



RSM2SNF

Research Supporting African MSMEs
To Provide Safe and Nutritious Food

Guidelines for Good Hygienic Practices for Tomatoes and Green Leafy Vegetables



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Foreword

The set of standards included in this document addresses Good Hygienic Practice (GHP) that help control microbial, chemical and physical hazards associated with all stages of the production and distribution of fresh tomatoes and green leafy vegetables in Nigeria. Thus, the guidelines cover practices from primary production to consumption with particular attention given to minimizing microbial hazards. The guidelines provide a general framework of recommendations that can be adopted across the complex tomatoes and green leafy vegetables value chains in Nigeria. Fresh tomatoes and green leafy vegetables such as cabbage, cucumbers, lettuce, fluted pumpkin (Ugwu), Amaranthus, Spinach etc. are produced, packed, distributed and sold under diverse environmental conditions across the country. It is recognized that some of the provisions in these guidelines may be challenging to implement in several contexts in Nigeria. This may be so, for example, when primary production is conducted on small farms and in areas where traditional farming is practiced. It is also recognized that Nigerian markets and processing clusters serve many actors and often have poor infrastructure. The guidelines are therefore, by necessity flexible, to allow for different systems of control and prevention of contamination for different actors in the Nigerian food system. It is anticipated that this “Guidelines on Good Handling Practices” document will be supplemented with training materials and non-technical communication pieces appropriate for different stakeholder groups in Nigeria. This document was drafted in accordance with the CXC 53-2003, Adopted in 2003, Revised in: 2010 (new Annex III for fresh leafy vegetables) and 2013 (new Annex V for Berries). However, its content has been adapted to fit the Nigerian context by providing examples drawn from lessons learned at various large Nigerian tomatoes and leafy vegetables markets. .

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About Research Supporting African MSMEs to Provide Safe and Nutrition Food (RSM2SNF)

The Research Supporting African MSMEs to Provide Safe and Nutritious Food (RSM2SNF) is funded by the Bill and Melinda Gates Foundation. RSM2SNF dives deep into the wholesale, logistics, processing, and retail segments of the value chains of several products, such as fish, tomato, and green leafy vegetables. The goal is to understand the midstream of these food value chains with a focus on Micro, Small and Medium Enterprises (MSMEs), and to inform policies and interventions to support MSMEs in providing safe and nutritious foods at affordable prices. This five-year project (2022–2026) is led by Michigan State University (MSU) working with partners in Nigeria and Tanzania.

1. Scope

These guidelines cover general hygienic practices from primary production locations to markets where fresh tomatoes and green leafy vegetables are sold. The objective is to make safe and wholesome products available, in particular those products intended to be consumed raw or lightly processed (e.g., steamed or as fresh juice). Specifically, these guidelines are applicable to fresh tomatoes and green leafy vegetables grown in open fields or in protected facilities (hydroponic systems, greenhouses/net houses, etc.). It also covers handling practices en route to and at food markets. The guidelines concentrate on all the hazards (microbial, chemical and physical) related to GHP.

In Nigeria some commonly consumed green leafy vegetables include Fluted Pumpkin (*Telfairia occidentalis*) locally called "Ugu" or "Ugwu", Water leaf (*Talinum triangulare*) locally called "Gure" among the Kanuri people, "Poi Shakara" among the Tiv people, and "Gbure" among the Yoruba people; Bitter leaf (*Vernonia amygdalina*) locally called "Onugbu" among the Igbos, "Ewuro" among the Yorubas, "Shiwaka" by the Hausas, and "Etido" in the Efik/Ibibio language, African spinach (*Amaranthus hybridus*), locally called Soko in Yoruba, and "Alefo" in Hausa., English spinach locally called "Amunututu" in Yoruba, "Odundun" in Igbo, and "Akunzumini" in Efik/Ibibio and Jute leaves, (*Corchorus Olitorus*) locally called "Ewedu" in Yoruba', "Rèré" by the Edo's and "Ayoyo" by the Hausas e.t.c

2. Use

The guidelines in this document follow the format of the *General Principles of Food Hygiene* (CXC 1-1969) and should be used in conjunction with it and other applicable codes, such as the *Guidelines on the Application of General Principles of Food Hygiene to the Control of Foodborne Parasites* (CXG 88-2016), *Guidelines on the Application of General Principles of Food Hygiene to the Control of Viruses in Food* (CXG 79-2012), the *Code of Practice for Packaging and Transport of Fresh Fruits and Vegetables* (CXC 44-1995), the *Code of Practice for the Processing and Handling of Quick Frozen Foods* (CXC 8-1976), and the *Guidelines for Risk Analysis of Foodborne Antimicrobial Resistance* (CXG 77- 2011). Due to the wide variation in the nature of fruits and vegetables and production practices, flexibility in application is an essential element of these guidelines. The implementation of any hygienic practice is proportionate to the risk of food-borne illness or the characteristics of the commodity (e.g., conditions and practices associated with growing tomatoes, cucumber, and lettuce present a higher likelihood of contamination at production because they are grown on or near the ground).

3. Definitions

Definitions of general expressions are included in the *General Principles of Food Hygiene* (CXC 1-1969). For the purposes of the guidelines, the following terms are defined as below:

3.1 Agricultural inputs— Any incoming material (e.g., seeds, fertilizers, including compost, water, agricultural chemicals, plant support) used for the primary production of fresh fruits and vegetables.

3.2 Agricultural worker — Any person who undertakes one or more of the following: cultivation, harvesting and packing of fresh fruits and vegetables.

3.3 Biological control —The use of biological agents (e.g., insects, micro-organisms and/or microbial metabolites) for the control of mites, pests, plant pathogens and spoilage organisms.

3.4 Biofilm — A microbial consortium adhering to a surface.

3.5 Composting —A managed process in which organic materials are digested aerobically or anaerobically by microbial action.

3.6 Cultivation —Any agricultural action or practice used by growers to allow and improve the growing conditions of fresh fruits or vegetables whether grown in an open field or in protected facilities (e.g.,

hydroponic systems, greenhouses/net houses).

