

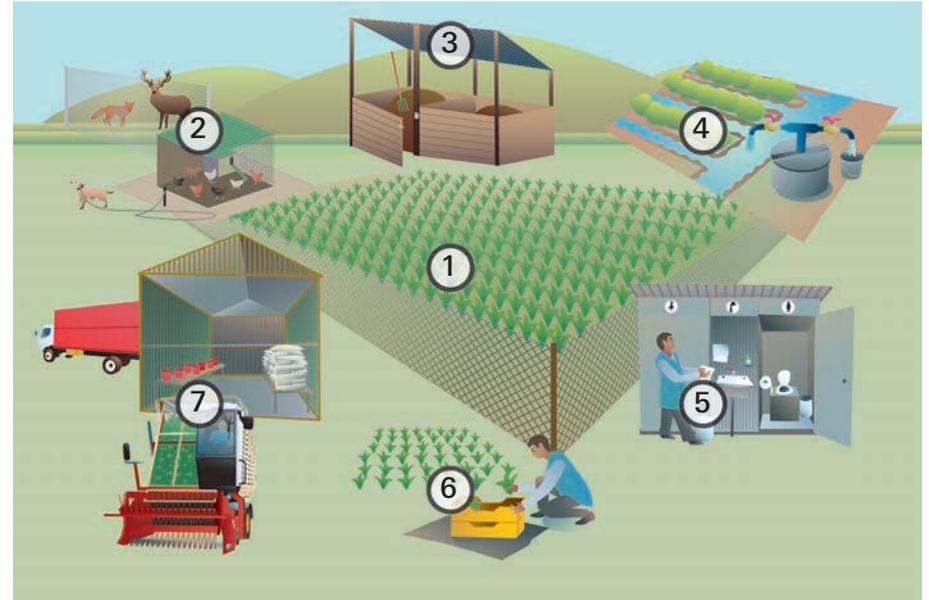
# Minimizing microbial contamination in primary production of fruits, vegetables, herbs and spices



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## Minimizing microbial contamination in primary production of fruits, vegetables, herbs and spices

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In the recent past, many plant-based ingredients, either processed or unprocessed, were found to be contaminated with pathogenic bacteria, viruses or parasites:

- In 2010, 272 individuals were infected with the bacterium *Salmonella*. This US outbreak was traced back to contaminated black pepper.
- In 2003, 640 people were sick and four died due to Hepatitis A virus in green onions. This was the most widespread Hepatitis A outbreak in the US.
- In 2015 in the US, 546 people were ill due to the parasite *Cyclospora* in fresh cilantro. Contamination was found to be caused by poor agricultural practices.

Where does the contamination at farm level come from? Contamination can have several origins, these are the so-called "routes of microbial contamination".

Seven routes have been identified, which are represented in the above illustration:

1. Growing field and adjacent land;
2. Animals;
3. Manure-based soil amendments;
4. Agricultural water;
5. Hygiene and human health;
6. Worker harvesting practices;
7. Equipment, premises and transportation.

This training booklet comprises seven chapters, one per route of microbial contamination. Each chapter summarizes and illustrates the main good agricultural practices to follow during farm activities in order to minimise the risk of microbial contamination posed by this particular route. By following these practices\*, you will improve the safety of the crop(s) you are growing and the safety of the people who are consuming them, as well as the health of your workers.

(Continuation page 4)

The scope of this training booklet is: fruits, vegetables, herbs and spices expected to be eaten raw or mildly processed (e.g. washed, frozen, freeze dried, dried...). However Good Agricultural Practices should be adhered to at any time, even for plant-based ingredients that will be subjected to a microbiological kill step such as pasteurization. This booklet was developed based on five "model" ingredients illustrated in the icons below: black pepper, onion, raisin, basil and parsley. Most recommendations given in this booklet can be extended to other plant-based ingredients. Sprouts are excluded from the scope.

This document refers to the Nestlé Supplier Code and the Responsible Sourcing Guideline. This booklet is a simplified version of the full training booklet carrying the same title which is available here: <https://www.nestle.com/aboutus/suppliers>. The full training booklet provides more details regarding how to achieve the recommendations illustrated in the present simplified version.

- The primary target audience is:
- Farmers
  - Farm workers (e.g. hand pickers and supervisory personnel in the field)
  - Raw material buyers (at supplier or at Nestlé level)

Never forget that safety starts in the growing field! Within a robust food safety management system, minimizing the risk of microbial contamination at farm level (during pre-harvest, harvest and post-harvest activities) is key to ensure the safety of the consumer.



\* Note: If local regulation is more stringent than a recommendation from this booklet, always follow local regulation.

