



Food and Agriculture Organization  
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# On-farm practices for the safe use of wastewater in urban and peri-urban horticulture

A training handbook for Farmer Field Schools  
in sub-Saharan Africa

Second edition



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Second edition

Food and Agriculture Organization of the United Nations  
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## Specific contributions:

**First edition:** Prof Robert Abaidoo (KNUST) coordinated the technical inputs of the various contributors and provided some technical information from the field tests. Bernard Keraita (IWMI) and James Akatse (Irrigation Development Authority, Ministry of Food and Agriculture) were the main authors of Unit 1: “Contamination of irrigation water and vegetables”. Bernard Keraita was the main author of Unit 2: “Five [now seven] easy ways to reduce health risks,” and Bernard Keraita and Modeste Kinane (FAO), were the main authors of Unit 3: “Monitoring and evaluating performance.” Collins K. Osei (KNUST consultant) was the main author of Unit 4: “Spread the word: Farmer-to-farmer training” and Unit 5: “Disseminate and communicate your

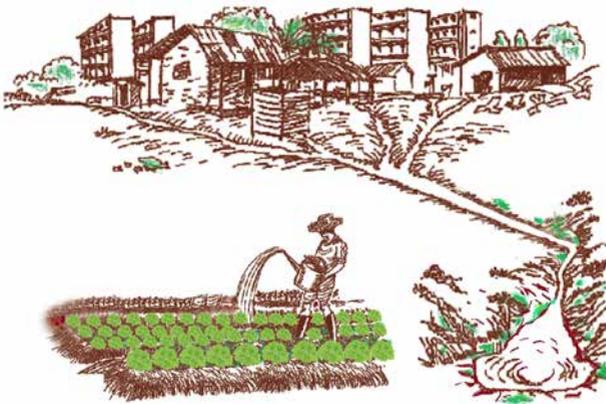
strategies for safe vegetable production.” Javier Mateo-Sagasta (FAO) coordinated the final production of the handbook, wrote the introductory sections and, together with Ines Beernaerts and Sasha Koo-Oshima (both from FAO), was involved in the final editing. The text was reviewed by Pay Drechsel (IWMI), while Anthony Youdeowei and Marjon Fredrix (both from FAO) ensured that the technical content of the handbook was compliant with the FFS approach. Paul Neate carried out the final language editing and K.G. Ato de Graft-Johnson (KNUST) illustrated the handbook with drawings.

**Second edition:** Desta Woldetsadik (Jigjiga University, Ethiopia) and Doreen J. Chirchir (Kenya) undertook the validation trials and farmer consultations in East Africa. The effort was coordinated by Bernard Keraita with additional graphics modified from artwork by K.G. Ato de Graft-Johnson (KNUST). Pay Drechsel and Bernard Keraita edited the second edition, including text revisions and additions, under the guidance of Sara Marjani Zadeh (FAO).

# Context for this handbook

The world's population is growing rapidly and concentrating in urban centres. This trend is particularly intense in developing countries, where an additional 2.1 billion people are expected to be living in cities by 2030. However, sanitation coverage (collection and treatment) is not keeping pace with urban growth and as a result most wastewater enters water courses untreated.

Many farmers in developing countries grow crops, especially vegetables, in urban and peri-urban environments using this wastewater, raw or diluted, to irrigate their crops (Figure 1). Such wastewater is often heavily contaminated with disease-causing organisms and chemical agents that can seriously harm the health of the farmers, the traders who handle crops and the people who consume them.



**Figure 1.** Irrigated agriculture using urban effluent

It is therefore very important for urban and peri-urban vegetable farmers to be aware of the health-risks associated with using wastewater for their irrigating crops and to know how to use wastewater safely at farm level to reduce those health risks.

Safe irrigation methods are essential when using wastewater for irrigation, but they need to be complemented with other practices from farm to fork to ensure the safety of others involved in the value chain. In 2006, the World Health Organization (WHO), together with the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Environment Programme (UNEP), adopted a multiple-barrier approach to reduce the health risks to farmers and consumers posed by using wastewater in agriculture (Figure 2). This approach opened the door to targeting a variety of entry points where health risks occur or can be mitigated before the food is consumed.



**Figure 2.** Multi-barrier approach to reducing health risks to farmers and consumers (Amoah et al., 2011).

This handbook focuses on low-cost and low-tech on-farm wastewater treatment and safe irrigation practices that farmers can adopt to grow safer products. When using the pronoun ‘you’, the handbook addresses extension officers, trainers of farmers, and farmers interested to apply and share new knowledge.

# The content of this handbook

This training handbook is a field guide for training urban and peri-urban vegetable farmers in safe practices for irrigating their vegetables with wastewater. It is designed to provide complete information, knowledge and skills for the successful safer production of vegetables in urban and peri-urban farming systems. Once you have gained this knowledge, we urge you to share the knowledge and skills you have gained with other farmers in your neighbourhood, so that they too can produce cleaner vegetables that are safer to eat. The handbook includes two chapters and several exercises to guide you.

The handbook covers five major topics:

- We explain how irrigation water might be polluted with wastewater from the town or city and how using such water for production of fresh vegetables poses health risks to you, the farmer, and to people who eat the vegetables you produce.
- We describe the various methods that you can use on your farm to reduce the health risks associated with using wastewater for irrigation.
- We show how you can check the performance and results of these safe practices.
- We help you to train other farmers in your neighbourhood.
- We explain ways to communicate the knowledge and skills acquired from the training to larger audiences, like through radio and field days.

By following these steps, you will be able to produce safer vegetables and show others how to do the same.

# Learning objectives

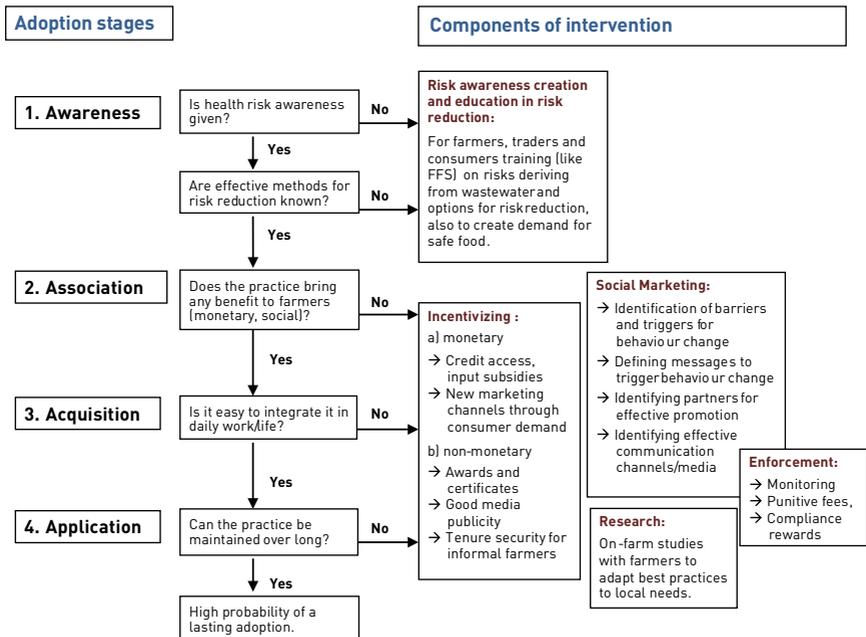
Once you have completed this training, you should be able to:

- Explain how contamination occurs in irrigation water and vegetables and its associated health-risks.
- Identify and select appropriate options to reduce health-risks of wastewater irrigation at the farm level, based on an understanding of farmers' motivation to adopt them.
- Monitor and evaluate the performance of the selected options.
- Train other farmers in the use of appropriate methods to reduce health risks in vegetable production
- Disseminate information and share your knowledge on the methods and practices for reducing health risks in urban and peri-urban vegetable production.