3.7 Farm –Any premises or establishment in which fresh fruits and/or vegetables are grown and harvested.

3.8 Grower –A person responsible for the management of the primary production of fresh fruits and vegetables.

3.9 Greenhouse – An indoor site, generally enclosed by glass or plastic, in which plants are grown.

3.10 Harvester –A person responsible for the management of the harvesting of fresh fruits and vegetables.

3.11 Hydroponics –A general term for the production of plants without soil in an aqueous nutrient medium.

3.12 Manure –Animal excrement, which may be mixed with litter or other materials, and may be fermented or otherwise treated.

3.13 Micro-organisms –These include yeasts, moulds, bacteria, viruses and parasites; the corresponding adjective is “microbial”.

3.14 Packing or Packaging – The action of putting fresh fruits and vegetables in a container (e.g., box, crate or basket) or package. This may take place in a field or within an establishment.

3.15 Packer –A person responsible for the management of post-harvest activities and packing of fresh fruits and vegetables.

3.16 Packing establishment/Packaging establishment or Packhouse/Packing house – Any premises on which fresh fruits and vegetables are packed/packaged.

3.17 Post-harvest activities– Activities performed incidental to packing involving minimal transformation of fresh fruits and vegetables, such as washing, sorting, culling, grading, cutting and trimming.

3.18 Primary production of fruits and vegetables –The steps involved in the growing and harvesting of fresh fruits and vegetables, including soil preparation, planting, irrigation, the application of fertilizers and agricultural chemicals, field-packing and transport to a packing establishment.

3.19 Ready-to-eat fresh fruits and vegetables–Any fruit or vegetable that is normally eaten in its raw state, intended for direct human consumption without any further microbiocidal steps. This may include any fruit or vegetable that has been washed, peeled, cut or otherwise physically altered from its original form but remains in the fresh state.

3.20 Standard Operating Procedure (SOP)–A set of detailed instructions describing how to carry out a routine activity.

Types of water:

3.21 Clean water –Water that does not compromise food safety in the circumstances of its use.

3.22 Potable water –Water which meets the quality standards of drinking water such as described in the World Health Organization (WHO) *Guidelines for Drinking-water Quality*.

4.0 Good Agricultural and Handling Practices

4.1 Primary Production environment guidelines (drawn from the *General Principles of Food Hygiene* (CXC 1-1969):

Fresh tomatoes and green leafy vegetables are grown and harvested under a diverse range of climatic and geographical conditions. They can be grown in production sites indoors (e.g., greenhouses) and outdoors, harvested and either field-packed or transported to a packing establishment, using various agricultural inputs and technologies, and on farms of varying sizes. Biological, chemical and physical hazards may therefore vary significantly from one type of production system to another. In each production area, it is necessary to consider the agricultural practices that promote the production of safe fresh tomatoes and green leafy vegetables, taking into account the conditions specific to the primary production area, type of products, and production and harvesting methods used. Procedures associated with primary production should be conducted under good hygienic conditions and should minimize potential hazards to health due to the contamination of fresh tomatoes and green leafy vegetables.

4.1 Environmental Hygiene

As far as possible, potential sources of environmental contamination should be identified prior to primary production activities. In particular, primary production should not be carried out in areas where the presence of potentially harmful substances would lead to an unacceptable level of such substances in or on fresh tomatoes and green leafy vegetables after harvest. For example, growers should evaluate present and previous uses of both indoor and outdoor primary production site(s) for fresh tomatoes and green leafy vegetable as well as the adjoining land (e.g., crop grown, feedlot, animal production, hazardous waste site, sewage treatment site, industry) in order to identify potential microbial hazards. The potential for other types of contamination (e.g., from agricultural chemicals, mining extraction sites, hazardous wastes) should also be taken into consideration.

If previous uses cannot be identified, or the examination of the growing or adjoining sites leads to the conclusion that potential hazards exist, the sites should be analysed for contaminants of concern. The assessment of environmental conditions is particularly important because subsequent steps may not be adequate to remove contamination that occurs during production and in some cases may lead to conditions that enable the growth of microbial pathogens. If the environment presents a risk to the primary production site, measures should be implemented to minimize the contamination of fresh tomatoes and green leafy vegetables after harvest at the site. When such risks are serious, the production site should not be used for fresh tomatoes and green leafy vegetable production.

The effects of some environmental events cannot be controlled. For example, heavy rains may increase the exposure of fresh tomatoes and green leafy vegetables to pathogens if soil contaminated with pathogens splashes onto them. When heavy rains occur, growers should evaluate the need to postpone harvesting fresh tomatoes and green leafy vegetables for direct consumption and/or to subject them to a treatment that will minimize the risk from pathogens. The risk from chemical hazards should also be assessed. The risk of contamination is greatest when heavy rains cause flooding and flood waters come into direct contact with fresh tomatoes and green vegetables. If tomatoes and green leafy vegetables that have come into contact with flood waters are not submitted to any measure to mitigate risks, they should not be eaten raw. This does not include flood irrigation, where the source of water is of known and appropriate quality.

4.1.1 Location of the Production Site

Production site locations should be evaluated, with regard to slope, potential for runoff (including from manure sources), flood risk and hydrological features in proximity to the primary production site.

The proximity of high-risk production sites, such as animal primary production facilities, hazardous waste sites

and waste treatment facilities, should be evaluated for the potential to contaminate production fields or water sources with microbial or other environmental hazards (e.g., runoff, faecal material, aerosols, and organic waste).

Growers should take measures to mitigate the risks associated with runoff and flooding (e.g., mapping the production field, terracing, digging a shallow ditch to prevent runoff from entering the field).

In the case of risk of contamination from dust, drift or aerosols, efforts should be made to protect fresh produce-growing and -handling areas. The use of an effective windbreak (whether natural, such as trees, or a constructed barrier) or protective covering are measures that could be used to reduce pathogen and chemical contamination of the primary production site.

