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Ethiopian Agricultural Authority



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ETHIOPIAN FOOD & DRUG AUTHORITY



Guidelines for improving the safety and quality of hot pepper (*Capsicum*) along the value chain in Ethiopia: Good agricultural and processing practices

RAISE-FS Guideline #004

Stichting Wageningen
Research Ethiopia



Guidelines for improving the safety and quality of hot pepper (*Capsicum*) along the value chain in Ethiopia: Good agricultural and processing practices

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Summary of document

This document outlines a framework aimed at addressing major challenges to protect consumers and promote trade by improving hot pepper production and processing systems, with a focus on safety and quality. It emphasizes leveraging continental and global free trade agreements to achieve these objectives. The guidelines were developed through a collaborative process involving input and guidance from relevant stakeholders and ministries.

Keywords: hot pepper, quality, food safety, trade, Ethiopia

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Contents

Preface	10
List of abbreviations and acronyms	11
1 INTRODUCTION	13
1.1 Background	13
1.2 Objectives	14
1.3 Scope of the guidelines	14
2 Good Agricultural Practices (GAP)	15
2.1 Site selection	15
2.2 Agroecological requirements	15
2.3 Land preparation	16
2.4 Seeds/seedlings access	16
2.5 Seedbed and seedlings preparation	16
2.6 Transplanting	17
2.7 Water requirements	17
2.8 Insect pests/diseases management	17
2.8.1 Major pests/diseases	18
2.8.2 Pepper root rot (<i>Phytophthora capsici</i>)	18
2.9 Weed management	18
2.10 Soil fertility management	19
3 Harvesting and post-harvest handling	20
3.1 Crop maturity	20
3.1.1 Fresh/green pods	20
3.1.2 Dry pods	20
3.2 Harvesting methods for fresh and dry pods	21
3.2.1 Harvesting containers for both green and dry pods	21
3.2.2 Best practices for field handling of hot pepper pods	22
3.3 Drying	22
3.3.1 Preparation for drying	22
3.3.2 Methods of drying	22
3.4 Grading, packaging and labelling	24
3.4.1 Grading	24
3.4.2 Packaging	25
3.4.3 Labelling (follow national or international standards)	25
3.5 Storage and transportation	26
3.5.1 On-farm and warehouse storage	26
3.5.2 Transportation	26
4 Good Manufacturing Practices (GMPs)	27
4.1 Process flow	27
4.1.1 Powder, essential oil and oleoresin extraction	27
4.2 Establishment	28
4.2.1 Location	28
4.2.2 Infrastructures	28
4.2.3 Buildings and Facilities	28
4.2.4 Water Supply	28
4.3 Training	29
4.4 Personal hygiene	29

4.5	Changing facilities and toilets	29
4.6	Hand-washing facilities in processing areas	30
4.7	Medical examinations	30
4.8	Lighting	30
4.9	Ventilation	30
4.10	Animal and pest control	30
4.11	Equipment and Utensils	30
	4.11.1 Materials, Design, Construction & Installation	30
	4.11.2 Cleaning and disinfection	31
	4.11.3 Maintenance	31
4.12	Production/Manufacturing	31
	4.12.1 Raw materials/ingredients	31
	4.12.2 Packaging materials	32
	4.12.3 Storage of packaging materials	32
	4.12.4 Processing	32
	4.12.5 Finished products	33
	4.12.6 Storage and handling of by-products	33
	4.12.7 Storage and handling of hazardous substances	33
	4.12.8 Quality Control	33
	4.12.9 Waste Management	34
5	Communication, training and awareness creation	35
6	Traceability system	36
	6.1 Key considerations for traceability	36
7	Certification	38
	7.1 Certification of the service	38
	7.2 Certification of the product	38
	7.3 Safety and quality control	38
8	Marketing	39
	References	40
	Annex 1. Terms and operational definitions	42

Preface

Hot pepper is a key condiment in the Ethiopian traditional cuisines because of its distinctive hotness, flavour, and colour. The food, economics, and health benefits placed hot pepper among the most demanded horticultural crops. Consequently, deepening its production, processing and consumption in the country's food culture. Furthermore, it generates income for producer households, transporters, traders, processors, food vendors, and creates employment opportunities to labourers along the value chain.

Despite its food and economic importance, hot pepper production and marketing face challenges related to low productivity, poor product quality, and contamination from pesticides, microbes, and mycotoxins. To minimize the potential impacts of these impediments, improve the food safety and quality, and increase competitiveness of hot pepper in the international market, Good Agricultural Practices (GAP), Good Handling Practices (GHP), and Good Manufacturing Practices (GMP) guidelines have been developed and would be available to users both in hard and electronic copies.

The GAP and GHP sections, led by the Ethiopian Agriculture Authority (EAA), focuses on farm-level actions like site and land selection, seed bed preparation, seedling raising, transplanting, soil, water and integrated pest management, and harvesting techniques. The GHP section deals with contamination prevention practices such as observing sanitation and hygiene during production, harvesting, drying, transporting, cleaning, sorting, packaging, and storing. The GMP section, led by the Ethiopian Food and Drug Authority (EFDA), offers crucial guidance for food processors to ensure safe, clean, and standardized production of pepper-based products. Additionally, the guideline emphasizes the need for certification, sustaining traceability, trustworthy marketing system that boost product quality, ensure food safety, and improve competitiveness of hot pepper.

The guidelines are outcomes of a collaborative effort involving various stakeholders, including government institutions, researchers, academia, development partners, and the private sector. It supports the national food safety strategy and regulatory framework, designed to strengthen certification systems, build capabilities, and improve traceability and market access.

The guides are anticipated to provide practical advice and serve as reference material for farmers, cooperatives, extension workers, processors, regulatory bodies, and others involved in the hot pepper value chain. We also hope that these guidelines serve as a foundational tool for enhancing the quality and safety of hot pepper throughout the value chain. By implementing the step-by-step outlined practices, stakeholders at all levels could make the hot pepper subsector more sustainable, safer, and competitive.

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List of abbreviations and acronyms

AAU	Addis Ababa University
EAA	Ethiopian Animal Authority
ECTA	Ethiopian Coffee and Tea Authority
EFDA	Ethiopian Food and Drug Authority
EIAR	Ethiopian Institute of Agricultural Research
EPHI	Ethiopian Public Health Institute
MoA	Ministry of Agriculture
MoTRI	Ministry of Trade and Regional Integration
ISO	International Organization for Standardization
PPE	Personal Protective Equipment
SWRE	Stichting Wageningen Research Ethiopia