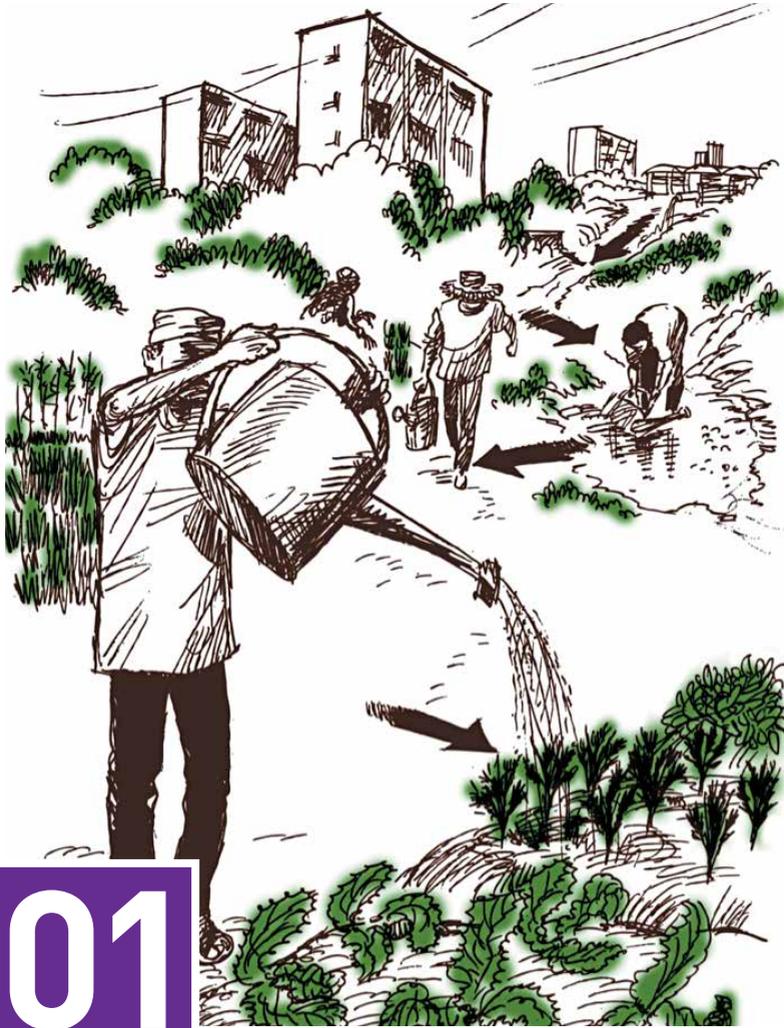
It is important to note that learning about new skills (i.e. education) does not translate automatically into the adoption of recommended practices. Behaviour change works best when farmers see an obvious advantage for themselves or their families, such as higher crop yields and income. Practices that improve food safety might appeal only if the causal link to the farmer's own cases of sickness is obvious; the link might not be straightforward, for example because some farmers produce only for the market and do not eat their produce, the risk factors are many, germs are invisible, and so on.

Moreover, new practices might come at a cost, at least of extra efforts, possibly more labour and certainly behaviour change. The benefits of safer food can only be a trigger for change if sufficient risk awareness has been created, especially along the value chain so that consumers and traders are also asking for it. Regulations can be very supportive, if monitored, and even more so combined with incentive systems for farmers, such as access to credit and niche markets that pay a premium, security of tenure, awards and

recognition and so on. Figure 3 offers an overview of a possible pathway from training to adoption and what is needed to facilitate that process. While the steps shown go beyond the scope of this manual, it is important to have the larger picture in mind.



**Figure 3.** Suggested strategy to facilitate behaviour change towards the adoption of farm-based interventions, for the reduction of health risks from wastewater irrigation in Africa (adapted from Drechsel and Karg, 2013). Farmer field schools (FFS) are one component of a set of interventions, which might be needed.



**Figure 4.** Contamination of irrigation water and vegetables.

# UNIT 01

## Contamination of irrigation water and vegetables

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### Introduction

There are many compelling reasons why farmers use wastewater for irrigation, although in many cases they may not be aware of the pollution level of the water they use (Figure 4). Wastewater, raw or diluted, is a reliable supply of water that allows farmers to grow crops throughout the year. It also contains nutrients that can improve crop growth. Furthermore, it is often the only water available, so farmers – especially in urban areas – have no choice but to use this water to irrigate their crops.

In this unit, you will be introduced to how irrigation water and vegetables become contaminated, and to the human health risks associated with the use of untreated wastewater to irrigate crops, especially fresh vegetables. It is important that you understand the contamination pathway, from the point where wastewater is generated to it arriving on farms. Unit 1 provides the background for the subsequent units by creating a general understanding of contamination and its associated effects.

### Learning objectives

Once you complete this unit, you should be able to:

- explain how and why farmers end up using wastewater on their farms; and
- identify health risks associated with irrigating crops with wastewater and how they can be transmitted.

### What is wastewater?

Wastewater is a combination of used water from one or more sources including domestic households, farms, institutions, and/or commercial and industrial establishments, containing toilet

water (black water), kitchen or bathroom water (grey water) as well as storm water. The exact composition of such polluted water sources varies widely, depending on the distance to the city, the sources of pollution (households, industry, agriculture) and how much the wastewater is diluted by other sources of water.

Here is a partial list of what untreated wastewater may contain:

- pathogens such as bacteria, viruses, protozoa and parasitic worms;
- organic particles such as faeces, hair, food, paper fibres and plant material;
- inorganic particles such as suspended solids, nutrients, sand, or heavy metals; and
- pesticides, grease, micro-plastics and other organic compounds or toxins.

Only some of these contaminants can be detected with the eye (like an oil film on the surface) or nose (bad smell). Most chemical and microbial contaminants (like bacteria and viruses) are invisible to the eye, but despite their small size can be very dangerous to human health. In sub-Saharan Africa, where industry is less developed, the reduction of **pathogenic threats** receives highest priority for safe wastewater irrigation.

## How does wastewater reach farms?

Some of the common routes by which wastewater arrives at farms include:

- Wastewater → stream/river → vegetable farm
- Wastewater → drain/gutter → vegetable farm
- Wastewater → drain/gutter → farm pond → vegetable farm
- Wastewater → stream → farm pond → vegetable farm
- Wastewater → runoff → shallow well → vegetable farm
- Wastewater → wastewater treatment plant → stream → vegetable farm

The route by which the wastewater arrives at a farm varies depending on the location of the farm, the season and the availability of other sources of water. In drier climates or during water scarcity, for example, wastewater may arrive at farms directly with little or no dilution, while in wetter climates wastewater is commonly diluted with water from other sources before arriving at the farm.

