beans for export. Farmers were already quite familiar with the crop, which is widely grown in the area. The company supplied seeds, agrochemicals on credit and a good extension service. The price offered for high-quality beans was attractive. Additional income-earning opportunities for women in sorting and packing the beans were also created. Respected farmers were appointed as agents of the company and received a commission per kilogram of beans delivered. Many households took up the opportunity and both growers and purchasing company flourished.

Adapted from: KIT, Faida MaLi and IIRI, 2006

Analysis

The crop was familiar to smallholders, making full use of their skills. It was compatible with other parts of the production system and strengthened women's economic position. The enterprise succeeded and both company and smallholders benefited.

Case study 2 – Unsuitable crop selection

A horticultural export company in Tanzania suddenly found a big overseas market for paprika chillies, a crop that is new to the area, expensive to grow and difficult to dry. Many farmers were recruited to grow chillies but most failed to control an unexpected pest attack. Harvesting came at a time when family labour was fully employed on other tasks. Women were reluctant to dry the crop because of the unpleasant effect of chillies on hands and eyes. The company had little experience of growing the crop and was unable to help. It failed to meet its export quota and the marketing agreement was cancelled. Company, farmers and facilitating NGO all suffered big losses and damage to their reputations.

Adapted from: KIT, Faida MaLi and IIRI, 2006

Analysis

The crop was unfamiliar to smallholders and the production technology risky and not compatible with other parts of the production system. Women were disadvantaged. The company could not redress these deficiencies so the enterprise collapsed.

Seed production and supply regulation

Throughout the country farmers are required to plant seed varieties and planting materials that are certified by a seed regulatory body. Any attempt to introduce uncertified planting materials may lead to yield losses and compromise farmers' efforts in crop production. Seed suppliers and farmers are required to consult with local extension staff for the information regarding the supply and purchasing certified seed as well as the suitability of the seed variety to local conditions.

Tanzania Seed Act 2003, provides guidance on seed policy and seed production systems.

- It promotes methodologies and prepares guidelines on seed production, certification, multiplication, testing, quality control, and exchange of seed and planting materials.
- It regulates variety release and registration.

FAO's Seed and Plant Genetic Resources Service also provides guidance on seed policy and seed production systems, the Web site address is www.fao.org/WAICENT/FaoInfo/Agricult/AGP/AGPS/SEED.

ORGANIZE FULL TRACEABILITY ON SEED AND PLANTING MATERIALS

It is important to organize full traceability on seeds and planting materials. The following information at least needs to be recorded.

- Supplier name
- Presence or absence of GMO
- Planting/sowing date
- Previous crop

GAP IN SOWING AND SEEDLING PRODUCTION

Seeds sowing and seedling management are primary activities critical for better quality and more produce. More skills are needed at this stage to ensure crop health and high yield.

Seed requirements

Plant density required, i.e. plants/ha, will determine the quantity of seed requirement for sowing. The principle is to have a large enough number of healthy and vigorous seedlings at planting date. The use of selected, treated seed is an excellent prophylactic method. Choose cultivars that possess high genetic resistance or tolerance to fusarial wilt, *Verticillium* wilt and root knot nematodes in particular.

SOWING FACILITY

The nursery should be installed in a place protected from direct sunlight, the prevailing winds and livestock. The soil should ideally be healthy, rich and flat with appropriate structure for sowing.

Sowing on prepared substrate

Soil blocks, or in pots (individual or cell packs) put one seed per block or container. Either soil for blocks or pots, a clean mix of compost and sand will be used; this must be permeable and such that the block will remain in good condition. This technique has many advantages:

- It avoids sowing in infested or exhausted soil.
- The seedlings are healthy and vigorous, less susceptible to subsequent stress and ready for planting out in a short time.
- Practically 100 percent re-growth is assured if the conditions of planting out are good (the root hairs remain intact).
- Any application of products (pesticide or other) is performed either directly in the substrate when the blocks are prepared or subsequently in local applications of very small amounts.

The substrates used must have: good porosity; rich organic content; low salinity; good moisture retention capacity; sterility with regard to pathogens and no weed seeds; balanced mineral content; they must not contain heavy metals (lead, mercury, cadmium, etc.) or substances that are toxic for the seedlings (chlorine, arsenic, etc.).

Sowing in the soil

The seedlings produced using this method are planted with bare roots, and re-growth is less successful than sowing in prepared substrate, especially when the weather conditions are unfavourable for establishment.

Preparation of seedbeds

Horizontal beds 1 m wide are prepared. They can be raised by 15 cm during rainy periods to improve drainage. They will be a maximum of 10 m long to make access and moving around in the nursery easier. Bottom dressing is applied in sandy soil: 50 U (units or kg/ha) nitrogen – 50 U P_2O_5 – 100 U K_2O .

The application of a minimum of 30 tonnes/ha, ideally 50 tonnes/ha, or organic matter is desirable. Prior disinfection may be necessary in case of infested or exhausted soil or during a period of unfavourable weather. The soil must be prepared, loosened and

pre-watered before sowing is performed. All watering will be done with watering cans with roses with small holes. It is essential to sow in soil that is moist but not too wet and to maintain the moisture content throughout the duration of the nursery. Watering doses and frequency must be adapted according to this criterion. Sow seeds in rows at 20-cm intervals at right angles to the axis of the bed. Mark out and make straight furrows. Carefully refill the furrows with fine, loose soil and tamp lightly.

Sowing depth

The seeds are sown at a depth of 0.5–1 cm in heavy soil and 1–1.5 cm in light soil. Sowing must be regular to obtain homogeneous, regular emergence, and as many seedlings as possible should be planted at the same time. Germination (epigeal) is 6 to 14 days after sowing (with soil temperatures of between 25 and 30 °C.). Anything that carries a risk of asphyxia (heavy soil, excess water, compacted soil, sowing too deep, etc.) will compromise emergence. The latter will be irregular and the seedlings will be subject to collar and root diseases.

Sowing dates

The scheduling of sowing dates must take many other important data into account, such as shipping capacity or the duration of the crop cycle (i.e. 22 to 25 weeks for cherry tomato), conditions during harvesting and crop protection.

PROTECTION OF THE NURSERY

Particular attention must be paid to protecting the nursery against insect pests, soil diseases and nematodes (disinfected/sterilized substrate), whitefly and other vectors of viruses (aphids and thrips). For example, insect-proof unwoven synthetic textile protection (of the Agryl P 17 + type) can be used but only when the weather is not too damp. Normal duration of the nursery: maximum 25–30 days.

GAP DURING TRANSPLANTING

The seedlings are ready for planting out when they have reached the 5–6 real leaf stage. The seedlings should be sorted at planting. Prefer short, stocky plants with large collars and that are vigorous and turgescence. They should be placed in the ground in such a way that the first real leaf is about 5–10 cm above the surface on condition that the soil is loose and not liable to water logging. The soil is firmed around the seedling, with moderate pressure applied around the stem but without wounding or crushing it. Moderate watering is required after planting. It is preferable to avoid excess water in the first days after transplantation to avoid the development of soil diseases (especially bacterial wilt) and to enhance root growth. It is preferable to plant out the seedlings at the end of the afternoon or when the sky is overcast in order to reduce stress. Before planting, ensure the full turgescence of the seedlings by watering the nursery sufficiently.

The ideal planting density depends on numerous factors such as the type of crop, development of the variety, the pruning method planned, the yields sought, temperature and light.

Some examples of planting layouts for cherry tomato

- Single rows 1.20 to 1.40 m apart with the seedlings at 0.40 m intervals along the row (21 000 plants/ha) for single-truss management.

- Double rows 0.80 m apart (2 m from centre to centre) with the seedlings at 0.50 m intervals along the row (20 000 plants/ha) for single-truss management.
- Double rows 0.80 m apart (2 m from centre to centre) with the seedlings at 0.80 m intervals along the row (12 500 plants/ha) for double-truss management.
- Plant out either on levelled land (mechanized cultivation, trickle irrigation), or on ridges (manual cultivation, furrow irrigation), on the upper third of the side of the ridge or on the top of the flattened ridge.

SUMMARY

1. To ensure high yield and quality produce, the use of pure certified seed and root stock is essential.
2. Traceability of product can only be assured when the source of seed used is known and controlled.
3. Seedling nursery should be installed in a place protected from direct sunlight, the prevailing winds and livestock. The soil should ideally be healthy, rich and flat with appropriate structure for sowing.
4. Sowing dates must take many other important data into account, such as shipping capacity or the duration of the crop cycle and other conditions, during harvesting and crop protection.
5. Excessive disturbance of the existing soil layers should be avoided during tillage to prevent the bringing to the surface of the poorer layers more likely to cause asphyxia and colonized by different micro-organisms as well as soil erosion.

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Module 5

Crop pests and diseases

LEARNING OUTCOMES

- Participants understand the impact of crop enemies and the needs for plant protection strategies.
- Participants be able to carry out observations on pests, disease and weeds.
- Participants understand crop infestation and damage during production and post-harvest.

PRACTICAL

Pests and disease observation in the field.

INTRODUCTION

It is estimated that more than 50 percent of global agricultural production is lost before or following harvest because of the combined effects of disease, pest attacks and weeds. Estimations of losses by region and crop, were published by E.C. Oerke *et al.*, 1994 for the eight most important crops (cotton, soybean, rice, maize, potato, coffee, wheat and barley). These estimations demonstrate the substantial differences that exist between the “potential production” of crop strains and the “real yields recorded”, and attribute this largely to damage caused by crop parasites, even in regions where the most recent agricultural techniques are used.

Farmers in Tanzania recognize the importance of production of food and non-food crops in maintaining their health and improving their livelihoods. However, the problem of pests and diseases continues to pose a challenge and is among one of the biggest problems in raising crop yields. The only medium- and long-term solution is therefore to increase productivity per hectare and to reduce post-harvest losses. Depending on the level of losses and the costs involved, an improvement in plant protection would seem to be an important strategy to increase food resources in Tanzania.

The causes of these considerable losses are mainly from phytophagous insects that are by far the most harmful, nematodes, fungus, virus and bacteria, and not forgetting weeds. Strategies for crop protection and methods of controlling crop pests are necessary in order to maintain high levels of production.

As stated earlier, the main pests responsible for crop damage in Tanzania are insects, nematodes, fungus, bacteria and viruses (Tables 1 and 2).

CROP INFESTATION AND DAMAGE DURING PRODUCTION AND POST-HARVEST

Crop enemies may be active in the early stages of production, right from seeding. It is essential to obtain healthy seed that is of high quality and free from infection (virus-free, invulnerable to bacteria and with no pest insect larvae). Seedbeds should be established in good sanitary conditions protected from nematodes, virus, disease-bearing insects, etc.

TABLE 1
Some important pests of crops in Tanzania

Cotton	Bollworms, cotton stainer, whitefly, aphids and leafhoppers (virus disease carriers)
Cereals (maize, etc)	Stem borers, armyworm, leafhoppers (virus disease carriers)
Vegetable crops	Aphids, whitefly, leafhoppers, thrips, caterpillars that eat leaves and fruit, nematodes, mites
Ornamental plants	Aphids, whitefly, mealy bugs, mites
Rice	Stem borers, leafhoppers, rice weevil, black weevil
Cashew nuts	Mealy bug, stem borers, Helopeltis bugs
Citrus fruit	Caterpillars, aphids, leaf miner, whitefly, psyllids
Cassava	Mealy bugs, green mites, white scale
Banana	Nematodes, banana weevil

Source: *Plant Pests Field Handbook*, Ministry of Agriculture and Food Security, 2002.

TABLE 2
Some important diseases of crops in Tanzania

Cotton	Bacterial blight, Fusarium wilt, Alternarial leafspot,
Cereals (maize, etc.)	Leaf rusts, Leafblights, Maize streak, smuts
Rice	Blast (pyricularia), Brown spot, Blights,
Vegetables	Seed rot, rust, fruit and leaf rot, grey mold, powdery mildew and downy mildew, blights
Potato	Early and late blight, Bacterial wilt
Vine	Powdery mildew and downy mildew, Gray mold
Pome fruit	Powdery mildew, Monilia brown rot
Cashew nuts	Powdery mildew, Anthracnose, and Die back
Groundnuts	Seed and Seedling rot, Cercospora leafspots, Rosette virus
Banana	Fusarium, Sigatoka leaf spot
Coffee	Fusarium wilt, coffee rust, coffee berry disease

Source: *Plant Pests Field Handbook*, Ministry of Agriculture and Food Security, 2002.

Inadequate GAP (unsuitable choice of field and soil type, inappropriate crop rotation, destruction of companion insects, poor weeding, poor clearing of post-harvest crop debris, contaminated agricultural tools, trimming wounds, etc.) may also be the cause of massive infestation.

EPIDEMIOLOGY AND DYNAMICS OF PEST POPULATIONS

Epidemiology of pest populations

Epidemiology is defined as the study of the development of a population of pests (insects, mites, nematodes, rodents, birds) on a host population (cultivated plants in a parcel or in an orchard).

International trade and airplane flight have also increased the introduction of many pests to new parts of the world. Where there are no natural enemies in a coexistent relationship with these pests, they can cause considerable damage to crops in their new habitat. As a result, international regulatory measures have been adopted to curb the extension of these potentially dangerous pests. There are lists (such as the lists prepared by the European Organization for Plant Protection [EPPO]) of **quarantine pests** (e.g.: *Helicoverpa armigera*, with respect to fruit and vegetable exports to Europe) for which growers are required to take special precautions (e.g.: phytosanitary certificates). Detection of these organisms (insects, bacteria, fungi, etc.) in batches of vegetables can result in their immediate destruction.

Pest population dynamics

Some species appear with great consistency every year, in regular quantities, whereas others seem to have disappeared but then abruptly appear as new, then once again disappear for one or several years.

The danger that a given pest represents depends on the species and on the host plant; and the numerical size of the pest population is the result of two groups of opposing factors.

- **The biotic factors:** (fertility, number of generations yearly, ability to develop on the host plants in the region under consideration).
- **The abiotic factors:** (climate, competition for food, enemies such as parasites, predators and diseases).

Case study 1 – Introduction of the Large Grain Borer (*Prostephanus truncates*) in Tanzania in late 1970s from Latin America



CEREAL RESEARCH CENTRE

Large Grain Borer (*Prostephanus truncates*)

The Large Grain Borer, a native to Mexico, which attacks maize, wheat, cassava, etc., was accidentally introduced to Tanzania in late 1970s through the shipments of maize from Latin America.

The quantity, date and distribution of rainfall have a direct influence on the pest, its enemies and the plant. The role of temperature is less important than in temperate regions.

DEVELOPMENT OF PLANT DISEASES

Introduction

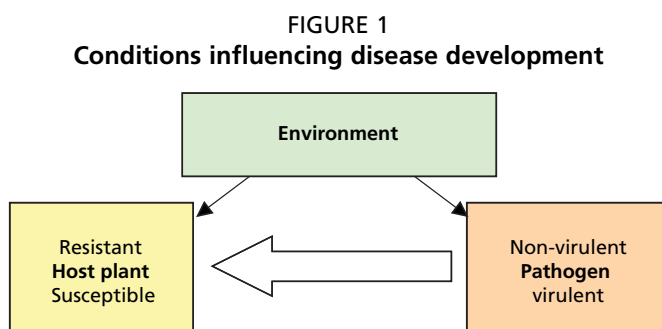
Disease is an abnormal condition in the structure or function of a plant caused by a continual irritating factor (causative agent or pathogenic agent). It is a process, which is not instantaneously visible as is a lesion. Diseases can be divided into two main groups: infectious (or biotic) and non-infectious (or abiotic).

Infectious diseases

Infectious diseases are caused by micro-organisms (fungi, bacteria, virus, mycoplasmas, rickettsia), which can be transmitted by various vectors (wind, water, plant contact, nematodes, insects, etc.) to other healthy plants, or which can be present in the soil, causing disease to new sensitive hosts. A pathogenic germ is therefore a living organism, which can be virulent – that is, which can cause disease to a plant (Figure 1).

Plant infectious diseases can only develop if the three following conditions occur:

- The host plant must be susceptible to the diseases.
- The pathogen must be virulent and capable of attacking the plant.



- The environment must be conducive to development of the disease (that is, it must be conducive to sensitivity and to virulence).

Non-infectious diseases (abiotic diseases)

Non-infectious diseases are caused by a variety of environmental, mechanical, nutritional and other factors (examples: air

pollution, soil compaction, herbicide post-effects, wrong fertilizer, nutrient deficiency, excess fertilizer, poor irrigation – example: blossom end rot of tomatoes, sunscald – frequent on melon for example). Non-infectious diseases cannot be transmitted to healthy plants.

Example of non-infectious disease

- **Blossom end rot of tomato.** This disease is caused by uneven, deficient irrigation, which causes poor calcium assimilation.
- **Lack of nutrient elements.** Both major (N, P, K, Ca, Mg) and minor (trace elements) are a major source of non-infectious diseases, which harm plant growth and production, and affect product quality. Some elements present in the soil can be downright toxic to crops (example: chlorides for green bean). Good plant health and production therefore depend on fertilization, which is well adapted to the crop, provided at the right time (fractionated intake is often recommended) and in the right form (chemical nature of the fertilizer, solubility, etc.) (Example: avoid fertilizers with KCl on bean).

Examples of deficiencies on bean

- ✓ Phosphorous deficiency is seen in the dark green coloration of the leaf blade, erect bearing, and browning then dropping of the leaves.
- ✓ Potassium deficiency causes dark green coloration and interveinal discoloration, and leaves roll downward.

WHY IT IS IMPORTANT TO TAKE CARE OF WEEDS

Weeds are bad plants, which invade good plants and deprive them their nutrients.

A weed is an herbaceous plant, and, by extension, a ligneous plant that is undesirable in the place where it is found. In addition to being undesirable in cultivated fields, orchards, plantations, pastures, etc., some plants are also undesirable in other specific cases such as along the banks of irrigation canals.

The close relationship between “good” plants and “bad” weeds, in particular when they belong to the same genus, makes weeding particularly difficult. Such is the case with cultivated rice (*Oryza sativa*) and the weeds *Oryza longistaminata* and *Oryza brevigulata*, with cultivated oats and wild oat, cultivated and wild carrot, and others.

Weeds have an abundance of seeds and the capacity to reproduce and to propagate either through seeds, or by vegetative propagation via rhizomes, bulbs, root suckers, root and stem fragments. Creeping rhizomes and rootstock are a fairly common reproductive system for certain annuals and many perennials (example: quack grass).

Some seeds can keep their germinative capacity over extremely long periods of time, reaching, for some species, ten years or so!

The direct harmfulness of weeds (competition effect)

- Weeds are powerful competitors for crops, especially when the crop is at the very beginning of its growth. Even in well-prepared, well-tilled fields, weeds will germinate and will compete with the cultivated plant. Weeds' requirements can exceed crop needs, which mean that weeds will drain soil reserves.
- Many weeds grow much faster than the crop, and suffocate the crop. Yields drop and sometimes the crop is wiped out.
- Weeds absorb part of the water and the nutrients, and partially deprive the planted crop of air and light. The reduced water resources, which transport the nutrients, directly affect photosynthesis.
- Sometimes, the weeds purely and simply take over from the cultivated plant, especially if the crop is slow to occupy the land (i.e. onion).

Indirect harmfulness

- Weeds host many pests and harmful diseases for cultivated plants. Weeds are secondary hosts for aphids, many rusts, some nematodes, and for many viruses (transmitted by the aphids and the nematodes in particular), mites (Tetranyques) and slugs. The presence of weeds provides cover for harmful rodents, which cause a drop in both yield and quality. Weedy crops provide favourable conditions for the development of certain diseases.
- The presence of weeds makes harvesting work much harder – a serious invasion of weeds can make it impossible to machine harvest! Thinning and ridging are harder to do, which increases losses and production costs.
- The moisture content in the harvested cereals can be higher, requiring drying after harvest.
- The foreign grains or seeds and the plant debris in the harvest downgrades the harvest and can even lead to refusal if the crops are intended for seed production or canning (toxic weed seeds).

Bad agricultural practices that contribute to weed multiplication and propagation

- The use of manure, which has not properly decomposed, is an excellent means of seed dispersal.
- The use of seed, which has been poorly sorted, the use of combine harvesters and certain growing techniques all facilitate the spread of certain perennial weeds.
- Allowing animals in the cultivated fields also contribute to seed multiplication. They carry seeds or flowers attached to their body surfaces or by eliminating them in their dung.
- Weeds also benefit from the progress achieved in agronomy. With rational fertilizing and irrigation, weeds – especially the herbicide-resistant species – benefit from reduced competition just as the crop does

GAP IN MANAGING CROP PESTS AND DISEASES

Implementing different methods to keep the crops healthy without solely relying on spray of pesticides, is called Integrated Pest Management (IPM). IPM is attractive because it has the following benefits:

- effective control;
- lower costs;
- safer to farmers and families;
- protects the environment.

IPM includes cultural, physical, biological and chemical methods to manage the pests. How farmers can implement and benefit from IPM is explained in Module 6.

SUMMARY

1. It is estimated that more than 50 percent of global agricultural production is lost before or following harvest because of the combined effects of disease, pest attacks and weeds.
2. The main pests responsible for crop damage in Tanzania are insects, nematodes, fungus, bacteria and viruses.
3. Inadequate **GAP** (choice of field and soil type, inappropriate crop rotation, destruction of companion insects, poor weeding, poor clearing of post-harvest crop debris, contaminated agricultural tools, trimming wounds, etc.) may also be the cause of massive infestation.
4. Bad agricultural practices, such as the use of manure that has not properly decomposed, may contribute to weed multiplication and propagation.
5. IPM is part of the more general framework of GAP to keep the crops healthy.