Terms and definitions

Terminology	Definition
Certification	certification as a procedure that provides written assurance that a product, process, or service meets certain standards. The certification body should be an organisation that performs the certification, which can be an official or recognised entity.
Certification body	an organisation that performs the certification, which can be an official or recognised certification body.
Critical Control Point (CCP)	a step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level (CAC/RCP 1-1969).
Fertiliser	any substance or nutrient element applied to soil to promote plant growth, increase crop yield, or improve crop quality.
Food-grade materials	a material that safeguards the hygienic, nutritional and organoleptic quality of the products without imparting any toxic substance or undesirable odour or flavour to the product.
Food Quality	a complex characteristic of food that determines its value or acceptability to consumers.
Food Safety	the assurance that food will not cause harm to the consumer when prepared and/or eaten according to its intended use.
Good Agricultural Practices (GAPs)	are a set of principles that can be applied to on-farm production and post-production processes. The goal of GAP is to produce safe and healthy food and non-food agricultural products while also considering economic, social, and environmental sustainability.
Good Manufacturing Practices (GMPs)	According to FAO, good manufacturing practices (GMPs) are procedures and practices that ensure the safety and quality of food, cosmetics, and pharmaceutical products.
Hardening	is the process of exposing transplants (seedlings) gradually to outdoor conditions. It enables transplants to withstand the changes in environmental conditions they will face when planted outside in the garden. It encourages a change from soft, succulent growth to a firmer, harder growth.
Food hygiene	the conditions and measures required to ensure that food is safe and suitable for consumption at all stages of the food chain. Food hygiene aims to prevent the spread of microorganisms and the introduction of contaminants during the production process. It also helps to prevent food from spoiling, which can reduce waste and negative economic consequences.
Personal Hygiene	a set of practices that help keep food safe and clean. Some of these practices include washing hands, keeping fingernails short and clean, avoiding coughing or spitting near food or water, covering any wounds on hands, using a toilet and keeping it clean, cleaning up feces from animals, etc. It is important to ensure that all personnel are aware of good personal hygiene, and that they understand and comply with a set of practices designed to ensure food safety.
Inspection	the examination of food, raw materials, and food control systems to ensure they meet quality and safety standards. This includes testing finished and in-process products.
Integrated Pest Management (IPM)	the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified. IPM measures also reduce or minimise risks to human and animal health, and the environment.
Mulching	is the process of covering the topsoil with plant material to improve the soil and crops.
Nursery	a place where seedlings are grown and cared for until they are ready to be planted.
Pest	any species, strain or biotype of plant, animal or pathogenic agent that is injurious to plants, plant products, materials or environments. It includes vectors of parasites or human and animal disease pathogens, as well as animals that cause public health nuisances.
Pesticide	any substance, or mixture of substances, either chemical or biological, intended for repelling, destroying or controlling pests, or regulating plant growth.
Pesticide residue	the trace amounts of pesticides that remain on or in food after being applied to crops.
Seedbed	the area where seeds are sown to germinate. The structure of a seedbed can affect a crop's early growth and development in several ways.
Seed sowing	Seed sowing, or planting seeds, is the process of planting seeds in soil.
Soil additives	a substance added to soil to improve its physical properties or fertility. Soil additives can improve water retention, drainage, aeration, structure, and permeability. Examples are animal manure, sawdust, compost, seaweed, and fish-based products.
Traceability / Tracing	FAO defines traceability as the ability to follow (trace) the movement of a food through the stages of production, processing, and distribution. Traceability is also known as the "one-step-back-one-step-forward" principle. Traceability is important for a variety of reasons, including product recalls, regulatory compliance, public health and sustainable fisheries management.
Tracking	the ability to follow the path of a traceable item throughout the supply chain as it moves between parties.
Transplanting	is the process of relocating a plant from one site to another in agriculture and gardening.

1 INTRODUCTION

1.1 Background

Food safety has become a major health challenge in both developed and developing countries in recent years. Foodborne illnesses, food fraud, and food scares are rising with the globalisation of supply chains and market diversification. Food contaminated with harmful bacteria, viruses, parasites, or chemical substances can cause over 200 diseases, ranging from diarrhoea to cancer. Addressing food safety and quality issues is fundamental to reducing chronic malnutrition and promoting economic development. Improving food safety and quality boosts agricultural productivity and drives economic growth, helping to break the cycle of poverty and malnutrition. Based on this fundamental scientific principle, Stichting Wageningen Research Ethiopia has facilitated the development of safety and quality guidelines for hot pepper to help tackle issues arising from agricultural and manufacturing practices.

The heavy burden of foodborne diseases underscores the need for a robust food safety strategy, along with clear guidelines and directives, in countries like Ethiopia, where agriculture is the primary source of income. This guide is formulated in a broader scope to provide a foundation for multi-sectoral collaboration, internal goal setting and sector-specific strategic planning. These guidelines encourage the Ministry of Agriculture (MoA), the Ministry of Trade and Regional Integration (MoTRI), the Ethiopian Agricultural Authority (EAA), the Ethiopian Coffee and Tea Authority (ECTA), the Ethiopian Food and Drug Authority (EFDA), and other stakeholders, to develop specific plans aimed at achieving an integrated approach and implementing high-priority actions to improve the safety and quality of hot pepper. The guidelines also provide a comprehensive framework covering the key components of an effective hot pepper safety control system, including foundational elements, agronomic practices, management and oversight, control measures, scientific and technical applications, and communications. The guidelines also cover the entire hot pepper value chain, from primary production to consumption.

Furthermore, a harmonised framework is provided for implementing activities that mitigate various safety and quality threats affecting consumers' health. These include adopting and promoting effective measures to strengthen government food control functions, build the capacity of the business sector across the food chain to produce safe food, and empower consumers to demand safe food.

These proposed guidelines present a framework for addressing key challenges, with the overall objective of protecting consumers and facilitating trade. This is to be achieved by leveraging both continental and global free trade accords and agreements, which require significant improvement in the current hot pepper production and processing systems, particularly in terms of safety and quality.

These guidelines were developed through a coordinated process involving various stakeholders from the Ministerial Offices, Authorities, Research Institutes, and Universities. Representatives from relevant institutions provided technical input and general guidance during their preparation.

1.2 Objectives

The guidelines highlight the following objectives for improving safety and quality of hot pepper products:

1. Strengthen safe and effective agronomic practices, post-harvest handling and processing of hot peppers.
2. Improve trade and market access for hot pepper at the national, regional, continental and global levels.
3. Improve institutional and legal frameworks that control the implementation of safe and high-quality hot pepper production along the value chain.
4. Establish and strengthen coordination mechanisms/platforms among stakeholders and value chain actors.
5. Enhance evidence-based advocacy, communication, and knowledge sharing to raise consumer awareness and promote empowerment.
6. Strengthen research, innovation, technology development and transfer.

1.3 Scope of the guidelines

These guidelines cover safety and quality issues along the hot pepper value chain, from production to consumption. They cover the principles, procedures and strategies needed to strengthen product safety and quality assurance systems, control elements and programs within a national hot pepper control system, as well as empower consumers. The guidelines also provide a foundation for multi-sectoral collaboration, internal organisational goal-setting and strategic planning. To effectively respond to hot pepper safety emergencies and assess the impact of the guidelines, strong collaboration among the Ministry of Agriculture (MoA), Ministry of Health (MoH), Ethiopian Agricultural Authority (EAA), Ethiopian Coffee and Tea Authority (ECTA), Ethiopian Food and Drug Authority (EFDA), Ministry of Trade and Regional Integration (MoTRI), Ethiopian Public Health Institute (EPHI), Ethiopian Institute of Agricultural Research (EIAR), Academia and the private sector is essential.

2 Good Agricultural Practices (GAP)

Summary

This section of the guidelines focuses on how to adopt GAPs on each sub-activity at the pre-harvest stage of hot pepper production:

- Site selection - Nursery/seed and crop
- Land preparation
- Seeds/seedlings access
- Seedbed/seedlings preparation
- Transplanting
- Water and soil fertility management
- Insect pest, disease and weed management

2.1 Site selection

- Identify the possible sources of contamination (biological/chemical hazards) on the site or on adjoining sites prior to use of the land.
 - Ensure that the site has not been used for the disposal of hazardous toxic substances by conducting a visual inspection and/or analysis through an officially accredited laboratory.
- If risks are identified, manage them before planting by following an appropriate risk management approach).
- Monitor and evaluate (M&E) the effectiveness of the risk management approach to prevent further contamination of the produce.
- Document the risks, M&E and risk management approach for further reference.
- During site selection, consider environmental protection by avoiding areas prone to soil erosion or water contamination.

2.2 Agroecological requirements

- Optimum altitude is between 1400 and 1900 meters above sea level.
- Day temperatures of about 25–28°C and night temperatures of 15–20°C are ideal for pepper growth.
- Sandy loam or sandy soil is preferred.
- Soil enriched with organic matter is more suitable.
- Loamy or sandy loam soil with good water-holding capacity is ideal.
- Soil pH should be between 5.5 and 7. If pH is below 5.5, apply lime according to local or regional recommendations (e.g. 1,000 kg/ha in some countries).
- Rainfall: 600–1200 mm annually.

2.3 Land preparation

- Clear the selected site of any existing vegetation, debris, particularly potential alternative hosts of insect pests/diseases.
- Remove weeds and other unwanted plants to minimise competition for nutrients and resources, and to increase soil porosity for the crop.
- At least 1–2 months before transplanting, plough the field sufficiently and deeply to a depth of 20 – 40 cm to break up the soil, improve aeration and ensure proper drainage.
- Remove and burn crop residues from Solanaceae plants (such as tomatoes, potatoes, eggplant, sweet peppers/green peppers, chilli peppers, etc.) to avoid possible risk of insect pest/disease build-up in the field.