Given the different degrees of dilution, the potential harm of the water to farm workers and consumers of irrigated crops might not be easily detectable via colour or odour, but requires laboratory analysis of water, soils or crops.

### What are the risks involved in using wastewater?

Excess nutrients, pathogens, heavy metals and pesticides are commonly found in wastewater and are harmful to people and the environment. The table below shows the main health risks to farmers and consumers when vegetables are irrigated with insufficiently treated wastewater as it is common in most parts of Africa.

**Table 1.** Main human health risks from irrigating vegetables with wastewater.

Kind of risk	Health risk	Who is at risk	How
Occupational risks (contact)	<ul style="list-style-type: none"> <li>Parasitic worms (helminths) such as intestinal roundworms and hookworm</li> <li>Diarrhoeal diseases, especially in children</li> <li>Skin infections causing itching and blisters on the hands and feet, but also dermatitis (eczema)</li> </ul>	<ul style="list-style-type: none"> <li>Farmers/ field workers</li> </ul>	<ul style="list-style-type: none"> <li>Contact with irrigation water and contaminated soils</li> </ul>
		<ul style="list-style-type: none"> <li>Children playing on the farm</li> </ul>	<ul style="list-style-type: none"> <li>Contact with irrigation water and contaminated soils</li> </ul>
		<ul style="list-style-type: none"> <li>Market vendors</li> </ul>	<ul style="list-style-type: none"> <li>Exposure to contaminated soils while harvesting</li> <li>Washing vegetables in wastewater</li> </ul>
Consumption-related risks	<ul style="list-style-type: none"> <li>Mainly bacterial and viral infections such as cholera, typhoid, hepatitis A, viral enteritis which mainly cause diarrhoea</li> <li>Parasitic worms such as ascaris</li> </ul>	<ul style="list-style-type: none"> <li>Vegetable consumers</li> </ul>	<ul style="list-style-type: none"> <li>Eating contaminated vegetables, especially those eaten raw</li> </ul>
		<ul style="list-style-type: none"> <li>Children playing on the farm</li> </ul>	<ul style="list-style-type: none"> <li>Licking soil</li> </ul>

## Exercise 1

Exercise 1 will help you gain a greater understanding of human health risks posed by the use of untreated wastewater to irrigate vegetables. Everyone in the group should take part in this exercise. Discuss everything freely and openly, and try to achieve consensus in the conclusions you reach.

### Exercise 1: Vegetable contamination and its health effects

#### Introduction

This exercise uses cause–effect analysis to help understanding the causes and effects of vegetable contamination on farming activities and vegetable consumers. Use a problem tree and visual cards to support the discussion. All participants should be involved in identifying causes and effects.

#### Objectives

- understand the sources of contamination of vegetables; and
- understand the effects of contamination on human health.

#### Timing

Best conducted at the end of a lecture and discussion session

#### Duration

30 minutes

#### Materials

Chair, markers and cards in four different colours for each participant and a whiteboard for each group.

**Note:** This exercise is designed for a small group of trainees (6–8 farmers). If there are more trainees, we recommend you split the group and work in parallel subgroups. The decision to do this should come from the participants in plenary.

#### Procedure

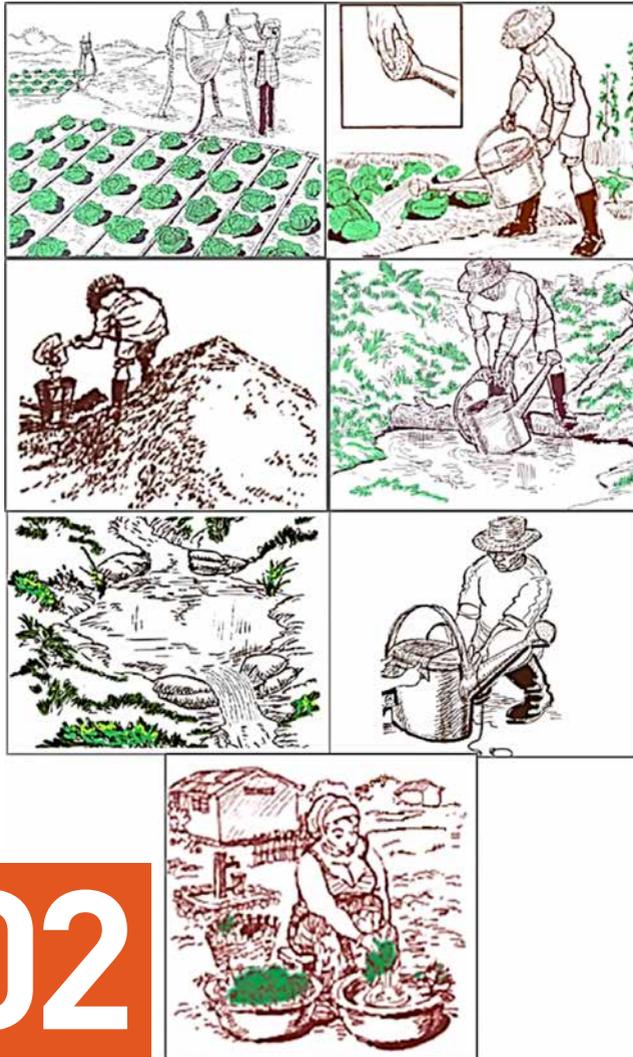
This procedure assumes you are the facilitator.

1. Introduce the exercise to the participants.
2. Supply each farmer with a marker pen and 5–7 cards in four different colours.

3. Guide the participants in drawing a problem tree diagram on the whiteboard. Write the problem, 'vegetable contamination,' in the centre of the board, where all participants can clearly see it.
4. Ask participants to write down causes of vegetable contamination on their cards, with one cause per card. Use cards of one colour. If any of the farmers cannot write, help them to write/visualize their points on their cards.
5. Collect the cards and stick them on the whiteboard in a row just below vegetable contamination. (Note: every participant's cards should be stuck on the board. If several participants write down the same or similar ideas, duplicates can be removed after discussion with the group.)
6. Use cards in another colour for the next step: ask participants to write down the causes of the problems identified (root causes).
7. Collect the cards and arrange them in another row just below the 'causes' layer.
8. Now ask participants to write on their cards the immediate effects of crop contamination. Use the cards of a third colour.
9. Collect the cards and arrange them in a row just above vegetable contamination.
10. Ask participants to write down the long-term effects of crop contamination on cards of a fourth colour.
11. Collect the cards and arrange them in a row just above the 'immediate effects' cards.
12. Finally, draw associations and linkages between causes and effects.

### Discussion

Encourage participants to discuss the causes and effects identified in their group(s). These discussions can identify more causes and effects, help to remove overlaps or even remove some of the causes and effects identified. Once the group members are satisfied with their problem tree, each group should present its problem tree to all the participants in plenary. Based on further discussions among all the participants, draw a final problem tree for each farming site or city.



