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TRAINING MATERIAL

Chili POSTHARVEST LOSSES REDUCTION

PILOT ACTIVITIES
OF
REDUCTION OF POSTHARVEST LOSSES (PHL)
CASE OF INDONESIA: Red Curly Chili

PT AGRO INDO MANDIRI

Acknowledgement

This training material was produced by Indonesian Center for Agricultural Postharvest Research and Development (ICAPRD) and PT Agro Indo Mandiri (AIM) through ASEAN Cooperation Project funded by JAIF, Japan and handled by Agency for Agricultural Research and development (IAARD) and Center of System (CS)

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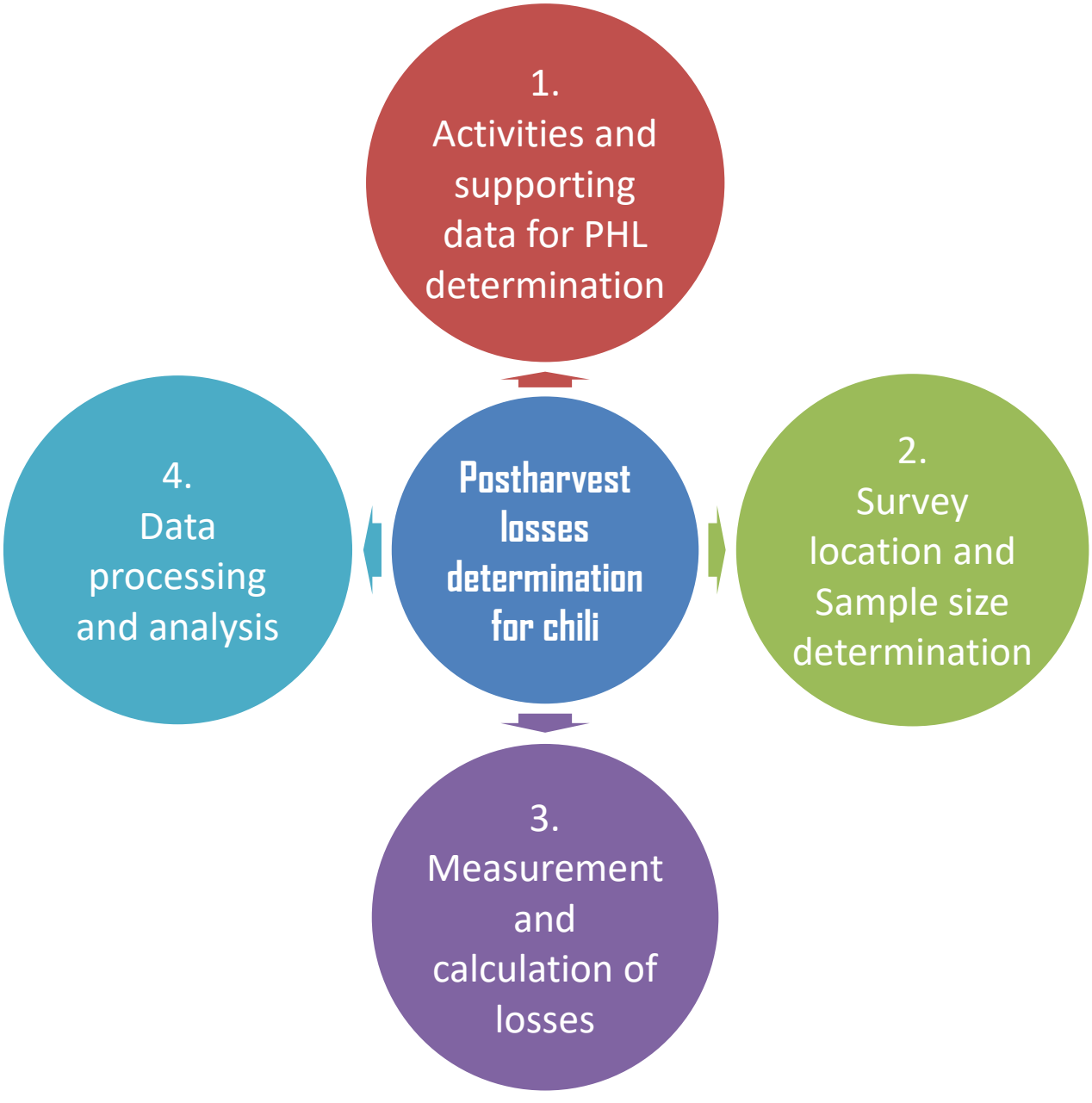
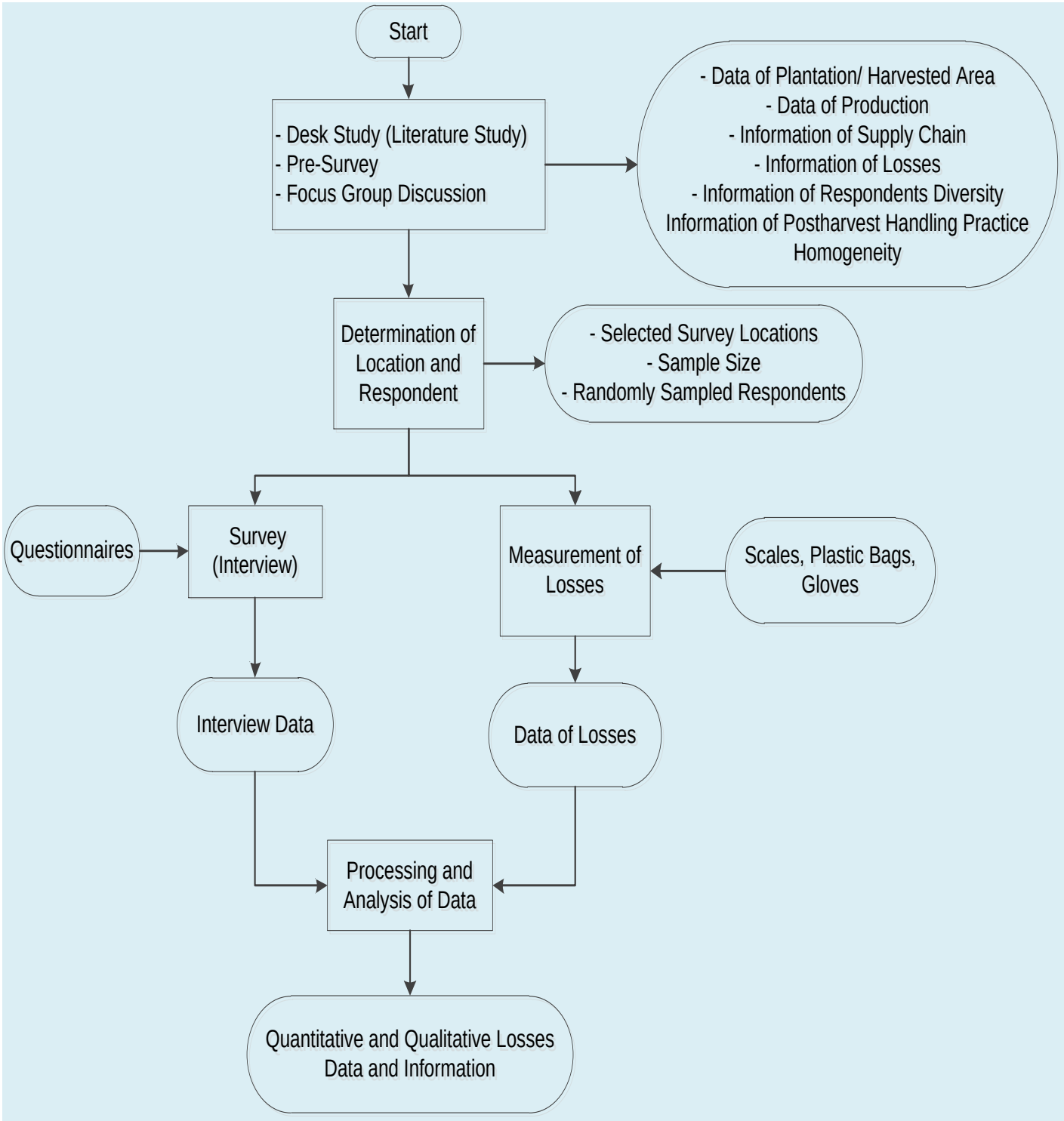