2.4 Seeds/seedlings access

- Use certified seeds/seedlings from accredited nurseries. Ensure the certificate includes key details such as quality, variety name, purity, batch number and vendor information.
- Seeds/seedlings should be free from harmful pests or visible signs of infestation, accompanied by pest/disease-free certification.
- Select varieties that are pest- and disease-resistant or tolerant, high-yielding and well-adapted to the local climate and growing conditions in your region (consult the Ethiopian Agricultural Authority, Variety Registry Book).
- Use varieties that meet high-quality standards for both local and export markets.
- If the seeds/seedlings are treated with fertilisers and/or chemicals, keep a record of the trade name and active ingredient, treatment dates, operator's name, application method, dosages and purpose of use.
- If seeds/seedlings are treated with additives or pesticides (e.g., fungicides, insecticides, biocides), use only approved additives or pesticides recommended by the Ethiopian Agricultural Authority.
- To raise your own seedlings from certified seeds, use a suitable insect-proof nursery to avoid insect entry and ensure strong, healthy plants.

2.5 Seedbed and seedlings preparation

- Pepper can be grown under rain-fed or irrigated conditions; determine the appropriate planting time based on the season and regional climate.
- Select a nursery site where other Solanaceae crops have not been grown in the last 3 to 4 years.
- The nursery site should also be located at least 200 meters from other pepper or Solanaceae plant fields, to avoid the transmission of insects and soil-borne diseases.
- Prepare a nursery bed 1 meter wide and 5–10 meters long, removing roots, stones and soil clods.
- Make drills on the seedbed spaced 10–15 cm apart.
- Seed rate: 600–750 g/ha.
- Thinly sow the seeds in the drills and cover lightly with soil.
 - Water the nursery regularly based on soil type, particle size, and weather conditions. Avoid over- or under-watering and follow local or regional recommendations.
- Three types of seedbeds can be used:
 - **Flat seedbed** where the land is level with an adequate drainage system.
 - **Elevated or raised seedbed** to avoid excess water on the seedbed during the rainy season or in areas prone to waterlogging.
 - **Sunken seedbed** in areas with a prolonged dry season to help conserve and economise water.
- Mulch the entire bed with grass or straw to protect seeds from being washed away during watering, and to shield them from strong, direct sunlight.

- Provide shade and cover the seedbed with organic materials such as dry grass. The shade protects young seedlings from exposure to sun.
- After germination, thin seedlings to 1–2 cm spacing. Begin proper management practices at the first true leaf stage to produce healthy and vigorous seedlings.
- Harden seedlings 1–2 weeks (no further shade is necessary) before transplanting by reducing watering frequency and gradually exposing them to direct sunlight.
- Raise extra seedlings to allow for the selection of vigorous, strong, and healthy transplants as needed.
- Protect seedlings from insects by using an insect-proof net (e.g., whiteflies can transmit viruses to young seedlings).
- Incorporate well-decomposed manure into the seedbed for healthy seedling production; the amount applied depends on the fertility of the soil.

2.6 Transplanting

- Prepare the land before collecting the seedlings from the nursery. Appropriate irrigation systems should be in place).
- Prepare staking about 15 days before transplanting, as this helps to produce healthier crops.
- Plant live wind breaks (such as sorghum, maize, elephant grass) 25–40 days before transplanting, or use alternative windbreak materials (such as plastic films, recycled or new grain sacks, etc.) to avoid lodging and mechanical damage.
- Manage soil moisture appropriately (depending on soil type, particle size, and weather conditions) to support healthy root development. Follow local or regional recommendations.
- Prepare ridges or raised beds along the contours to facilitate drainage of excess water from the root zone, ensuring adequate aeration for successful plant development.
- Transplant seedlings at the 4–6 true leaf stage (15–20 cm tall), usually 6–7 weeks after sowing, depending on weather conditions.
- Use healthy, properly hardened seedlings.
- Transplant seedlings either early in the morning or late in the evening.
- Plant spacing: 60 cm × 45 cm or 70 cm × 30 cm, depending on the variety (plant population ranges from 34,188 to 47,619 ha⁻¹)
- Bury plant roots firmly in the soil, but not deeper than half the height of the seedling.
- Apply water to the field or directly at the base of the plants immediately after transplanting.
- If plastic mulch is used, place it before transplanting.

2.7 Water requirements

- Always use agricultural water that is free of contaminants.
- Avoid watering plants in the evening as wet plants are more likely to develop diseases.
- Soils should be well drained. Avoid letting them dry out completely or remain waterlogged, as both conditions can promote disease. Avoid over-watering or under-watering.
- Determine the frequency, type and method of irrigation based on soil type, weather conditions, plant growth stage (follow local or regional recommendations). If needed, install an irrigation system (furrow, drip or sprinkler) to provide consistent moisture to the plants throughout the growing season (follow recommendations).

2.8 Insect pests/diseases management

- Monitor plants regularly for insect pests, diseases and associated environmental or weather factors as early detection enables timely intervention.
- Keep records of observed insect pests and diseases with relevant environmental factors.
- Manage insect pests and diseases using recommended strategies, which may include single control strategies such as certified, released resistant or tolerant varieties, cultural practices

(field sanitation/hygiene, intercropping, crop rotation, solarisation), mechanical control (insect traps, hand picking, screening house), chemicals/pesticides as a last resort using only nationally registered products), or through an integrated pest management (IPM) approach that combines two or more of these recommended strategies.

- Maintain good field hygiene by removing and destroying infected plant debris, weeds, and volunteer plants to reduce sources of insect pests and disease inoculum.
- Use crop rotation as an IPM strategy to avoid the build-up of pests and diseases in the field. An effective crop rotation program should span 3–4 years and include crops from different plant families (e.g. Solanaceae → Brassicaceae → Fabaceae → Alliaceae).

2.8.1 Major pests/diseases

- For timely intervention, it is important to become familiar with the major insect pests and diseases affecting hot pepper.
- Bacterial wilt, fusarium wilt, pepper root rot (*Phytophthora capsici*), anthracnose, parasitic nematodes, viral diseases, aphids, white fly, and thrips are common pests and diseases of hot pepper in Ethiopia (focus on the major pests and diseases in your locality or region).
- Manage pest and diseases using recommended strategies such as IPM (consult an agricultural development agent).
- Manage insect pests and diseases that affect pods, as damaged pods are more susceptible to contamination by microbes like toxigenic fungi and may serve as a source of inoculum if harvested along with healthy pods.

2.8.2 Pepper root rot (*Phytophthora capsici*)

Disease symptoms

- Seedlings fail to emerge or die shortly after emergence.
- Stems usually show a dark, shrivelled area at the soil line.
- Plants may wilt at any growth stage, even when soil moisture is adequate.
- As the disease progresses, the leaves defoliate and the stalks wither and die.
- Taproots and smaller, lateral roots show water-soaked, dark brown to black discoloration, with very few lateral roots remaining on the plant.

Integrated pepper root rot management

- Ensure proper soil drainage before planting.
- Prepare raised fields and seedbeds.
- Select varieties that are less susceptible to the disease.
- Use disease-free seeds or transplants.
- Avoid planting when soil temperatures are low.
- Use water sprinklers during seedling preparation.
- Apply light irrigation to prevent overwatering.
- Use alternative furrow irrigation in heavy soils.
- Apply preventative fungicides in soils with a history of root rot or poor drainage.
- Use recommended and registered fungicides: Mancozeb 64% + Metalaxyl 8%.

2.9 Weed management

- Keep the field as weed-free as possible to reduce competition for nutrients, sunlight and moisture.
- Avoid bruising the roots during weeding.
- Pepper is vulnerable to weed competition, particularly during early growth stages.
- To control weeds and loosen the soil, cultivation should be done 3–4 times until flowering starts. After transplanting, the first weeding and second weeding are recommended at 20 and 40 days, respectively.[JF1][GA2]
- Regularly inspect the field and remove weeds manually, following recommended practices.