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## Definitions

### **Crop production area:**

A plot of land where all growing, harvesting, and on-farm post-harvesting activities (e.g. sun-drying) are performed. This includes the growing field, toilet and hand washing facilities, potential storage areas and post harvest premises.

### **Growing field:**

A plot of land used to grow crops.

### **Storage area:**

A facility/contained area inside or outside the crop production area, used to store harvesting containers before use and/or harvested crops before their transportation to the processing plant.

### **Agricultural water:**

Water used for agricultural activities in the crop production area, such as: irrigation, pesticide and fertilizer preparation, cleaning of equipment and hand washing. In this document, agricultural water does not include water used during post-harvest processes.

### **Potable water:**

Water that meets the microbial standard for drinking water from World Health Organization (*E. coli* must not be detectable in any 100 mL sample).

### **Municipal water:**

Potable water provided by the municipality.

### **Primary treated sewage water:**

Sewage water treated with a primary treatment. A primary treatment aims to reduce any settleable solid within the sewage water via mechanical treatment (filtration and sedimentation).

### **Secondary treated sewage water:**

Sewage water treated with primary and secondary treatment. Secondary treatment aims to decompose remaining suspended solids from the primary treated sewage water and to greatly reduce the microbial load via biological treatment (e.g. stabilization ponds).

### **Disinfected water:**

Water treated (e.g. chlorination) to remove pathogenic microorganisms such as *Salmonella* and viruses. Secondary treated sewage water can be disinfected to remove remaining pathogenic microorganisms that were not removed by previous treatments.

## Primary production flows

The following ingredients were selected as model crops to illustrate the summary recommendations given in this booklet. There are undoubtedly variations in practices depending on the country/region, operation size, individual grower preferences, subsequent primary processing (e.g. drying versus freezing) and distance between farm and primary processing plant. Therefore, the primary production steps described are representative of production flows.

Recommendations given throughout the document aim to minimize the risk of microbial contamination at each step of these primary production flows. They can be extended to other plant-based ingredients having similar, or partially similar primary production flows.



**Black pepper**



**Onion**



**Raisin**



**Basil**



**Parsley**

## Primary production flows

### Black pepper

Sun-dried



Manual harvesting

Manual or mechanical separation of berries and spikes

Cleaning or blanching\*

Sun-drying

Bagging

Transportation to primary processing (e.g. grading)

### Onion



Manual or mechanical harvesting

Drying in the field

Collection from the field

Transportation to storage areas\*

Ventilated storage\*

Transportation to primary processing (e.g. drying)

## Primary production flows

### Raisin

Sun-dried



Manual or mechanical harvesting

Dipping\* and sun-drying

Mechanical separation of raisins and stems

Transportation to primary processing (e.g. cleaning and sorting)

### Basil and parsley



Manual or mechanical harvesting

Unloading into crates at on-farm post-harvest facility\*

Cooling and short cold storage before transportation\*

Transportation to primary processing (e.g. freezing or drying)

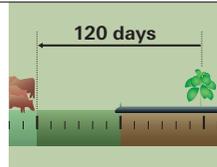
\* optional steps depending on country/region, operation size, individual grower preferences, subsequent primary processing (e.g. drying versus freezing) and distance between farm and primary processing plant.

## Growing field and adjacent land

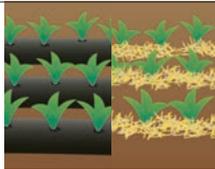
Select fields carefully to reduce the risk of microbial contamination.



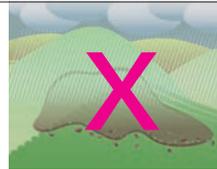
If livestock has been grazing in the field, ensure a time lapse between livestock grazing in the field and harvest of minimum 120 days or according to local regulation.



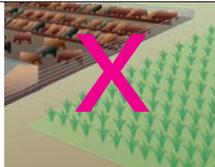
Irrespective of previous land use, a protective system should be implemented when the crop can be contaminated by the soil e.g. plastic coverage or straw on soil (not applicable for root crops).



Avoid using land which may be subject to water and/or soil run-off from higher land/or neighbouring land.



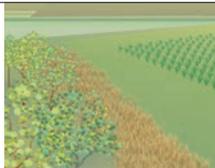
Avoid the use of land adjacent to animal production facilities.



Avoid the use of land adjacent to industrial and/or urban activities such as sewage treatment or municipal waste collection.



If there is a risk of contamination from above situations, implement physical barriers such as vegetative buffer areas, mounds or ditches.

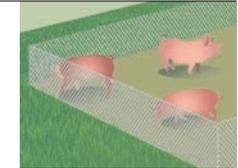


## Animals

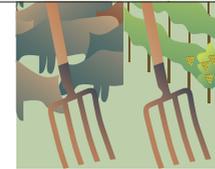
Control movements of domestic animals.