4.1.2 Animals and human activity

Humans and many animal species that may be present in the primary production environment are known to be potential carriers of food-borne pathogens. In Nigeria, it is common for animals such as goats, sheep, chickens, dogs and cows to move around farms. In addition, wild animals (such as grass cutters and rats) can be a difficult risk to manage because their presence is intermittent. When the environmental hygiene step (Section 4.1) evaluates the risk as serious, and animals and human activities may present the risk of direct contamination of the crop and soil, as well as indirect contamination via surface water sources and other inputs, efforts should be made to minimize contamination. The following should be taken into consideration:

- Appropriate biological, cultivation, physical and chemical pest-control methods should be used in order to exclude animals from the primary production and handling areas to the extent practicable. Possible methods include the use of physical barriers (e.g., fences), active deterrents (e.g., noise makers, scarecrows, images of owls, foil strips) and/or cultural methods (e.g., crop rotation).
- Primary production and handling areas should be properly designed and maintained to reduce the likelihood of attracting vectors (e.g., insects and rodents). Possible methods include minimizing standing water in fields, restricting animal access to water sources (which may be based on local ordinances for public irrigation systems) and maintaining production sites and handling areas free of waste and clutter.
- Fresh fruit and vegetable primary production areas should be evaluated for evidence of the presence of wildlife or domestic animal activity (e.g., presence of animal faeces, bird nests, hairs/furs, large areas of animal tracks, burrowing, decomposing remains, crop damage from grazing), particularly near harvesting. Where such evidence exists, growers should evaluate the risks to determine whether the affected area of the production site should be harvested for direct consumption.
- To the extent possible, the entrance of non-essential persons, casual visitors and children should be controlled in the harvest area as they may present an increased risk of contamination.

4.2 Good Agricultural Practices and Hygienic Handling during primary production of fresh tomatoes and green leafy vegetables

4.2.1 Agricultural input requirements

Agricultural inputs should not contain contaminants (as defined under the *General Principles of Food Hygiene* (CXC 1-1969)) at levels that may adversely affect the safety of fresh tomatoes and green leafy vegetables and should take into consideration the *WHO guidelines on the safe use of wastewater and excreta in agriculture and aquaculture*, as appropriate.

4.2.1.1 Water for primary production

An adequate supply of water of a suitable quality should be available for use in the various operations in the primary production of fresh tomatoes and green leafy vegetables. The source of the water used for primary production and the method of delivery can affect the risk of contamination.

The quality of water may vary. Several parameters may influence the risk of microbial contamination of fresh fruit and vegetables: the type of irrigation (e.g., drip, sprinkler, overhead), the source of water, whether the edible portion of the fresh fruit or vegetable has direct contact with irrigation water, the timing of irrigation in relation to harvesting and the occurrence of pathogenic organisms in the irrigation water. Water for primary production, including for frost protection and protection against sun scald, which has contact with the edible portion of fresh tomatoes and vegetables should not compromise their safety. The following should be taken into consideration:

- Growers should identify the sources of water used on the farm (e.g., municipality, well, open canal, reservoir, river, lake, farm pond, reused irrigation water, roof water, reclaimed wastewater, discharge water from aquaculture). Examples of water sources that present the lowest risk of contamination are:
 - Water in deep wells or boreholes, provided they are appropriately constructed, maintained, monitored and capped;
 - Water in shallow wells, provided they are not influenced by surface waters and are appropriately constructed, maintained, monitored and capped;
 - Rainwater, provided the integrity of the water capture, storage and distribution system is maintained.
- Water sources that pose a higher risk of contamination may need further treatment, for example:
 - Reclaimed or wastewater: before using reclaimed or wastewater for crop irrigation, an expert should be consulted to assess the relative risk and determine the suitability of the water source. Reclaimed wastewater subjected to different levels of treatment should be in compliance with the *WHO guidelines for safe use of wastewater, excreta and grey water used in agricultural production* specific to the irrigation of tomatoes and green leafy vegetables marketed to consumers as fresh, fresh-cut, pre-cut or ready-to-eat.
 - Surface water (e.g., rivers, lakes, canals, lagoons, reservoirs): when contaminated, options such as sand filtration or storage in catchments or reservoirs to achieve partial biological treatment should be considered. The efficacy of these treatments should be evaluated and monitored.
- Growers should assess the microbial and chemical quality of water and its suitability for the intended use and identify corrective actions to prevent or minimize contamination (e.g., from livestock, wildlife, sewage treatment, human habitation, manure and composting operations, agricultural chemicals, or other intermittent or temporary environmental contamination, such as heavy rain or flooding).
- Where necessary, growers should have the water they use tested for microbial and chemical contaminants, according to the risk associated with the production. The frequency of testing will depend on the water source (i.e., lower for adequately maintained deep wells, higher for surface waters), the risks of environmental contamination, including intermittent or temporary contamination (e.g., heavy rain, flooding), or the implementation of a new water treatment process by growers.
- If water testing is limited to non-pathogenic indicators, frequent water tests may be useful to establish the baseline water quality so that subsequent changes in the levels of contamination can be identified. High testing frequency may be considered until consecutive results are within the acceptable range.
- Growers should reassess the potential for microbial contamination if events, environmental conditions (e.g., temperature fluctuations, heavy rainfall) or other conditions indicate that water quality may have

changed.

- When testing, growers may consult, if necessary, the experts in order to determine and document the following:
 - Which tests need to be conducted (e.g., for which pathogens and/or sanitary indicators);
 - Which parameters should be recorded (e.g., temperature of water sample, water source location and/or weather description);
 - How often tests should be conducted;
 - How test results should be analysed and interpreted over time, for example to calculate the rolling geometric mean, and
 - How test results will be used to define corrective actions.