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Module 6

Integrated pest management (IPM)

LEARNING OUTCOMES

- Participants understand IPM approach in managing crop pests
- Participants understand crop protection principles

INTRODUCTION

Pest management is part of the more general framework of **GAP**, and for optimum crop protection, specific control methods must be used in association with the complete range of available cultural techniques (rotation, crop staggering, soil tillage, integrated fertilizing, etc.), emphasizing the role and impact of agronomical and ecological factors.

CROP PROTECTION BASICS

For crop protection to be meaningful it must be conceived as part of a comprehensive approach or strategy carefully thought out and built on a sound base of fundamental knowledge:

- Crop follow-up (agronomy) and understanding of biological data on parasites (including parasite damage potential and parasitoid action).
- Knowledge and research on the agro-ecosystem (including crop sensitivity to surrounding conditions and to parasites).
- Knowledge of the biological, physical and chemical properties of plant protection products (including mode of action, effective dose, persistence and side-effects, formulations).
- Knowledge of regulations: approved and prohibited substances, restrictions on use, acceptable dose level, pre-harvest interval (PHI), authorized maximum residue limits (MRL).

Bad practices

- **“Blind” chemical control:** based on a treatment calendar and determined by estimating a recurrent risk.
- **Chemical control based on advice:** systematic insurance treatment.

In order to implement effective crop protection, the approach entails a series of steps summed up in the steps below:

1. Identify: diseases, pests and alien plants
2. Define: intervention threshold
3. Decide on: procedures for intervention
4. Assess: impacts, effectiveness, selectivity, environment, humans, production and quality

Review of the various stages in intervention

Stage 1: Identify

- Pests identification and inventory (biology and ecology).

- Evaluation of the crop system: genotypes, economic worth, role in the farming operation, system of rotation, sensitivity according to stage.
- Relationship with their natural enemies on the one hand and, on the other, with their host plants.

Stage 2: Define intervention threshold

Assessment of the need for planned intervention or treatment. This entails determining the harmfulness, in terms of potential lost yield, of the different pathogens, pests or alien plants identified, for each crop considered, at its specific stage of development and in light of environmental factors.

Depending on the type of pest, there are several different methods for identifying and evaluating populations:

- ***For insects:***
 - ✓ Methods of observation: counting and trapping (visual trapping, colour trapping, pheromone-based olfactory trapping).
- ***For pathogens:***
 - ✓ Direct observation (bacteria, viruses, fungi). One must be able to recognize abnormalities as they arise or develop and identify the exact cause of the symptoms observed (change in colour, deterioration of organs, anatomical modifications).
- ***For weeds:***
 - ✓ Periodic observation of the plot is still the simplest way to evaluate alien plant populations.

To make sure interventions are timely and particularly to rationalize the use of insecticides, the concept of an intervention threshold (pest densities or extent of its injury when it is advisable to treat), is recommended.

Beyond a certain level of parasitism or damage threshold, the drop in yield because of infestation justifies intervention. This is called the intervention threshold (also known as the economic damage threshold or “*economic threshold*”).

In practice, intervention at a threshold is not easy to implement, because it entails:

- ***Evaluating the extent of crop infestation*** correctly (sampling).
- ***Assessing the risks*** for the crop or harvest in light of the extent of infestation, the phenological stage of crop development, its sensitivity and weather conditions.
- ***Evaluating the relationship between expected earnings*** (depending on the monetary value of the crop or harvest) *and the cost of the intervention* (e.g. product + application).

This makes it especially important to understand and have a firm grasp of the dynamics of populations and more specifically those of pests and beneficials.

Stage 3: Decide

Selecting the intervention, and especially the most suitable treatment, is difficult, because farmers are almost always confronted with a complicated phytosanitary protection problem. An attack by a single pest is exceptional, more like a “plague” (locusts, rodents, birds, etc.) and requiring special intervention techniques (e.g. eradication campaign), while in other cases, the farmer makes the choice himself or with the help of advisors (extension agents, etc.) of the most suitable “technical package” (also called “phytosanitary kit”).

Stage 4: Assess

The next step is to evaluate the impact of the various aspects of the intervention(s) chosen in order to balance its/their “costs” and “benefits”:

- Effectiveness and profitability for the farmer.
- Selectivity for the crop and the non-target organisms.
- Compliance with MRLs (consumer safety).
- Side-effects on the operator, domestic or wild animals.
- Effects on the environment (soil, water, plants, air).
- Effects on cultural techniques (such as direct seeding and mechanical harvesting).
- Possibly related social consequences (such as shorter working hours if herbicides are used).

INTEGRATED PEST MANAGEMENT (IPM)**Definition**

FAO defines IPM as:

“A pest management system that in the socio-economic context of farming systems, the associated environment and the population dynamics of the pest species utilizes all suitable techniques in as compatible a manner as possible and maintains the pest population levels below those causing economic injury.”

In simple language

IPM is a pest management approach that uses all available pest control methods, including but not limited to the judicious use of pesticides, to optimize a crop’s ability to resist the pest with the least hazard to man and the environment (Box 1).

BOX 1
Why is it called IPM?

- ✓ Integrated means mixed together – we are mixing different methods together to get the best solution.
- ✓ We use the word pest loosely to refer to things that damage the crop and in this way include plant diseases, insect pests and weeds.
- ✓ The word management is used, rather than control, because we want to manage the pest numbers at low level, rather than killing all the pests. If we kill all the pests they will be no food for beneficial insects (i.e. farmer’s friends), and we will have to use more chemicals each time the insect pests appear.

IPM is attractive because it has the following benefits:

- Effective control of pests
- Lowers costs
- Safer to farmers and families
- Protects the environment.

IPM can help to prevent the build-up of pesticide resistance, where farmers need much higher doses of pesticide because pests are becoming harder to kill.

Different methods in IPM

IPM uses many different methods together to control pests and diseases.

- Cultural methods: involve farming practices that prevent problems such as:
 - ✓ Crop rotation
 - ✓ Sowing date
 - ✓ Plot selection and layout
 - ✓ Associating crops
 - ✓ Destruction of crop residue
 - ✓ Tilling
 - ✓ Reasoned fertilization
 - ✓ Resistance varieties.
- Biological control: involves the use or promoting natural enemies (predators and parasitoids):
- Physical methods: where pests are killed or prevented from reaching the crops by physical means (i.e. planting maize on the edge of cabbage field, maize acts as physical barrier to cabbage pests)
- Chemical methods: where chemicals are used to kill the pests. The chemical may be manufactured pesticides or natural extract from plants such as neem and pyrethrin.

Cultural methods

Crop rotation: whatever the type of production, crop rotation offers various advantages in plant protection:

- **Best use of topsoil:** Continual or frequently repeated cultivation of the same species on the same land leads to imbalanced use of the various strata of the soil. Several seasons of monoculture tend to deplete the layer of soil from which the plant draws its mineral nutriment.
- **Preventing the development of disease and pests:** Diseases and pests specific to the cultivated species or family may survive in the soil (e.g. fungal sclerotia, cyst nematodes, etc.) or in crop litter (insect pupae in stalks, etc.) through to the following year. Hence, repeated cultivation of the same or related crops may allow such organisms to proliferate and epidemics to develop. Crop rotation can help reduce certain phytosanitary risks. Furthermore, because the same diseases and pests may affect a range of different crops, it is advantageous to organize lengthy, varied rotations. The introduction of trap plants or (prolonged) fallow periods can also alleviate some phytosanitary problems.
- **Preventing the growth of specific types of unwanted flora:** Repeated use of the same selective herbicides (or those having the same mode of selectivity) generally leads to selection of a specific weed that in just a few years can become difficult to control. In addition, certain crops not covering the ground promote the growth of weeds whereas others that cover the ground rapidly tend to choke weeds.
- **Crop rotation offers two advantages:** the clearing effect (either naturally or by mechanical intervention) of certain crops, and alternation of weed control strategies. The growth of weeds can thus be controlled throughout the entire rotation.

Sowing date

“**Crop staggering**” is often necessary, so that a given stage in the development of the host plant (seedlings, for example) no longer coincides with the stage of disease

contamination or pest infestation, thereby limiting the damage the latter causes to crops. To determine the best sowing date, the crop growth and development cycle must be compared with the pest populations building cycle.

Plot selection and layout

To make sure that crops are grown under optimal conditions, it is important to choose the appropriate site for the variety to be sown or planted – the right exposure, soil type and structure, and slope. For example: Healthy soils provide necessary plant nutrients, which are important for strong, healthy growths that help plants to resist pests and diseases.

Associating crops

Associating certain crops with others seems to have a positive impact on pest dynamics (promoting insect development or diverting them from the primary crop), trap crop or on the density of useful entomofauna; example of associating crops:

- Flowering plants, such as marigold, phacelia alyssum and coriander, to provide shelter and food for beneficial insects such as wasps.
- Marigold also attract thrips to move out of cultivated crop.
- Maize lines on the edge of brassica, such as kale or cabbage, acts as a trap crop by confusing pests moving in search of cultivated crops; maize flowers also provide food for beneficial insects.

Destruction of crop residue

Destruction of crop residue, a practice that dates way back, can be effective if the inter-campaign period can be strictly observed. Destroy crop residues by ploughing, burying, composting or feeding them to livestock. During plant growth, pull out and destroy any plants that are badly affected by pests (e.g. whiteflies) in the late afternoon or evening to prevent pests from moving to another crop.

Reasoned fertilization

There are interactions between fertilization and crop protection. Whether applied on the ground or in the form of a nutritive solution, the type of fertilizer must be balanced. Excessive use of nitrogen must be avoided: Overly vegetative, vigorous growth facilitates the development of various diseases, predatory insects and weeds. Rational use of fertilizers is important at a time when farmers are facing economic constraints and try to limit production costs, putting the priority on immediate profits.

Use of resistance varieties

The ideal solution for farmers would be to have a plant stock that is resistant or at least tolerant to disease and the various pests, even though it would not last forever, because pathogens and pests can overcome that resistance or tolerance. Avoid planting uncertified seeds; they can be a source of diseases and pests.

BIOLOGICAL CONTROL

Biological control is a method for controlling a pest by using or promoting its natural enemies or a disease by fostering its antagonists. Biological control is directed primarily against pests (insects, mites and nematodes). Any predatory, parasitoid (entomophagous

Case study 1 – Tomato varieties that are diseases tolerant

Tomato variety, Tanya and Tengeru – which were bred at Africa Vegetable Regional Development Centre (AVRDC) at Tengeru Arusha – are much preferred by tomato growers in Tanzania because of late blight disease (*Phytophthora infestans*) tolerant. These two varieties are well adopted by tomato growers in Tanzania and fetch good price in big cities such as Dar-es-Salaam, Mbeya and Arusha.

Case study 2 – Coffee varieties that are resistant to leaf rust and Coffee Berry Disease (cbd)

Coffee is one of the major agricultural export commodities in Tanzania, yet for decades coffee plantations have suffered from leaf rust and CBD diseases. The impact of these two diseases is very remarkable, as growers are spending many resources for inputs to manage the problem. Recently, Tanzania Coffee Research Institute (TACRI) released coffee varieties, such as TSC 8, which are resistant and growers do not require spraying against these diseases.

fungi) or infectious (viruses) organisms that limit the frequency and severity of irruptions are considered natural enemies of crop pests.

Predators

Either consume the prey they capture immediately or use them to feed their offspring. This category includes the *Neuroptera Chrysopidae* and *Hemerobiidea*, as well as numerous species of *Coleoptera* – lady bird beetle, *Diptera* (flies), *Thysanoptera* (thrips), *Hymenoptera Vespidae* (paper wasps), and *Sphecidae* (sphecoid wasps), spiders and carnivorous mites. (Example: the use of predator mite – *Phytoseiulus persimilis* – against red spider mite in flowers and vegetables in Arusha.)

Parasitoids

Parasitoids are insects that lay their eggs on or in the body of an insect belonging to another species. Their larvae consume the host's tissues and eventually kill it. Some families of *Diptera* or *Hymenoptera* belong to this group.

Importing natural enemies to combat those new pests has become an increasingly important aspect of biological control. The first step is to find out where the pest came from, identify its main natural enemies in that original environment, and determine which of the latter offers the greatest potential and should for that reason be imported. The second task is to establish those beneficial in the regions where the pest has become a problem. Because of their specificity, parasitoids are generally ideal candidates, but a variety of predator species have also been introduced successfully.

Pathogenic agents

Any micro-organisms that infect the cells and tissue of a host and multiply there are known as pathogenic agents. Fungi, viruses, bacteria and *protozoa*, all have certain entomopathogenic species.

Case study 3 – Successful classical biological control in Tanzania

Cassava mealy bugs – the pest that attacks cassava leaves and shoots – threatened to wipe out the cassava crop in Tanzania in late 1980s. The pest is now under control, after the introduction of its natural enemy, a wasp parasitoid (*Epidinocarsis lopezi*) in cassava fields.

PHYSICAL CONTROL

- This involves the use of covering crops with nets; because this practice is expensive, it is only recommended for high-value crops.
- Hand removal of pests is recommended for small plots.
- Planting windbreaks – growing in line of tall plants – such as maize with cabbage, maize acts as catch crop, preventing pests moving to such a crop.

METHODS OF OBSERVATION AND SAMPLING OF FIELD PESTS

Methods of field observation and sampling of pest populations

Though there are many different methods for evaluating population density, they may all be classified in two main groups: direct counting and indirect methods (trapping, extraction, etc.), in addition to which there are specific diagnoses and sampling techniques for fungi.

Crop monitoring methods include plant sampling (scouting) and use of insect traps and indicator plants.

Traps reduce crop inspection time considerably and lead to timely interventions. Yellow sticky traps and water traps are useful to detect leaf miners, fruit flies (pepper maggot), whiteflies, and thrips. Blue traps are used for detection of thrips. Bait traps are used for monitoring fruit flies. Pheromone traps are specific traps and are commonly used to monitor fruit flies, and moths such as fruit worms and cutworms.

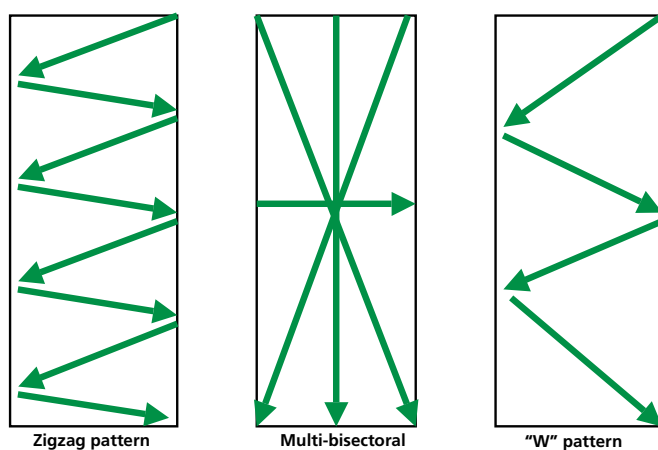
Example: yellow traps and blue traps are currently being used by the farmers in Arusha to monitor white flies and thrips in cucumber grass house. At least one trap per hectare should be placed around field margins. Traps are more reliable when hung about 1 m high.

Sticky traps can be made by painting a small board (yellow or blue) and coating it with a commercial product (e.g. Tanglefoot) or with mineral oil, petroleum jelly or grease. The number of traps per area depends on the stage of the crop. A recommendation from India for field-grown peppers is to set yellow traps at 10 traps per hectare.

To scout a crop, the farmer surveys the crop area to get an overview of the major problems and the general condition of the crop. This is followed by methodical inspection of the crop, picking plants at random at sampling sites and filing observations in a prepared inspection sheet. Different sampling sites should be chosen each time the crop is inspected. The number of sampling sites on each stretch will depend on the size of the field. The number of plants to be inspected on each site will depend on the size of the plants, the crop and spacing. For sweet peppers, it has been recommended to check 60 plants chosen randomly in 0.1 ha). For a smallholder plot, 10 sites per farm unit and 10 plants per sampling site should be adequate. While carrying out random sampling, the grower should be alert to unusual problems and conditions in the rest of the field.

Scouting involves thorough inspection of the sample plant from soil and roots to the top of the newest shoot, carefully checking both the upper and under sides of

FIGURE 1
Sampling patterns



leaves, flowers and fruits. Check for incidence and severity of pests and diseases and any other abnormality in the crop. Check for presence and abundance of natural enemies.

In the nursery, attention should be given to pests such as cutworms, aphids, whiteflies and thrips, and damping off. At transplanting, watch for cutworms, and white grubs, which may cut the seedlings. In the field, watch early in the season for pests and diseases such as aphids, leaf miners, mites, thrips, and whiteflies, and viral diseases. At the beginning

of fruit set, concentrate on pests and diseases that damage fruits. It is important to detect mites, thrips, fruit worms and fruit flies in early stages of development. They are a greater problem than foliar feeders because damage to fruits or blossoms directly affects the marketable part of the plant. Control may be necessary if moderate damage is observed.

Sampling patterns vary, depending on farm size and crop. Examples include zigzag, multi-bisectoral and “W” patterns as shown in Figure 1.

THE USE OF CHEMICAL CONTROL (PESTICIDES) AS THE LAST SOLUTION

In integrated pest management, pesticides cannot be used unless:

- They are absolutely necessary, and no other control method has proven effective enough or realistic economically relative to the crop’s market value.
- They are non-hazardous to the environment and, especially, sufficiently selective towards antagonists or natural enemies.

Pesticide use in relation to GAP will be discussed in detail in Module 7.

SUMMARY

1. FAO IPM as: “a pest management system that in the socio-economic context of farming systems, the associated environment and the population dynamics of the pest species, utilizes all suitable techniques in as compatible a manner as possible and maintains the pest population levels below those causing economic injury.”
2. IPM methods include the following:
 - Cultural methods: include crop rotation, soil tillage, use of trap crops, and change in planting or harvesting time, intercropping with other crops or with varieties that repel pests.
 - Mechanical and physical methods: techniques such as collecting pests with traps, physical barriers, heat, cold, sound barriers or screens.
 - Biological control: include the uses of microbial pathogens (e.g., bacterium, fungus, or virus) that generally attack a specific pest and the release of predators and parasitoids to control insect pests or weed species.

- Chemical methods: involves the use of pesticides, which are chemicals that are intended to prevent, destroy, repel or mitigate any pest, or intended for use as a plant regulator, defoliant or desiccant.
3. Though there are many different methods for evaluating pest population density, they may all be classified in two main groups: direct counting and indirect methods (trapping, extraction, etc.).

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Module 7

Pesticide application

LEARNING OUTCOMES

- Understanding pesticide best practices
- Understanding the importance of pesticide safe use
- Understanding the importance of observing MRL

INTRODUCTION

General definition of pesticides

The term “pesticides” can be defined as “a substance or association of substances”.

- That is intended to repel, destroy or combat:
 - ✓ undesirable species of plants or animals causing damage or otherwise harming the production, processing, storage, transport or marketing of foodstuffs, agricultural products, wood and wood products, or animal feed.
- That is used to:
 - ✓ limit losses in crop yields;
 - ✓ protect stored foodstuffs;
 - ✓ increase the comfort of the farmer;
 - ✓ limit the development of pathogens for humans and animals;
 - ✓ destroy undesirable plants (herbicides, algicides, moss killers);
 - ✓ destroy parts of plants, slow down or prevent undesirable growth of plants (haulm destroyers, anti-sprouting agents, etc.).

PESTICIDE TYPES ACCORDING TO THE TARGET PESTS

Pesticides are commonly named after the pests that they help to control.

Pesticide names

Pesticides have a trade name, which is written in a large letter, on the pesticide label. The active ingredient (poison part) has a common name, which appears on much smaller print on the label. There are several products with different trade names, which all contain the same pesticide, Active Ingredient.

Pesticide hazard classification and uses



All pesticides can be dangerous, some very dangerous while others are less dangerous. The level of danger is usually marked on the pesticide label as hazard classification in the World Health Organization (WHO) systems. The Categories are Ia, IIb, II, III, or unclassified. Some countries indicate these hazards by a colour code (Table 1).

Pesticide formulations

There are different types of formulation such as:

- Emulsifiable concentrate (EC)
- Wettable powders or granules (WG)
- Dust

TABLE 1
Toxicity of pesticides – WHO classification

WHO Class	Color of the toxicological band	Danger symbol	LD 50 (mg/kg body weight)			
			ORAL		DERMAL	
Ia. Extremely hazardous EXTREMELY TOXIC	Red		Solid	Liquid	Solid	Liquid
			<5	<20	< 10	<40
IIb. Very hazardous TOXIC	Red		5–50	5–50	20–200	10–100
II. Moderately hazardous HARMFUL	Yellow		50–500	50–500	200–2 000	100–1 000
III. Slightly hazardous CAUTION	Blue		>500	>2 000	>1 000	>4 000

DO NOT USE Class Ia and IIb pesticides, even a small quantity on the skin can poison you

Class	Description
Ia. e.g. Temik (nematicide)	Extremely hazardous, DO NOT USE
IIb. e.g. Furadan	Highly hazardous, DO NOT USE
II. e.g. Sumithion, Malathion, Dimethoate	Moderately hazardous, take great care
III. e.g. Decis, Karate	Slightly hazardous, take care
Unclassified	Unlikely to cause hazard, but still take care

Pesticide mode of action

- **Insecticides** may affect insects by:
 - ✓ Direct contact;
 - ✓ Secondary contact (insect touching the sprayed leaves or any part of the plant);
 - ✓ Ingestion (insects eat or suck the liquid of sprayed plant);
 - ✓ Repelled (insects run away from the smell or taste);
 - ✓ Fumigant action (the insects breathe in the pesticide vapour).
- **Herbicides** may be:
 - ✓ Non-selective herbicide that kill all the plants;
 - ✓ Selective herbicides, that kill some plants;
 - ✓ Contact herbicide – kill only the leaves they touch;
 - ✓ Translocated herbicides – travel down the roots and kill them too;
 - ✓ Foliar herbicides – applied on the leaves;
 - ✓ Soil applied herbicides – applied to the soil to kill the weeds.
- **Fungicide** may be:
 - ✓ Non-systemic fungicides, only stay on the surface of the leaves and kill fungus on contact. These are **PREVENTIVE** fungicides.
 - ✓ Systemic fungicides – move inside the plant system and kill fungus inside the plant. These are **CURATIVE** fungicides.