02

**Figure 5.** Farm-level options for risk reduction.

# UNIT 02

## Seven easy ways to reduce health risks

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### Introduction

In Unit 1, you were introduced to how contamination occurs in irrigation water and vegetables as well as its associated risks to human health. In this unit, you will be shown various risk-reduction options for threats from pathogens such as bacteria, parasitic worms, and guided on how to select the best options for growing crops on your farms (Figure 5). The ideal option is of course if the farmer can access water that has been well treated. However, this requires developed capacities and large investments for the construction, maintenance and operation of sanitation and wastewater facilities, which are often not available.

Here we look at a number of low-cost risk-reduction measures that could be appropriate for urban vegetable farmers in sub-Saharan Africa.

### Learning objectives

Once you have completed this unit, you should be able to:

- identify various farm-level options to minimize pathogenic health risks in vegetable production; and
- select risk-reduction options suitable for your own farm.

### Farm-level options for risk reduction

There are many low-cost approaches you could use to significantly reduce health risks from wastewater on your farm. Some of these can be combined for even greater reduction in contamination. Some of these low-cost options are discussed below.

## Use less contaminating irrigation methods

Reducing contact between edible parts of vegetables and irrigation water reduces contamination on vegetables and so reduces health risks for consumers.

For example, drip irrigation (Figure 6a) applies water directly to the roots of the plants and minimizes contamination of leafy vegetables such as lettuce and cabbage. Drip irrigation wets the soil nearest the roots of the plants and, unlike overhead methods such as watering cans and sprinkler irrigation, does not splash contaminated water and soil onto the plant's leaves. Furrow irrigation (Figure 6b) also minimizes contact between the irrigation water and edible parts of high growing vegetables such as green pepper, but uses more water. However, the risk reduction may not apply for root crops such as carrots.

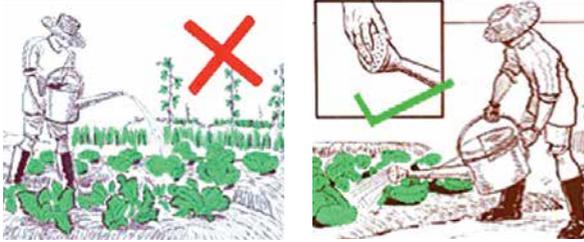


**Figure 6a.**  
Drip irrigation



**Figure 6b.**  
Furrow irrigation

If you use watering cans, even with clean water, on a field previously irrigated with wastewater, crops can still get contaminated from soil particles splashed on the leaves. Small changes in how you use the watering can will help reduce this type of contamination. Hold the can low when watering the plants and attach a rose (cap) to the spout (mouth) of watering cans (Figure 7). Together, these reduce splashing of contaminated soils onto the crop's leaves. However, you should be aware that any rainfall, even in the dry season, is likely to splash soil onto the crop's leaves, regardless of the irrigation method used.



**Figure 7.** Hold the can low and use a rose on the spout to minimize splashing of soil onto the leaves of the crop

### Stop irrigating some days before harvest

Most pathogens are easily killed by harsh environmental conditions such as heat, sunlight and lack of water. So, even if these pathogens get on your crop's leaves from soil or contaminated water, they will die off in the dry season if you stop irrigating your crops a few days before you harvest them. Generally, withholding irrigation for more days before harvesting leads to a greater decrease in contamination. However, withholding water also affects crop growth and may reduce yields where the climate is hot. In cooler climates, like Addis Ababa (Ethiopia), the number of days without irrigation can be increased without a similar negative impact on yields as in the hotter Kumasi or Accra (Ghana).

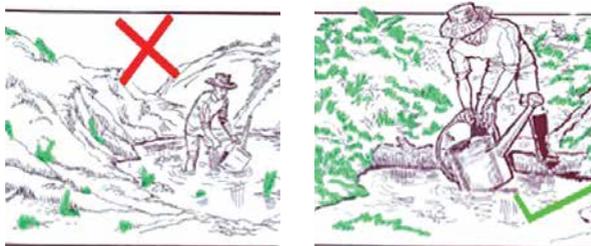
For water-sensitive crops that need daily irrigation, such as lettuce, you can withhold irrigation for 2–4 days before harvesting to reduce contamination with little loss of yield. Vegetables that are less water-sensitive, such as green pepper, spring onions and cabbage, can do without irrigation for longer without significant losses of yields. For such crops, you can stop irrigating more than four days before harvest to minimize contamination.

### Use sedimentation ponds

In water, most organisms that cause disease are attached to silt and other particles and will settle to the bottom of ponds and slow-flowing streams. Some others such as worm eggs will settle because they are heavier than water. If you pass irrigation water

across a series of smaller ponds, or leave irrigation water in the main pond to settle for few days, and carefully collect water from near the surface without stirring up particles settled at the bottom, you will reduce contamination significantly. Here are three ways you can do this:

- Do not walk into ponds or water sources when collecting water. Instead, place a plank of wood across the pond and stand on this when collecting water (Figure 8).
- Design your main water supply ponds to allow more sedimentation and less disturbance when collecting water. Circular, conical ponds about 0.7 m deep and 1–1.5 m in diameter work well.
- If you can, use two or three smaller ponds along the channel to the farm, transferring water from the first to the second and then to the third. That is where you collect water for irrigation, while the first (and second) pond will be traps for pathogens. Grow grass around your ponds to reduce run-off from contaminated soil into the ponds.



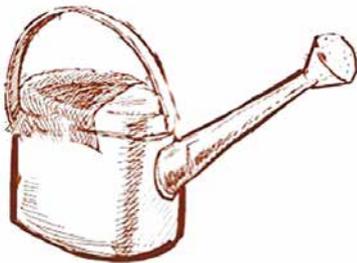
**Figure 8.** Do not walk into ponds to fetch water (left). Stand on a plank of wood to collect water (right).

### Use simple filtration techniques

Filtration systems remove disease-causing microorganisms from polluted water by trapping them in the filtration media. Once they have been trapped they die or are removed by exposing them to heat or predators. Large pathogenic microorganisms such as parasites are generally trapped mainly by straining while smaller organisms such as bacteria and viruses are trapped by adsorption.

Slow sand filters and fabric filters are among the simplest and cheapest filtration systems.

- **Sand filters:** If you collect water from gutters, drains and streams, place porous sandbags across the stream so that the water flows through the sandbags and collect water downstream of the bags. This works even better if you use a series of sandbags. You can also use a mix of gravel and sand to form a porous trench through which water flows into your ponds. Fine sand filters can be easily constructed on farms.
- **Fabric filters:** Some locally available fabrics such as cotton, mosquito netting and nylon can be used to sieve irrigation water before use, for example to filter water as it is poured into watering cans (Figure 9). However, although they are cheap and easily used, fabric filters are not as effective as fine sand filters in cleaning water as they only capture contaminants attached to larger visible particles, like leaves or litter.
- Where water can be filtered through buckets or tubes, alternating layers of fine sand and biochar could be used. However, such systems slow down the water flow and might best fit drip kits (Figure 6a, P20).



**Figure 9.** Use nylon netting to remove coarse debris from water as it is poured into watering cans

## Taking advantage of irrigation infrastructure

In cases, where polluted water is used within formal irrigation systems, for example close to the city, the irrigation infrastructure can specifically support farmers and food safety. As water moves in the canals, especially when unlined, heavier pathogens (like worm eggs) settle on the rough surfaces and ground while the ones exposed to the environment especially sun light (like viruses, bacteria) will in part die-off due to unfavourable living conditions. Thus, the slower the flow and longer the passage (ideally some days) from water source to water use, the greater the impact.