- Use organic mulch (e.g., straw or wood chips) or plastic mulch to effectively suppress weed growth, conserve soil moisture, and regulate soil temperature.
- Use crop rotation with crops from unrelated families to disrupt weed life cycles and reduce weed pressure over time.
- Use nationally registered, recommended pre-emergent and post-emergent herbicides.

2.10 Soil fertility management

- During seedlings preparation (if needed), apply 200 g of DAP per seedbed at planting and 100 g of Urea per seedbed at thinning, at the first true leaf stage. Follow local or regional recommendations. [JF3]
- At transplanting, apply 200 kg/ha of DAP or 242 kg/ha of NPS. The type of fertiliser and amount needed are based on soil analysis results. Follow local or regional recommendations.
- Thoroughly mix fertiliser into the soil.
- Use well-decomposed organic fertiliser according to local recommendations, as undecomposed organic fertiliser can be a source of contaminants.

3 Harvesting and post-harvest handling

Summary

This section focuses on:

- Harvesting methods for hot pepper – green and dry pods
- Field handling practices for hot pepper
- Drying methods
- Sorting during harvesting and drying
- Checking residual levels
- Grading, packaging and labeling
- Storage practices – on-farm and warehouse
- Transportation practices

3.1 Crop maturity

Maturity is a major factor in determining the nutritional quality of hot pepper fruit.

- Hot pepper pods should be harvested once they reach physiological maturity (which marks the end of the seed-filling phase, occurring 49–53 days after anthesis) and any time after this stage during the ripening process.
- The hot pepper is mature and ready for picking when the berry has reached its maximum size and the pericarp remains green but still feels firm to the touch. At this stage, the fruit is described as 'mature green'.



(a)



(b)

Figure 1 Figure (a) Mature green hot pepper pods and figure (b) Mature dry hot pepper pods

(Source: [Google][JF4][GA5] photo)

3.1.1 Fresh/green pods

- Hot peppers intended for the fresh market should be harvested when fully developed (at the mature-green stage) and at any point during the ripening process. The pedicel should be left intact on the fruit

3.1.2 Dry pods

- Hot peppers should be harvested when they are fully red and starting to dry.

- To pick a mature hot pepper pod from the plant, grasp the fruit stalk (or pedicel) at the abscission layer between your thumb and forefinger and pull upwards; the ease of detachment is a good indicator of fruit maturity.
- The pedicel breaks off cleanly at its base when the berry is physiologically mature.
- Hot peppers typically reach maturity within 60 to 70 days (Reference).

3.2 Harvesting methods for fresh and dry pods

- The harvesting method, stage of maturity, and physical injuries can influence the nutritional composition of hot pepper fruits.
- Mechanical damages (e.g., bruising, surface abrasions, and cuts on pods) can result in accelerated loss of vitamin C and provide entry points for storage pests.
- Harvest hot pepper berries during the cooler times of the day, such as early mornings or late in the evening. High temperatures cause the pods and pedicels to lose turgidity or firmness, making detachment more difficult.
- Wash harvesting containers with detergent, then sanitise them with a 5–10% bleach solution before each use.
- Be careful to avoid breaking the branches of plants during the picking process.
- Harvest only under dry conditions, as wet pods are very susceptible to post-harvest rot.
- Do not pull clusters of peppers from the plant. Remove berries individually.
- Do not harvest immature pods. Immature fruits are very light green in colour and have a shorter shelf life.
- Harvest green hot pepper pods carefully, causing as little damage to the plant as possible.
- Green hot pepper pods can be harvested by hand (hand-picked) using a sharp, clean knife or scissors.
- Dry hot pepper pods can be harvested manually.
- Make a clean cut to detach the pods from the stem.

Attention:

- Long periods of field work result in high labour costs, with the continuous increase in base wage rates for manual harvesting.
- Manual harvesting is time-consuming, and labour shortages during the picking season can cause delays in harvesting, leading to poor product quality.
- Using a harvesting machine, particularly for dry pods, can be an excellent option to reduce harvesting time and lower labour costs.

3.2.1 Harvesting containers for both green and dry pods

- The containers used for collecting harvested pods from the field should preferably be made of durable plastic, such as high-density polyethylene (HDPE) (Figure 2), which can withstand repeated washing and sanitation. Wooden crates may also be used.
- The containers should be shallow and well ventilated.



(a)



(b) [IK6]

Figure 2 HDPE stackable packing crates

Source (CARDI, 2007) and b) Wooden crates source (dreamstime.com)

3.2.2 Best practices for field handling of hot pepper pods

- Harvesters must wash their hands with soap and water and, if possible, wear sanitary gloves.
- Diseased, damaged, deformed and overripe pods should be separated.
- Harvested pods should be placed in a shaded 'cooling area' immediately after harvest to allow field heat to dissipate.
- Overripe hot peppers should be placed in a separate container. Decaying pods should never be placed in harvesting crates.
- Do not wash hot pepper berries as water on the surface accelerates tissue breakdown.
- Always handle pods carefully as any site of damage on the pod can become a potential point of decay.
- During transport, cover crates with a light-coloured tarpaulin or other material to reduce heat build-up.

3.3 Drying

3.3.1 Preparation for drying

- Inspect the hot peppers, discarding any with soft spots, unusual odours or other signs of bacterial or mould contamination.
- Clean hot peppers should be soaked for up to 2 minutes in water at 90°C (dip them into boiling water for approximately 2 minutes).
- This process helps reduce microbial contaminants, facilitates drying, improves the appearance of the dried peppers and enhances their flavour (for commercial production purposes only).

Location for drying/Site selection

- The drying location should be clean and free from dust, dirt, farm animals and/or other potential sources of contamination.
- The drying platforms should be elevated above the ground and fenced to protect from any pests or farm animals.

3.3.2 Methods of drying

The methods used to dry hot peppers include sun drying, solar drying, oven drying, food dehydrators, air drying, and air fryers. Sun drying and solar drying are recommended based on the Ethiopian context.

Sun drying

- Lay hot peppers flat on a large tray or plastic sheet (preferably black polyethylene sheets) making sure they do not overlap (each pepper should have air circulation on all sides).
- Cover the tray/plastic sheet with a thin mesh screen to protect the peppers from insects and dust.
- Sun drying can take a number of days.
- Rotate (flip) the peppers every few days.
- All drying procedures should be performed hygienically (e.g., cover mouth, wear hand gloves etc.).

Attention:

- When using sunlight to dry hot peppers, avoid placing them on the bare ground.



Figure 3 Bad practice in hot pepper drying – sun drying directly on bare soil (Tu et al., 2012)

Solar drying

- Place hot peppers in a single layer on black polythene sheets or wire-mesh trays inside the drying chamber of the solar dryer.
- Line the inner side walls of the drying chamber with aluminium foil to reflect solar radiation back into the chamber.
- Cover the hot peppers with glass films to maximise solar radiation capture throughout the day.
- Turn the hot peppers every 2–3 hours to ensure even drying and prevent moisture build-up on the bottom.
- Solar dryers can be more efficient than sun drying and can produce higher-quality hot peppers. Drying hot peppers in a solar dryer can reduce drying time by about 49–54%.
- A solar dryer consists of three main components: a drying chamber, a solar collector, and an airflow system, as illustrated in Figure 4.

Attention:

- The clean hot peppers should be dried at temperatures below 60°C to prevent loss of volatile compounds.
- Dry the hot peppers to a safe moisture content of approximately 10%.
- For household preparation, drying should be continued until the hot peppers attain a steady weight.
- Peppers can be sliced for drying, but keeping them whole gives a better appearance, makes them easier to store and reduces the risk of bacterial contamination.

How long do hot peppers take to dry?

- The drying time will depend on the type of hot pepper and the method of drying used.
- Thicker-skinned peppers will take longer to dry than those with thinner skins. Slicing the peppers can speed up the drying process, but it also increases the risk of contamination.
- Drying can take anywhere from a couple of hours to five or six days (up to 70 hours).