Factors to consider when choosing pesticide

- Efficacy of active ingredient
- Safer active ingredients
- Safer formulations
- Safer packing
- Mode of action
- Resistance – change the type of pesticide active ingredient regularly to prevent pest resistance building up

PESTICIDE REGULATION IN TANZANIA

According to the **Plant Protection Act 13 – 1997** and the **Plant Protection Regulation 1999** all pesticides to be in Tanzania must be registered by Registrar of Pesticide. Registration of a pesticide is a scientific, legal and administrative process through which regulatory authority examines the chemical and physical properties of the pesticide, its effectiveness, its potential for causing toxic human health effects and environmental effects resulting from its use. The manufacturer of the pesticide must provide data for tests done according to Plant Protection Act guidelines when seeking registration. Registration enables authorities to control quality, use levels, efficacy claims, labelling, packaging and advertising. Registration also helps to ensure that the interests of end users are well protected. Pesticides should be used only on crops for which they are registered. The use of pesticides on other crops or at inappropriate levels can result in produce being refused for importation thus leading to significant loss of income for growers, packers and shippers.

Farmers are advised to obtain their pesticide requirements from authorized pesticide dealers and to observe on the label if the pest control product is registered by TPRI.

SELECTING PESTICIDE FOR APPLICATION IN THE FIELD

Pesticide selection must take into account the following:

- **Marketing authorization:** in compliance with authorized uses and approved dosages.
- **Obligatory precautions for use:** (application period, pre-harvest interval, maximum authorized dose, existence or not of untreated areas, protective equipment) and any restrictions on use.
- **Any MRL** for the crop/pesticide combination in question: If the crop is for export, account must be taken of the MRL on the market where it is to be distributed (national MRL, European harmonized MRL or MRL set under the Codex Alimentarius).

Pesticide sprayer operator must first and foremost follow the instructions (doses, interval between treatments, number of applications and Pre-Harvest Interval [PHI]) provided on the labels of locally authorized products. Following such instructions, however, does not necessarily guarantee compliance with MRL currently in force in the European Union countries. To comply with European regulations on pesticide residues, it is recommended that the producer use pesticides only within the limits of GAP.

- ✓ A particular pesticide should be used only for the purposes or crops that it was approved for, and only under authorized conditions, doses and intervals.
- ✓ The use of unauthorized pesticides is a common barrier to international trade.

GAP, BEFORE, DURING AND AFTER SPRAYING PESTICIDE

It is important to follow label instructions for the mixing, loading and handling of the specific pesticide being used and the actual conditions of use

- Do not spray pesticide during high winds, high sun and when it is raining.
- The amount of pesticide concentrate needed to treat a specific site should be carefully calculated.
- The water used to prepare pesticides should be free of pathogenic organisms.
- Special attention should be paid to spray equipment, pumps and nozzles used to apply pesticides.
- To minimize the potential for over or under treatment, accidents and spills, equipment should be calibrated for accuracy and checked frequently for malfunctions.
- Spray equipment should be regularly washed to prevent possible contamination of fruits or vegetables with compounds not authorized for that commodity and to avoid accidentally overdosing.

Warning signs

These should be posted on fields that have recently been treated with pesticides to prevent workers or visitors from inadvertently coming in contact with treatment chemicals. Such signs should only be removed after the established re-entry period into the field has passed so that residual levels are at an acceptable level.

Personal protection equipment (PPE) during mixing, filling and cleaning/ maintaining the sprayer

Thorough training of personnel responsible for using and applying pesticides is critical. They should be aware of the dangers that can result from improper use of the product. They also should be trained in the use of safety equipment and application devices such as:

- gloves or plastic bags on hands;
- eye protection – i.e. visor, goggles, to protect eyes;
- cotton clothes to cover the body, long trouser legs worn outside the boots and long sleeves;
- boots or shoes that cover the feet (NEVER sandals);
- a hat;
- a light disposable mask or respirator;
- waterproof apron or large plastic bag to cover the front of the body;
- always have soap and water available to clean spilled pesticide off the skin.

Field workers should be reminded that adverse health effects caused by pesticides are often not noticeable in the short term, but can develop over time if exposure is not reduced.

Remember to keep children, pregnant women and animals at a safe distance during the spraying.

Cleaning and maintaining the sprayers

After spraying, the sprayers should be washed with soap or detergent at the special designated area to avoid contamination. Care should be taken not to remove the protective clothes or gloves until you are through with the washing. Washing and the remains from spraying should be poured in a special designed soak pit; the soak pit may

be filled with charcoal or small stones to avoid contamination of water, soil and animals (NEVER pour washing in the rivers/streams or irrigation canals). Cleaned sprayers should be kept in the safety store and personnel involved in the spraying must take a shower immediately. Protective equipment should be inspected periodically and kept clean and in good condition. After use, all equipment should be carefully washed in soapy water and rinsed with clean water.

Time before entering the spray field (withholding period)

Some crop protection products require a wait between spraying and authorized return to the field. This first allows residues to fall to an acceptable level and prevents the risk of contamination of persons working in or crossing the field. When such risks exist, the minimum waiting period before returning to the field is specified on the label. These instructions must be followed scrupulously and, even when no period is mentioned, waiting for 24 hours after the last application is an elementary precaution. These periods for humans also apply to animals.

Pre-harvest intervals – (PHI)

The label must specify, according to the product, the waiting period between the last spray and harvesting date. This period must be strictly observed so that the residue level does not exceed the acceptable limits.

Organize full traceability

As for other cultivation operations, it is important to organize full traceability of pesticide applications. The following information at least will be recorded for each application:

- date of application (in relation to sowing date);
- the product used (full name, supplier, formulation, batch number, etc.);
- the dose actually used (measurement made);
- the volume of mix (per ha);
- the type of application (apparatus, nozzle, volume per ha, spray width [swath], speed) and spraying conditions (rain, wind, etc.).

This traceability is more important, as it is sought to ensure for the distributor and processor that the product harvested is in conformity with phytosanitary quality standards and, in particular, respects the MRL authorized for the product(s) on the foodstuff concerned.

Hints on pesticide spraying

- Before deciding to spray, carry out field scouting – check for pest, diseases and natural enemies.
- Read the label carefully; it contains important information on safety and application.
- Badly maintained or leaky sprayer should not be used; it will contaminate the personnel carrying out spraying.
- Choose the right nozzle and size – cone for insecticides and fungicides, and deflector for herbicides.
- Calibrate the sprayer to spray the right amount of pesticides and water.
- Wear protective clothing (cover the head and feet) when mixing, filling and spraying pesticides.

- Spray down winds of your body and move up winds in the crop to avoid touching or breathing the spray, move at a steady speed.
- Use water or soft brush to clean blocked nozzles, never blow into the nozzles or use the sharp stick, nail or knife.
- Sprayed field should be clearly marked to prevent people from entering until safe to do so.
- If pesticide is spilled on the skin or in the eyes, wash it off quickly with clean water.

PESTICIDE STORAGE

The pesticide storage facility should:

- be properly identified;
- be away from children, animals, and all water sources;
- be away from all water sources;
- have a concrete floor to facilitate clean up in the event of a spill or leak, well ventilated and has enough light;
- not include foodstuffs, animal feed or other articles such as clothing, tobacco, medicines, cosmetics, etc. If storage of pesticides in the same warehouse as other merchandise is unavoidable, they should at least be separated by a permanent partition wall at least 3 m high;
- store pesticides in groups according to their hazard category: flammable, combustible, corrosive, toxic, oxidizing agents, etc. The principle advantage of these measures is the reduction to a minimum of the risk of fire and its consequences;
- clearly post a warning sign with the words, **DANGER PESTICIDES – NO SMOKING, DRINKING OR EATING**; a skull and crossbones symbol at least 20 cm high should also appear on the sign.

Storage of pesticides in rural areas (on smallholdings)

- Provide an unused empty cabin or a drum with door cut for pesticide storage.
- Keep pesticides under lock and key in a cupboard or box inside the empty cabin.
- Hide the keys, to the cupboard or box and cabin where the pesticides are stored, in a safe place.
- Never store pesticides in the kitchen.
- Never store pesticides in bedrooms or in occupied rooms.
- Never leave pesticides within the reach of children.
- Put up clearly visible signs forbidding entry to the cabin where pesticides are stored.
- Always keep pesticides in their original containers.
- Avoid storing pesticide for a long time, because they may become obsolete.
- Never decant pesticides into beverage or oil bottles.
- Keep pesticides away from fire and out of direct sunlight, rain.
- A warning sign with a skull and crossbones should be kept in place.

Remember to keep a container of clean water (eye wash) outside the pesticide store, to clear any pesticide splashes.

TRANSPORTING PESTICIDE

The following measures should be taken when transporting pesticides:

- Never transport pesticides with people, food or animal feeds.

- Pesticides should be transported locked in a box and kept back in the pickup or in the car boot, never in the passenger compartment.
- Always carry some absorbent materials, such as toilet paper, sawdust, soap and water, to clean up any spills.

DISPOSAL OF EMPTY PACKAGING CONTAINERS

Empty, properly rinsed pesticide containers can be disposed of at most sanitary landfills. Well-rinsed metal cans can be punctured and buried at a depth of at least 80 cm in an area far away from any dwelling and water point. In view of the persistent, volatile nature of many pesticides, disposal by burning or burying on the farm is discouraged. In this case, if burial is authorized, the FAO directions (1985) should be followed to avoid any risk to the environment.

PESTICIDE POISONING AND FIRST AID

Signs of pesticide poisoning

Dizziness, feeling sick, tiredness, worry, excitedness, sweating, salivation, shaking hands, stomach cramps, blurred vision, pupils of the eye become very small, and unconsciousness.

First Aid

Act quickly – speed is essential

- Check breathing and give artificial respiration if necessary.
- Wash contaminated skin or eyes with a great deal of water.
- Remove contaminated clothes.
- If the patient is unconscious, lie him or her down on the side.
- Call for the transport to a medical centre.
- Continue First Aid during transport.
- Take with you the pesticide container or label to enable medical staff to identify best treatment.

MAXIMUM RESIDUE LIMITS (MRL)

What are MRL?

MRL are defined as the Maximum Concentration of Pesticide Residue (expressed as milligrams of residue per kilogram of food/animal feeding stuff) likely to occur in/ or on food and feeding stuffs after the use of pesticides according to GAP, i.e. when the pesticide has been applied in line with the product label recommendations and in keeping with local environmental and other conditions.

What is the purpose of MRL?

MRL are intended primarily as a check that the pesticide is being used correctly (i.e. that the GAP for pesticide usage is being observed) and to assist international trade in treated produce.

How are MRL set by Codex?

The activity of the Codex Alimentarius related to Pesticide Residues is carried out under the umbrella of the Joint FAO/WHO Meetings on Pesticide Residues (JMPR). It was established in 1963 following a decision by FAO Conference that the CAC

should recommend MRL for pesticide and environmental contaminants in specific food products to ensure the safety of foods containing residues.

Case study 1 – Environmental impact related to pesticides use by smallholder farmers in vegetable production in northern Tanzania

A study carried out in northern Tanzania districts (Arumeru, Monduli, Karatu, and Moshi rural) to investigate farmers' practices on vegetable pest management using pesticides, related cost and health effects, revealed that: the types of pesticides used by the farmers in the study areas were insecticides (59 percent), fungicides (29 percent) and herbicides (10 percent) with the remaining 2 percent being rodenticides. About a third of the farmers applied pesticides in mixtures. Up to 90 percent had a maximum of 3 pesticides in a mixture. In all cases, there were no specific instructions either from the labels or extension workers regarding these tank mixtures. Fifty-three percent of the farmers reported that the trend of pesticide use was increasing, while 33 percent was constant and 14 percent was decreasing. More than 50 percent of the respondents applied pesticides up to 5 times or more per cropping season depending on the crop. Insecticides and fungicides were routinely applied by 77 percent and 7 percent, respectively by these farmers. Sixty-eight percent of farmers reported having felt sick after routine application of pesticides. Pesticide-related health symptoms that were associated with pesticides use included skin problems and neurological system disturbances (dizziness, headache).

The study concluded that there is a wide range of pesticides being used for pest management and vector control in agricultural areas, but many farming communities in northern Tanzania are not adequately informed about the hazards associated with the chemicals. As a result, farmers use pesticides without full understanding of their impact on human health and the environment.

Source: A.V.F. Ngowi *et al.*, *Pesticides use by smallholder farmers in vegetable production in Northern Tanzania* (PUBMED: Crop Prot. 2007 November; 26(11): 1617–1624).

Case study 2 – Kenya French beans farmers practicing GAP – Pesticides safe use



Sprayers are wearing protective clothes during pesticide mixing and spraying.



Pesticides are locked in the cabin.



The rinse water is poured in a special soak pit to reduce contamination



Case study 3 – Procedures after spraying

Mr Fredrick Ngige, Kenya French bean grower, says:

“We always follow the procedures after spraying. When the spray team is through with their work out there in the field, certain rules must be adhered to.

“Before leaving the crop, they must hoist a red flag to warn everyone that spraying has been done. This flag means no one can pass through the field or harvest the crop. Everyone in our community is aware of this. After hoisting the red flag, the spray team – there can be five of them – brings the pumps (knapsack sprayers) to the soak pit ready for washing. Or if there is more spraying to do for a neighbour with the same chemical then they move on to the next farm. Whichever farm they visit the same rules apply.

“Now back to the soak pit area. The soak pit is specially designed. We dig a pit about 4 feet deep and 4 feet wide. After this we go to the river or a waste quarry to collect pebbles or small stones to put at the base of the pit. The purpose of the stones is to assist in the drainage of water. As such, you will never find water flooding the soak pit.”

Source: *Bridging the GAP – supporting smallholders in Kenyan export horticulture* – Voice from the field: www.wrenmedia.co.uk; January 2007.

FAO is responsible for proposing draft MRL for substances under evaluation, based on field trials that are conducted worldwide, and WHO is conducting toxicological evaluations of the pesticides.

When the risks for consumers are considered as acceptable, they are adopted as Codex MRL following agreement of the Codex Committee on Pesticide Residues (CCPR). The results of the evaluations are published (monographs related to residues and toxicological evaluation). Hence, there exists a database on Codex MRL established by CODEX (*see useful links section at end of this Module*).

In conclusion, it is important to re-emphasize that these MRL are not maximum toxicological limits *per se* and a violation is not necessarily a cause for concern for public or animal health. They are based on GAP and they represent the maximum amount of residue that might be expected on a commodity if good practice was adhered to during the use of a pesticide.

Tanzania pesticide maximum residue level legislation

Currently there is no legislation for pesticide residues, including the setting of MRL in food commodities in Tanzania, it is therefore recommended to the producers to refer to a database on Codex MRL established by CODEX. For exporters to EU countries, the EU commission has set over 17 000 Community MRL for various commodities. It should be noted that EU MRL also apply to all imported food commodities. If no authorized uses exist on crops not grown in EU (such as papaya or pineapple), then a specific dossier (import tolerance), so as to define a MRL should be submitted. For GLOBALGAP

Certification, exporter is required to use the national or equivalent accredited laboratory to good laboratory practices for carrying out pesticide residue analysis.

Where a pesticide residue analysis indicates an excess MRL in a crop being grown, supportive documents must be provided indicating remedial steps and action taken to address the problem.

SUMMARY

1. Pesticides is defined as “a substance or association of substances that is intended to repel, destroy or combat undesirable species of plants or animals causing damage or otherwise harming the production, processing, storage, transport or marketing of foodstuffs, agricultural products, wood and wood products, or animal feed.”
2. All pesticides are dangerous, some very dangerous while others are less dangerous. The level of danger is usually marked on the pesticide label as hazard classification in the WHO systems. The Categories are Ia, IIb, II, III, or unclassified. Do not use pesticides under Categories Ia and IIb.
3. The Plant Protection Act 13 – 1997 and the Plant Protection Regulation 1999 require all pesticides to be in Tanzania to be registered by the Registrar of Pesticide.
4. All personnel responsible for using and applying pesticides must wear PPE during mixing, filling, and cleaning/maintaining the sprayer. These include:
 - gloves or plastic bags on hands;
 - eye protection, i.e. visor, goggles, to protect eyes;
 - cotton clothes to cover the body, long trouser legs worn outside the boots, and long sleeves;
 - boots or shoes that cover the feet (**NEVER** sandals);
 - a hat;
 - light disposable mask or respirator;
 - waterproof apron or large plastic bag to cover the front of the body;
 - always have soap and water available to clean spilled pesticide off the skin;
5. Keep pesticides in a lockable store to avoid pollution and reduce fire hazards.
6. Sprayed field should be clearly marked to prevent people from entering until safe to do so.
7. Always observe PHI, (the waiting period between the last spray and harvesting date). This period must be strictly observed so that the residue level does not exceed the acceptable limits.
8. MRL is intended primarily as a check that the pesticide is being used correctly (i.e. that the GAP for pesticide usage is being observed) and to assist international trade in treated produce.

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Module 8

Workers welfare, health and safety

LEARNING OUTCOMES

Participants understand the issues related to national labour regulations for agricultural workers.

PRACTICAL

Discussion on Agricultural Workers Health and Safety as stipulated in the OSHA ACT 5 of 2003.

INTRODUCTION

GAP related to human welfare, health and safety include those that direct all farming practices to achieve an optimum balance between economic, environmental and social goals; and provide adequate household income and food security.

AGRICULTURAL WORKERS WELFARE, HEALTH AND SAFETY LEGAL FRAMEWORK

The Tanzania Occupational, Health and Safety (OSHA) Act 5 of 2003, parts V and VII, gives provisions for safety and health of a person at a workplace, and includes agricultural workers. In addition, the Employment and Labour Relation Act 6 of 2004 gives provisions on workers' wages, contracts and other benefits. Both acts adhere to safe work procedures with acceptable working hours and allowance for rest periods; instruct workers in the safe and efficient use of tools and machinery; set reasonable wages and non-exploitation of workers, especially women; allow employees to form and become members of the Tanzania Plantation Agricultural Workers Union (TPAWU) and to have written employee contracts. There are also provisions for equal rights for both men and women field workers. Employers are required to comply with regulations under these Acts to avoid confrontations with workers and penalties during OSHA inspections

WORKER HEALTH, SAFETY AND WELFARE

Health and safety policy statement

Each farm is required to have a Health and Safety Policy Statement that represents the policy and system against which employers will monitor and assess its health and safety performance. Every person has a legal responsibility to look after his own health and safety and that of others, and compliance with this policy and system is mandatory for all employees, contractors and visitors.

The policy statement, associated procedures and practices should be subject to regular audits, reviewed annually and amended in light of experience and developments to ensure that the company's health and safety performance is continually improved.

Risk assessments

The Act requires the producer to carry out an annual risk assessment of safe and healthy working conditions for the farm. This assessment will be used to develop an action plan to promote safe and healthy working conditions.

Training in accidents and emergencies procedure

Each farm manager is required to ensure that there is always at least one person trained in First Aid on the farm. The First Aiders will be retrained annually. The target is to have at least one trained person per farm/shift per 50 employees maximum. First Aid Training Certificates must be filed in the farm office together with records of the training programmes given.

Training for each category of staff must be undertaken and records filed, and this includes:

- Basic hygiene training for the handling of produce.
- Basic pesticides handlers training for each spray worker.
- Training for the machine operator.

Equipment and accident procedures

First Aid boxes must be present in the vicinity of the workplace and secured against the risk of theft; all separate buildings and permanent installations on the farm shall be equipped with a complete First Aid kit, which would be available and accessible in case of emergency. The farm manager must ensure that the First Aid box is always sufficiently equipped (Paracetamol, piritons, magnesium sulphate, methylated spirit, eusol, plaster, cotton, alcohol scissors, surgical gloves). This should be controlled by the health officer on each farm.

Accident procedure and a fire procedure form must be displayed on all farm notice boards and at the chemical and fertilizer stores. These procedures must be within 10 m of the plant protection product store and in all mixing areas, including those in the field. The accident and fire procedures shall be in both English and Swahili **and** indicating updated telephone numbers of persons to contact in an emergency.

There must be at least one fire extinguisher available on the farm with a current service date. Potential hazards in the farm, e.g. waste pits and fuel tanks, workshops as well as treated crops, must be clearly identified by warning signs.

Administration of First Aid on farms and procedures for using First Aid boxes

1. The First Aid kit must be kept in a locked box. Only workers who have formal training in First Aid must have the key.
2. Only the trained First Aid worker can issue medicine from the box, and the paperwork must be signed by the appointed First Aid personnel.
3. The First Aid worker must keep records in a book in the following manner:

Date	Patient and complaint	Medicine issued	Balance	Person treated

4. The health and safety officer must sign off the sheet weekly.
5. At the end of the month a monthly medical kit stock count must be made and signed by the health and safety officer.