If the water source is found to have unacceptable levels of indicator organisms or is contaminated with food-borne pathogens, corrective actions should be taken to ensure that the water is suitable for its intended use. Possible corrective actions to remove contaminants include the use of chemicals such as chlorine to kill such pathogens. Generally, the proper maintenance of wells, water filtering, chemical water treatment, the prevention of the stirring of the sediment when drawing water, the construction of settling or holding ponds or water treatment facilities are all possible strategies to deal with water quality. The effectiveness of corrective actions should be verified by regular testing. Where possible, growers should have a contingency plan in place that identifies an alternative source of water.

4.2.1.1.1 Water for irrigation and harvesting

The type of irrigation or water application method affects the risk of contamination. The timing, the quality of water used, and whether the water has direct contact with the edible portion of the plant should all be considered when selecting the type of irrigation or application method to use. Overhead irrigation (where water is sprayed from the top by a machine or traditional irrigation methods such as a bucket or watering can) presents the highest risk of contamination because it wets the edible portion of the crop and can splash soil on the product. The duration of wetting can be several hours, and the physical force of water-droplet impact may drive contamination into protected sites on the leaf/produce. Subsurface or drip irrigation that results in no wetting of the plant is the irrigation method with the least risk of contamination, although localized problems may still arise, e.g., when using drip-irrigation, care should be taken to avoid creating pools of water on the soil surface or in furrows that may come into contact with the edible portion of the crop.

Water for agricultural purposes should be of suitable quality for its intended use. Special attention should be given to water quality in the following situations:

- Irrigation by water-delivery techniques that expose the edible portion of fresh tomatoes and green leafy vegetables directly to water (e.g., sprayers), especially close to harvest time;
- Irrigation of tomatoes and green leafy vegetables that have physical characteristics such as leaves and rough surfaces that can trap water;
- Irrigation of tomatoes and green leafy vegetables that will receive little or no post-harvest wash treatments prior to packing, such as field-packed produce.

Additionally, growers, where appropriate, should:

- Evaluate the water-distribution system to determine if a contamination source is evident and can be eliminated; and
- Establish no-harvest zones if irrigation source water is known or likely to contain human pathogens and where failure at connections results in overspray of plants or localized flooding.

4.2.1.1.2 Water for fertilizers, pest control and other agricultural chemicals

Water used for the application of water-soluble fertilizers, pesticides and agricultural chemicals in the field and indoors should be of the same quality as water used for direct contact irrigation and should not contain microbial contaminants at levels that may adversely affect the safety of fresh tomatoes and green leafy vegetables, especially if they are applied directly on edible portions of the fresh tomatoes and green leafy vegetables close to harvest. Human pathogens can survive and grow in many agrichemicals, including pesticides.

4.2.1.1.3 Hydroponic water

Microbial risks of water used in growing tomatoes and green leafy vegetables hydroponically may differ from the microbial risks of water used to irrigate tomatoes and green leafy vegetables in soil because the nutrient solution used may enhance the survival or growth of pathogens.

It is especially critical in hydroponic operations to maintain the water quality so as to reduce the risk of contamination and survival of pathogens. The following should be taken into consideration:

- Water used in hydroponic culture should be changed frequently or, if recycled, treated to minimize microbial and chemical contamination;
- Water-delivery systems should be maintained and cleaned, as appropriate, to prevent microbial contamination of water; and in the case of combination of aquaculture and hydroponics (i.e., aquaponics), effluent from fish tanks should be treated to minimize microbial and chemical contamination.

4.2.1.1.3 Water for other agricultural uses

Clean water should be used for other agricultural purposes, such as dust abatement and the maintenance of roads, yards and parking lots, in areas where fresh tomatoes and green leafy vegetables are grown. This includes water used to minimize dust on dirt roads within or near primary production sites. This provision may not be necessary when water used for this purpose cannot reach the tomatoes and green leafy vegetables.

4.2.1.2 Manure, biosolids and other natural fertilizers

The use of manure, biosolids and other natural fertilizers in the production of fresh tomatoes and green leafy vegetables should be managed to limit the potential for microbial, chemical and physical contamination.

Pathogens may be present in manure, biosolids and other natural fertilizers and may persist for weeks or even months, in particular if the treatment of these materials is inadequate. Manure, biosolids and other natural fertilizers contaminated with chemicals at levels that may affect the safety of fresh tomatoes and green leafy vegetables should not be used. Where necessary, in order to minimize microbial contamination, the following practices should be taken into consideration:

- Proper physical, chemical or biological treatment methods (e.g., composting, pasteurization, heat drying, UV irradiation, alkali digestion, sun drying or combinations of these) should be adopted to reduce the risk of potential human pathogen survival in manure, biosolids and other natural fertilizers. The level of pathogen reduction achieved by different treatments should be taken into account when considering suitability for different applications.
- Composting, if done properly, can be a practical and efficient method to inactivate food-borne pathogens in manure. In general, only fully composted animal waste or plant material should be applied to production fields. Manure, biosolids and other natural fertilizers which are untreated or partially treated should not be used after plant emergence or after a transplant is put into the soil

unless appropriate corrective actions are being adopted to reduce microbial contaminants, such as waiting for such sufficient time to elapse between application and the harvest of fresh tomatoes and green leafy vegetables as to reduce pathogens remaining in the amended soil to levels that are unlikely to result in contamination of the product.

- When using aerobic composting methods, regularly and thoroughly turn compost heaps to ensure that all of the material will be exposed to elevated temperatures because pathogens can survive for months on the heap surface.
- When using anaerobic methods, special consideration should be given to determining the length of time needed to inactivate pathogens that may be present.
- Growers who are purchasing manure, biosolids and other natural fertilizers that have been treated to reduce microbial or chemical contaminants should pay particular attention to the selection of the supplier, including obtaining documentation from the supplier that identifies the origin, treatment used, tests performed and their results.
- Growers should not use biosolids or other natural fertilizers close to harvest unless properly composted or used in a manner not reasonably likely to contact the edible portion of the produce.
- Contamination from manure, biosolids and other natural fertilizers from adjoining fields should be minimized. If potential for contamination from adjoining fields is identified, preventative actions (e.g., care during application and runoff controls, covering compost piles to avoid contamination from wind drift) should be implemented to minimize the risk.
- Treatment or storage sites should not be located in proximity to fresh fruit and vegetable production areas.
- Cross-contamination from runoff or leaching by securing areas where manure, biosolids and other natural fertilizers are treated and stored should be prevented.