How can you tell when hot peppers are dry?

- By touching them. Dried hot peppers are crispy and brittle.
- Peppers that still feel soft or sticky need more drying time.

How to store dried hot peppers

- Store dried hot peppers in an airtight container in a cool dark place, such as a pantry (a room where food, dishes and kitchen supplies are stored) or cupboard.
- Store dried peppers in a vacuum-sealed bag, zipper bag, mason jar or other suitable container to help protect them from moisture.

How long do dried hot peppers last?

- Dried hot peppers can last for one to two years, when stored correctly.
- The flavour of dried peppers will gradually degrade over time, so it's best to prepare them in batches and replenish supplies every year.

Determination of moisture content

- The moisture content of hot peppers can be determined using the gravimetric method (loss on drying), moisture analysers, and other techniques.

Sorting during harvesting and drying

- Hot peppers are hand-sorted after harvesting to remove defective or inferior quality fruit, and to classify them by quality and size. [JF9][GA10]
- Spoiled, broken, fungus-attacked and insect-infested pods, as well as plant debris and dust, should be separated from the good-quality pods after harvesting and before shipment or storage.
- Sorting hot pepper pods is important to achieve uniform quality during storage.
- The discarded materials should be properly disposed of to prevent recontamination of the clean produce.
- Hand sorting is an important postharvest strategy to help prevent mycotoxin contamination.



Figure 4 Hand sorting of mouldy and insect-infested hot pepper

(Source: Dreamstime – White mould on orange chili peppers)

Checking residue levels

- To ensure safety of hot peppers, toxicant residue limits should be tested, specifically for pesticides and mycotoxins (Aflatoxin and Ochratoxin A.) before packaging for shipment or storage.
- Toxicant residues might arise in the field before harvesting and/or after harvesting due to improper handling and drying procedures.
- It is recommended to test for any residue levels.
- Residue analysis can be conducted at testing laboratories available within the country.

3.4 Grading, packaging and labelling

3.4.1 Grading

- Grading is based on variety, size, colour and degree of ripeness. Size grading can be carried out during harvest or in a pack-house.

- At the pack-house hot peppers are graded by hand, either on a moving conveyor belt or at a standard grading table.
- Only hot peppers that attain the minimum standard specifications are selected.

3.4.2 Packaging

- Dried hot peppers are hygroscopic and must be packaged quickly after drying using a material that serves as a barrier to moisture, such as vacuum-sealed or modified atmosphere packaging.
- Suitable packaging materials include polyethylene bags such as low-density polyethylene (LDPE), high density polyethylene (HDPE), and Purdue Improved Crop Storage (PICS) bags, which can be used to store dried hot peppers for extended periods.



Figure 5 Figure (a) Polyethylene bag and figure (b) PICS

(Source: Google photo)

- New bags should be used when packing hot peppers in the growing/harvest area for transport, storage, or for further sale, to prevent microbial, physical and chemical contamination.
- Bags should be inspected immediately before use to ensure they meet the manufacturer's quality standards, and if necessary, cleaned and/or disinfected. Washed bags should be well drained and dried before filling.
- The net weight of hot peppers per pack and the type of packaging materials used should be in line with the buyer's requirements.

3.4.3 Labelling (follow national or international standards)

- The following information is typically required to be included on the packaging:
 - Name of the product
 - Country of origin
 - Location
 - Year of production/harvesting
 - Name and address of producer, wholesaler (exporter)
 - Description of the product e.g., grade, variety
 - Net weight

3.5 Storage and transportation

3.5.1 On-farm and warehouse storage

- Store bags off the floor and on pallets at least 30 cm away from walls to prevent moisture build-up from condensation and to reduce the chance of moisture entering through walls.
- Internal walls, floor surfaces, and the junctions between the floor and walls and between two walls, should be constructed with smooth, waterproof, non-absorbent, washable and non-toxic materials.
- Control insect and rodent activity and maintain appropriate moisture levels and temperature in the storage room.
- Storage facilities should be dry, well-vented structures that provide protection from rain, surface water drainage, entry of rodents and birds, and temperature fluctuations.
- Disinfect storage facilities using appropriate substances which do not cause off-odours, flavours or contaminate the crop. The use of registered fumigants or insecticides within permissible limits may be beneficial.
- Relative humidity in storage conditions should be controlled e.g., maintained below 75%.
- Store the dried hot peppers at a moisture content below 10%.
- Dried hot peppers should not be stored with other food commodities (such as fruits or vegetables) or non-food products (such as kerosene or lubricating oils).
- Document all storage procedures implemented each season including notes on key measurements (e.g., temperature, moisture content, and humidity) and record any deviations or changes from recommended practices.

3.5.2 Transportation

- **Preparation for transportation:**
 - Containers and transport vehicles (e.g., wagons, trucks) should be clean, dry and free from crop residues, old plant material, dust, insects and visible fungal growth before use or re-use.
 - Trucks and containers should provide adequate ventilation and minimise condensation, whilst ensuring protection from rain.
 - Prevent re-entry of water or moisture into the hot peppers and protect them from pests and debris.
 - Inspect trucks regularly for rips in the covers or leaks in the undersides that could allow road water to enter.
 - Trucks must be clean, dry and odour-free, to prevent cross contamination from previously transported products.
 - Place bags on pallets to avoid contact with the floor where condensation from ceilings or walls may gather.
 - Maintain ample space between bags and the roof and sides of the containers to maximise airflow between and around the bags.
- **Loading and unloading:**
 - Protect the dried hot peppers from moisture re-entry, rain, pests, rodents, dust, and other contaminants during loading and unloading to and from the warehouse.

4 Good Manufacturing Practices (GMPs)

Summary

This chapter is intended:

- To implement quality systems and risk management approaches to ensure the production of safe and high-quality hot peppers
- To describe procedures and quality assurance measures that comply with GMP standards for safe and quality hot pepper production
- To address the design and construction of hot pepper manufacturing plants, maintenance of plant equipment, good personal hygiene practices, sanitation of plant equipment and facilities, and relevant staff training
- To define requirements that support technological advancements and innovations in the manufacturing process to improve the quality and safety of hot pepper products.
- Sorting during harvesting and drying
- Grading, packaging and labeling
- Storage practices - on farm and warehouse

4.1 Process flow

4.1.1 Powder, essential oil and oleoresin extraction

- The pepper and spices intended for grinding must be inspected to ensure they are free from dust, impurities, mould, and immature peppers.
- The salt used should comply with the national edible salt standards (CES70).

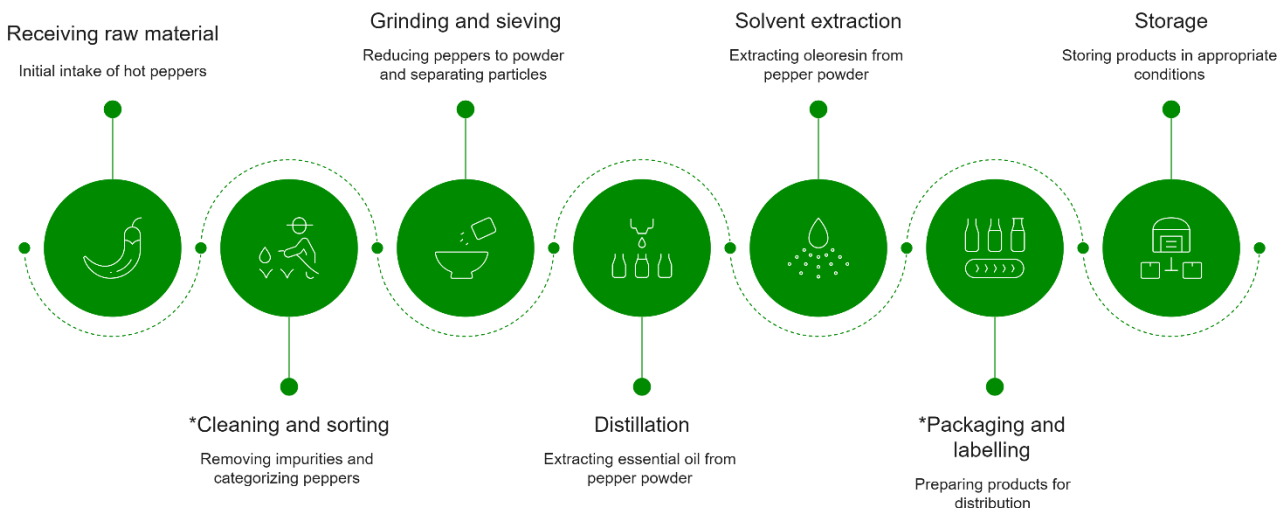


Figure 6 Flow diagram for processing hot pepper into powder, essential oil, and oleoresin

Note that: Processing steps marked with an asterisk (*) are critical control points (CCPs), which should be properly managed to prevent mycotoxin contamination, especially in pepper powder production.