Electrical installations

Where required, electrical installations must be done by qualified and competent employees with the necessary qualifications. As evidence, their certificates must be filed in the farm office.

Pedestrian safety

Tractor drivers and other machine operators must be well trained and must be careful of all employees and pedestrians.

Protective equipment

OSHA Act 5, 2003, Part VI Sect: 65 requires all employers in agricultural activities to ensure that no employee is exposed to:

- hazardous machinery or equipment;
- harmful animals or insects;
- infectious agents or allergens;
- hazardous agrochemicals;
- hazardous environments while employed as agricultural workers.

For example: handling crop protection products and spray safely.

There must be annual voluntary health checks for those persons handling and applying pesticides and results of the health check filed in the farm office.

Spray workers should be provided with the appropriate PPE, which must be checked weekly and recorded.

PPEs must be cleaned after every working day and allowed to dry before use. The management shall provide the required cleaning detergents. The spray supervisor shall inspect all PPEs after they are washed and certify they are clean. There must be water/showers on every farm to deal with operator contamination.

PPE storage

PPE must be kept in a secure locker or room with good ventilation, separated from other materials and equipment. There shall also be available during all applications a secure locker or room for the storage of the operator's personal clothes and new protective clothing separate from other materials and equipment. PPE must be stored separately from crop protection products.

Safety signs

As stated earlier, there must be permanent and legible signs indicating potential hazards such as waste pits, fuel tanks and workshops.

After spraying session(s), the spray supervisor must install a sign in the field reading "*Treated area, do not enter*", which will be removed after 24 hours. The area will also be roped off with red tape/string as a deterrent. Pregnant and lactating mothers must be kept off an extra 24 hours.

WELFARE**On-site medical facilities**

The law requires on-site medical facilities, including a FIRST AID kit and trained first-aiders to be available on every farm. Each employee is obliged to undergo a medical checkup before appointment as a farm employee and undergo regular medical checkups during the full period of employment as an agricultural worker.

Drinking water

Drinking water for human consumption should be potable – that is free of micro-organisms and/or chemical substances that can jeopardize human health. Ensuring the availability of potable water for field workers will minimize the risk of their developing diseases and consequently contaminating fresh produce. Regular water tests should be in place to ensure that drinking water is free from any faecal coliform bacteria and *E. coli*; if the test is positive, an investigation of the water treatment and distribution system must be carried out.

As suggested earlier, in most urban and rural areas, water should be boiled or treated with *Water Guard* or chlorine, as precaution. To prevent contamination, it is important that water used for hand washing should be of drinking water quality.

Recommended precautions for handling drinking water in the fields

- Water supply systems should be in good condition and operating properly and monitored.
- Water should be stored in clean, previously sanitized containers and tanks.
- Water containers should be washed and sanitized on a daily basis.
- Water storage containers should be closed at all times.
- Containers should be kept away from the sun and excessive heat.
- Disposable cups should be provided and each person should use a different cup.
- Frequent microbiological and physical evaluation should be performed on drinking water when the water is being stored or treated on-site.
- Simple organoleptic evaluations (colour, odour and taste) of water should be part of the daily monitoring procedures.
- If any of the water quality tests indicate the quality is not adequate, the water should be replaced to reduce the chances of infection and the proper authorities should be notified of the problem.

Living quarters

Living quarters, if provided, should be located at a proper distance from the fields so as not to pose a health risk to persons; the quarters must be habitable with the basic services and facilities, such as running water and toilets.

Toilets and sanitary facilities

Adequate toilets with hand wash facilities must be provided near grading areas, living quarters and production areas. The toilets shall be in a good state of hygiene, accessible to employees and no more than 500 m from the area of working activity.

Pit latrines are acceptable provided they are fully enclosed with a concrete base and are gender specified (marked women or men). Toilet paper must be provided. Hand washing facilities should be serviced with running water and non-perfumed soap. If running water is not possible, potable water may be provided in drums with a tap.

Ensure that microbial analysis of hand washing water is done at least annually and the results filed in the farm office.

Toilets must be regularly cleaned and the cleaning schedule must be recorded and be available for inspection.

All toilets must have signage in both Swahili and English language stating, *Now wash your hands, or NAWA MIKONO HAPA*. This sign must be on the interior of the toilet door.

Sitting facilities

Suitable sitting facilities must be provided to enable workers to take advantage of resting periods.

Pregnant women

Women when pregnant must notify their supervisors. They must not be permitted to chemical stores, near spray equipment or mixing areas. Pregnant workers or lactating mothers with babies must not enter areas, for a minimum of 48 hours, where plant protection products have been applied. A notice on pregnant employees shall be posted on the farm notice board.

Salary and wages

Employment and Labour Relation Act No. 6 of 2003, specifies that minimum wages for agricultural workers be enforced and multi-stakeholder forum be established to set living wages. The law emphasizes written contracts for every employee, grants sick leaves and annual leaves, and when applicable, housing allowance and promotion. The interests of part-time workers and unfair dismissal are also explained in this Act.

Long working hours

Agricultural workers must not be subjected to longer working hours than those stipulated by the national labour law; the management must adequately remunerate overtime and also consider unattended children at home because of overtime work.

Gender

The labour law requires that both men and women workers be treated equally, that they be provided with the same opportunity for promotion and sexual harassment is prohibited.

Child labour

Child labour is prohibited on the farms; children's welfare must be considered and facilitated to attend schools.

HEALTH AND SAFETY MEASURES

- Knives and other implements must be kept sharp – this reduces the risk of injury from using too much pressure when trimming and harvesting.
- If machinery is used, moving parts should be enclosed with guards, where possible.
- Adequate health and safety training should be provided if new technologies and/or working practices are introduced, e.g. if fertilizers or pesticides are recommended, measures should be in place for smallholders who cannot read instructions.
- Recommended fertilizers and pesticides should be packed in sizes that women can carry.
- Latrines should not be located near open water sources used for irrigation or drinking water.
- Properly located latrines should be available near sites of production – this enables smallholders to use these facilities when they need to, thus discouraging the incidence of defecation in the field, which increases the risk of faecal contamination.
- Smallholders should be trained in basic sanitation and personal hygiene to prevent unintentional transmission of food-borne illnesses to others, e.g. *Salmonella* spp.,

Shigella spp., *E. coli* and hepatitis A viruses; farmers should be informed that good hygiene protects them from illness.

- Farm workers with open sores, boils or infected wounds on parts of the body that might come into contact with others, or with fresh produce, must not take part in harvesting, sorting or packing.

SUMMARY

1. Health and safety measures are critical both to protect the growers and agricultural workers from possible injury and to avoid the occurrence of hazards in fresh produce eaten by consumers caused by, for example, poor personal hygiene. Misuse of chemicals, especially pesticides, can cause serious health problems and is, therefore, of concern to producers. It is important to ensure that growers are aware of and are trained to deal with health and safety measures.
2. Social issues important to horticultural supply chains, governing the relationship between employer and employee, are normally managed by codes of practice and include: Right to the legal minimum or a living wage; Restriction of child labour; Prohibition of forced and bonded labour; Rights to freedom of association and collective bargaining; Health and safety in the workplace.

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Module 9

Hygiene in the field

LEARNING OUTCOMES

- Understanding farm hygiene practices in relation to food safety and quality.

INTRODUCTION

Following the series of food safety crises that has hit several countries in the world, such as mad cow disease and dioxin, the protection of consumer health has become a major preoccupation. Farmers in the food sector are under the obligation to guarantee the innocuousness of the products that they distribute. Each actor of the food production and distribution chain has to take all the necessary measures so the food products that are put on the market present no risk for consumer health. Because food risks can originate in the production sites, in the field, in the packing plant or during transport, the rules of general hygiene applicable to the food sector are valid for primary production.

FIELD HYGIENE

A large proportion of fruit and vegetables are eaten raw. The operations linked to production in the field, in the packing plant, as well as the equipment and accessories used (machines, packaging material, etc.) must reduce to a minimum the potential risks for consumer health that may arise from the contamination of fresh fruit and vegetables.

Each producer must use measures of hygiene and practices that are adapted to the specific conditions of the site, the type of product, the methods and technologies used and the personnel, in order to control food risks and to favour the production of healthful food.

Hygiene of the field environment

The production of fresh fruit and vegetables must be avoided in areas where the presence of potential harmful substances could contaminate the fruit and vegetables produced.

When possible, before cultivating new land, the producer must evaluate the former uses of the sites as well as the adjacent sites, in order to identify the potential risks for fruit and vegetables.

Human and animal excrement constitute the first source of contamination of fruit and vegetables by pathogens. Multiple cases of food poisoning observed worldwide often originate from contamination by faecal matter. The abundance of labour of all ages (children, youths under 18, etc) on village farms constitutes an aggravating factor for the risk of faecal contamination. Very often women, who constitute the largest proportion of labour for harvesting and in packing plants, are accompanied by their children who go to the toilet anywhere on the site.

It would therefore be wise to set up systems to control access both to the fields as well as to the packing plants.

How to control the quality of agricultural inputs?

Well-prepared animal manure is a very effective and safe fertilizer. But if it is inappropriately used, this organic matter can contain pathogens, which are harmful to human health.

With the discharge of irrigation waters or strong rainfall, the micro-organisms of the manure can contaminate the crops. The fruit and vegetables whose edible part is not in contact with the soil present a lesser risk, on condition that they are not mixed up at harvest with the specimens already contaminated by the ground (e.g.: fruit picked off the ground).

Storage and use of manure

Manure must be stored so as to avoid contamination of the environment by runoff, seepage or by the wind. The construction of separation structures (concrete screed or clay bed, etc) around manure treatment or storage sites may help reduce the risks of contamination of underground water by the leachate.

Through runoff, rainwater falling on a heap of manure (the leachate) can cause microbiological contamination of the sites and crops. The leachate represents a risk comparable to that of the manure from which it originates.

It is necessary to manage the use of manure and other natural fertilizers (organic matter, etc) in order to limit the risk of microbial, chemical or physical contamination. Manure can in fact be contaminated by heavy metals or by other chemical products. It can also contain pathogenic micro-organisms.

In order to reduce the risks of contamination by the pathogens that they may contain, the following measures may be put into practice:

- Protect the heaps of manure under a roof or cover them with a tarpaulin.
- Do not store manure near a water supply or near where the harvests are stored.
- Clean the machines or accessories used to handle the manure before coming into contact with fresh produce.
- Establish a plan of circulation for the farm in order to avoid a tractor (for example) driving over manure before going into the fields.
- Bury the manure in the soil before planting the crops.
- Wait as long as possible to harvest after applying the manure.

Treatment of the manure

The quantity of pathogens can be reduced naturally by simply leaving the manure exposed to the fluctuations of temperature, humidity and outside light. In order to spread manure treated in this way on the crops, producers must be sure that its decomposition is well advanced. The duration of this decomposition varies according to the region and the climate, as well as according to the type and source of the manure. These passive treatments must not be confused with those that require the farmer to intervene, such as composting.

Animal exclusion

All animals including mammals, birds, reptiles and insects are considered vehicles for contamination with pathogenic organisms. A large number of micro-organisms can be found on the surface of animals (hair, feathers, hide, etc.) and in their respiratory and gastrointestinal systems.

In addition to food-borne pathogens, animals can carry much spoilage micro-organisms, which can greatly reduce the quality and shelf-life of fresh produce. Quality deterioration also can be accelerated by physical damage to the surface of the fruit or vegetables caused by animals, birds and insects. In addition to lowering quality, the wounded surfaces become an open door to pathogenic and spoilage organisms, greatly increasing the risk of contamination of the internal portions of the produce (Box 1).

BOX 1

Faeces are usually considered the major source of pathogenic organisms from animals

However

- ✓ Some pathogenic bacteria commonly associated with animal skin include *Salmonella*, *Staphylococcus* and *Streptococcus*.
- ✓ The feathers and other parts of domestic birds also can be contaminated with these organisms.
- ✓ Wild birds, reptiles and amphibians are potential sources of *Salmonella*.

Although it is impossible to eliminate all animal life from areas where fruit and vegetables are cultivated, measures to protect crops and particularly the harvests against the damage caused by animals must be taken.

It is advised to avoid letting domestic animals wander in crop zones. It is advisable to confine these animals (in a pen or courtyard, for example) or to protect access to crops with fences, for example.

Where it proves necessary, producers must envisage measures to guarantee that animal waste does not pollute crop zones.

Controlling water quality

On a farm, water has numerous uses: irrigation, dilution of pesticides and fertilizers, cleaning installations and equipment, etc.

It can be the source of direct contamination and spread micro-organisms into the crops. Thus, the water in contact with fresh fruit and vegetables is a potential source of pathogens. If these pathogens survive on produce, they can threaten the health of the consumer and cause food poisoning.

Water can spread numerous micro-organisms, such as the following pathogenic strains: *Escherichia coli*, *Salmonella* and hepatitis A virus. Depending on the nature of the pathogen, even a minor contamination can result in food poisoning. As far as possible, all the sources of contamination of farm water must be located.

Drinking water must be identified and distributed by a separate network from water that is not suitable for drinking (colour code, etc.). Drinking water supplies must not be contaminated by exposing them to agricultural inputs used for crops. Water quality must be regularly controlled by bacteriological and physico-chemical analyses. In order to reduce as much as possible the risks of contamination from water, irrigation methods should be adopted to avoid or to limit to a maximum the contact between the water and the fruit and vegetables (example, trickle irrigation).

Cleanliness of crop zone

Care must be taken with the cleanliness of crop zones and areas where harvests are handled and stored; the following measures should be undertaken.

- Waste must not accumulate in zones where fresh fruit and vegetables are handled and stored or in an adjacent environment.
- An appropriate area must be reserved for storing and eliminating waste. Appropriate infrastructures and equipment must be available for this purpose.
- The zone fitted out for collecting and treating waste must be situated far from water supply points and crop zones.
- Rubbish bins must be available to encourage waste collection.
- The containers for non-edible or dangerous substances must be specifically designated and be made of waterproof material.

If necessary, these containers must be locked in order to prevent deliberate or accidental contamination.

Toilets

Toilets must be available in order to ensure an appropriate degree of body hygiene.

If toilets are poorly managed, the risk of contamination of fruit and vegetables is considerably increased.

Good toilets enable not only to reduce the risk of contamination of fruit and vegetables, but they also help protect workers and consumers against food poisoning.

These toilets must be designed to ensure a hygienic elimination of waste and to avoid contamination of production sites, fresh fruit and vegetables and agricultural inputs (Box 2).

BOX 2

It is possible to install a septic tank when the following conditions are respected

- ✓ The ground must be permeable.
- ✓ The level of underground waters, rock or any impermeable layer must be more than 1.2 m under the soil surface.
- ✓ There must always be a minimum of 60 cm between the bottom of the hole and the level of the water table.
- ✓ The slope of the land must be less than 30 percent.

Microbial contamination from other foodstuffs or non-food sources can occur during loading, unloading, storage or transport (Box 3).

At each stage of the chain, the hygiene conditions of the transport and handling of fresh fruit and vegetables must be examined. Fresh fruit and vegetables must be separated from other foodstuffs and from any source of contamination by pathogens.

Some general hygiene rules for transport of fresh produce from the farm

The vehicles or equipment used for the transport of fresh fruit and vegetables must be kept clean in order to reduce the risk of contamination of these products.

BOX 3

Important considerations for fruit and vegetable when performing on-farm transportation

- ✓ Avoid unnecessary delays.
 - ✓ Protect from the sun, rain and dust.
 - ✓ Transport must happen with care to prevent damage.
 - ✓ Basic hygiene practices must still be followed.
 - ✓ Do not use same transport mechanism that is used to transport other products, i.e. animals, agriculture equipment or products.
- The cleanliness of the equipment is vital. Loading a product can be deteriorated by:
 - ✓ odours from preceding deliveries or incompatible loads;
 - ✓ residues of toxic chemical products;
 - ✓ insects living in the equipment;
 - ✓ remains of rotting agricultural products;
 - ✓ debris blocking the openings for evacuating the air circulating along the floor.

Case study 1 – Hygiene in the farm by Nandarasi Gate self-help group – smallholders snow peas growers in Kenya

Farm hygiene for Nandarasi Gate farmers is the rule of the day; they have assigned somebody to check and clean the toilets every morning and record what has been done, and outside of every toilet there is a container of portable water and soap for washing hands.



Pit latrine in the field is covered to control flies.



Toilet is cleaned every morning and records of hygiene are kept.



Water container and soap is placed outside of every toilet in the field.
Farm hygiene require everybody who visits the toilet to wash their hands with soap.

Source: *Bridging the GAP – supporting smallholders in Kenyan Export horticulture* –
Voice from the field: www.wrenmedia.co.uk; January 2007.

- The trucks and crates must be checked to verify their odour and their state of cleanliness before any new loading operation.

It is essential to know the nature of the preceding loads of the transport vehicle and take this information into account before using it for a new load: If the trucks are not cleaned between the different loads, those for example having recently transported animals, fish or non-edible products are a potential source of microbial contamination of fresh fruit and vegetables.

SUMMARY

1. The production of fresh fruit and vegetables must be avoided in areas where the presence of potential harmful substances could contaminate the fruit and vegetables produced.
2. Manure must be stored so as to avoid contamination of the environment by runoff, seepage or by the wind. The construction of separation structures (concrete screed or clay bed, etc.) around manure treatment or storage sites may help reduce the risks of contamination of underground water by the leakage.
3. All animals, including mammals, birds, reptiles and insects, are considered vehicles for contamination with pathogenic organisms. A large number of micro-organisms can be found on the surface of animals (hair, feathers, hide, etc.) and in their respiratory and gastrointestinal systems. Although it is impossible to eliminate all animal life from areas where fruit and vegetables are cultivated, measures to protect crops and particularly the harvests against the damage caused by animals must be taken.
4. In plantations, the toilets must not be situated near a source of irrigation water or in a place likely to be flooded by strong rainfall. Leaks from poorly constructed or badly located toilets may contaminate the soil, water supplies or the fruit and vegetables.
5. Before the harvest, the areas for storing fresh fruit and vegetables must be cleaned. These zones must be checked to ensure that they are not infected by pests, rats or insects.
6. When using open vehicle to transport fresh produce, care must be taken to protect the produce from dust, rain and the sunburn; the product should be covered throughout the journey, and the covered vehicle should have a ventilation system designed with wind catchers and ducts.

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Module 10

Assessment of maturity and harvesting

LEARNING OUTCOMES

- Understand the importance of maturity indices and their impact on shelf-life and quality.
- Develop an appreciation of how maturity indicators are determined.
- Participants understand the importance of best harvesting methods for small-scale farmers.
- Importance of using adequate harvesting equipment and appropriate containers.
- Importance of an effective hygiene programme to ensure containers are clean and equipment does not transmit pathogens to the produce.

Adapted from: *Horticultural Chain Management for Eastern and Southern Africa – Theoretical Manual*; FAO and Commonwealth Secretariat – March 2008.

INTRODUCTION

Fresh produce must be harvested at the correct stage of maturity if it is to maintain its quality attributes throughout its post-harvest life. Prematurely harvested produce is highly susceptible to shrivelling and mechanical damage and it is of inferior flavour and colour when ripe. Over-mature produce may be fibrous, soft and of poor eating quality in terms of sweetness, flavour and colour. It is, therefore, essential that those involved in harvesting receive training to identify the correct maturity indices for the produce concerned. Furthermore, careful and correct harvest techniques are essential in ensuring the integrity of harvested produce and preventing rejections at the pack house. Wounding during harvest can provide entry points for pathogens, therefore causing decay. Those involved in harvesting must be trained in efficient and careful handling of fresh produce.

PHYSIOLOGICAL AND COMMERCIAL MATURITY

Fruit quality is greatly impacted by maturity at harvest

Physiological maturity – refers to a particular stage in the development of a plant or plant organ. A fruit is physiologically mature when its development is over. A physiologically mature fruit may not necessarily be commercially mature. For example, papayas are harvested for domestic markets at physiological maturity, i.e. when three-quarters of the fruit assumes a yellow to green colour.

Commercial maturity – pertains to the timing of harvest to meet specific market and consumer requirements. A fruit is commercially mature when it reaches a developmental stage at which it can be marketed for a specific purpose, e.g. for consumption in the fresh state, or for processing. Papayas, for example, are harvested for export at the mature stage, i.e. when the fruit is firm and easy to handle. On arrival at the destination the fruit is ripened in ripening rooms.

Note that commercial maturity has little impact on physiological maturity.

TABLE 1
Established methods for the evaluation of maturity in horticultural crops

Subjective maturity indices	Objective maturity indices
Appearance – colour, size and shape	Total soluble solids concentration (TSS)
Touch – texture, hardness or softness	Titrateable acidity (TA)
Smell – odour or aroma	Firmness measurements
Resonance – sound when tapped	Oil content
Sweetness – sourness, bitterness	Dry matter
	Measurement of starch and sugar
	Total soluble solid concentration and acidity ration (TSS: TA)

Source: Adapted from *Horticultural Chain Management for Eastern and Southern Africa – Theoretical Manual*; FAO and Commonwealth Secretariat– March 2008.