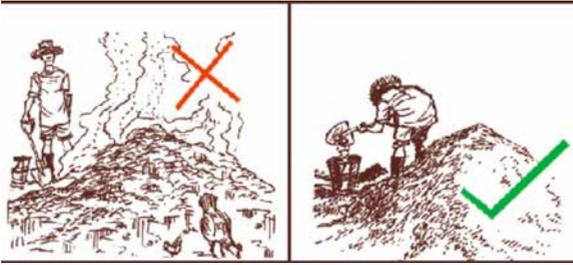
In larger irrigation systems, irrigation water is stored in tanks or reservoirs. Any residence time in tanks and reservoirs causes sedimentation, of silt, clay and larger pathogens. Weirs (Figure 10) can be effective barriers, where large numbers of worm eggs can accumulate at the bottom and hence be removed from the water flowing downstream. The same applies to other barriers across canals, such sandbags. Some reservoirs may also have floating plants, which can filter off some of the pathogens.



**Figure 10.** Weirs and barriers can be effective traps for worm eggs

## Use manure with care

To fully address crop contamination, you have to go a step beyond wastewater irrigation, by avoiding the application of fresh manure on your crops. Fresh manure can 'burn' seedlings and only a matured (composted) manure no longer contains organisms that can harm human health (Figure 11). Manure should be kept in dry heaps, and turned frequently to allow for proper composting (internal heat development) and maturing before it is applied to crops. Do not apply manure on the edible parts of vegetables. It is best to apply manure directly on the soil before or just after you transplant your crops.



**Figure 11.** Fresh and unsuitable manure (left) and matured and suitable manure (right)

### Use clean water after harvest to remove sand and dirt

In countries like Ghana, vegetables are sold on the farm; the traders harvest them and often wash the crops free of sand and dust in the nearest available water, which is often the polluted stream or pond also used for irrigation.

However, harvested vegetables should always be washed with clean water, if possible tap water (Figure 12).



**Figure 12.** Incorrect and correct vegetable washing

### How to chose the best way to reduce contamination

You should choose the system best suited to your local conditions, supported by building up risk awareness, following a step-wise approach to possible options:

1. Could farmers get access to land with safer water sources in the vicinity and are they willing to move?
2. Could safer groundwater be used, and farmers be supported to access it?
3. Could farmers be encouraged (and/or accept) to grow other (cash) crops that are not eaten raw or where the harvested part is not in contact with irrigation water?

4. Could farmers be encouraged to set up and use on-farm pond systems to treat irrigation water before use?
5. Could farmers be encouraged to adopt safer irrigation practices to protect consumers, as well as personal protection measures (like hygiene and rubber boots) to protect themselves and their families?

With respect to these best practices, it is suggested that farmers test different options and adapt to their local conditions (Exercise 2). When comparing different options for safer on-farm practices, consider effects on yield, labour requirement, additional capital costs and ease of operations and maintenance. Farmers might express additional concerns, as shown in Box 1. However, the adaptations should not undermine the targeted elimination of pathogens, which might require laboratory tests for verification.

**Box 1:** Specific concerns about health-risk-reduction approaches raised by farmers during field trials in Kumasi, Ghana

**Ponds:**

Effort needed to change their usual habits when collecting water (and uncertainty about what may happen during the dry season when water is scarce) and the extra area the new improved ponds will occupy.

**Filters:**

Cost of installing and maintaining sand filters; whether sand filters can filter enough water to irrigate the entire farm; time it will take to get good quality water; where to dispose of sediments from filtered water; extra labour required; and skills required maintaining the filters.

**Irrigation methods:**

Cost and availability of drip kits; theft of drip kits from the field; clogging of emitters of drip kits; low cropping densities for furrow and drip irrigation; extra labour needed to maintain furrows and fill buckets for drip kits; and inconveniences to other farm activities, e.g. drip laterals making it hard to weed and difficulty in applying manure in furrows.

**Withholding irrigation:**

Effect on yields and freshness of produce; and the special arrangements required with vegetable buyers (market women).

## Exercise 2

Exercise 2 will help you choose the best way to treat wastewater for irrigating your crops. Table 2 could be enlarged and printed to serve as an assessment sheet.

**Table 2.** Assessment sheet for risk reduction options (with example scoring)

		Selection criteria					Overall score
		Health risk reduction	Labour requirements	Maintenance requirements	Impact on crop yields	Others	
Consumption risk reduction option	Access to safe water as replacement	5					
	Growing crops that are not eaten raw	4					
	Drip irrigation	5					
	Furrow irrigation with harvested crop part not in water contact	2					
	Withholding irrigation for 3+ days	3					
	Use of multiple ponds and not stepping in ponds	2					
	Sand filters	2					
	Watering can cover	1					
	Crop washing with tap water after harvest	3					
	Occupational risk mgt.	Personal protection (rubber boots, hand washing, ...)	4				
	Others						

## Exercise 2: Choosing the best local options to reduce risk from using polluted water for crop irrigation

### Introduction

You have seen various ways to reduce the health risk of using wastewater to irrigate your crops, but not all of them may be suitable for your farm or farming location. This exercise will help you discuss, compare and select options likely to be suitable for your farm.

### Objectives

- To enable you to identify and select options for health risk reduction best suited to your farm

### Timing

Best conducted at the end of a lecture and discussion session

### Duration

30 minutes

### Materials

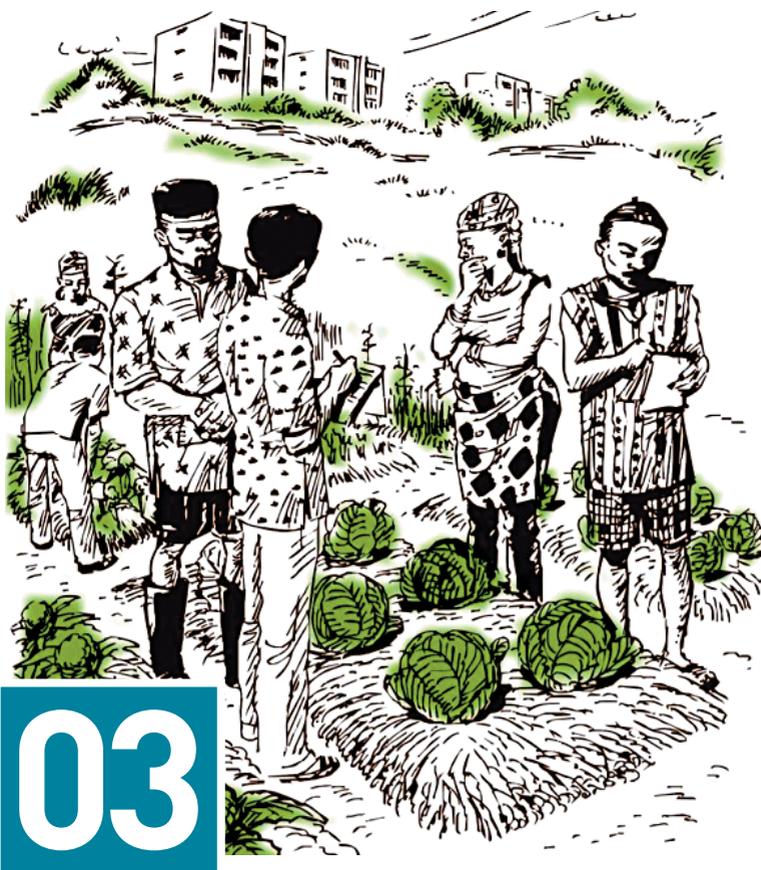
Resource person familiar with the options; a chair for each participant, whiteboard, markers for each participant and facilitator and assorted coloured pieces of paper.