4.2 Establishment

4.2.1 Location

- Buildings should be located, designed, constructed, adapted and maintained to suit the operations carried out within them and to protect materials and products from contamination or deterioration.
- The area should be free from objectionable odours, smoke, dust and pollutants, should not be prone to flooding, and should have suitable access via road, rail or other means of transportation.

4.2.2 Infrastructures

- Pepper processing establishments should have adequate and suitable roads for motorised traffic, as well as reliable water supply and electric power.
- Proper drainage systems should be in place to prevent flooding, and provisions made to facilitate regular cleaning.

4.2.3 Buildings and Facilities

- Buildings and facilities should be constructed from suitable materials and follow sound construction practices (refer to the country's standards for specific details).
- Regular inspections of buildings and facilities should be conducted to identify defects and ensure timely repairs.
- Facility design should permit easy and thorough cleaning and facilitate proper supervision of hygiene and sanitation activities.
- Buildings and facilities should be designed to prevent pest entry and harbouring, and to facilitate fumigation when necessary.
- Buildings and facilities should be designed to provide effective separation, by partition, location or other means, between operations that may cause cross contamination.
- Buildings and facilities should be designed to facilitate a logical flow of processing and handling operations, ensuring hygienic practices throughout.

Floors and Walls

- Floors and walls, where appropriate, should be made of concrete, or non-slip tiles without crevices, and should be easy to clean and disinfect. Floors should slope sufficiently for liquids to drain toward trapped outlets. Walls should be painted in light colours.
- Cracks and crevices in the premises, including equipment, should be eliminated whenever possible, or permanently sealed.

Ceilings

- Ceilings of buildings where pepper and other similar spices are processed and stored should be easy to clean and there should not be any leakage or dampness caused by waterlogging on roof tops.

Windows and other openings

- Windows and other openings should be fitted with insect-proof screens that are easy to clean.

Doors

- Doors should be of the close-fitting type.

4.2.4 Water Supply

- Clean, piped water free from contamination should be available in buildings where peppers are handled or processed. There should be no cross contamination between potable and non-potable water sources.

- As a general principle, only potable water, which complies with the Ethiopian national standard (CES 58) for drinking water, should be used in food handling.
- Non-potable water may be used for steam production, refrigeration, fire control and other purposes not connected with food preparation, provided it is approved by the relevant official regulatory agency.
- Water re-circulated for re-use within an establishment should be properly treated and safe to ensure that no health hazards arise from its use.

4.3 Training

- Each new employee should receive training upon employment. This training should be repeated, modified or extended as required.
- It is important to provide refresher training on GMP, and on personal hygiene in particular, whenever poor hygiene practices are identified.
- Appropriate GMP and personal hygiene training should also be given to employees who may come into contact with manufacturing areas or activities, e.g., office, maintenance and cleaning personnel.
- Persons responsible for training red pepper handlers and conducting internal and external GMP audits should be trained to a nationally recognised standard, where applicable.

4.4 Personal hygiene

- Hands should be washed thoroughly after using the toilet, after handling contaminated material and whenever necessary. Notices requiring hand washing should be prominently displayed and hand-washing facilities should be easily accessible.
- Personnel should keep clean all parts of their person, clothing or overclothing likely to come into contact with the product.
- Personnel with any open cuts or abrasions on exposed parts of their body should not handle open products. If permitted to continue working in the manufacturing area, the wound must be covered with a plaster.
- Personnel should not spit, smoke, use snuff or chew gum in manufacturing areas, particularly in 'open product' areas. Food and drink must not be taken into or consumed in manufacturing areas.
- Personnel should avoid sneezing or coughing over raw materials, intermediate products or finished products.
- Personnel should wear clean, washable or disposable overclothing (including headgear and, where appropriate, neck-coverings and beard snoods).
- Persons confirmed to be suffering from, or carriers of, certain kinds of foodborne illnesses like salmonella or other diseases likely to pose a risk to consumers, must not be allowed in any manufacturing areas.

4.5 Changing facilities and toilets

- Suitably located and adequate changing facilities and toilets should be provided and properly maintained in all establishments.
- Hygienic hand washing and drying facilities should be provided adjacent to toilets.
- Notices should be prominently displayed directing personnel to remove factory garments before using the toilet, and to wash their hands afterward.

4.6 Hand-washing facilities in processing areas

- Adequate and conveniently located hand-washing facilities should be provided where required, and equipped with suitable soaps and/or disinfectants, as well as hand-drying equipment.

4.7 Medical examinations

- Personnel who come into contact with hot pepper in the course of their work should undergo periodical medical check-ups. Medical examinations of food handlers must also be conducted whenever clinically or epidemiologically necessary.
- Management should ensure that individuals suffering from communicable diseases are not permitted to work in pepper and other ingredient-handling areas.
- Any affected person should promptly report their condition to management, seek appropriate medical treatment and obtain sick leave.

4.8 Lighting

- Adequate natural or artificial lighting should be provided throughout the establishment, particularly in work areas and at inspection points.

4.9 Ventilation

- Adequate ventilation should be provided to permit free flow of clean air, to prevent excessive heat, steam condensation and dust, and to remove contaminated air.

4.10 Animal and pest control

- No animals should be allowed in the establishments.
- Infestation control should be overseen by trained personnel or a professional infestation control company hired for regular inspections, advice and treatments, if required.
- An effective and continuous animal and pest control program (for insects, rodents and birds) should be established and implemented.
- The establishment and its surrounding areas should be routinely inspected for signs of infestation to ensure effective pest control.
- Pesticides should only be used if other precautionary methods are found to be ineffective.
- Before applying pesticides, care should be taken to safeguard pepper, equipment and utensils from contamination.
- After any pesticide application, all equipment and utensils that may have been contaminated must be thoroughly cleaned prior to being used again.

4.11 Equipment and Utensils

4.11.1 Materials, Design, Construction & Installation

- All equipment and utensils used in food handling areas, and which may come into contact with food, should be made of food-grade materials such as stainless steel.
- Equipment should be so designed and constructed to prevent hygiene hazards and to allow for easy and thorough cleaning and disinfection.
- The design should allow for easy disassembly to facilitate thorough wet cleaning.

4.11.2 Cleaning and disinfection

- Adequate facilities should be provided for cleaning and disinfection of working equipment.
- A cleaning and disinfection schedule should be established to ensure that all areas of the facility are thoroughly cleaned and dried, with special attention to critical areas such as equipment and materials.
- The air handling system (if present) should be included in the cleaning and disinfection schedule.
- The cleaning and disinfection schedule should describe whether to use wet cleaning or dry-cleaning methods.
- Water presence in dry processing areas may result from improper use of clean water during cleaning.

4.11.3 Maintenance

- Buildings, equipment, utensils and all other physical facilities of the establishment, including drains, should be maintained in a safe, hygienic and fully operational condition.
- If a roof leak introduces water into the dry production or packaging environment, production should be halted. The leak should be fixed, and the affected area cleaned, disinfected, and dried, before production can resume.

4.12 Production/Manufacturing

- Before starting any manufacturing operation, ensure that the work area and equipment are clean and free from any leftover materials, packaging materials, products, product residues or any documents not required for the current operation.
- Production staff should follow the defined and authorized procedures for each stage of the manufacturing process.
- All personnel should be encouraged to immediately report any incidents or potential incidents of contamination involving raw materials, intermediate products or finished products.
- Details of all operations must be accurately recorded in the Lot Manufacturing Record or Lot Packaging Record.