MATURITY INDICES

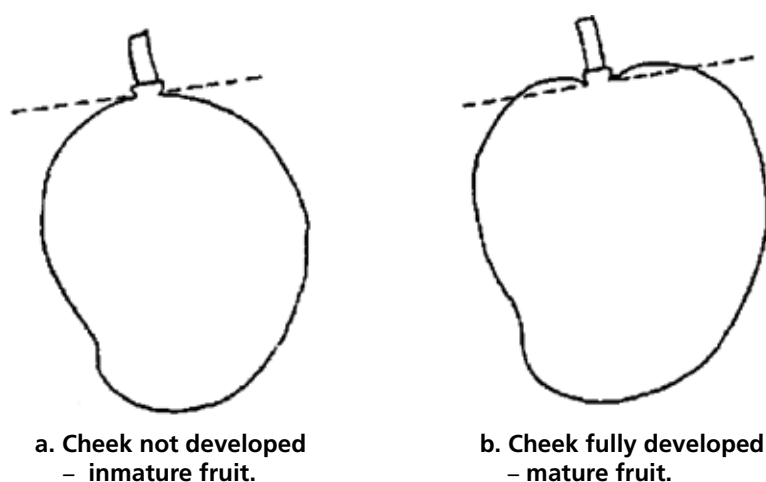
The maturity index of a fruit provides an indication of its stage of development or maturation. Maturity indices are based on characteristics that are known to change as the fruit matures. Maturity indices for harvest can be either subjective or objective (Table 1).

Subject criteria for evaluating fruit maturity

Fruit shape and size

Fruit shape may in some cases be used to evaluate maturity. Some cultivars, for example, become less angular in cross section with development and maturation. The size and shape of stone fruit, such as peaches in particular, is affected by variety, seasonal conditions, and crop load and orchard variability. Constant measurement of these fruits is, therefore, vital in order to determine when they are of a marketable size. Some fruits are considered mature when fruit shoulders and sutures are well developed and filled out. Similarly, the fullness of the cheeks adjacent to the pedicel in mangoes (Figure 1) provides an indication of maturity.

FIGURE 1
Physiological cheek development of mangoes



Source: Adapted from *Horticultural Chain Management for Eastern and Southern Africa – Theoretical Manual*; FAO and Commonwealth Secretariat– March 2008.

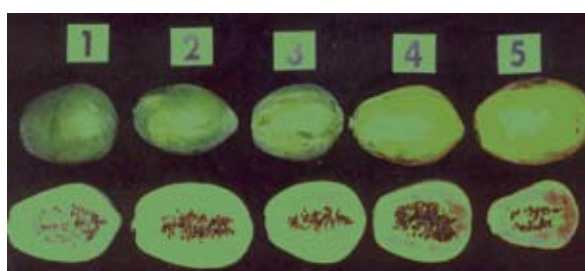
TABLE 2
Established methods for evaluation of maturity in selected horticultural crops

Maturity index (subjective)	Produce
Abscission	Melon
Colour	Tomato
Colour	Papaya
Stage of development	Lettuce
Cheek, size, colour, dry matter	Mango
Shape	Banana

Number of days after full bloom

Day after full bloom (DAFB) can provide an approximate harvest date or a “ballpark guess”. This approach relies on a reproducible date for the time of flowering and relatively constant growth period from flowering through to maturity. The major problem with this type of measurement is that there is little consistency from year to year and a wide range in suggested DAFB values.

FIGURE 2
Example of colour change for papaya



Source: Adapted from *Horticultural chain management for Eastern and Southern Africa – Theoretical Manual*; FAO and Commonwealth Secretariat – March 2008.

Fruit aroma

Volatile compounds synthesized during ripening give fruit their characteristic odour and provide an indication of the level of maturity. Fruit odour is generally detectable by humans when the fruit is completely ripe and is of limited use in commercial situations.

Fruit colour

As fruit mature and ripen they undergo a colour change from green to red or yellow, for example – papaya (Figure 2). The appearance of the colour for certain cultivars, e.g. tomatoes (Table 2) can, in some cases, signal an appropriate time to harvest. Skin colour is not, however, considered the most accurate index of maturity.

SAMPLING OF FRUIT FOR EVALUATING MATURITY

In order to determine the optimum harvest date within an orchard, a random sample of 20 fruit must be collected from each orchard block, and the soluble solids, firmness and starch content measured. Steps indicated in Box 1 must be followed for correct sampling:

Box 1

- ✓ Select five trees at random within the orchard block.
- ✓ Depending on the size of the fruit, pick fruit (about ten for small fruit such as litchi) of similar size from each tree at eye level, approximately 1.5 m from the ground.
- ✓ Select a mix of fruit from the inside and outside of the canopy and from a north, south, east and westerly direction; damaged fruit should be avoided.
- ✓ Sampling should be done a number of times leading up to harvest.

Maturity indices for selected fruit and vegetables are shown in Tables 3 and 4

TABLE 3

Maturity indices for selected fruit

Crop	Maturity indices
Citrus	<ul style="list-style-type: none"> • Change in colour (green to orange) • Ease of separation • Starch content • Rate of respiration • Days from blooming • Seed colour (green to brown) • Change in organic acid • Juice content (>50 percent)
Papaya	<ul style="list-style-type: none"> • 33 percent colour development for long-distance market and 85.5 percent colour development for local market • Harvested when fruit show signs of yellow to purple colour
Pineapple	<ul style="list-style-type: none"> • When fruit show signs of yellowing • High TSS and low acidity (TSS 13 percent, acidity 0.5–0.6 percent) • Tips of the bracts projecting as the eyes start drying • Acid ratio 21–27 and specific gravity 0.98–1.02
Banana	<ul style="list-style-type: none"> • Bunches are harvested when the top leaves start drying • The colour of the axis of the fingers changes from dark to light green • Brittleness of the floral ends should fall with slight touch • Changes in the angularity of fingers from triangular to round or sharp • Number of days from emergence of inflorescence: 95–110 days • Pulp to skin ration – 120:1.2
Mango	<ul style="list-style-type: none"> • Slight colour development of the shoulder or fullness of the shoulders; change in colour of pedicel from green to brown • Growth of the fibres on the stone/corrugations • Flow of latex from the stalk, e.g. faster drying latex • Summation of days taken from flowering to maturity by tagging flowers • Appearance of bloom on the surface of the fruit • Computation of heat units or cumulative degree day • Change in lenticel morphology • Specific gravity of 1.0–02 for varieties Alphonso and Pairi

Source: Adapted from: *Horticultural chain management for Eastern and Southern Africa – Theoretical Manual*; FAO and Commonwealth Secretariat– March 2008.

TABLE 4

Maturity indices for selected vegetables

Crop	Maturity indices
Peas	<ul style="list-style-type: none"> • Sugar content> 5–6 percent: sugar declines with maturity; ration of starch to protein increases • Tenderness and appearance of pods – should be well filled with young tender peas • Changing in colour from dark to light green, with firmness of 5kg/cm²
Carrots	<ul style="list-style-type: none"> • Size is the primary consideration and at least ¾ diameter • Proper colour development, without zoning
Tomato	<ul style="list-style-type: none"> • Mature green, pink or breaker (just starting to turn red) and red ripe • Pulp surrounding the seeds is jelly-like, seeds slip away from the knife • For long-distance shipment, is harvested at the mature, green stage • The ripe stage indicates that most of the surface is pink or red, and firm

Source: Adapted from *Horticultural chain management for Eastern and Southern Africa – Theoretical Manual*; FAO and Commonwealth Secretariat– March 2008.

HARVESTING

Manual harvesting

Manual harvesting is one of the most popular methods of harvesting produce. Workers must, however, be properly trained if quality is to be assured. The selection of a harvesting procedure will depend on the produce characteristics.

Advantage of manual harvesting

Manual harvesting remains one of the most popular methods for harvesting produce:

- Pickers can selectively pick if trained properly.
- Selective picking can also ensure that fruit only at its required quality is harvested, i.e. required size, colour, free from defects and diseases.

Basic principles for harvesting

- Harvest good quality crop.
- Maintain hygiene and quality standards during harvesting and throughout the post-harvest chain.
- Harvest during the coolest part of the day – early morning or late evening under light conditions.
- Protect the harvested produce in the field by keeping it in a shaded environment.

How to harvest fresh produce

Vegetables

Either the whole or a part of vegetative growth can be harvested by hands only or sharp knives. Knives must be kept sharp and clean at all times to prevent from spreading virus diseases from plant to plant. Harvesting methods vary with plant parts harvested:

- leaves only (spinach, rape, etc.) and lateral buds (Brussels sprouts): the stem is snapped off by hand;
- above-ground part of the plant (cabbage, lettuce): the main stem is cut through with a heavy knife, and trimming is done in the field (the cut stem must not be placed on the soil);
- bulbs (green onions, leeks, mature bulb onions): immature green onions can usually be pulled from the soil by hand; leeks, garlic and mature bulb onions are loosened by using a digging fork as for root crops (such as carrots) and lifted by hand.

Flower structures

Immature flower heads (cauliflower, broccoli) can be cut with a sharp knife and trimmed in the field; broccoli can be snapped off by hand and subsequently trimmed.

Fruits

Many ripe fruits and some immature seed-bearing structures, such as legume pods, have a natural break-point of the fruit stalk, which can easily be broken at harvest. Fruit and other seed-bearing structures harvested in the immature or unripe green state are more difficult to pick without causing damage to either the produce or the plant. These are best harvested by cutting them from the plant, using clippers, secateurs or sharp knives. The clippers may be mounted on long poles for tree fruit, with a bag attached to the pole to catch the fruit. Plucking methods vary according to the kind of produce being harvested:

- Ripe fruit with a natural break-point, which leaves the stalk attached to the fruit, are best removed by a “lift, twist and pull” series of movements, e.g. apple, passion fruit, tomato.
- Mature green or ripe fruit with woody stalks that break at the junction of the fruit and the stalk are best clipped from the tree, leaving up to a centimetre of fruit stalk attached. If the stems are broken off at the fruit itself, disease may enter the stem scar and give rise to stem end rot, e.g. mango, citrus, avocado.
- Immature fruit with fleshy stems can be cut with a sharp knife, e.g. zucchini, okra, papaya, capsicum; these can also be harvested by breaking the stem by hand, but this method may damage the plant or fruit and the rough break will be more susceptible to decay than would a clean cut.

Recommended good harvesting procedures

- Use white clean cloth and gloves.
- Use correct clean containers.
- Prevent overfilling.
- Prevent damaging the fruit, dropping the fruit in to the containers at a distance and rough handling.
- Use selective harvesting and correct maturity index.
- Use correct equipment and harvesting techniques.
- Harvesting time and weather conditions.

Harvesting containers

Rigid containers, such as wooden and plastic crates, and plastic buckets can be used for the field collection of harvested produce. Containers must be smooth, with no sharp edges or projections as these could damage the produce. They must be clean and must not be overfilled.

Harvesting bags equipped with either shoulder slings around the neck, or waist slings, can be used for the collection of firm-skinned fruit such as citrus and avocados. They are easy to carry and leave both hands free to harvest. Harvesting bags must be designed to open at the base, so as to allow produce to be emptied easily into a field container without tipping the bag.

GAP DURING HARVESTING

Containers used for field collection

- Must be smooth, with no sharp edges or projections to damage the produce.
- Must be clean.
- Must not be overfilled.

Harvested produce

- Must not come into contact with the soil or contaminated surfaces, e.g. surfaces that are visibly contaminated with dirt, oil or chemicals.
- Must not be dropped.
- Must be gently transferred to collection bins and protected from sun or rain until such time that it can be transported to the pack house.

Cuts and bruises must be avoided during harvesting operation.

Personnel, participating in harvesting and grading

- Farm workers who are in direct contact with fresh fruit and vegetables must have good habits of body hygiene and wear clean clothes and cover their hair.
- Any farm worker with cuts or wounds, if authorized to continue working, must protect them with waterproof bandages.
- They must wash their hands with soap, before starting harvesting of fruit and vegetables and each time they return to the handling areas after a pause, immediately after having used the toilets and after having handled any contaminated product. It is recommended to brush under nails and between nails, rinse and dry the hands with the dry towel. The use of shared towels is not advisable.
- Each farm worker must go through hygiene checklist; those who fail hygiene check should be leased to go back home.

The state of health of the staff involved in harvesting

- Staffs with health problems involving diarrhoea or open lesions (skin lesions or infected wounds) constitute risk vectors.
- Any person with cuts or wounds must protect themselves in order to avoid any direct contact with the products. A purulent lesion or an infected wound may come into contact with fresh fruit and vegetables or equipment used for their harvesting, and transmit infectious diseases.
- Staff known to carry a certain disease or infection must not be authorized to go into the zone where products are handled. Any person in this situation must immediately inform management of the disease or symptoms.

Personal behaviour during the harvest

- The farm worker must avoid behaviour that can lead to contaminating food, such as smoking, spitting, chewing gum, eating, sneezing or coughing, near non-protected fruit and vegetables.
- Personal belongings, such as jewellery, watches or other objects, must not be worn or taken into fresh fruit and vegetable harvesting zones.

SPECIFIC HARVESTING TRAINING NEEDS

- The methods of evaluating the readiness of the crop for harvest, and the rejection of unsuitable produce at harvest, according to market requirements.
- The actual technique to be employed in harvesting produce, e.G. Breaking the stem or plucking, clipping, cutting or digging.
- The use of harvest containers and the transfer of produce to field or marketing containers.
- The selection of marketable produce at the field assembly point and (if applicable) grading for size and quality.
- The correct application of post-harvest treatment (where produce is to be packed on the farm directly into marketing packages), e.G. Fungicides, wax coating.
- The method of packing market packages or other containers.

TEMPERATURE MANAGEMENT DURING HARVESTING

At harvest, the temperature of the fruit is close to that of the ambient air, which varies according to the location and time of year. In order to ensure the lowest possible temperature at harvest, it is generally recommended that fruit and vegetables be

harvested during the coolest part of the day, which is usually early morning. Citrus fruits are one exception to this recommendation, given that they are damaged if handled in the morning when they are turgid.

Harvest produce must be retained under shade or in a cool temporary storage area, and must be pre-cooled within the shortest period of time in order to remove the field heat.

The use of charcoal cooler for pre-cooling practice

In Tanzania, most of production areas are not accessible to electricity, it is therefore recommended to use a charcoal cooler for pre-cooling practices. A “charcoal cooler” is made of charcoal between chicken wire mesh, The charcoal cooler should be designed to ensure that all air passing into the cooler passes through the charcoal (no gaps in the charcoal walls). The charcoal should be kept wet to enhance the cooling effect. This can be achieved using a drip line at the top of the charcoal wall, fed from a water tank on the roof. Always remember to maintain product traceability throughout all operations.

Regardless of the cooling method used, care must be taken to assure the cooling medium does not contaminate the produce.

GAP FOR THE MAINTENANCE OF HARVESTING EQUIPMENT

All field equipment used in harvesting produce must be cleaned and repaired on a regular basis. It is important that farmers ensure that all equipment (i.e. knives, pliers) issued to harvesters is accounted for at the end of the picking day. Farmers must also check whether all equipment is still sound and unbroken. If a knife blade is broken, the harvester’s batch numbers must be traced and the produce put on hold to prevent physical contamination.

If produce has been delivered to a pack house, the manager should be informed and the batch put on hold. If a pack house is HACCP-certified, it is essential that pack house management be notified. Under such circumstances, pack houses might implement online metal detectors for the identification of contaminated batches.

Torn bags, broken boxes and other containers used in harvesting must be repaired if produce damage is to be avoided; wooden splinters from containers, for example, could cause wounding of produce, ultimately resulting in infection and decay. Broken equipment is also difficult to maintain in a hygienic condition because small cracks provide the ideal niche for microbes, which may cause decay or present a food-safety concern.

Regular cleaning of all harvesting equipment is essential. All harvesting tools must be washed daily in a soap solution and in certain cases, as occurs with heavy soil or sticky substances, a disinfectant such as bleach should be used at recommended concentrations. The intervals for cleaning larger items of harvesting equipment, such as large collection containers, will vary in accordance with the type of produce harvesting season, while harvesting crates should be washed daily to remove the latex secretions from the stem-end of the fruit; if not removed regularly, the mango crates will become stained and soiled, which should pose a food-safety risk.

All harvesting equipment should be stored overnight in a closed facility, protected from rats and birds. The most important reason for protecting the equipment at night, or over weekends or during non-harvesting periods, is to ensure that the equipment stays

intact and is not contaminated with animal faeces unnecessarily, which could introduce a food-safety risk further down the chain. Maintaining harvesting equipment makes sound economic sense, because such equipment often reflects considerable investment by the farmer.

Case study 1 – Hygiene during the harvesting – Kenya peas grower, Mr Gerald Wanjohi

“All water I use in the farm and grading shade is treated with *WaterGuard*. I maintain four water cans; HW1 is set at grading shade, HW2 at the toilet, HW3 at the chemical store, and HW4 as portable water, which I carry to the farm during picking, just in case somebody can sneeze necessitating to wash hands. My grading shade table is covered with washable PVC to avoid bacterial contaminations from wood surfaces; after grading, the fine beans are kept in crate attached with labels with details of crop specifications including farmer’s name, block number, date, product and varieties. Even if a piece of hair is found in the crate, it can be traced to the particular plot and the people who handled it.”

Source: Voice from the field: www.wrenmedia.co.uk; January 2007.

Case study 2 – Beth Muthoni – Fine beans grower in Kenya

Before going to the field to harvest, I and my colleague go through hygiene checklist. For example, the pickers nails have to be short, clean with no paint or vanish. The pickers are also not allowed to wear any perfumes. Picker who fails hygiene checklist are leased to go back home. The remaining ones wash their hands thoroughly and proceed to the farm to harvest.

While harvesting, we are trained not to cut the calyx to reduce the chance of rotting. After harvest the beans are kept in the minimum shade to protect them from scorching sun. During transporting to the grading shade, beans are covered to avoid any contamination.

The graders wash up and change into white overalls and head covered before starting grading.

Source: Voice from the field: www.wrenmedia.co.uk; January 2007

Analysis

Kenya farmers maintain hygiene during production and harvesting to protect the produce from contaminations, hence protecting the consumers’ health and their market as well.

SUMMARY

1. Fresh produce must be harvested at the correct stage of maturity if it is to maintain its quality attributes throughout its post-harvest life.
2. The maturity index of a fruit provides an indication of its stage of development or maturation. Maturity indices are based on characteristics that are known to change as the fruit matures.

3. Manual harvesting is one of the most popular methods of harvesting produce. Workers must, however, be properly trained if quality is to be assured.
4. Harvested produce must:
 - not come into contact with the soil or contaminated surfaces, e.g. surfaces that are visibly contaminated with dirt, oil or chemicals;
 - not be dropped;
 - be gently transferred to collection bins and protected from sun or rain until such time that it can be transported to the pack house.
5. Farm workers who are in direct contact with fresh fruit and vegetables must have good habits of body hygiene and wear clean clothes and cover their hair.
6. Staff known to carry a certain disease or infection must not be authorized to go into the zone where products are handled. Any person in this situation must immediately inform management of the disease or symptoms.
7. The farm worker must avoid behaviour that can lead to contaminating food, such as smoking, spitting, chewing gum, eating, sneezing or coughing near non-protected fruit and vegetables.
8. Harvest produce must be retained under shade or in a cool temporary storage area, and must be pre-cooled within the shortest period of time in order to remove the field heat.
9. All field equipment used in harvesting produce must be cleaned and repaired on a regular basis.
10. All harvesting equipment should be stored overnight in a closed facility, protected from rats and birds.

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Module 11

Traceability and record-keeping

LEARNING OUTCOMES

- Participants understand the importance of traceability and record-keeping.
- Understand the key component of a traceability system.

PRACTICAL

- Prepare recording sheets for the product traceability.

INTRODUCTION

Consumer safety has become one of the most critical and priority issues for the food supply chain, an effective and cost-efficient traceability system to pinpoint a source of problem to a specific region, packing facility, group of growers, a grower or even a field is needed. Each farmer or farmer group must keep records to facilitate traceability of the product at all stages from “farm to fork”, i.e. from the field in which the crops are grown (and under what conditions), to the pack house and from the pack house to the airport cool stores, and finally on to the supermarket and the consumer.

WHAT IS TRACEABILITY?

According to Codex Alimentarius, traceability or product tracing is the ability to follow the movement of food through specified stages of production, processing and distribution. This definition encompasses two concepts:

- tracking**, which refers to the ability to determine in real time the exact location and status of the produce in the logistic chain;
- tracing**, which refers to the ability to reconstruct the historical flow of produce on the basis of records maintained throughout the chain.

Why is traceability so important?

The traceability system provides an important element of **Quality** and **Safety Assurance** in the horticultural chain. The product can be traced back through the supply chain to the site of the production, including the inputs used, operation undertaken during production, post-harvesting and marketing. It also allows the product to be tracked as it moves through the chain from the producer to consumer (Figure 1). In doing so, the traceability system can facilitate

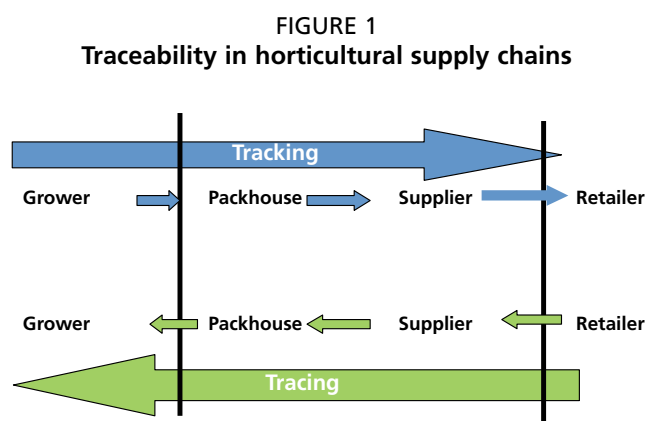


FIGURE 2
A farmer displaying a simple handwritten record in
her French bean plot



product recall and withdrawal and assist the management to identify the origin of the food safety problem.

What are the key components of traceability?