4.2.1.3 Soil

Soils should be evaluated for hazards. If the evaluation concludes that such hazards may compromise the safety of crops, control measures (e.g., topsoil replacement or solar-heat disinfection) should be implemented to reduce hazards to acceptable levels. If this cannot be achieved by available control measures, growers should not use these soils for primary production.

Fresh tomatoes and green leafy vegetables may come into direct contact with soil during growth and/or harvesting. When necessary, growers should use production practices (e.g., site selection, mulch) to minimize the contact of produce with the soil.

4.2.1.4 Agricultural chemicals

Growers should use only agricultural chemicals authorized for the cultivation of the specific fruit or vegetable and in accordance with the manufacturer's instructions for the intended purpose. Residues of agricultural chemicals should not exceed levels as established by the *Codex Alimentarius Commission*.

Agricultural workers who apply agricultural chemicals should be trained in proper application and safety procedures.

Growers should keep records on the application of agricultural chemicals, which should include information on the date of application; the chemical used; the crop sprayed; the pest or disease against which it was used; and the concentration, method and frequency of application; They should also keep records on harvesting to verify that the time between application and harvest is appropriate. Agricultural chemical sprayers should be calibrated, as necessary, to control the accuracy of the rate of application.

The mixing of agricultural chemicals should be carried out in such a way as to avoid contamination of water and land in the surrounding areas.

Sprayers and mixing containers should be thoroughly washed after use, especially when used with different agricultural chemicals on different crops, to avoid contaminating tomatoes and green leafy vegetables. Wash water should be disposed of in a manner that does not contaminate produce or growing areas.

Agricultural chemicals should be kept in their original containers, labelled with the name of the chemical and instructions for its application. Agricultural chemicals should be stored in a safe, well-ventilated place, away from production areas and harvested tomatoes and green leafy vegetables and disposed of in a manner that does not risk contaminating crops or the primary production environment.

Empty containers should be disposed of as indicated by the manufacturer. They should not be used for other purposes.

4.2.1.5 Purchasing and receiving inorganic fertilizers and supplements (as explained by Strengthen Vietnamese SPS capacities for trade-Improving safety and quality of fresh vegetables through the value chain approach)

The inorganic fertilizers to be used must be only on the list of allowable production, sale and use in Nigeria.

For organic fertilizers:

- Farmers should buy the processed manure (decomposed manure)
- In the case that manure is untreated, they need to use appropriate methods of composting to reduce the risk of living organisms that can cause contaminated products and harm for human health and environment.

Methods for composting manure in farm:

- Identify and select appropriate methods of composting with available materials. Should use the improved heat annealing (material organic is biodegradable overtime) and use the floating and submerged incubation, microbial supplements should be added and mix them every 15-20 days for decomposing.
- Places that contain materials for composting must be far from the agricultural materials, water resources, and harvest instruments, harvested and packaged vegetables;
- The raw materials of compost and compost heap should be managed and manipulated carefully to avoid product contamination.
- Should minimize the risk of cross contamination between raw materials input to finished composed manure.
- Tools that are used in mixing, composting and raw materials need to be cleaned to prevent the contamination to other production materials and harvested vegetables.
- Farmers and workers that have contact with compost materials, composting must implement good hygiene: wash hands, clothing and boots before moving to field for production or contact to products.

Storage of inputs

- Fertilizers and fertilizer supplements should be preserved in dry and appropriate places and have methods to avoid infecting to other agricultural supplies, packaging equipment, products and water.

- Manure must be loaded, unloaded and transported carefully to avoid any risk of infection for products.

Input use

- Only use fertilizer when necessary and consistent with nutritional requirements of tomatoes and green leafy vegetable.
- Fertilizers must be mixed into soil and the supplements should be applied immediately after fertilizing.
- Organic fertilizer should not be applied to the tops/ leaves and fruits of vegetables.
- When organic fertilizer is used for vegetables that have growing time under 60 days, it should be applied before planting and mixed with soil after applying.
- Organic fertilizer (particularly nitrogen) will not be applied before harvesting at least 10 days.
- If the farmers use the tool for fertilizers, they must maintain proper cleaning of the tools
- Farmers that have contact with organic fertilizer and supplements must clean boots, clothing and limbs before moving to the other fields, especially in the fields are being harvested.

4.2.1.6 Biological control

Consumer safety should be considered when using competing biological organisms and/or their metabolites applied for the control of pests, mites, plant pathogens and spoilage organisms in fresh tomatoes and green leafy vegetables.

Growers should use only biological controls that are authorized for the cultivation of the specific fruit or vegetable and in accordance with the manufacturer's instructions for the intended purpose.

4.2.2 Indoor facilities associated with growing and harvesting

For operations where fresh tomatoes and green leafy vegetables are grown indoors (e.g., greenhouses, hydroponic cultures), suitable premises should be used.

Some protective agricultural structures should be located in the field (e.g., hoop houses, high tunnels). Factors that influence the magnitude and frequency of the transfer of pathogenic micro-organisms in the field – such as climate, weather, topology, hydrology and other geographic characteristics in or nearby the field – may pose a similar risk for the cultivation inside these protective structures. Methods for the adequate maintenance of the environment around such structures include:

- Properly storing equipment, removing litter and waste, as well as cutting weeds or grass within the immediate vicinity that may constitute an attractant, breeding place or harbourage for pests;
- Adequately draining areas that may act as a source of contamination to prevent:
 - the breeding of pests;
 - runoff, leakage or pooled/settled water flowing into food-growing areas;
 - the transfer of contaminants via equipment or foot traffic;
- Taking appropriate measures to minimize any risks from surrounding land use or environment.