4.12.1 Raw materials/ingredients

- Raw materials (various spices, salts, peppers) should not be accepted by the establishment if they are found to contain physical, biological or chemical contaminants that cannot be reduced to acceptable levels through cleaning or processing.
- Laboratory test results for each raw material should be provided by the supplier or attached when supplied or purchased.
- If raw materials are procured from an unapproved supplier, the manufacturer must conduct the necessary safety and quality tests. The test results must fall within acceptable limits and be properly documented.
- Raw materials should be inspected and sorted prior to processing and, where necessary, laboratory tests should be conducted.
- This inspection may include:
 - ✓ Visual inspection for foreign matter, mould and insect infestation.
 - ✓ Sensory evaluation involving smell, appearance and feel, and where appropriate, taste.
 - ✓ Testing for microbiological or mycotoxin contamination by a qualified laboratory, as necessary.

Delivery of raw materials

- Each delivery lot should be assigned a reference code to enable its identification throughout storage and processing.

- The documentation should allow full traceability, so that any lot of finished products can be linked back to the corresponding raw material deliveries used in its manufacture and to the associated laboratory records.
- All deliveries should be stored and clearly marked to ensure their identity is maintained throughout handling and use.

Raw material storage

- Raw materials kept in the storage should be maintained under appropriate temperature and humidity conditions to protect them from contamination and infestation, and to minimise quality deterioration.
- Products that could negatively affect the shelf life, quality or flavour of spices must not be stored in the same room or compartment as the spices.
- Sensitive spices that may be affected by contact or proximity to other spices should be stored separately.

4.12.2 Packaging materials

- Each packaging material and label must comply with the established specifications to ensure that:
 - The packaging material is of food-grade standard.
 - The packaging provides adequate protection to maintain the chemical and physical stability of the product throughout its declared shelf life under the recommended conditions for storage and use.
 - In instances where packaging is in direct contact with the product, there must be no significant adverse interaction between product and packaging material.

4.12.3 Storage of packaging materials

- All packaging materials should be stored under hygienic conditions.
- Stocks of packaging materials should be inspected regularly to ensure they remain in acceptable condition.
- Packaging materials should also be inspected immediately prior to use.

4.12.4 Processing

- Care should be taken in the production layout and practices, to prevent cross-contamination between products.
- Multiple packaging lines should be properly segregated to avoid the risk of cross-contamination.
- Before production begins, checks should be carried out to ensure that:
 - ✓ The product name and appropriate reference are clearly displayed at each production line.
 - ✓ The production area is clean and free from unrelated products, product residues, waste material, raw materials, packaging materials, or documents that are not relevant to the production to be undertaken.
 - ✓ The correct materials and documentation have been issued.
 - ✓ The machine settings have been correctly configured.
 - ✓ All plant and equipment are clean and ready for use.
- Process conditions should be closely monitored and controlled using suitable methods such as sensory, instrumental and laboratory testing, and on-line checks for correct packaging and datemarking.
- All instruments used for monitoring processes (e.g. thermometers, temperature gauges, pressure gauges) should undergo regular and documented accuracy checks.
- Production premises and equipment must be effectively cleaned.
- All personnel and visitors entering the production area must comply with personal hygiene protocols.

4.12.5 Finished products

- The label on the packaging of finished hot pepper products shall comply with CES 73 requirements.
- Packed finished products should be quarantined until checked and approved by Quality Control for compliance with the relevant Finished Product Specification.
- Finished products must be reconciled, approved and signed off by an authorised person prior to being released for sale.
- Samples from each lot of finished products should be retained for at least the shelf life of the product.

Storage of finished products

- Effective storage operations should be designed to ensure:
 - ✓ All products are easily accessible for load assembly as required.
 - ✓ Proper stock rotation FIFO (first in, first out) and FEFO (first expired, first out).
- Storage and transportation of finished products should be carried out under conditions that:
 - ✓ Prevent contamination, including the development of pathogenic or toxigenic micro-organisms.
 - ✓ Protect against undesirable deterioration of both the product and its container.
 - ✓ Ensure the delivery of safe, clean and wholesome products to consumers.
- Storage area temperatures should be kept at appropriate levels to maintain the wholesomeness of the products received and stored in these areas.
- The humidity levels in the warehouse should also be controlled.
- Finished products should be stored in designated areas under appropriate storage conditions and for the required duration.
- Finished products should be stored on pallets, racks and other storage infrastructure with periodic visual checks.
- Quarantined or rejected finished products should be stored in designated areas.

Transporting finished products

- Vehicles used to transport pepper should be clean and well protected to ensure that the products are not exposed to weather conditions.
- Pepper products should be transported under conditions that maintain the integrity of the packaging and the product within it.
- Containers should be inspected prior to loading to ensure they are clean and free from insects, pests, harmful organisms, and residues that could affect the quality of the pepper and other similar spice products.

4.12.6 Storage and handling of by-products

- By-products of processing that are not classified as waste and may have future use should be stored and handled separately to avoid contamination of pepper products.
- By-products should be removed from the work area daily, or more frequently when necessary.

4.12.7 Storage and handling of hazardous substances

- Hazardous substances (e.g., chemicals and reagents) must be kept in suitable containers, clearly labelled and stored in locked rooms or cabinets used only for that purpose.
- They should be dispensed and handled only by authorised, properly trained personnel, or by individuals under the strict supervision of trained personnel.
- Extreme care should be taken to avoid contamination.

4.12.8 Quality Control

- In addition to any regulatory controls, it is advisable for the establishment to monitor product quality at all stages through its on-site laboratory. This control should help monitor the quality

and safety of finished products and reject any pepper or other raw materials unfit for human consumption.

- When tested in accordance with standard methods, the products should comply with the relevant physical, chemical and microbiological standards for contaminants set by national and international authorities.

4.12.9 Waste Management

- Pepper processing establishments should have an efficient and well-maintained effluent and waste disposal system.
- Effective waste management strategies are crucial for capsicum pepper processing industries to minimise environmental impact and promote sustainability.
- Waste management should be based on the following principles:
 - Prevention or minimisation of waste
 - Reuse of materials wherever feasible
 - Waste recycling when possible
 - Controlled waste disposal to protect health and the environment.
- For the storage, transportation, and disposal of hazardous waste, it is important to follow local regulations and guidelines.
- It is important to have a waste disposal agreement with licensed waste management companies to ensure safe and compliant handling of hazardous waste.
- Wastes should be segregated into different categories such as organic waste, packaging materials, and hazardous waste. This ensures easier handling and appropriate treatment of each waste stream.

5 Communication, training and awareness creation

- Tailored training and awareness programs on the hot pepper value chain should focus on enhancing overall efficiency, quality, safety and competitiveness of hot pepper products.
- Farm workers/employees, government staff, farmers, consumers, merchants, brokers, exporters, and other value chain actors should be properly trained to improve their knowledge and skills in the safe and approved handling of produce.
- Responsible stakeholders and supply chain actors should establish a consistent communication platform to share information and discuss areas for improvement to ensure the quality and safety of hot peppers.
- All hot pepper value chain actors and stakeholders should work together to design effective communication strategies and mechanisms for training and raising awareness.

Some key considerations:

- Clearly identify the target audience such as consumers, producers, traders, processors, transporters and experts at different levels.
- Conduct a needs assessment to understand the current behaviour of the target audience.
- Formulate the goals and objectives for the communication efforts.
- Develop concise, regular and appropriate communication materials and messages.
- Identify accessible communication channels for the audience, such as mass media i.e., television, radio, newspapers, magazines, telephone, outdoor and transit advertising, direct mail, websites, posters etc.
- Implement regular monitoring and evaluation of the communication approach.