A traceability system includes a documentation system and mechanism for marking the produce, thereby allowing it to be followed from the farm to the consumer. A record must be kept at each step of the supply

chain, i.e. in the field, at the pack house, at the supplier and the retailer, and during the transit from each of these points.

How can small-scale farmers implement traceability?

At small-scale farmer's level, a simple handwritten product label and hand written records held at various steps in the chain is recommended (Figure 2).

EXAMPLE OF USE OF RECORDS AS MANAGEMENT TOOLS

A traceability system enables the company to investigate the source of food contamination whenever such case is reported. For example, if a product contains at least a minimum of the following information:

- Date of harvest
- Farm identification number
- Who handled the product from the grower to consumer
- Identifying code at each distribution level for retail

A company will use the above information to conduct an investigation. Efforts in this investigation will focus on locating possible sources of contamination. Investigators may look at factors such as water management and drainage, flooding or other weather-related contamination, waste management and manure usage, sanitation and handling of tools and equipment, worker health and hygiene, and management of both domestic and wild animals. Once the investigators establish the source of contamination, correction measures will be put in place to prevent further occurrence of the problem.

On other hand, small-scale farmers stand to benefit from keeping operation records and related costs to compare the benefits of implementing GAP in their farms. The revenue from sales of produce is compared to the costs of inputs and farms operations. The information generated from this exercise enables the farmers to implement cost reduction strategies and improve production systems. In a broad term, this improves food security, food safety and quality and environmental sustainability of agriculture. Table 1 shows an example of how farmers could keep the records and calculate the operation costs and profit.

Comments

A farmer has generated TZS 309 000 as profit within three months investment in green pepper farming; green pepper farming business is viable to Mr Adrian Massawe.

Pesticide use and application record

Name of farmer: _____

Farm location: _____

Crop: _____

Hectares: _____

TABLE 1

Example of GAP record-keeping and calculation of profit and loss for small-scale farmers

Farmers name:		Adrian Massawe	Crop: Green pepper	Hectares: 1.0
Date	Farm operation	Costs (TZS)		
20/4/08	Land preparation	45 000		
1/5/08	Seedling nursery preparations	12 000		
15/5/08	• Seeds (gm)	35 000		
	• Labour	12 000		
	• Implements and other inputs (fertilizer, pesticide, etc.)	24 000		
	• Nursery maintenances	40 000		
2/6/08	Seedling transplanting related costs (labour, watering, etc.)	32 000		
12/6/08	Irrigation costs	65 000		
25/6/08	Fertilizers (quantity and costs) 4 bag urea @30 000	120 000		
29/6/08	Labour cost for application of fertilizers	40 000		
1/7/08	Pesticides (quantity and costs) 4 liters @25 000/liter	100 000		
13/7/08	Labour for pesticide application	25 000		
16/7/08	Weeding (labour costs)	60 000		
2/08/08	Harvesting and sorting labour costs	45 000		
2/08/08	Transportation to pack house	20 000		
	Total farm operation costs	675 000		
Date	Produce sales			
	Kg	Sales (TZS)	Costs (TZS)	
2/08/08	800	@400	320 000	
12/08/08	1 200	@400	480 000	
24/08/08	460	@400	184 000	
		Total	984 000	

Profit and loss calculation from green pepper farming		
Sales revenue (TZS)	Farm operation costs	Profit
984 000	675 000	+309 000

Fertilizer application

Name of farmer: _____

Farm location: _____

Crop: _____

Hectares: _____

GAP EMPHASIZES ON KEEPING FIELD OPERATIONS AND COSTS RECORD

For producers/growers to be able to realize the benefits of GAP, it is important to keep records for each field operation and related costs. Through the records you can monitor the profit or loss. At the end, the producer should be able to make its own assessment of performance and achievement.

Date applied	Name of operator	Hours worked	Field name/ number	Pesticide			Application		Reason for application	Harvest interval	Harvest date
				Product name	Active ingredient	Supplier	Rate	Method			

Comments _____

Example of record-keeping format for field operations

1. Farmer: _____
 - a. Name: _____
 - b. Address: _____
2. Site: _____
 - a. Location: _____
 - b. Altitude: _____
 - c. Topography: _____
 - d. Soil type: _____
 - e. Rainfall: _____

Mean annual (mm): _____

Mean monthly (mm): _____
 - f. Temperature – means monthly maximum and minimum: _____
 - g. Water supply for irrigation (source, quality, reliability): _____
 - h. Vegetation: _____
 - i. Previous land use: _____
3. Area of crop: _____
 - a. Total area of farm (ha): _____
 - b. Current year's planting (ha): _____
 - c. Previous year's planting (ha): _____ Production (kg): _____

Land preparations

Date	Operation	Method	Cost	Outcome

Nursery activities (where seedlings are produced for transplanting)

Date	Operation	Materials used (type, quantity, cost)	Labour (quantity, cost)	Outcome

Transplanting (where practiced)

Date	Area planted	No. of seedlings	Spacing	Cost	Outcome

Sowing (where direct seeding is practiced)

Date	Area	Seed (gm)	Method	Spacing	Cost	Outcome

Fertilizer application

Date	Area	Amount (Kg)	Type	Material cost	Labour cost	Impact

Irrigation

Date	Area irrigated	Method	Material quantity/cost	Labour amount/cost	Impact

Weed control

Date	Area weeded	Method	Material quantity/cost	Labour amount/cost	Impact

Pest and disease control

Date	Type of pest/disease	Impact pre-treatment	Treatment date/type	Materials quantity/cost	Labour amount/cost	Result of treatment

Harvest

Date	Area	State of crop	Method	Cost	Outcome

Sorting, cleaning, packing

Date	Method	Materials quantity/cost)	Labour amount/cost	Outcome

Production and sales

Area harvested	Date planted	Date harvested	Quantity harvested (kg)	Quality grade/%	Value of crop sold

WHY A PRODUCER NEEDS A PRODUCT QUALITY CONTROL REPORT

Raw materials are defined as product brought in from a grower or producer normally in an unsorted or partially sorted condition requiring further processing, e.g. washing, grading, selection. It is essential that raw material is safe, legal, and meets the standards and specifications laid down. The responsibility for ensuring that growers understand and accept their own responsibilities rests with the buyer of the produce. It is essential to explain the use of this record to growers; by doing so, the growers can make prevention measures if anything is wrong with the produce.

Product quality control reports should be prepared covering

- Product, variety
- Date of receipt, time of receipt and inspection
- Source, grower's code or name
- Total of consignment and total inspected
- Weight (or count) to be recorded
- Temperature on receipt
- Quality and condition of product
- Decision (accept/accept with proviso on further sorting/reject with explanation of reason)

TRAINING RECORD

Each grower should keep a training record to verify the level of competence in GAP.

1. A training record should cover the following:
2. Name of the farmer
3. Knowledge on:
 - GAP
 - Record-keeping
 - Personal hygiene (including health and safety)
 - Crop hygiene (including harvesting and handling of crops)
 - Pest and disease control
 - Maintenance of equipment
 - Cleaning and calibration of equipment
 - Use of protective clothing
4. Date tested and comments

SUMMARY

1. Traceability or product tracing is the ability to follow the movement of food through specified stages of production, processing and distribution.
2. A traceability system includes a documentation system and mechanism for marking the produce, thereby allowing it to be followed from the farm to the consumer.
3. Small-scale farmers can implement a traceability system by simply keeping a handwritten product label and handwritten records at various steps in the chain.
4. A traceability system enables the company to investigate the source of food contamination whenever such case is reported and implement preventive measures.
5. Small-scale farmers benefit from keeping records of operations and other related costs, as such information is used to calculate the profit and loss of farming business.

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Chapter 4

Developing an effective training course

INTRODUCTION

This section is aimed at assisting trainers in implementing the steps for planning, organizing and evaluating a training course. It complements the other sections on good agricultural practices for improving the safety and quality of fresh fruit and vegetables by providing information that can be useful in the preparation of a training course. This section is based primarily on cited FAO publications related to training methods and planning for effective training.

Module 1

Planning for effective training – identifying needs and setting objectives¹

LEARNING OUTCOMES

- To assist trainees in applying the key steps in planning effective training
- To provide practical information on identifying training needs and setting training objectives

PRACTICAL

- Problem solving exercise: Planning an effective training course on GAP

INTRODUCTION

Training is a complex activity and must be carefully planned. Too often when technical experts are hired to conduct a workshop or a training session little thought is given to careful planning and design of the instruction. Design and preparation of a training course usually consumes more time than delivery of the material. This Module reviews steps for effective planning and delivery of a training course.

Definitions

- Training** – extends and develops capabilities for better job performance. It involves transfer of new knowledge, skills, behaviours and attitudes to perform specific roles in the workplace.
- Trainers** – include extension educators, university faculty, government officials, NGOs, industry personnel and consultants.
- Trainees** – are the people responsible for producing or handling fresh fruit and vegetables.

As already stated, training extends and develops capabilities for better performance on the job. It involves transfer of new knowledge, skills, behaviours and attitudes to perform specific roles in the workplace. Persons charged with training to improve the quality and safety of fresh fruits and vegetables include extension educators, university faculty, government officials, industry personnel and consultants. The audiences, or trainees, are the people responsible for producing or handling the fresh fruit and vegetables, i.e. the farmers (both managers and workers) and packing house and warehouse personnel.

¹ Adapted from *Improving the Safety and Quality of Fresh Fruits and Vegetables – A Training Manual for Trainers*, 2002, University of Maryland.

Trainee motivation

People are motivated to learn when they see that:

- ✓ through learning they can satisfy a need or a want;
- ✓ they may earn prestige, and/or increase their income and therefore provide a better livelihood for themselves and their family.

In all training/learning environments trainee motivation is essential for receptivity and learning. Research has shown that learning is at a maximum when people are motivated to learn (Knowles *et al.*, 1998). For example, fresh food that is produced using GAP can result in more income to all involved in the production process.

To highlight the importance of improving the quality and safety of fresh fruit and vegetables, trainers may outline the following points:

- Agriculture makes an important contribution to the economy of most countries
- Fresh fruit and vegetables have been associated with outbreaks of food-borne illness, some of which have resulted in deaths
- Food produced for rural and urban communities and for the export market must be safe to avoid human illness and lost trade opportunities
- Safe food is vital in protecting consumer health and the reputation of the exporting country
- Safety and quality controls are required at all stages in the food chain, including that of the primary producer: the farmer or grower
- During implementation of training, continually referring to these practical considerations will help trainees recognize the importance of the subject matter and motivate them to learn

Planning for effective training

- ✓ Identify the participants and set a date for the training course
- ✓ Assess needs of the training participants
- ✓ Set training objectives
- ✓ Prepare and organize training content
- ✓ Select training methods and prepare materials
- ✓ Organize the training course
- ✓ Develop evaluation strategy

Successful training requires careful planning by the trainer. Planning helps the trainer determine that the appropriate participants have been invited to the training course and that the training is designed to meet their needs in an effective way.

IDENTIFY THE PARTICIPANTS

Target audiences may be identified by the trainer or by other professionals as an observed group needing assistance. Alternatively, trainers may be approached by a group of several individuals seeking help to address a common problem or need.

To address a common need it may be necessary to provide two different levels of training: one for training of trainers (ToT) and the other for farmers. It is important to ensure that all of the trainees have received the appropriate level of information to bring about the desired change and achieve training objectives.

Adult learning is strengthened when:

- ✓ The message is pitched at the right level
- ✓ The message adds to or builds on the existing knowledge of the audience
- ✓ The learner is motivated and has a desire to learn

Research indicates that learning by adults is strengthened when: (Zemke and Zemke, 1984):

- The message is pitched at the right level
- The message adds to or builds on the existing knowledge of the audience
- The learner is motivated and has a desire to learn

Farmers carry out many of the tasks that affect quality and safety of fresh produce. Therefore, they are a primary audience for training on improving the safety of fresh fruit and vegetables. Farmers generally have a great deal of life experience and knowledge about farming practices and can build on this base knowledge through access to information. Recognition of their existing knowledge by the trainer is important for a productive learning environment. A trainer should respect the expertise of the farmers in order not to appear insulting. Farmers may come to the training environment with strong fixed ideas on the subject matter. These ideas may interfere with their acceptance of new information or new skills. A respectful attitude and presentation of training material that adds to existing knowledge will help ensure acceptance of new ideas.

To ensure the information is delivered at the appropriate level, the trainer needs to listen and learn from the target audience about their existing level of knowledge. A formal assessment of their understanding of the subject matter can be made as indicated below.

Once the target audience is identified, the trainer should ensure that they are invited and able to attend the training course. The trainer may need to determine the most appropriate season, days of the week and time to conduct the training course to ensure the participation of the identified group.

ASSESS PARTICIPANTS' NEEDS**Needs assessment**

A needs assessment:

- ✓ Identifies the gap between “what is” and “what should be”
- ✓ Indicates what training should focus on
- ✓ Helps to define the training objectives and the selection of the training activities

Perhaps one of the most important and most often overlooked aspects of the planning stages of a training course is needs assessment. As already stated, a needs assessment

identifies the gap between “what is” and “what should be.” It indicates what training should focus on and helps to define the training objectives. It also aids in the selection of the training activities (Swanson *et al.*, 1997).

The assessment indicates what the participants want and need from the training so that the training course is useful to the participants (Swanson *et al.*, 1997). Based on this, the training objectives for the course can be established.

A needs assessment helps avoid common mistakes in training, such as:

- ✓ Including a topic that is already familiar to the trainees
- ✓ Including a topic that has little relevance for the trainees
- ✓ Omitting a topic that is important to the trainees

The trainer may have a perception of the needs of the trainees, but validation of needs is essential. A realistic look at the situation of the trainees will help the trainer focus the presentation to the needs and realities of the participants. A need assessment will also indicate additional information that should be presented, identify problems trainees may have with the topic and provide information on possible constraints that could prevent trainees from applying the new information and practices.

An assessment of the trainees’ needs can be carried out by meeting with the trainees, administering questionnaires and/or reviewing key materials such as policy documents, annual reports and evaluations. The needs assessment can be conducted in advance of the training or in the initial stages of the training course. The trainer should be alert to any new needs or problem areas the trainees may identify during the course.

A trainer who is less familiar with the specific circumstances and working environment of their trainees may need to conduct a more in-depth needs assessment. It might include gaining an increased familiarity with the trainees’ concerns through field visits, discussions with their supervisors and/or more in-depth interviews with the trainees.

SET TRAINING OBJECTIVES

Training objectives state what will be accomplished as a result of the training and are defined in light of the needs identified. They arise out of gaps and deficiencies identified in the process of needs assessment. Training objectives may indicate that trainees will display an understanding of certain concepts, demonstrate a given skill or show a change in attitude. Content, method of instruction, reading material, lab exercises and forms of evaluation strategies are all derived from identifying the training objectives. Without measurable training objectives, learning cannot be successfully planned or evaluated.

Clear training objectives provide a sound basis for:

- ✓ Organizing the trainer’s work
- ✓ Informing trainees of the learning expected
- ✓ Selecting the training materials and methods
- ✓ Delivering an effective training program
- ✓ Evaluating the success of the training course

Well-defined training objectives will keep all involved on the right track throughout the training. They provide an important link between the needs assessment and the design and preparation of the training materials. The trainer can assess if the objectives were met, indicating whether the training was successful in meeting the needs of the trainees. The training objectives therefore provide the basis of evaluation.

Objectives for training may involve:

- ✓ Improving skills
- ✓ Increasing knowledge
- ✓ Changing attitudes

In converting needs into objectives, three areas of performance may be identified: skills, knowledge and attitude (Swanson *et al.*, 1997). Skills-related objectives indicate what the trainee can do, demonstrate or perform as a result of the training. Knowledge-related objectives refer to the participants' ability to identify, define or describe given concepts as a result of the training. Attitude objectives are less easy to measure although it may be useful to make explicit the desired attitudinal change.

The trainer and the trainees should understand and agree on the objectives of the training course. It is a useful technique for the trainer to refer to the course objectives at key times in the course to ensure that the trainees recognize how the training is progressing towards achieving the objectives. When participants know what is expected of them they can organize their efforts more effectively.

SUMMARY

1. Training involves transfer of new knowledge, skills, behaviours and attitudes to perform specific roles in the workplace.
2. In order for training to be effective, trainees must recognize the importance of the subject matter and be motivated to learn. With regard to the safety of fresh fruits and vegetables, training is important because:
 - Agriculture makes an important economic contribution to most countries
 - Fresh fruit and vegetables have been associated with outbreaks of food-borne illness, some of which have resulted in deaths
 - Food produced for local use and for the export market must be safe
 - Safe food is vital in protecting consumer health and the reputation of the exporting country
 - Safety and quality controls are required at all stages in the food chain.
3. The steps in planning for effective training include:
 - Identify the participants and set a date for the training course
 - Assess the needs of the training participants
 - Set training objectives
 - Prepare and organize training content
 - Select training methods and prepare materials
 - Organize the training course
 - Develop an evaluation strategy.

4. A needs assessment identifies the gap between “what is” and “what should be.” It indicates what the training should focus on, helps to define the training objectives and aids in selection of the training activities.
5. Training objectives state what will be accomplished as a result of the training and are defined in light of the needs identified. They arise out of gaps and deficiencies identified in the process of needs assessment.

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Module 2

Preparing and organizing the training content¹

LEARNING OUTCOMES

- To assist trainees in applying key steps in planning effective training
- To provide trainees with practical information on organizing the content of the training course
- To provide trainees with practical information on selecting training methods and teaching aids

PRACTICAL

- Problem solving exercise: Planning an effective training course on GAP
- Field site visit guide

INTRODUCTION

The content of the training course should link directly with problem areas identified in the needs assessment and the training objectives. The training content can be organized in outline form to help prioritize and sequence the material (Swanson *et al.*, 1997). The end result should be that the training content is presented at the correct level to meet the objectives of the trainees.

Preparing and organizing the training content

- ✓ The training content and flow of information should maintain the interest of the audience
- ✓ The training content can be organized in outline form
- ✓ Each step in the outline should contain a distinct message that may be presented in introduction, body and conclusion form

In some instances the trainer may have a very clearly defined objective, even before the needs assessment. For example, when a new law is being introduced, certain groups may need to be informed about the new law, how it will affect them and their responsibilities under it.

Outlining the training content will help identify the key messages to be presented. Presentation of a message is usually organized into the three main parts: introduction, body and conclusion (Carey, 1999). One or more messages may be covered in each meeting session.

¹ Adapted from *Improving the Safety and Quality of Fresh Fruits and Vegetables – A training Manual for Trainers*; 2002, University of Maryland.

INTRODUCTION

Opening statements should attract attention. The introduction should include such key points as the purpose of the session, an outline of the information to be covered, how the information will be presented, how it will achieve the purpose of the session and the personal benefit to the trainers. A primary consideration in planning the introduction of a talk is to acknowledge what the trainees have been exposed to prior to this presentation and to address what information will follow.

Body

The information presented should flow in a logical way. The message should not be overloaded. A few well-developed points are more effective than too many.

Conclusion

A summary of the main points should be made. Trainees can be asked what specific action should be taken following this course. Close with a strong final statement. New information should not be presented at this time.

A trainer has the attention of the participants primarily at the beginning and end of a session. Therefore, for greatest impact, it is good practice to make key points in the introduction of the topic and to summarize them again at the end. An adage often used to advise public speakers says: "Tell them what you're going to tell them, tell them, and tell them what you told them."

SELECT TRAINING METHODS

Once the training content has been outlined and the messages have been identified, training methods can be selected. A training method is a strategy or tactic that a trainer uses to deliver the message so that the trainees achieve the objectives of the programme (Wentling, 1993). One or more training methods can be used in the presentation of a message. It is good to use a variety of training methods throughout a training course to maintain the interest of the trainees.

Factors to consider when selecting a training method

- ✓ *Size of audience:* Larger audiences often require more formal training methods with less audience participation
- ✓ *Maintaining attention through interaction:* Methods that involve the trainees in the instruction have the advantage of maintaining attention and involving all participants
- ✓ *Variety:* Selection of different types of methods often maintains the interest of trainees
- ✓ *Available resources/infrastructure:* Where resources are limited, the opportunity to use resource intensive techniques, such as field visits and demonstrations, may also be limited
- ✓ *Duration of the training session and amount of information to be covered in it:* Methods that involve discussion and casework take longer than more lecture-oriented methods
- ✓ *Experience of the trainer:* The trainer must be comfortable using the chosen method
- ✓ *Training aids required to support each method and the time and resources to prepare and use them*

Lecturing is the most frequently used method for delivering a message. There are, however, a variety of other techniques for conveying information to trainees. These are described in Table 1.