### Procedure

1. Give each participant a sheet of paper with all risk-reduction options discussed listed in one column and the selection criteria on top row as shown in Table 2.
2. Ask the resource person to explain every option and then each participant to rate the options on a scale of 1–5, where 1 is least suitable and 5 is most suitable
3. Add up the score on each row. The total on each row should be the overall score for each option
4. Give participants (or participant groups) coloured papers so that they rank the three most suitable options (three options with the highest scores)
5. Place these cards on the whiteboard.

### Discussion

Discuss the rating and ranking done by each farmer. Compare the rankings by farmers from different farming sites. Discuss whether ranking will be similar for both dry and wet seasons and for different crops. Involve the resource person to comment on the results with further guidance.



03

**Figure 13.** Farmers monitor and discuss field observations.

# UNIT 03

## Monitoring and evaluating performance

---

### Introduction

In Unit 2 you were introduced to various ways to reduce the health risks of using wastewater to irrigate your crops, and were guided in the process of choosing appropriate options. This unit introduces how to monitor and evaluate the risk-reduction systems you use to make sure they are working well and are effective. The process of monitoring and evaluation involves careful observations and testing, and can be done in partnership with extension agents and researchers (Figure 13).

### Learning objectives

Once you have completed this unit, you should be able to:

- effectively monitor and evaluate the performance of selected health risk reduction options.

### What to monitor and evaluate

The performance of health risk reduction options is monitored and evaluated at two main levels: observing irrigation water and observing irrigated vegetables.

Indicators are used to measure performance and effectiveness of selected options. Such indicators might be quantitative or qualitative. As germs cannot be seen with the eye, lab analysis or proxy indicators are needed.

Quantitative indicators (e.g. the number of pathogenic organisms in a given amount of water) give the best results, and should be used if laboratory facilities are available and affordable.

If laboratory facilities are not available or affordable, you can use a combination of several qualitative indicators, such as those

presented in Table 3. A combination is important since even water, which, for example, does not smell, can contain harmful pathogens.

**Table 3.** Qualitative indicators used by farmers to monitor and evaluate performance of health risk reduction options

Monitoring point	Indicators	Monitoring and evaluation criteria	
		Good	Bad
Irrigation water	Source	Groundwater	Urban drain, stream passing urban area, open or closed sewer
	Colour	Clear	Dark grey or foam
	Smell	Odourless	Foul
	Particles, trash and solid material in the water	No particles, trash or solid materials	Full of particles, trash and solids
	Cessation duration	2 to 4 days before harvesting	Irrigated until harvesting
Vegetables	Soil particles on leaves	No particles	Soil particles on leaves
	Poultry manure on leaves	No particles	Poultry manure on leaves
	Watermark (dots)	No watermarks	Watermarks present
	Colour (for green vegetables)	Green	Yellowish/brownish
	Size/yield	Large	Small
	Amount of irrigation water on edible parts	No water	Presence of water
	Handling during harvesting	Vegetables placed on clean material	Vegetables placed on soil surface
	Washing medium	Clean tap or groundwater	Local (possibly polluted) water from local streams or ponds

## How to monitor performance of health-risk-reduction options

Generally, operational monitoring should be based on simple and regular observations that provide meaningful information about performance of the selected health-risk option in use (see Figure 5 and Plate 7). When monitoring is done on-farm, extension agents should establish 'learning' plots adjacent to your plots.

If the monitoring and evaluation show that the selected option does not perform as expected, the extension agent should help the farmer to find out why the system is not performing well and either help improve its performance or explore alternative options.

### Exercise 3

This exercise will show you how to monitor and evaluate the performance of selected health risk reduction options for irrigated urban agriculture.

Before you perform this exercise, you need to understand the scoring scheme, which uses a scale of 1 to 5. The trainer will explain this in detail to ensure that all participants fully understand the process and the logic of the scoring scheme. You can perform a series of trial runs to confirm that everybody understands and is comfortable with using this scoring scheme.

Once you understand the scoring system, you can use it on your own to assess the performance of selected health risk reduction options for vegetable production.

## Exercise 3: Monitoring performance of selected health risk reduction options

### Introduction

After you have selected appropriate options to reduce health risks from wastewater irrigation, it is important that you know how to assess their effectiveness.

### Objectives

- to enable you to assess the performance of options implemented to reduce health risk.

### Timing:

Best done in the field and at the end of a lecture

### Duration:

30 minutes

### Materials

Field notebooks and vegetable farms that have implemented one or more health risk reduction options

### Procedure

- The training needs to be done in a large vegetable farming site where some health risk reduction options have been implemented and data are available
- Divide the participants into groups of 6–8
- Give each participant a sheet of paper for recording the performance of risk-reduction option(s) observed on the basis of the chosen indicators (e.g. those listed in Table 3). Each participant rates the options on a scale of 1–5, where 1 means very bad, 2 = bad, 3 = average, 4 = good and 5 = very good
- Each group walks a transect in the farm
- Stop at three or four regular intervals on vegetable beds and water sources. Observe the water and the vegetables, and give a score for each of the indicators related to water and vegetables.

### **Discussion**

Encourage participants to discuss their individual ratings and compare ratings from different groups. Farmers should discuss the monitoring parameters (indicators) they used, other new ones they could use and how to improve the health risk reduction options implemented. The facilitator should explain how the authorities could assist with laboratory analysis.



04

**Figure 14.** A trained farmer explains the technique of filtering wastewater with a cloth to colleagues.

# UNIT 04

## Spread the word: farmer-to-farmer training

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### Introduction

This unit focuses on helping you to use participatory training methods to transfer your knowledge about the safer use of wastewater to other farmers, how to use training materials, how to motivate farmers and how to evaluate reactions to the training (Figure 14).

### Learning objectives

Once you have completed this unit, you will be able to:

- list the components of the group training process;
- use appropriate participatory methods to train adults;
- discuss the use of good training materials to facilitate training;
- understand that adoption goes beyond training; and
- describe appropriate methods to evaluate training.

### The training process

Effective training begins with proper planning. To plan effectively, you must:

1. identify training needs;
2. determine training objectives;
3. determine training content;
4. select appropriate training methods;
5. use appropriate training materials;

6. implement training in a participatory way with farmers; and
7. understand adoption and evaluate training.

Three of these steps will now be described, namely:

1. selection of appropriate training methods;
2. use of appropriate training materials; and
3. understanding adoption and evaluation of training.