6 Traceability system

The traceability system (tracking and tracing) refers to the ability to access information about a product at any stage of production, processing and distribution, through a system of recorded identifications. Table 1 outlines recommended data requirements for a paper-based traceability system. [JF11]

6.1 Key considerations for traceability

- All value chain actors are expected to maintain records that facilitate timely and accurate traceability.
- Personnel should be trained, dedicated and honest when recording data.
- Suppliers or distribution centres should mark cases with human-readable data.
- The traceability system should be audited on a periodic schedule to address any deviations or non-conformances throughout the supply chain.
- The highlights of traceability systems for whole pepper and processed pepper powder are provided in Annex 2.

Table 1 Paper-based traceability system (based on GAP and GMP) at different stages

Types of Actors / Location	Recommended data requirements
At farm level	<ul style="list-style-type: none"> ✓ Production season: ✓ Name of the product (Hot Pepper): ✓ Type of product/varieties: ✓ Site location/GPS: ✓ Name of farm/association of farms: ✓ Source of seed: ✓ Date of sowing: ✓ Type, rate and time of pesticide use: ✓ Type, rate and time of fertiliser use: ✓ Date of planting/transplanting: ✓ Date of harvest: ✓ Date and type of cleaning, sorting, drying, bagging & storage: ✓ Date of shipment: ✓ Crop rotation (history of land use): ✓ Quantity: ✓ Source/location: ✓ Name of the product/material: ✓ Date and time of receipt: ✓ Date of re-packing/re-sorting: ✓ Year of production:
Cleaning stations / Packing house / Storage	<ul style="list-style-type: none"> ✓ Name and location of store: ✓ Type of storage facility: ✓ Certificate of compliance (tag/batch number): ✓ Net weight of bag: ✓ Number of bags per container: ✓ Date of shipment: ✓ Any other information deemed appropriate by the competent authority:
Transporter	<ul style="list-style-type: none"> ✓ Name of the product: ✓ Supplier name and address: ✓ Mode of transportation: ✓ Conditions of transport (clean vehicles, container, pre-history of loaded materials, pest infestation and other materials): ✓ Date and time of transportation: ✓ Transporter information (name and contact details):

Traders (Local and Exporter)

- ✓ Supplier Batch No.:
 - ✓ Name of the product:
 - ✓ Distributor/Trader name:
 - ✓ Country of origin:
 - ✓ Date of receipt of product:
 - ✓ Date of re-packing/re-sorting:
 - ✓ List and amount of ingredients:
 - ✓ Date and place of processing:
 - ✓ Packaging material used:
 - ✓ Date of Expiry/Best before date:
 - ✓ Certificate of compliance:
 - ✓ Date of shipment:
 - ✓ Net weight of packaging:
 - ✓ Contact person's name and contact details:
 - ✓ Destination:
 - ✓ Date of departure:
 - ✓ Any other information deemed appropriate by the competent authority:
-

7 Certification

Certification ensures that the product complies with quality, safety, performance, environmental, or other defined criteria set by a recognised entity.

7.1 Certification of the service

- To obtain permission for pepper processing, companies must ensure compliance with local food safety laws and regulations.
- The process of obtaining a safety and quality certificate for hot pepper involves applying for and undergoing a certification process.
- Companies that wish to go beyond the basic regulatory requirements can obtain certification through a voluntary food safety program.
 - QMS, GAP, GHP, GMP, HACCP, Organic, Non-GMO, FSMS (ISO 22000), GLOBAL GAP, BRC, Plant-Based, and Fair-Trade certifications are the main company-based certificates that provide consumers with confidence that the plant product they are consuming is safe and of high quality.

For information on Global GAP certification, refer to the link below.
(<https://www.globalgap.org/producers/>) [JF12]

7.2 Certification of the product

Key aspects of product certification include:

- 1) **Evaluation:** Testing and assessing the hot pepper product against relevant standards or requirements.
 - 2) **Verification:** Conducting audits or inspections to ensure the hot pepper product consistently meets these standards.
 - 3) **Certification mark:** Issuing a certificate or label (such as a national standard mark, or ISO certification) to indicate the product's compliance.
 - 4) **Continuous monitoring:** Regular checks to confirm ongoing compliance with the standards.
- For the safety and quality of hot pepper products, the following product-based certifications should be issued for the consignment:
 - Phytosanitary certificate or Health certificate
 - Organic Certification
 - Non-GMO certificate
 - Fumigation certificate

7.3 Safety and quality control

- The appropriate regulatory body should oversee the safety and quality of hot pepper in accordance with national standards set for the product and international market requirements.
- In-house testing and control procedures can be used, provided that proper validation and verification procedures are maintained.
- Regular monitoring and inspection of both the system and the product are crucial.
- Plant products that do not meet safety standards should be rejected and not used.
- For further regulatory and control systems, use the Ethiopian standards quality parameters.

8 Marketing

Good management practices (GMPs) involve specific practices that farmers can implement to ensure successful marketing of their hot pepper crops. These practices aim to improve market access, increase product value, and maintain the quality and safety of hot peppers. Actors in the Ethiopian hot pepper marketing value chain include collectors/assemblers, brokers, primary cooperatives and their unions, wholesalers, retailers, processors, exporters, commercial farms and small-scale farmers. Each of these value chain actors plays a role in ensuring that hot pepper products meet quality standards and comply with food safety regulations.

Key good agricultural practices (GAPs) and good manufacturing practices (GMPs) for hot pepper marketing are:

- **Grading and sorting:** Sort hot peppers based on their colour, pungency, shape, size, and purity. Consistently graded hot peppers fetch better prices in the market.
- **Product differentiation:** Differentiate hot peppers by highlighting unique qualities, such as organic certification, geographical indications, or specific production methods. This can help create a competitive advantage and attract niche markets.
- **Packaging and labelling:** Use clean and appropriate packaging and labelling that adheres to the required standards.
- **Branding:** Create a compelling brand story for Ethiopian hot peppers that communicates a unique selling proposition and distinguishes the product from competitors e.g., Mareko, Halaba, Tedele, Gojeb, Gojam (Bure), Gondar (Denbya).
- **Value addition:** Explore opportunities to add value to hot peppers through processing, packaging, or product diversification. This can increase product shelf life, create new market opportunities, and command higher prices.
- **Efficient supply chain management:** Optimise the supply chain to reduce post-harvest losses, minimise transportation costs, and ensure timely delivery to the market.
- **Market linkages and contract farming:** Establish strong partnerships or contracts with value chain actors to secure reliable and diversified market outlets and negotiate fair prices for hot peppers. Farmers can benefit from assured markets, technical support, access to inputs, and a stable source of income. At the same time, buyers can ensure a consistent supply of high-quality hot peppers that meet their specific requirements.
- **Market promotion and communication:** Implement effective marketing and communication strategies to reach target customers and promote the Ethiopian Hot Pepper brand.
- **Compliance with quality and safety standards:** Adhering to local and international quality and safety standards ensures consumer confidence and facilitates access to premium markets.
- **Collective marketing and market information:** Collective marketing of hot peppers can shorten long marketing chains by bypassing intermediaries thereby increasing the prices farmers receive.
- **Traceability and Sustainability:** Highlight the traceability of Ethiopian hot peppers to showcase transparency and accountability throughout the supply chain.
- **Continuous improvement:** Regularly evaluate and adapt marketing strategies based on market feedback and changing consumer preferences.

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Annex 1. Terms and operational definitions

Category	Details for Pepper	Details for Pepper Powder
Product Type	Whole pepper	Processed pepper (ground/powdered)
Source or Origin	Identifies the farm, geographic location, and cultivation practices	Tracks farm of origin and processing unit where grinding occurs
Supply Chain Stage	Farming → Harvesting → Storage → Packaging → Distribution → Retail	Farming → Harvesting → Processing/Grinding → Storage → Packaging → Distribution → Retail
Key Traceability Data	<ul style="list-style-type: none">- Farm ID- Packaging house- Harvest date- Storage facility ID- Transport details	<ul style="list-style-type: none">- Farm ID/Batch number- Production line ID- Processing date- Packaging details
Importance	Ensures quality, prevents adulteration, and verifies origin.	Ensures food safety, controls contamination risks, and verifies authenticity.



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Ethiopia's transformational agenda.