TABLE 1
Common training methods

Lecture	<ul style="list-style-type: none"> • Mostly an oral presentation, but may be supplemented with visual aids or handouts • The technique is generally confined to presenting only the expert's point of view • Often used because it is easier to organize and a great deal of information can be presented in a short period of time • Useful when there is a large group of trainees
Lecture/ Discussion	<ul style="list-style-type: none"> • Variation of the lecture where the trainer increases trainee participation through facilitation of discussion at set times during the session • Discussion is often initiated through the use of questions • Trainer must plan the discussion and carefully choose the questions to lead the discussion
Demonstration	<ul style="list-style-type: none"> • Oral explanations combined with visual activities • Method demonstrations show processes, concepts and facts and are especially effective in teaching a skill that can be observed • A result demonstration shows the outcome of some practice or innovation, such as field tests of soil treatments or product sanitation procedures and water treatments
Group discussion	<ul style="list-style-type: none"> • Trainer leads the trainees as a group through a discussion of a given topic • May or may not be preceded by a short explanatory lecture
Symposium	<ul style="list-style-type: none"> • A series of lectures presided over by a moderator • Allows for the presentation of several points of view or • Several related topics
Panel	<ul style="list-style-type: none"> • A dialogue among several experts sitting in front of the room • A moderator coordinates the discussion • Differs from a symposium because panel members have an opportunity to discuss and interact with each other's ideas and views
Forum or discussion groups	<ul style="list-style-type: none"> • Following one or more presentations, the audience interacts and discusses the topic(s), bringing up a wider range of views • Discussion groups encourage/allow everyone to participate, even if the audience is large • Group should be monitored to insure that one person is not dominating the activities
Case studies	<ul style="list-style-type: none"> • Information is given to the trainees detailing a specific situation or problem and the trainees are assigned (as individuals or discussion groups) the task of making recommendations for the most appropriate action to solve the problem • Introduces a practical aspect to the training environment and creates a problem solving situation similar to that many trainees may face after returning to work
Field visits	<ul style="list-style-type: none"> • A visit to an organization or workplace, such as a farm or packing house, that demonstrates the practical application of the ideas under discussion • Care must be taken that the place to be visited is aware of the objectives of the field trip • Adds a practical aspect to the training • Trainees need to be properly prepared for the visit and should be encouraged to make specific observations that will be discussed upon return to the classroom

Source: Adapted from Carey, 1999.

Selection of the method most appropriate for the participants in a training session and for the information to be presented is an important part of planning the training session.

In preparing a presentation, remember the 5 "Ps"

- ✓ Proper
- ✓ Planning
- ✓ Prevents
- ✓ Poor
- ✓ Performance.

The organization of the training content and the selection of the appropriate training method for delivering the messages require careful planning. Planning enables the trainer to project confidence and control throughout the training session and to work with the trainees to achieve training objectives.

An example of an approach that incorporates maximum trainee involvement might be to start with a lecture introducing the reasons why workers should be encouraged to use field sanitation units. The lecture could be followed by a group discussion about the practical difficulties preventing use of these units and how these difficulties can be overcome. The trainees could then implement the new sanitation practices in the field. After a suitable time, a review could assess sanitation unit usage by workers. In a follow-up meeting, trainees might discuss the benefits of the new practices and highlight any other areas of concern that may require further advice and training.

SELECT AND PREPARE MATERIALS

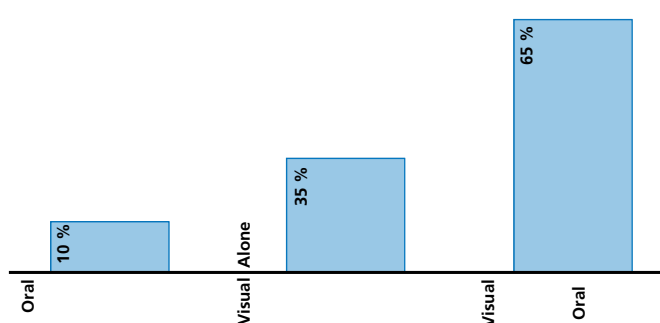
Research shows that most people learn things through at least three of the five senses. The trainer should try to use training methods that appeal to the senses of sight, hearing, smell, taste and touch.

In general, instruction by spoken or written word is more effective when it is supported by methods that stimulate the other senses (OSHA, 1996). When participatory, hands-on methods are used, they serve to convert the symbolism of words into images in the learners' mind. Visual aids and hands-on exercises help make an abstract concept

into a practical reality. This improves the chance for storage in long-term memory (improved retention and recall). The more senses to which instruction appeals, the stronger the impact of the message (Figure 1).

Training aids refer to all forms of support prepared for and used in training. As most training courses rely principally (though not exclusively) on the spoken word, carefully chosen well-prepared materials can

FIGURE 1
Retention of information



make an important contribution to effective learning. They often make it easier for trainees to understand the message as the information can be arranged in a logical, clear manner with emphasis on the most important points.

Training aids improve the effectiveness of the trainer (Cheek and Beeman, 1990). To develop effective aids, the trainer must think through their message from the receivers' viewpoint. The trainer can feel more relaxed as the aids help insure the flow of information. Aids may also help trainers feel less pressure as the trainees are focused on the training aid for part of the time.

Visual aids are especially useful in reinforcing the key points made by the trainer in an oral presentation. They can be very useful in describing points that are difficult to explain verbally. Anything that can be quantified or is factual can be presented visually. Visual aids should be tested on others before using them in the training room. It is also important to check the availability of equipment needed for visuals, both in planning for their use and on the day of the presentation.

A variety of print materials can be used to enhance the learning process. These may include handouts, summary notes, workbooks or manuals. They have a clear advantage in that they provide a summary and/or can present additional information and can reduce note taking. They can be made available to the trainees for reference after the training session. A disadvantage is that these materials may distract from the trainer. Care must be taken to insure that trainees are not overwhelmed by so many print materials that they lose focus on the trainer.

ORGANIZE THE TRAINING COURSE

The trainer should envision the flow of the training course before it begins. The more the trainer can visualize the format of the training course, the more prepared he/she is for any questions or problems that may arise. A prepared trainer is a relaxed and more effective trainer.

Questions that should be addressed when organizing a training course include:

- How will the topics be introduced?
- Would a question be a good way to start?
- Which training methods will strengthen the message?
- What questions are the trainees likely to ask?
- What questions should the trainer ask the trainees?
- When should breaks be planned in the session?

Planning will also involve developing the schedule or programme for the course. This will set out the course duration and the division of training sessions for each day.

A programme for the training course is useful to:

- Guide the trainers in leading the course
- Organize the flow of information
- Ensure a balance between theoretical information and practical sessions
- Prevent repetition of information between different trainers
- Include adequate breaks
- Allow adequate time for all sessions
- Ensure the interest and motivation of the trainees
- Summarize and conclude the session and look ahead to the following session

Attention spans will vary from person to person, with the subject matter involved and with the situation. In lecture-oriented training sessions, the presentation should not exceed 20 minutes. Trainers often allow 40–45 minutes for practical and casework sessions.

Trainers need to allow time for adequate interaction with the audience when using questions, exercises and visual aids. Breaks in a lecture presentation, such as demonstrations, illustrations or question periods, have the effect of refreshing the training session. It is important however that the breaks support the main body of the message. Also, time must be allowed periodically (every 1–2 hours) to allow trainees to stretch their legs and use the facilities.

SUMMARY

1. Outlining the training content will help identify the key messages to be presented. Presentation of a message is usually organized into three main parts:
 - *Introduction* – should include key points such as the purpose of the session, an outline of the information to be covered, how the information will be presented, how it will achieve the purpose of the session and the personal benefit to the trainees
 - *Body* – the main message presented as a few well-developed points flowing in a logical manner
 - *Conclusion* – summary of the main points. May include specific action that should be taken following this course
2. A training method is a strategy or tactic that a trainer uses to deliver the message so that the trainees achieve the objectives of the programme. Lecturing is the most frequently used method for delivering a message. There are, however, a variety of other techniques for conveying information to trainees. These include: lecture/discussion, demonstrations, group discussion, panels, forums, discussion groups, case studies and field site visits
3. Instruction by spoken or written word is more effective when it is supported by methods that stimulate the other senses. Visual aids and hands-on exercises help make an abstract concept into a practical reality. Print materials are useful to supplement lectures because they reduce note taking and provide a reference after the class has ended. Care should be taken that supplemental material does not distract the trainees, taking attention away from the message
4. Developing a programme for the training course helps the trainer organize the flow of information, avoid repetition between trainers, ensure interest and motivation of trainees, and assure continuity between trainers and between sessions.

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Module 3

Conducting and evaluating the course¹

LEARNING OUTCOMES

- To assist trainees in applying key steps in planning effective training
- To identify considerations in using a team-teaching approach
- To assist trainees in applying key elements of evaluation to training activities

Using a training team

When the training course takes place over several hours or a number of days and different types of information are covered, a team of trainers may be used.

INTRODUCTION

As already stated, when the training course takes place over several hours or a number of days and different types of information are covered a team of trainers may be used. An advantage of a team approach is that the diversity of different trainers makes the course more interesting. It can become difficult to maintain attention if trainees have to listen to one trainer for an extended period.

The members of a training team should be chosen to ensure they have complementary styles, skills and knowledge. All trainers should be technically competent in their subject and have experience as a trainer. Team members must have credibility with the trainees. In addition to being technically competent, trainers must be familiar with the real circumstances in which the trainees work and the problems they face. Trainers need to be willing to participate in the total training activity. They may be called on to add comment to a co-trainer's topic during the discussion sessions, prepare for an additional training session if required, interact with the trainees during free time between the training sessions and contribute as needed to practical exercises.

In team teaching it is common to have a leader or facilitator to coordinate the training course. This person may be responsible for the selection of the training team. They should assure that all trainers are familiar with the other members of the teaching team and that they are working together to assure the training objectives are met. The team leader may need to hold meetings or arrange conference calls to assess the progress of planning and training and to determine when improvements are needed. The lead trainer should also provide leadership in developing the schedule or programme for the course.

¹ Source: Adapted from *Improving the Safety and Quality of Fresh Fruits and Vegetables – A Training Manual for Trainers*; 2002, University of Maryland.

Tasks of the training team leader

- ✓ Brief trainers on their role in the training course
- ✓ Facilitate introductions and allow time for trainers to become familiar with each other's strengths
- ✓ Create a teamwork atmosphere
- ✓ Discuss the training objectives
- ✓ Provide information on the participants and local circumstances
- ✓ Hold regular meetings to assess progress of the training and any improvements required

LOGISTICAL SUPPORT

The steps above have focused on aspects of training related to content development and presentation and the preparation required before training begins. In addition to these issues there are logistical arrangements that need to be considered before, during and after the training course. The trainer should ensure that the logistical support arrangements are in place and satisfactory to accommodate each session of the training course.

The following sample list includes key points that the trainer may consider.

BEFORE THE TRAINING

- Identify and engage appropriate instructors
- Select suitable training venues (well-lit and well-ventilated with adequate space away from sources of noise)
- Select and notify the trainees, through the proper channels, of the dates, time and location
- Prepare training materials: handouts, overheads, etc.
- Arrange for appropriate training equipment (may include microphone, chalkboard and chalk, flipchart paper, writing materials, slide and/or overhead projector, LCD projector and computer, video equipment, screen, spare bulbs, etc.)
- Arrange training room, seating arrangements, name cards, position of chalkboard, screen, etc.
- Arrange coffee and meal breaks during course
- Arrange transportation/accommodation as needed for outside speakers/trainers

DURING THE TRAINING

- Remind other trainers of their sessions
- Introduce and thank trainers
- Meet emergencies (rearrange or cover sessions)
- Check facilities and equipment (projects, boards, chalk, etc.)
- Ensure trainees receive course materials
- Have trainees introduce themselves
- Introduce visitors

FOLLOWING THE TRAINING

- Leave room tidy – return equipment and aids to proper place
- Compile feedback/evaluations from course participants
- Prepare thank you letters as needed for guest speakers, volunteers, etc.

- Prepare reports on course

CHECKLISTS

Sample checklist for the day before your session

- ✓ Visit the training room and be sure you know how to control the lights and ventilation
- ✓ Check the arrangement of the tables and chairs. The trainees should be able to see trainers and visual aids clearly
- ✓ Confirm the catering arrangements for coffee breaks, lunch and/or other refreshments
- ✓ Arrange the projector to have the largest, most focused picture possible
- ✓ Check supplies – handouts, visual aids, flipcharts, makers, pens, etc.

Because there are many details to remember when making the final arrangements for the training course, trainers may wish to develop more detailed checklists to support them in their preparation for the training. Examples of checklists that may be developed include ones to assist the trainer in assuring required facilities, equipment, supplies and materials.

Sample checklist for a field demonstration

- ✓ Fix a time for the training session
- ✓ Visit the farm or food plant the day before the training session
- ✓ Ensure that work will be conducted during the time of the training session
- ✓ Verify the practices that you want the trainees to observe
- ✓ Explain the objectives to the farm or plant manager
- ✓ Agree with the manager on the conduction of the training session, number of trainees, what they will observe, etc.

EVALUATING TRAINING

Although evaluation is presented as the final portion of the discussion on developing effective training, it is important to plan the evaluation strategy well before the training takes place. Evaluation is not merely an activity at the end of the training course, but is also an on-going process throughout the training that allows the trainer(s) to assess how well the course is progressing and that objectives are being met.

Training evaluation

“A systematic process of collecting information for and about a training activity that can then be used for guiding decision-making and for assessing the relevance and effectiveness of various training components.”

Training evaluation already has been described as a systematic process of collecting information for and about a training activity that can then be used for guiding decision-making and for assessing the relevance and effectiveness of various training components (Raab *et al.*, 1987). Training evaluation gives a measure of the extent to which the training has been successful in accomplishing the training objectives. Evaluation methods result in feedback from the trainees. Proper evaluation allows for continual improvement of the training programme.

Evaluation strategies

- ✓ Pre-training
- ✓ Process
- ✓ Terminal
- ✓ Follow-up

The choice of evaluation strategy depends on the purpose of the evaluation (Hakimian and Teshome, 1993):

- Pre-training evaluation occurs during course development and allows for pre-testing of the adequacy, scope and coverage of the training programme under preparation. This type of evaluation checks out shortcomings of the training and allows corrective steps at an early stage. Pilot tests of presentations and materials are part of pre-training evaluation.
- Process evaluation is conducted while the course is in progress. This ongoing assessment allows for adaptations to be made during the course as needs are identified. This evaluation may involve a formal evaluation where feedback is sought from trainees at the end of each day, each session or on a particular schedule. Also included may be observations by the trainer regarding trainees' responses.
- Terminal evaluation occurs upon completion of the course. This type of evaluation allows trainers and trainees to assess how well course objectives were met and where adjustments are needed for future training efforts.
- Follow-up evaluation is usually conducted at some point after the training. Because a training programme is often conducted to bring about changes in behaviour or attitudes related to the working methods of the trainees, training effectiveness is best assessed following a lapse of time, for example, two months, after the training course. By this time trainees have had time to rethink the training that they received and to incorporate the information into their work.

Terminal evaluation, at the end of a training course, is most common and is used to allow trainees an opportunity to provide feedback on the usefulness of the training and on aspects of the training that could be improved for future training courses. Four criteria have been suggested to evaluate training programmes: reaction, learning, behaviour and results (Kirkpatrick, 1976). Each criterion is used to measure different aspects of the training programme. *Reaction* measures how the trainees liked the programme in terms of content, methods, duration, trainers, facilities and management. *Learning* measures the trainees' skills and the knowledge they were able to obtain during the training. *Behaviour* is concerned with the extent to which the trainees were able to apply their knowledge to real field situations. *Results* are concerned with the tangible impact of the training programme on individuals, their job environment or the organization as a whole.

Evaluation can be informal or formal. Informal methods involve feedback provided by trainees through language, questions, interest and enthusiasm for the topic. The trainer may request formal feedback by asking questions to assess the trainees understanding and appreciation of the subject discussed. Common formal evaluation methods include written evaluations or questionnaires completed by the trainee or a structured interview with the trainee about training techniques and information gained.

Feedback should be analysed. This will allow the trainer to amend and improve materials for subsequent training. It may also identify gaps in training that need to be addressed. It is essential that the best use is made from all feedback received and that it is not simply an exercise on paper.

In addition to feedback received from the trainees on the use and effectiveness of the training course, self-evaluation by the trainer is essential. Every time training is conducted, the trainer should assess how he/she functioned as a trainer and make adjustments before the next training programme. If a team teaching approach is used, team members should be asked for input regarding training organization and effectiveness. A meeting of the teaching team after the course to assess the training is a good way to conduct this evaluation.

Although trainers often view evaluation as a necessary exercise with very little value, effective evaluation can be a valuable tool. Benefits of conducting evaluation include:

- Measuring how well the course objectives were achieved
- Improving the efficiency of training to allow better use of limited resources
- Highlighting the value of the training and increasing the organizations' commitment to training
- Fostering interest in training at all levels of the organizational structure

SUMMARY

1. When the training course takes place over several hours or a number of days and different types of information are covered, using a team of trainers is desirable. An advantage of a team approach is that the diversity of different trainers makes the course more interesting.
2. A training team leader may be identified. This person may be responsible for the selection of the training team; for assuring that all trainers are working together to assure the training objectives are met; for assessing the progress of planning and training; and for developing the schedule or programme for the course.
3. Because there are many details to remember when making the final arrangements for the training course, trainers may wish to develop detailed checklists to support them in their preparation for the training.
4. Training evaluation is a systematic process of collecting information for and about a training activity. This information can then be used for guiding decision-making and for assessing how well the course is progressing and that objectives are being met. Evaluation is not merely an activity at the end of the training course, but is an on-going process throughout the training.
5. The choice of evaluation strategy depends on the purpose of the evaluation.
 - Pre-training evaluation occurs during course development and allows for pre-testing of the adequacy, scope and coverage of the training programme under preparation.
 - On-going process evaluation throughout the course allows for adaptations to be made during the course as needs are identified. This evaluation may involve

a formal evaluation where feedback is sought from trainees and/or observations by the trainer regarding trainees' responses.

- Terminal evaluation, the most common evaluation strategy, occurs upon completion of the course and allows assessment of how well course objectives were met and where adjustments are needed for future training efforts.
- Follow-up evaluation after the training looks at training effectiveness following time for trainees to re-think the training that they received and to incorporate the information into their work.

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Annex 1

Additional resources

PART I – VOLUNTARY CERTIFICATION

What is voluntary certification?

The certificate is a written guarantee by an independent certification agency that the production process or the product complies with certain standards established by certain organizations or countries. These certification standards can focus on environmental issues (such as soil conservation, water protection, pesticide use or waste management), or on social issues (such as producer income, workers' rights, occupational health and safety) or on other aspects of production such as food safety and food quality. Complying with these standards can contribute to the protection of local resources, improve the health of workers, and provide other benefits for producers, consumers, and farming communities.

Why do these programmes exist?

Many consumers are increasingly aware of the hazards, social and environmental problems associated with the production and trade of the food they consume. In response to these interests, different types of voluntary certification schemes have been developed by private organizations, governments as well as the business sector in order to resolve these problems.

Why certify?

Certification is used to demonstrate that a product has been produced in a certain way or has certain characteristics. It can help differentiate the product from other products, which can be helpful to promote the product in different markets. Certification can also help improve market access, and in some cases, result in a better producer price. Certification is mainly used when the producer and the consumer are not in direct contact, in the international market, where for instance the consumer cannot easily verify that the product was produced in the manner described by the producer.

Producers can choose among different types of certification. The decisions to obtain certification as well as the type of certification chosen are important decisions that influence farm management, investments and marketing strategies. However, because all certification programmes have different objectives their requirements differ.

What are the costs?

The cost of meeting a standard and getting certified depends on the kind of changes the producer will have to make on his/her farm and on the type of certification program chosen. In general, costs are based on the time spent doing the farm inspection (farm audit) and on the expenses of the inspector(s).

ORGANIC AGRICULTURE

What is organic agriculture?

Organic agriculture is a system of production that maximizes the use of farm resources, putting emphasis on soil fertility and biological activity while avoiding the use of non-renewable resources and synthetic fertilizers and pesticides in order to protect the environment and human health. Organic agriculture therefore involves much more than just not using pesticides. In East Africa, organic farming is arising notably for crops such as cocoa, coffee, tea, cotton, cashew, honey, herbs and spices, pineapple, mango, sesame and peanuts.

What are the main requirements?

There are specific requirements for most organically certified crops as well as livestock, fish farming, bee keeping, forestry and the harvesting of wild products. Organic standards for production require that there is a conversion period (or time that a farm has to use organic production methods before it can be certified, usually 2–3 years). If the situation allows counting these years in retrospection, it could be shortened to 1 year. The certifier decides on this. Among the requirements are standards for the selection of seeds and planting materials; the diversity of crops on the farm; the maintenance of soil fertility and the recycling of organic materials; water conservation and the prohibition of genetically modified inputs. There are also criteria for the use of organic fertilizers and compounds for the control of pests, diseases and weeds. For animal production, there are normally requirements for animal health, feeding, breeding, transport and slaughter procedures.

How to get certified?

Standards for organic farming have mainly been developed by private certification bodies but a number of countries also have national organic standards and regulations. In East Africa, there are national and regional certification initiatives. In Tanzania there is a national certification body called **Tancert**. For the moment, the certification that it delivers is for the domestic market. Tancert is working with the Institute for Marketecology Ltd, Switzerland (IMO), in order to obtain international recognition. Uganda, Tanzania and Kenya have already established organic standards at a regional level and if producers want to export their products, they must meet the organic labelling regulations of the importing countries.

The choice of a certification body is very important. The certification body chosen by the producer must be officially recognized in the country where the product is to be sold or it should have an agreement with the national certification body of the country where the production is to be sold.

In the case of a larger group of smallholders producing the organic product for export, direct inspection of all farmers by the certification body is not practical. In order to reduce costs and improve efficiency, the producers or the organization supervising them can develop an Internal Control System (ICS). This is a documented system in which the producer group demonstrates that through training and internal inspection the organic standards are met. The external certification body checks the system rather than the individual farmers.

The conversion period is often costly for the producer because extra costs are made (mainly for certification) while the produce must still be sold at the conventional prices. On top of that, starting to produce according to organic practices can result in higher production costs and lower yields, at least initially.

What are the main opportunities and constraints?

Organic agriculture may represent an interesting opportunity for many producers in Tanzania and may become an important tool to improve the quality of life and income of producers. Producers shift to organic agriculture for a variety of reasons. Some feel that the use of agrochemicals is bad for their health and the environment, while other producers are attracted by the higher prices and the rapidly growing market for many organic products in recent years. Changing to organic agriculture may be easier or more profitable for some producers depending on whether they use agrochemicals intensively, own their land or have access to labour (as organic production often demands more labour), organic fertilizers and other permitted inputs.