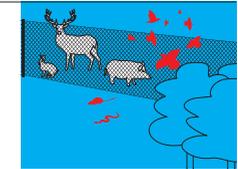
Keep farm animals confined and far away from water sources, growing fields and storage areas.



Use dedicated tools for farm animal activities and crop activities.



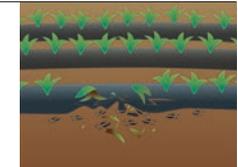
Prevent intrusion and minimize habitat of wild animals in the crop production area e.g. by using fences and bird repellants and avoiding waste.



Do not use rodenticides or chemical repellants in the growing field.



Take corrective actions when clear evidence of animal intrusion in the field is found.

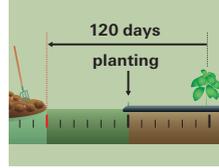


## Manure-based soil amendments

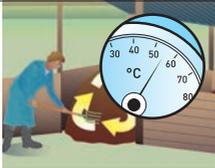
Apply manure prior to planting.



Apply raw manure at least 120 days before harvest or according to local regulation.



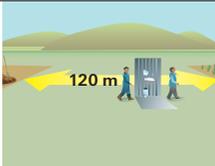
Use composted manure which has followed controlled composting (rather than simple stock piling): record temperature, time and, when applicable, number of turnings.



Validate on-farm controlled composting and/or ask for a certificate of compliance if you purchase treated manure from an external source.



Avoid cross-contamination between raw manure/composting areas and crop production area.



## Agricultural water

Identify the source of the water (e.g. surface, well, municipal...). Perform this identification for all water applications (e.g. irrigation, hand washing etc).



Type A agricultural water is agricultural water having direct or indirect contact with crop and requires microbiological testing for *E. coli* in 100 mL.



The testing frequency of type A water will vary according to the water source and its associated risk (refer to risk table page 14).



The *E. coli* target for type A water is  $\leq 100$  CFU/ mL but should not exceed 1000 CFU/100 mL. Water sources with *E. coli*  $> 1000$  CFU/100 mL cannot be used as type A water, unless treated to decrease the microbial numbers.



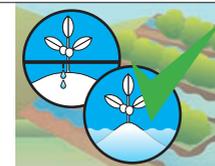
Type B agricultural water has no direct or indirect contact with crop and does not require testing.



For bulbs and root crops, agricultural water is only of type A.



Use of drip or furrow irrigation of crop is recommended.



Prevent contamination of water in wells and in water collection/storage systems: cover wells and water tanks, fence ponds etc.



## Microbiological risk ranking of agricultural water according to water source and type of application

		WATER: TYPE OF APPLICATION					
		IRRIGATION				OTHER USE OF WATER	
		Flood irrigation	Overhead irrigation	Furrow irrigation <sup>2</sup>	Drip irrigation	Pesticide and fertilizer preparation	Cleaning of equipment and hand washing <sup>3</sup>
WATER: SOURCE	Untreated Surface Water (including shallow wells)	High risk	High risk	High risk	High risk	High risk	High risk
	Secondary treated Sewage Water	High risk	High risk	High risk	High risk	High risk	High risk
	Untreated ground Water	Medium risk	Medium risk	Medium risk	Medium risk	Medium risk	Medium risk
	Untreated rain Water	Medium risk	Medium risk	Medium risk	Medium risk	Medium risk	Medium risk
	On-farm disinfected Water <sup>1</sup>	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk
	Municipal Water (potable water)	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk

**High microbiological risk** – Untreated surface water and shallow wells are vulnerable to microbial hazard contamination; secondary treated sewage water may still contain pathogens.

**Medium microbiological risk** – Depends on the microbiological quality profile of the ground water and rain water (usually good – if installations for collecting and storing the water are in good condition and well maintained, see section “Wells, water collection, storage and distribution systems” page 47 for details).

**Negligible microbiological risk** – Either municipal or on-farm disinfected water or water which is never used in contact with the harvestable part of the crop e.g. furrow irrigation or drip irrigation.

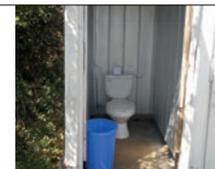
- Disinfected water can be surface water or ground water or rain water or secondary treated sewage water which has followed a disinfection process at farm, such as chlorination.
- Negligible risk ranking when there is no risk that the irrigation water from the furrow splashes on the harvestable part of the crop. If there is a risk of splashing then the risk ranking becomes the same than Type A water.
- It is best practice to use potable water (water that meets microbial standards for drinking water) for hand washing and cleaning of equipment in contact with the crop. When it is not possible to use such potable water, agricultural water with *E. coli* ≤ 100 CFU / 100 mL is allowed (see chapter 5 on Hygiene and chapter 6 on Equipment).