### **Participatory training methods**

The success of adult training depends largely on the methods used. Since the majority of our training participants are usually adults (above 16-18 years), we require a participatory training environment for success. Participatory training involves using training methods that allow everyone to participate in the learning process. At the same time, facilitators, by listening carefully to what the trainees say, will help to adjust solutions to expressed challenges.

Key elements of participatory training include the following:

- use of a wide range of methods and techniques that ensure the active involvement of all participants;
- the trainer as a facilitator rather than as a teacher;
- use of group dynamics to understand your farmers' needs;
- contributions towards interaction among participants and group-building process; and
- sharing of knowledge, information and skills.

Farmer-to-farmer training also relies heavily on the experiences and indigenous knowledge of both the trainer and the learners.

Examples of participatory training methods include the following:

- interactive lectures;
- group discussions;

- role play;
- field case studies;
- plenary discussion groups;
- question and answer sessions;
- interactive demonstrations and field days;
- buzz groups (three or four people);
- brainstorming sessions;
- field trips.

### Exercise 4

The primary objective of Exercise 4 is to draw your attention to the differences between conventional classroom teaching methods and those used in participatory training.

The exercise uses role playing. Before the role play, you, as the trainer, should brief all the training participants on the concept and modalities of the role play and provide detailed guidelines on the observations to be made during the role plays. It is important that you emphasize that observations during the role play are meant to identify the major differences between the two training methods, NOT to criticize individual participant's performances. Write the conclusions reached by consensus on a flip chart and have the entire training group review them; they should be accepted by all training participants.

## **Exercise 4:** Comparison of participatory training with conventional classroom training methods

### **Introduction**

Participatory training methods allow everyone to participate in the learning process, and are best suited to training adults. This exercise uses role play to demonstrate differences between participatory training and conventional classroom teaching methods by observing the relationship between teacher or trainer and learner. It is aimed at helping you to teach other farmers to become trainers.

### **Objectives**

- Build participants' awareness of the differences between participatory methods and conventional classroom teaching methods.
- Appreciate the use of participatory training methods in training vegetable farmers.

### **Timing**

Best conducted at the end of a short lecture and discussion session

### **Duration**

30 minutes

### **Materials**

Three chairs, three books and a pointer

### **Procedure**

1. Ask for 6–8 volunteer participants and split them into two groups.
2. Brief one group on the roles of the teacher and learners in traditional classroom learning.
3. Brief the second group on the roles of the trainer or facilitator and learners in a participatory group training environment.
4. Each group then performs a role play to simulate learning cum teaching in either traditional classroom or participatory group learning styles.

5. The rest of the participants observe the role plays and note the differences between the two methods in terms of their approaches.

### Observations/results

At the end of the role play:

- Ask the participants who observed the role play to list the differences and similarities of the two training or teaching styles.

### Discussion

In discussing the role play, ask the following questions:

- What are some of the features of the traditional training method?
- What are some of the features of the participatory training method?
- What basic concepts demonstrate the differences between the two approaches?
- What can we learn from the results of the exercise?

## Training materials

To facilitate training, you need to use appropriate training materials or teaching aids to enhance effective communication and learning. Training materials are sources of information during and after training and also guide trainers and training participants during training. It is a good idea to help training participants to design their own training materials, also sometimes known as visuals, as this helps deepen their understanding of the knowledge they are acquiring.

There are two main types of training materials:

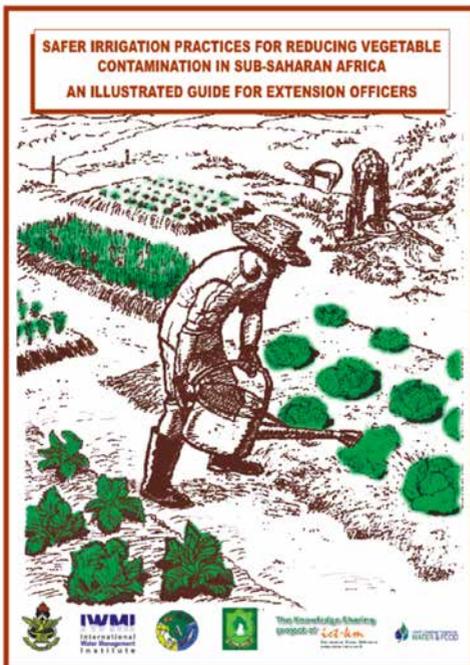
- print materials (like Figure 15) – e.g. handouts, farmer or extension manuals, field guides, flipcharts and posters;
- non-print materials – e.g. video and audio recordings.

Some training videos for farmers and others can be found here:

- Safe farming practices: [https://www.youtube.com/watch?v=Aa4u1\\_RblfM&feature=youtu.be](https://www.youtube.com/watch?v=Aa4u1_RblfM&feature=youtu.be)
- Safe practices in the street food sector: [https://www.youtube.com/watch?v=DXHkQE\\_hFg4&feature=youtu.be](https://www.youtube.com/watch?v=DXHkQE_hFg4&feature=youtu.be)
- Case study on Ghana's La area: [https://www.youtube.com/watch?v=f\\_EnUGa\\_GdM&feature=youtu.be](https://www.youtube.com/watch?v=f_EnUGa_GdM&feature=youtu.be)

Good training materials have the following features or attributes:

- They provide accurate information that meets the objectives of the training.
- They are simple, attractive, easy to read and to understand; that is, they are reader-friendly.
- They are well organized, with information and illustrations presented in a logical sequence.



**Figure 15.** Example of printed training materials (free download)

## **Understanding adoption and evaluating the training**

Evaluation is very important in training. It tells trainers which components of the training worked well and which need to be improved, and whether the training has achieved its objectives.

Content should cover lessons learned and new skills but also aspirations for making use of the training (barriers, opportunities, needs, ...) to be able to design a follow-up training or call for supporting interventions as outlined in Figure 3.

Evaluation of training is best done progressively at the end of each day of training and finally at the end of the entire training course. There are several ways to evaluate training through feedback from training participants. These include:

- questions and answers;
- mood assessment tests;
- ballot box tests;
- field analysis tests;
- expressions of aspirations;
- itemized response technique (participatory identification of major training activities, and assessment and recording of what went well, what needs improvement and actions to be taken to improve training).



**Figure 16.** Farmers discuss vegetable innovations with an extension agent

# UNIT 05

## Disseminate and communicate your strategies for safe vegetable production

---

### Introduction

In Unit 4, we learned that training, especially farmer-to-farmer training, strengthens the capacity of farmers to share information with other farmers.

In this unit, we learn about other methods of disseminating or sharing information. Some of the most frequently used channels for disseminating information to enhance learning include discussions with extension officers (Figure 16), farmer-to-farmer discussions and dialogue, farmers' field days, television and radio.

### Learning objectives

Once you have completed this unit, you should be able to:

- list types of methods use to share or disseminate agricultural information;
- describe commonly used channels of communication used to enhance learning; and
- organize field days to disseminate information on options for minimizing health risks in vegetable production.