The main international market for organic produce is Europe (United Kingdom, Germany, Austria, France, The Netherlands). The United States has a growing market and some products are being exported to Japan. The main export products are cocoa, cotton, coffee and tea. Organic agriculture is mostly practiced by smallholders but the price premium and the importance of the European market may encourage large producers to use this type of practice. Competition is coming mostly from Latin America and the risk that the organic market becomes oversupplied may both decrease the price premium. However, in return this decrease might lead to more and more consumers to prefer organic products to conventional products.

FAIRTRADE**What is Fairtrade?**

The Fairtrade organizations work to improve market access and trading conditions for small-scale producers and plantation workers. In order to do this, Fairtrade organizations pay a minimum guaranteed price to the producer, plus an extra allowance or Fairtrade premium – which producer organizations must use for organizational strengthening and community development. For production on plantations, the primary aim is to improve the conditions for the workers. The Fairtrade Labelling Organizations International (FLO) is the worldwide umbrella organization for Fairtrade standard setting and certification (head office is in Bonn, Germany). There are currently 24 international organizations in Europe, America, Asia and Oceania. In East Africa, Fairtrade certified products are mostly coffee, tea and cut flowers.

What are the main requirements?

To obtain certification, producer associations must comply with certain standards. These associations or cooperatives must function in a democratic manner.

For plantations, there are a number of requirements related to the functioning of the plantations and the treatment of workers. These relate to issues such as: freedom of association and collective bargaining; workers' housing and sanitation; worker's health and safety; and no child or forced labour. In addition, the plantation must comply with the environmental and social laws in the producing country and demonstrate continual improvement in annual inspections (audits).

There are also requirements aiming at the protection of the environment.

How to get certified?

Fairtrade certification can be applied for by a group of producers in a cooperative, a farmer association or large farms with an organized labour force. Local auditors inspect the farm and the certification agency, FLO-Cert Ltd, decides whether or not to certify

the producer association or plantation. Once certified, there is an annual inspection to check that the producers or plantations comply with the Fairtrade minimum and progress requirements and how the Fairtrade premium has been used. Producers have to pay fees for both initial certification and annual certification renewal, based on the costs of inspection.

Exporters and processors who take legal ownership of a product need to be registered with FLO (they don't need to be certified) and submit quarterly reports on Fairtrade products handled. Exporters and processors do not (yet) use the label, but they pay a registration fee and an annual renewal fee.

Traders in the importing countries, who use the FLO certification mark on their packages, currently pay the certification cost through a license fee. Licensees so far are based in the 23 countries where there are National Initiatives, as these are the organizations registering licensees.

What are the main opportunities and constraints?

A producer association or a plantation can benefit from Fairtrade certification because certified products normally receive higher and more stable sales prices. The price paid to producers is determined by production costs, taking into consideration any additional costs that might arise from meeting the Fairtrade requirements, such as providing living wages for workers. On top of the price a Fairtrade premium is paid. There are certain requirements on how the Fairtrade premium has to be spent. In general, it aims at improving the living conditions of its members in rural communities.

A key constraint in the Fairtrade system is that a group of producers can only get certified if there is a market for their Fairtrade labelled products. In order to enter the Fairtrade system, a good first step is to check if there are Fairtrade standards for the product to be exported. Nineteen products or product groups can presently be certified Fairtrade.. The second step is to ask FLO and Fairtrade importers for information regarding market opportunities for the specific product. Another constraint is that when a producer association or a plantation has been certified there is no guarantee that the whole production will be sold and marketed as "Fairtrade".

GLOBALGAP – WHAT IS GLOBALGAP?

GLOBALGAP is a voluntary private sector certification system created by the European Retailer Produce Working Group made up of 31 members, mostly large supermarket chains operating in Western Europe. It should be borne in mind that GLOBALGAP is not a European Union regulation. The aim of GLOBALGAP is to increase consumers' confidence in food safety by developing GAP that must be adopted by producers.

Unlike the other certification programmes, the focus of GLOBALGAP is **not** on environmental or social issues but rather on food safety and traceability so that the end product can be linked to the farm where it was produced. However, standards also cover requirements on the use of pesticides, workers safety and compliance with national labour regulations. GLOBALGAP has so far developed GAP standards for fresh fruits and vegetable production, (green) coffee, flowers and dairy (check their Web site).

What are the main requirements?

The GLOBALGAP standards require that producers establish complete control and monitoring systems. Products are registered and can be traced back to the specific farm unit where they were grown. GLOBALGAP rules are relatively flexible about field

practices such as soil fumigation and fertilizer usage. There are strict regulations about pesticide storage and pesticide residue limits. In addition, it is important to document and justify how the product was produced, so detailed records must be kept about farm practices.

How to get certified?

Private certification agencies approved by the GLOBALGAP Secretariat (FoodPLUS) can certify for GLOBALGAP. Both individual producers and groups of producers can apply for certification, the cost of which depends on the certification agency chosen and the time spent on the inspection. In addition to the certification fee, the producer must also pay a small annual fee to FoodPLUS to maintain the certification.

What are the main opportunities and constraints?

To obtain GLOBALGAP certification the producer needs to maintain a complete administrative system to keep track of all farm activities. This requires a sufficient administrative and financial capacity; consequently it is easier for large-scale producers to meet the requirements. There are support schemes to assist smaller producers and producer groups to obtain GLOBALGAP certification (line from EU-COLEACP).

The GLOBALGAP certified producer has an advantage selling products to one of the 105 associated members of the GLOBALGAP group. These retail members increasingly require that their suppliers have GLOBALGAP certification. Being GLOBALGAP certified often gives a producer the status of preferred supplier. Most of the associated members operate in the United Kingdom, the Netherlands and Germany.

There is no special price premium or product label associated with GLOBALGAP, as it is a minimum standard focused on business-to-business relations rather than directly consumer oriented.

UTZ CERTIFIED – WHAT IS UTZ CERTIFIED?

UTZ CERTIFIED is a certification programme that enables coffee producers to demonstrate good agriculture practices and efficient farming. This programme was founded in 1997 by Guatemalan coffee producers and the Dutch coffee roasters, Ahold Coffee Company. Formerly known as Utz Kapeh, it updated its name to UTZ CERTIFIED in March 2007.

The code of conduct is benchmarked against the GLOBALGAP coffee code. Some criteria from ILO (International Labour Organization) conventions have been added.

What are the main requirements?

The main objectives of UTZ CERTIFIED are to enable consumers and buyers to answer two questions, namely: “Where does the coffee come from?” and “How was it produced?”

To reach these goals, a web-based traceability system has been created and producers must meet the Chain of Custody requirements such as separating Utz CERTIFIED coffee from non-Utz CERTIFIED coffee and keeping records of direct suppliers and buyers.

UTZ CERTIFIED Code of Conduct

An UTZ CERTIFIED Code of Conduct has been developed. It comprises good agricultural and business practices, environmental and social criteria.

Good agricultural and business practices' criteria

- Compliance with maximum residue levels and banned crop protection product
- Workers trained properly
- Implementation of accident and emergency procedures
- Implementation of hygiene rules and practices
- Annual internal inspection

Environmental criteria

- Reduce and prevent soil erosion
- Responsible and minimum use of agrochemicals
- Minimize water usage and environmental pollution
- Optimize use of sustainable energy
- Protect water sources
- No deforestation of primary forests

Social criteria

- Workers are protected by national laws and ILO conventions regarding age, working hours, pensions, working conditions, collective bargaining and safety
- Workers receive protective clothing when working with chemicals
- Access to health care for the workers and their families
- Access to education for children

How to get certified?

UTZ CERTIFIED certification can be applied by any coffee producer or group of producers. Interested farmers have to go through a self-assessment process to compare their current situation to the UTZ CERTIFIED Code of Conduct.

Once the producer (group) is ready to get certified, a certification body approved by UTZ CERTIFIED will carry out inspection in order to check compliance with UTZ CERTIFIED requirements. If inspection is passed successfully the UTZ CERTIFIED certificate is issued.

The certified producers or group of producers must be inspected on an annual basis.

What are the main opportunities and constraints?

UTZ CERTIFIED certification enables coffee farmers to produce a value-added coffee. They may therefore benefit from a price premium. They don't have to pay any fees, as the UTZ CERTIFIED administration fee is covered by buyers. Producers are also guaranteed to produce coffee in a sustainable way. Certified products are differentiated, as they bear the UTZ CERTIFIED logo.

The main constrain is that UTZ CERTIFIED certification requires the necessary administration and financial capacity to be able to comply with criteria such as traceability. Another constraint is that there is only one product that can be certified, namely coffee. However, UTZ CERTIFIED is working on the possibility to include more products.

More information on UTZ CERTIFIED certification: www.utzkapeh.org

ISO 22000

The ISO 22000 voluntary standard has been developed to facilitate the setting up of food safety management systems. It incorporates the HACCP principles. ISO 22000 has been elaborated by ISO along with the CAC, the Confederation of the Food & Drink Industries of the European Union (CIAA), the International Hotel and Restaurant Association (IH&RA), the CIES Global Food Safety Initiative (GFSI) and the World Food Safety Organization (WFSO). Therefore, ISO 22000 harmonizes the requirements of national food safety management systems on a worldwide basis.

Any stakeholder of the food chain (crop producers, feed producers, food producers, processors, wholesalers, retailers) can use ISO 22000 independently or in combination with other management system standards. The ISO logo cannot be used on the certified products.

For further information on ISO 22000 Standards: <http://www.iso.org>

BRC GLOBAL STANDARD

The BRC standard is a private voluntary standard developed by the British Retail Consortium (BRC). The standard has been set up in order to protect consumers' health and to enable British retailers to comply with the United Kingdom Food Safety Act. Therefore the BRC standard can be considered as a tool that provides retailers with a common basis for the audit of companies supplying retailer branded food products. The use of this standard requires the adoption and implantation of HACCP principles, and the setting up of a documented and effective quality management system. BRC standards also cover factory environment standards and process control. It can be applied by any food supplier company.

The application of the BRC Global Standard requires certification by a third party. Certified products are differentiated in the market as they carry the BRC logo.

For further information on BRC Standard and certified organizations: <http://www.brc.org.uk/standards/>

OVERVIEW OF MAIN CERTIFICATION SCHEMES

The main opportunities and constraints of the main certification schemes

Certification	Concerned organizations	Goals
Organic	<ul style="list-style-type: none"> Small, medium and large producers 	<ul style="list-style-type: none"> To maximize farm resources and to protect the environment and human health
ISO 22000	<ul style="list-style-type: none"> Large agro-industries including food processing 	<ul style="list-style-type: none"> To implement an environmental management plan
Utz CERTIFIED	<ul style="list-style-type: none"> Small, medium and large producers or groups of producers 	<ul style="list-style-type: none"> To grow coffee in a sustainable way while also complying with environment and labour laws
Fairtrade	<ul style="list-style-type: none"> Small producers in associations and plantations with an organized labour force 	<ul style="list-style-type: none"> To improve market access and trading conditions for small producers
SA8000	<ul style="list-style-type: none"> A limited number of plantations and agro-industries 	<ul style="list-style-type: none"> To improve working conditions and safety in the workplace
GLOBALGAP	<ul style="list-style-type: none"> A limited number of medium and large agro-industries and producer groups organized by exporters 	<ul style="list-style-type: none"> To improve food safety and traceability of the products

Certification	Main opportunities	Main constraints
Organic	<ul style="list-style-type: none"> • Producer often receives a better price • Market is growing • Large variety of products can be certified 	<ul style="list-style-type: none"> • Usually 2–3 year conversion period • Technical difficulties of not using agrochemicals
ISO 22000	<ul style="list-style-type: none"> • May help improve efficiency and reduce environmental impact • A well-known industrial standard 	<ul style="list-style-type: none"> • No particular price premium is paid • Certification costs may be high • May not give market advantage
Utz CERTIFIED	<ul style="list-style-type: none"> • Producer benefits from premium • Producer does not pay administrative fees 	<ul style="list-style-type: none"> • Administrative and financial burden can be high • Only coffee can be certified
Fairtrade	<ul style="list-style-type: none"> • Producer receives a better price • Longer term and more stable trade relationship 	<ul style="list-style-type: none"> • Only a limited number of producers are certified (depends on market opportunities) • Once certified there is no guarantee sale
SA8000	<ul style="list-style-type: none"> • Tool for corporate public relations • May improve efficiency and reduce labour turnover and absenteeism 	<ul style="list-style-type: none"> • No particular price premium is paid • Certification costs may be high • Difficulty to implement in seasonal production
GLOBALGAP	<ul style="list-style-type: none"> • Improves access to the GLOBALGAP supermarket chains in Western Europe • May help the producer adapt to other traceability regulations 	<ul style="list-style-type: none"> • High administrative burden • No particular price premium is paid • Certification costs may be high

PART II – SOME IMPORTANT INTERNATIONAL BODIES IN AGRICULTURE

International Plant Protection Convention (IPPC)

The IPPC was established in 1952 to ensure that international SPS are adopted. The purpose of IPPC is to set phytosanitary standards and to harmonize measures that might affect the trade. It aims to prevent the spread and introduction of plant pests and diseases, and to promote effective control measures. In addition, it requires member countries to establish appropriate checks and balances, and certification schemes and disinfection systems. The international treaty requires the safety of imports and exports of plant products that are likely to contain pests or diseases.

The issue of how to defend crops against their enemies is of concern to all and necessitates an organization capable of preventing a phytopathogenic agent from entering a given country or area and entrusted with issuing the certificates required to market plant products. In the first case, the priorities of regulation are the crops in uncontaminated countries or regions. In the second case, the primary purpose of regulation is to protect the marketed product and its user.

Risk assessment procedures

All phytosanitary regulations must stem from an assessment of risk in accordance with a procedure codified by FAO, and the Pest Risk Assessment (PRA) procedure. This procedure concerns harmful agents fitting the definition of a quarantine organism. According to the IPPC, a quarantine pest is a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled. The risk analysis procedure will take into consideration criteria of a geographical, biological and economic nature, such as the

probability of the pathogen's introduction, its dissemination potential and the economic impact, should it be introduced in a previously uncontaminated area.

Need for accurate, up-to-date information

One essential requirement in risk analysis is to have accurate, reliable information on the geographical distribution of the agent under consideration. For that purpose, FAO, Regional Plant Protection Organizations (RPPO) and various international organizations (EU) publish material tracking the emergence of pathogenic agents and their distribution around the world.

Quarantine and eradication measures

Imports may be prohibited by phytosanitary regulations or authorized only subject to preliminary phytosanitary inspection or disinfection of the goods. After the first outbreak of a quarantine agent, efforts can be made to prevent its spreading through a regulatory requirement to report the disease, enforcement of measures for its eradication or containment, or even the abandonment of cultivation of certain sensitive species or varieties.

Phytosanitary certification

Phytosanitary certificates are issued by a qualified authority, which has to guarantee that the product is free from all diseases covered by quarantine laws. For the so-called "quality" organisms, certification guarantees the user that the product is suitable for the purpose for which it was purchased.

Tanzania phytosanitary regulations

Phytosanitary regulatory matters in Tanzania are governed by Plant Protection Act, 1997, Part II Section 8:- (National quarantine measures, plant import and export control), and it regulates:

- The importation and export of plant materials, soil, beneficial organisms and plant products
- Issuing phytosanitary certificates for export and importation of agricultural products

Plant protection inspectors are stationed at the border entries around the country and offer phytosanitary services and certifications. Figure 1 shows a sample of Tanzania phyto-sanitary certificate.

Food and Agriculture Organization of the United Nations (FAO)

FAO was founded in 1945 with the mandate to raise the level of nutrition and the standards of living, agricultural productivity, and to the better condition of the rural poor. (<http://www.fao.org>). FAO is the largest specialized agency in the United Nations and the leading organization for agriculture, forest, fisheries and rural development in the world. FAO headquarters is located in Rome, Italy, with regional office in Ghana, Chile, Thailand and Egypt.

World Trade Organization (WTO)

The World Trade Organization was established in 1995 as the result of Uruguay Round of negotiations (<http://www.wto.org>). The most important functions of WTO include:

- Providing a forum for multilateral negotiations

FIGURE 1
Sample of Tanzania phyto-sanitary certificate

PHYTOSANITARY CERTIFICATE

Plant Health Services of TANZANIA

11/95

This is to certify

that the plants, parts of plants or plant products described below or representative samples of them were thoroughly examined, on by an authorized officer of the Ministry of Agriculture and were found to the best of his knowledge to be substantially free from injurious diseases and pests; *and that the consignment is believed to conform with the current phytosanitary regulations of the importing country both as stated in the additional declaration hereon and or otherwise.

*Fumigation or disinfection treatment:

Date: Duration of Exposure:

Treatment: Chemical and concentration:

*Additional declaration: The Plant Protection Regulations have been observed

Charge for inspection at Shs. 1 000/-per ton or part of a tonne. Amount received Shs... Cts...

.....20
(Stamp of the Service) (Signature)

.....
(Designation)

*Delete as required.

DESCRIPTION OF CONSIGNMENT

Name and address of exporter

Name and address of consignee

Number and description of packages

Last country from which shipment was made.....

Distinguishing marks

Means of conveyance Point of entry

Quality and name of product

Botanical name

- Contributing to the transparency of national trade policies
- Administering and implementing multilateral trade negotiations
- Seeking to resolve trade disputes

Codex Alimentarius Commission (CAC)

The CAC was established in 1962 following a resolution passed by the Eleventh Session of the FAO Conference and the Sixteenth World Health Assembly (<http://www.codexalimentarius.net>). These two bodies adopted statutes and rules of procedure of the commission, which manage the joint FAO/WHO Food Standards Programme. The main objectives of the Codex are to:

- Protect the health of the consumer
- Facilitate international trade on food

The standards, codes, guidelines and recommendations address safety and quality of food exchanged in international trade. Some important aspects addressed by Codex on food safety include:

- Food standards for various commodities
- Hygiene practices
- Pesticide evaluation and residue limits
- Veterinary drugs
- Guidelines for contaminations

PART III – WHERE TO FIND ADDITIONAL INFORMATION**CAC – FAO/WHO**

The Codex Committee on Food Hygiene (CCFH) initiated work on a Code of Hygienic Practice for the Primary Production, Harvesting, and Packaging of Fresh Produce. A proposed draft code is currently being reviewed. For information on this draft code of practice and other activities of the CAC, please contact the Secretariat of the Joint FAO/WHO Food Standards Programme at:

Secretariat of the Joint FAO/WHO Food Standards Programme
Food and Agriculture Organization of the United Nations
Viale delle Terme di Caracalla
00153 Rome, Italy
E-mail (Internet): Codex@fao.org
Codex meeting agendas, reports and standards can be accessed from FAO's
Web page: <http://www.codexalimentarius.net/>

World Trade Organization (WTO)

The WTO is the only global international organization dealing with the rules of trade between nations. The goal is to help producers of goods and services, exporters and importers conduct their business. Information on WTO and its activities may be obtained via the Internet at: <http://www.wto.org>

Food and Agriculture Organization of the United Nations (FAO)

This Manual was prepared in collaboration with the Rural Infrastructure and Agro-industries Division (AGS) of FAO. More information on the work of the Division on food quality and safety matters, including fresh fruit and vegetable production, is available on the AGS homepage <http://www.fao.org/ag/ags/subjects/en/agribusiness/foodquality.html>

In addition, a number of related publications on water quality, extension training, food quality and safety can be obtained by contacting FAO through its web site: <http://www.fao.org> or by requesting a publication catalogue from:

Food and Agriculture Organization of the United Nations

E-mail (INTERNET): publications-sales@fao.org

Production is only half the battle: A training manual in fresh produce marketing for the Eastern Caribbean. Written by Stephen Harris, FAO, Bridgetown, Barbados, December 1988: A practical training manual developed for the Eastern Caribbean as part of a FAO/INPhO project. Available electronically at: <http://www.fao.org/inpho/vlibrary/x0014e/X0014E00.htm>

World Health Organization (WHO)

Related publications and a publication catalogue can be obtained from WHO:

World Health Organization

Distribution and Sales Service

1211 Geneva 27

Switzerland

<http://www.who.org>

A key reference available from WHO is *Surface Decontamination of Fruits and Vegetables Eaten Raw: A Review*; Food Safety Unit, World Health Organization. WHO/FSF/FOS/98. Written by Larry R. Beuchat, Ph.D. Article is available via the Internet at <http://www.who.int/fsf/fos982~1.pdf>

Good Agricultural Practices (GAP) on horticultural production for extension staff in Tanzania

Training manual

To reduce the risks from contamination associated with production practices of fresh produce and promote market opportunities, FAO and the UN System in Tanzania in partnership with the Government of the United Republic of Tanzania and the horticultural industry are devoting efforts to develop training materials.

This Manual aims at contributing to create awareness of the different aspects to be considered when implementing good agricultural practices (GAP). It is addressed to extension agents, the private sector and junior policy makers engaged in improving agricultural practices and ensuring food safety. Emphasis is placed on applying GAP and good manufacturing practices (GMP) throughout the food chain.

The Manual is divided in four Chapters. Chapter 1 emphasizes the importance of GAP in the horticultural supply chain. Chapter 2 provides an overview of the organizational strategies to enhance competitiveness in horticultural chains. Chapter 3 describes in detail the different elements of GAP. Chapter 4 gives directions for trainers on how to develop an effective training course. The Annex 1 presents a number of additional resources related to quality assurance and certification systems on GAP.