**4**  For root and bulb crops, type B water becomes type A water with its associated high, medium or negligible risk according to the water source.

For microbiological water testing recommendations, refer to the full training booklet.

## Hygiene and human health

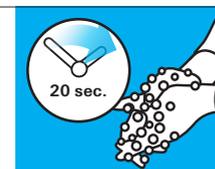
Provide clean toilets with toilet paper, which are connected to a sewage disposal system.



Provide hand wash station with soap, with either potable water or type A water with *E. coli* ≤ 100 CFU/100 mL, disposable towels and waste basket.



Wash your hands!



Manage waste in the crop production area.



Use signs to show and remind restriction rules in the crop production area such as no eating, smoking etc.



Follow good personal hygiene practices and do not work in the crop production area if you have illness symptoms.



Implement a cleaning and disinfection procedure in the event of a body fluid incident such as vomiting.



Train workers! (on hygiene, risk from illnesses, cleaning procedures etc).



## Worker harvesting practices

Train workers on hand harvesting practices e.g. do not harvest crops that have signs of contamination or that have fallen on the ground.



Always handle crops carefully to avoid internal and external damage.



Keep harvesting containers off the ground and do not use them for other purposes.



For crops that are dried on-farm, start processing on the day of harvesting.



In the event of a severe flooding with crops submerged, these crops should not be harvested.

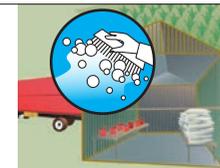


## Equipment, premises and transportation

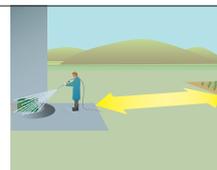
Perform cleaning (and sanitizing) of harvesting/post-harvesting equipment, tools and machines in contact with the crop, ideally before each use.



Perform regular cleaning (and sanitizing) of storage areas, post-harvest premises and transportation vehicles.



Conduct these cleaning (and sanitizing) activities away from the crop to reduce the potential for contamination.



Before use, keep harvesting containers off the floor or ground in a sufficiently contained area.



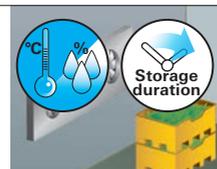
On-farm storage areas should be sufficiently contained to protect the crop from external contamination (e.g. from pest ingress).



Sun-drying areas should have foot-paths to prevent anyone from walking on the crop. Sun-drying should not be performed in direct contact with the soil.



Storage rooms should be dry and well ventilated. Recommended temperature and relative humidity vary according to the crop and will influence storage duration.



Use transportation vehicles which are closed or at least with a covering such as tarpaulin. For refrigerated trucks, temperature should be controlled and monitored.



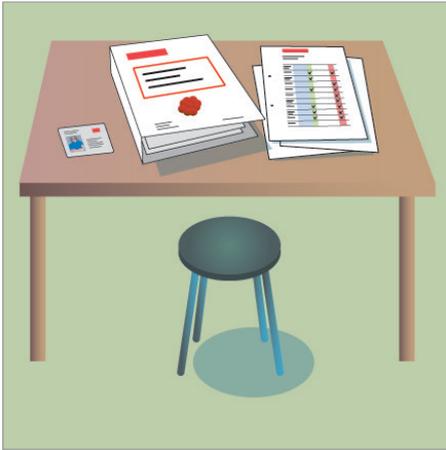
## Records and Documents

Do not forget to keep important records and documents.

Records are important to show that an action is taken e.g. regular cleaning of toilets, cleaning of equipment, microbiological water analyses result, workers training etc.

Documents are important to show conformance to a requirement e.g. training material on hygiene, procedure for cleaning of equipment, procedure for agricultural water sampling etc.

A person should be responsible to maintain the records and documents in a timely manner.



## Think about foreign bodies!

This reminder is not linked to microbial contamination, but...

From crop harvesting to transportation to processing plant, the risk of foreign bodies should be minimized, e.g.:

- Damaged crates/buckets/tools should be properly repaired or disposed of.
- Sun-drying areas, storage areas and transportation vehicles should be maintained and inspected to not be a source of foreign bodies (e.g. plastic, stones, insects, wood etc).





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**Concept**

Nestec Ltd., Nestlé Research Center, Lausanne (Switzerland)

**Design**

[www.christianstucker.ch](http://www.christianstucker.ch)

**Production**

PCL, Renens (Switzerland)