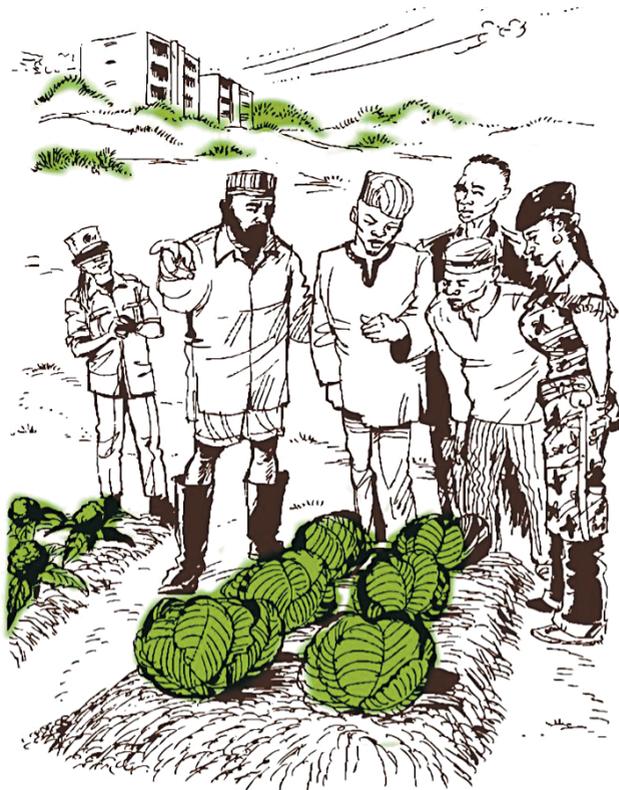
### Farmer-to-farmer discussions and dialogue

Farmer-to-farmer discussion is the most commonly used method for disseminating information on food and agricultural production in sub-Saharan Africa. This approach uses various techniques, such as individual discussions, group discussions and informal social networks. Urban farmers can take advantage of these techniques to enhance the dissemination of appropriate health risk reduction options in urban vegetable

production. Farmer-to-farmer dissemination of information can be enhanced by training a core group of farmers in the application of appropriate ways to minimize health risks in vegetable production, and then giving these farmers the task of disseminating these technologies to other farmers through farmer-to-farmer training, dialogue and discussions.

## Farmers' field days

Farmers' field days can be effective platforms for disseminating information on minimizing health risks in urban vegetable production. As a trained facilitator/farmer, you can organize field days to promote practical learning through sharing and exchanging ideas, as shown in Figure 17.



**Figure 17.** A farmer explaining a point during a field day.

Farmers' field days can:

- provide a forum for socializing and exchange of ideas about successful agricultural technologies that can be applied in local environments;
- provide opportunities for farmers to see and discuss farming and related activities with other farmers;
- enable farmers to learn through demonstrations of alternative practices that result in increased yields;
- enable farmers to learn about the performance of agricultural technologies that have been successfully applied and adopted by other farmers;
- enhance the participation of farmers and extension workers in the process of learning;
- provide a feedback mechanism from farmers to extension agents and researchers; and
- stimulate interest and create awareness of the importance of adopting health risk reduction practices in urban vegetable production.

### **When to organize field days**

Field days are best organized when:

- • Most exhibits are available to be shown.
- Farmers and other stakeholders are available to participate.
- Farmers can show the results of a procedure, technology or innovation, especially effective options for health risk reduction in urban agricultural production.

### **How to organize a field day**

The following steps will help you to plan and conduct a successful field day.

### ***Planning a field day***

1. Identify the specific objectives to be achieved by the field day.
2. Identify the target audience.
3. Work with the farmer group to decide on the date, venue and time of the field day.
4. Identify key farmers from the group to tackle various tasks such as presentations, managing the exhibits and showing visitors around the exhibits.
5. Publicize the field day widely in advance among the communities.

### ***Conducting the field day***

- During the field day, observe all local traditional protocols.
- Show farmers and other stakeholders around the plot.
- Present the objectives of the field day (this should be done by a local farmer).
- Help host farmers who are displaying exhibits to explain their exhibits and the practices they are demonstrating to all participants, emphasising their advantages.
- Facilitate a discussion of the practices and exhibits. Record participants' comments and reactions and use these in planning for future field days.
- Provide information to farmers who show interest about how they can participate in testing the practices or technologies they have seen at the field day.

### **Use of radio and television for information dissemination**

Radio and television are useful mass communication tools for effective dissemination of agricultural information because they:

- use the spoken word and images to overcome the barrier of illiteracy;

- provide the warmth of the human voice to effectively communicate local problems and solutions;
- reach large audiences in rural areas and thus create awareness and interest among local farmers.

### **Using radio and television to disseminate agricultural information locally**

There are various ways that you, as a facilitator, can use radio and television to disseminate information at the local level, including the following:

- Programmes can be broadcast live and taped for later broadcast.
- Programmes can be recorded on audio and video cassettes and distributed to farmers who own cassette and video players for individual or group listening and viewing.

### **Timing broadcasts**

Radio and television broadcasts on agricultural topics should be aired when farmers and other stakeholders can listen or watch. This is usually early in the morning before they go to their farms or late in the evening when they return from the farm.

### **Producing and presenting radio and television broadcasts**

The following actions will help you to prepare and present programmes for broadcast.

- Base your programmes on local problems and use local dialects and languages that farmers will easily relate to and understand.
- Emphasize current activities, trends, issues and developments.
- Attract listeners' attention through catchy introductory sounds (jingles).
- Provide information in a flowing, personalized manner so that it is easy to follow.

- Speak in normal conversational voice at a natural speed.
- Repeat important facts such as dates, times and places of meetings.
- Encourage interaction by inviting listeners to call into the programme. Asking questions and posing problems helps to engage the attention of listeners and viewers.

Note that interviews with successful farmers are usually more effective at communicating information to other farmers than speeches by agricultural scientists.

## Exercise 5

This exercise introduces you to the basic process of organizing field days to share knowledge and skills in the adoption of health-risk reduction practices for urban vegetable production. You should pay particular attention to the critical steps of the process, namely identifying the specific objectives of the field day, planning and managing the field day.

You should ensure that participants take the lead and have full ownership of the exercise.

### **Exercise 5:** Organizing a field day to disseminate information on minimizing health risks in urban vegetable production

#### **Introduction**

It is important that you share your knowledge and skills of how to minimize health risks in urban vegetable production with other vegetable farmers who use wastewater to irrigate their fields. One way you can do this is by organizing a field day.

#### **Objective**

- Build your awareness of the use of field days to promote locally relevant ways to minimize health risks in urban vegetable production

**Timing:**

Best conducted at the end of a set of lectures and discussion session.

**Duration:**

2 hours

**Material**

An urban vegetable farm

**Procedure**

1. State the objectives of the field day, identifying the specific knowledge and skills to be acquired.
2. Show farmers around the field for about 45 minutes.
3. Explain the practices and exhibits to all participants, emphasizing advantages of the practices being explained.
4. Demonstrate individual risk-reduction practices and help the farmers to repeat the operation.

**Observations/Results**

At the end of the field day:

- Ask the participants to recall the major outcome of the field day.

**Discussion**

As you demonstrate each of the risk-reduction practices, ask the following questions:

- What were the steps we just followed on minimizing health risks in urban vegetable production?
- Which steps were the most difficult and will need more practice?
- Will you feel comfortable implementing this practice on your vegetable farm?
- How many of you would want to organize a field day on your farm to demonstrate what you have learned to other vegetable farmers?

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