4.2.2.1 Location, design and layout

Premises and structures used to store or pack fresh tomatoes and green leafy vegetables or store food contact equipment should be located, designed, constructed and maintained to avoid contaminating fresh tomatoes and green leafy vegetables and harbouring pests such as insects, rodents and birds.

The internal design and layout should permit compliance with good hygienic practices for the primary production of tomatoes and green leafy vegetables indoors, including protection against cross-contamination between and during operations. Each establishment should be evaluated individually in order to identify specific hygienic requirements for each product.

4.2.2.2 Water supply

An adequate supply of clean water with appropriate facilities for its storage and distribution should be available in indoor primary production. Non-potable water systems should be identified and should not connect with or allow reflux into potable water systems. This can be accomplished by having a separate system for potable water.

- Avoid contaminating water supplies by exposure to agricultural inputs used for growing fresh produce;
- Clean and disinfect water storage facilities on a regular basis; and
- Control the quality of the water supply.

4.2.2.3 Drainage and waste disposal

Adequate drainage and waste disposal systems and facilities should be provided. These systems should be designed and constructed so as to avoid the potential for contamination of fresh tomatoes and green leafy vegetables, agricultural inputs or water supplies.

The following should be considered:

- Good drainage should be maintained around the structure to eliminate standing water.
- All waste should be removed and stored away from the facility to prevent harbourage of pests.
- Plant debris and cull piles should be removed promptly from inside the structure. There should be no permanent plant refuse to attract or harbour pests, around the outside of the structure or nearby.
- Refuse containers should be emptied regularly.

4.2.3 Personnel health, hygiene and sanitary facilities

Hygiene and health requirements should be followed to ensure that personnel who come into direct contact with fresh tomatoes and green leafy vegetables during or after harvesting are not likely to contaminate them. Visitors to a farm should, where appropriate, wear protective clothing and adhere to the other personal hygiene provisions in this Section.

If gloves are used, a procedure for glove use in the field should be documented and followed. The procedure should include hand washing before glove use. If the gloves are reusable, they should be made of materials that are easily cleaned and disinfected, and they should be cleaned regularly and stored in a dry clean area. If reusable, gloves should be discarded when they become torn, soiled or otherwise contaminated. Glove use alone is not a suitable substitute for good hand-washing practices.

Where appropriate, there should be written Standard Operating Procedures (SOPs) relating to health, hygiene and sanitary facilities. The SOPs should address worker training, facilities and supplies to enable agricultural workers to practice proper hygiene, and company policies relating to expectations for worker hygiene as well as illness reporting. In the context of smallholder farming where written SOPs are not feasible, there should be records related to health, hygiene and sanitary facilities.

4.2.3.1 Personnel hygiene and sanitary facilities (location, design and maintenance)

Hygienic and sanitary facilities should be available for the maintenance of an appropriate degree of personal hygiene. To the extent possible, the hygienic and sanitary facilities should:

- be located in close proximity to the fields and indoor premises, in sufficient number to accommodate personnel and appropriate for both women and men, so as to encourage their use and reduce the likelihood of agricultural workers relieving themselves in the field;
- be appropriately designed to ensure the hygienic removal of wastes and avoid the contamination of growing sites, fresh tomatoes and green leafy vegetables or agricultural inputs;
- provide adequate means for hygienically washing and drying hands;
- be maintained under sanitary conditions and in good repair;
- include clean running water, soap, toilet paper or equivalent, and single use paper towels or equivalent; multiple use cloth drying towels should not be used; hand sanitizers should not replace hand washing and should be used only after hands have been washed;

4.2.3.2 Health status

People known or suspected to be suffering from or carrying a disease or illness likely to be transmitted through fresh tomatoes and green leafy vegetables should not be allowed to enter any food-handling area, including harvest area, if they are likely to contaminate these food products. Any person so affected should immediately report illness or symptoms of illness to the management.

The following should be considered:

- Growers should be encouraged to recognize symptoms of diarrheal, or other food-transmissible communicable diseases or conditions such as infected wounds and reassign agricultural workers as appropriate to an activity that does not affect the safety of the product.
- Agricultural workers should be encouraged and, where feasible, motivated with appropriate incentives to note and report symptoms of diarrheal or food-transmissible communicable diseases.
- Medical examination of agricultural workers should be carried out if clinically or epidemiologically indicated.

4.2.4 Post Harvest

Post-harvest activities are the processes done immediately after harvesting the produce, including grading, cleaning, sorting and packing. Thus, postharvest treatment extends the shelf life of the product and its activities should be carried out in a way that maintains the quality and safety of the produce. The tomatoes and green leafy vegetables should be sorted and graded on the farm before transportation to processing facilities or markets. A pack house should be created on or near the farm where the grading, sorting and cooling of the tomatoes and green leafy vegetables will take place.

4.2.5 Environmental Hygiene

As far as possible, potential sources of environmental contamination should be considered when designing and locating a packing house/location for sorting, grading and packaging. In particular, sorting and grading should not be carried out in areas where the presence of potentially harmful substances would come in contact with the produce. A packing house usually integrates reception areas, precooling section. Packing floor, packing materials storage (e.g., plastic crates), hand washing areas,

and dispatch areas. Toilets are also expected to be on the farms

4.2.5.1 Animals and human activity

As during production, it is important to ensure that humans and animal species that could be potential carriers of food-borne pathogens are kept away from the location where sorting and grading and packaging is happening. In Nigeria, it is common for animals such as goats, sheep, chickens, dogs and cows to move around farms. This occurs in the intermittent presence of wild animals such as grass cutters and rats that can also carry diseases. To avoid animals and human activities that may present the risk of direct contamination of the crop, the following should be taken into consideration:

- Appropriate biological, cultivation, physical and chemical pest-control methods should be used in order to exclude animals from the handling areas to the extent practicable. Possible methods include the use of physical barriers (e.g., fences) and active deterrents (e.g., noise makers, scarecrows, images of owls, foil strips)
- Sorting and grading areas should be properly designed and maintained to reduce the likelihood of attracting vectors e.g. making sure the handling areas are free of waste and clutter.
- To the extent possible, the entrance of non-essential persons, casual visitors and children should be controlled in the handling areas as they may present an increased risk of contamination.

4.2.6 Preventing cross contamination:

During harvest and post-harvest activities, effective measures should be taken to prevent the cross-contamination of fresh tomatoes and green leafy vegetables from agricultural inputs or personnel coming into direct or indirect contact with fresh tomatoes and green leafy vegetables. To prevent the potential cross-contamination of these food products, harvesters and other agricultural workers should adhere to the recommendations presented below.

- The field should be evaluated for the presence of hazards or contamination prior to harvest to determine if the field or portions thereof should not be harvested.
- Harvesting methods vary depending on the characteristics of the product. Specific control measures should be implemented to minimize the risk of contamination from micro-organisms associated with the method of harvesting.
- Manual harvest is a common practice for some fresh tomatoes and green leafy vegetables and may lead to food safety hazards if not properly done.
- Growers should take measures to improve sorting and grading, as the extent of soil and extraneous matter/debris present during and after harvesting may pose a risk of contamination.
- Care must be taken when packing fresh tomatoes and green leafy vegetables in the field to avoid contaminating containers or bins by exposure to manure or other contamination sources.
- Excessive dirt and caked mud should be removed from product and/or containers during harvest.
- Setting harvested fresh tomatoes and green leafy vegetables directly on soil after harvest and before loading into the transport vehicle should be avoided so as to avoid contamination.
- Containers used repeatedly during harvest should be cleaned after each load.
- Only clean water should be used to remove dirt and debris from fresh tomatoes and green leafy vegetables at all times.

- Fresh tomatoes and green leafy vegetables unfit for human consumption should be left unharvested or segregated during harvesting. Those which cannot be made safe by further processing should be disposed of properly to avoid contamination of food products and agricultural inputs.
- When padding is used with post-harvest handling equipment to prevent damage, it should be constructed of material that can be cleaned and disinfected. Ensure that padding is cleaned and disinfected before and during use.
- Harvesting containers that come into direct contact with fresh tomatoes and green leafy vegetables should not be utilized for any other purpose than holding these products (e.g., storing personal items, lunch, tools, fuel, waste).
- Harvesting containers should not be placed directly on the ground and should not be stacked if stored on the ground at any time (to avoid the soiled bottom of one container sitting atop another and directly or indirectly contaminating the product in other containers).

4.2.6.1 Personal cleanliness

Agricultural workers and other people who have direct contact with fresh tomatoes and green leafy vegetables should maintain a high degree of personal cleanliness and, where appropriate, wear suitable protective clothing and footwear. Workers should wear clean clothes and their personal protective clothing and equipment should only be used in the assigned areas. When personnel are permitted to continue working with cuts or wounds to the hands covered by waterproof dressings, they should: wear gloves to cover the bandages, thereby providing a secondary barrier between them and the fresh tomatoes and green leafy vegetables they handle; or be reassigned to another working area where they do not handle fresh tomatoes and green leafy vegetables or food contact surfaces directly.

Personnel should wash their hands before starting work involving the handling of tomatoes and green leafy vegetables, each time they return to handling areas after a break, immediately after using the toilet, or after handling any contaminated material where this could result in contamination of fresh tomatoes and green leafy vegetables.

4.2.6.2 Personal behaviour

Agricultural workers should refrain from behaviour which could result in the contamination of food, for example: smoking, spitting, chewing gum or tobacco, eating, or sneezing or coughing over unprotected fresh tomatoes and green leafy vegetables.

Personal effects (e.g., jewellery, watches, purses, backpacks, clothes) should not be worn or brought into fresh tomatoes and green leafy vegetables production areas if they pose a threat to the safety and suitability of the food.

4.3 Transport

Fresh tomatoes and green leafy vegetables should be transported under conditions which will minimize the potential for microbial, chemical or physical contamination. The following should be considered:

4.3.3 Prevention of cross-contamination

During transportation of tomatoes and GLVs, effective measures should be taken to prevent the cross-contamination of fresh tomatoes and green leafy vegetables. To prevent the potential cross-contamination of these food products, transporters should make sure that the tomatoes and GLVs are not mixed with other food or non-food items. This is extremely important as clean and well sorted and graded tomatoes and GLVs can get contaminated when mixed with other products.

In addition to efforts to minimize cross-contamination, transporters should adhere to the recommendations presented below to preserve the quality of the tomatoes and GLVs being transported.

- Each transporter should ensure that the vehicles/trucks used to move tomatoes and GLVs are carefully washed, clean, and disinfected prior to use.
- Fresh tomatoes and green leafy vegetables should not be transported with animals.
- Fresh tomatoes should be stored in crates during transportation to avoid damage and easy contamination.
- Transporters should make sure that the containers (plastic crates or bowls or basins) used for transporting the product have been cleaned and disinfected prior to use
- Fresh tomatoes and green leafy vegetables should not be transported in vehicles previously used to carry animal manure, biosolids or pesticides.
- Fresh tomatoes and green leafy vegetables should not be offloaded directly on the floor at the market.
- Transporters should ensure that the farmers have removed as much soil as possible from fresh tomatoes and green leafy vegetables before they are transported.
- During transportation the fresh tomatoes and green leafy vegetables should not be placed directly on the vehicle floor
- Products should be covered during transportation to prevent contamination from vehicles, bicycles and tricycles fumes and microbes in the air.

4.4 Storage at the market

Fresh tomatoes and green leafy vegetables should be stored under conditions which will minimize the potential for microbial, chemical, or physical contamination. The following should be considered:

4.4.1 Prevention of cross-contamination

During storage of tomatoes and GLVs, effective measures should be taken to prevent the cross-contamination of fresh tomatoes and green leafy vegetables. To prevent the potential cross-contamination of these food products, traders should ensure that the tomatoes and GLVs are stored separately in specific areas designated to the products.

In addition to efforts to minimize cross-contamination, traders should adhere to the recommendations presented below to preserve the quality of the tomatoes and GLVs being stored and sold in open markets.

- Each trader should ensure/require that the vehicles/trucks that are bringing their products are washed, clean, and disinfected prior to loading their product. This is particularly important for multipurpose vehicles that are used to move different kinds of products.
- Fresh tomatoes and green leafy vegetables should not be stored in a location where animals have access to. They should be kept away from animals.
- Fresh tomatoes should be stored in crates to avoid damage and easy contamination.
- Traders should ensure that their fresh tomatoes and green leafy vegetables are not offloaded directly on the floor at the market.

- Traders should remove as much soil as possible from fresh tomatoes and green leafy vegetables before they are stored. Where possible, traders should require that their customers (farmers) have removed as much soil as possible from fresh tomatoes and green leafy vegetables before they are transported.
- The store for fresh tomatoes and green leafy vegetables should have pallets for storage.
- Storage areas should be as cool as possible to prevent over ripening of the product and quick deterioration

4.4.2 Trading and display of products in the market

Fresh tomatoes and green leafy vegetables should be displayed in the market under conditions which will minimize the potential for microbial, chemical or physical contamination. The following should be considered:

4.4.2.1 Prevention of cross-contamination

During the display of tomatoes and GLVs, effective measures should be taken to prevent the cross-contamination of fresh tomatoes and green leafy vegetables. To prevent the potential cross-contamination of these food products, traders should make sure that the tomatoes and GLVs are not mixed with other food or non-food items while on display for sale. This is extremely important as clean and well-sorted and graded tomatoes and GLVs arriving at the market can still get contaminated when mixed with other products that might not have been properly handled or are carriers of disease while at the market.

In addition to efforts to minimize cross-contamination, traders should adhere to the recommendations presented below to preserve the quality of the tomatoes and GLVs while on display in their stalls or on their tables in the market.

- Fresh tomatoes and green leafy vegetables should not be displayed in a location where animals have access to. They should be kept away from animals.
- Fresh tomatoes should be kept in clean plastic create or containers to avoid damage and easy contamination while on display
- Traders should ensure that their fresh tomatoes and green leafy vegetables are not kept on the floor in their stall or at any location in the market. The stall where fresh tomatoes and green leafy vegetables are being sold should have pallets for storage.
- Traders should wash their tomatoes and GLVs with clean potable water from bore hole or pipe borne water.
- Traders should ensure that the water used for washing tomatoes and GLVs is changed regularly.
- Display areas in the market should be as cool as possible to prevent over ripening of the product and quick deterioration.

4.5 Cleaning, maintenance and sanitation in the market

In many instances in Nigeria, processing occurs in open markets or processing clusters within or close to markets. Premises for trading/processing tomatoes and GLVs should be kept in an appropriate condition to facilitate cleaning and disinfection. Equipment should function as intended to prevent contamination of fresh tomatoes and green leafy vegetables. Cleaning materials should be clearly identifiable, stored separately in secure storage facilities, and used in accordance with manufacturer's instructions for their

intended purpose.

4.5.1 Cleaning programmes

Cleaning and disinfection programmes should be in place to ensure that any necessary cleaning and maintenance is carried out effectively and appropriately. Cleaning and disinfection systems should be monitored for effectiveness and regularly reviewed and adapted to reflect changing circumstances.

Specific recommendations are as follows:

- Proper cleaning and sanitation of equipment is important for manual and mechanical harvesting, since knives and other equipment can damage fresh tomatoes and green leafy vegetables, lead to cross-contamination or facilitate the entry of contaminants that may be in soil or water.
- Harvesting equipment, such as knives, pruners and machetes, that come into direct contact with fresh tomatoes and green leafy vegetables should be cleaned and disinfected regularly or as the situation warrants.
- Clean water should be used to clean all equipment coming into direct contact with fresh tomatoes and green leafy vegetables, including farm machinery, harvesting and transportation equipment, containers and knives.
- When not in use, cleaned harvest containers and transport trucks should be covered and kept in such a location and manner as to prevent possible contamination (e.g., from pests, birds, rodents, dust, water).

4.5.2 Cleaning procedures and methods

The appropriate cleaning methods and materials will depend on the type of equipment and the nature of the tomato or vegetable. The following procedures should be adopted:

- Cleaning procedures should include the removal of debris from equipment surfaces, the application of a detergent solution, rinsing with clean water, and, where appropriate, disinfection.
- Cleaning and disinfection programmes should not be carried out in a location where the rinse might contaminate fresh tomatoes and green leafy vegetables.
- Cleaning chemicals may be subject to approval by the competent authority and should be handled and used carefully and in accordance with manufacturer's instructions.

4.5.3 Pest-control systems

- Pests are destructive insect that destroy foods, not only are they detrimental to foods but they also bring diseases to humans.
- Pest control is the process of managing and preventing pests, such as insects, rodents, and other animals, from causing damage to tomatoes and vegetables.
- Physical methods of pest control such as traps and barriers should be used.
- Chemicals such as insecticides, pesticides should not be use in the market because they are sources of chemical hazards to foods.

4.5.4 Waste management

- Suitable provision should be made for the storage and removal of waste in the market.
- Waste should not be allowed to accumulate in tomato and vegetable handling and storage areas or the adjoining environment.
- Storage areas for waste should be kept clean.
- Store the culled tomatoes and vegetables on-site in a pile area for a limited time.
- Compost fruit and vegetable culls.
- Dispose of fruit and vegetable waste in a local Sub-Title D landfill.

4.5 Training

Training plays important role for the change in behavior by improvement of knowledge, skill & ability of the different stakeholders along the value chain. To follow up and enhance more technically about the local methods, techniques, learning & experiences with current technical needs are the major reason for continuous training. The training should focus on the management of the safety challenges which arises during the farming, postharvest, transportation, storage and marketing of fresh tomatoes and green leafy vegetables. The training should be able to enhance the technical skills of stakeholders along the value chain to meet basic food safety and hygienic standards. The training is to be facilitated with a well-constructed basic food safety manual

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