1.
Activities and supporting data for PHL determination
2.
Survey location and Sample size determination
3.
Measurement and calculation of losses
4.
Data processing and analysis
Postharvest losses determination for chili

Activities and Supporting Data for PHL Determination



DESK STUDY & FOCUS GROUP DISCUSSION

- To obtain data of plantation/harvested area and chili production, supply chain and losses
- The data obtained are to be confirmed by conducting pre-survey in the target location
- Identification of behavior of supply chain actors as the basis to determine distribution and diversity of respondents of survey

- Data obtained in desk study are further confirmed in Focus Group Discussion (FGD)
- FGD aims to capture should include actors of supply chain, experts, government, chili business practitioners

Example. Table of Data Obtained in FGD

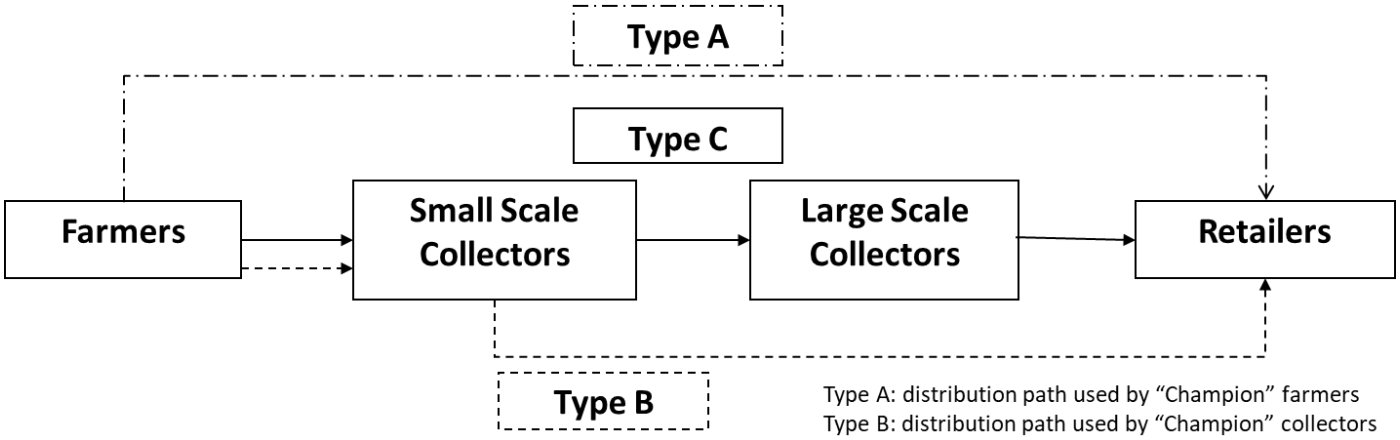
Supply Chain Actors and Postharvest Handling Practice in ….

Actors	Total number[a)]	Activity[b)]	Losses[c)]	Technology that use
1. Farmers				
2. Small scale collector	B	3 4 7	…% …% …%	Bycycle Plastic, sack ,etc
3. Large Scale collector				
4. Processing industries				
5. Retailer				
6. Supermarket				

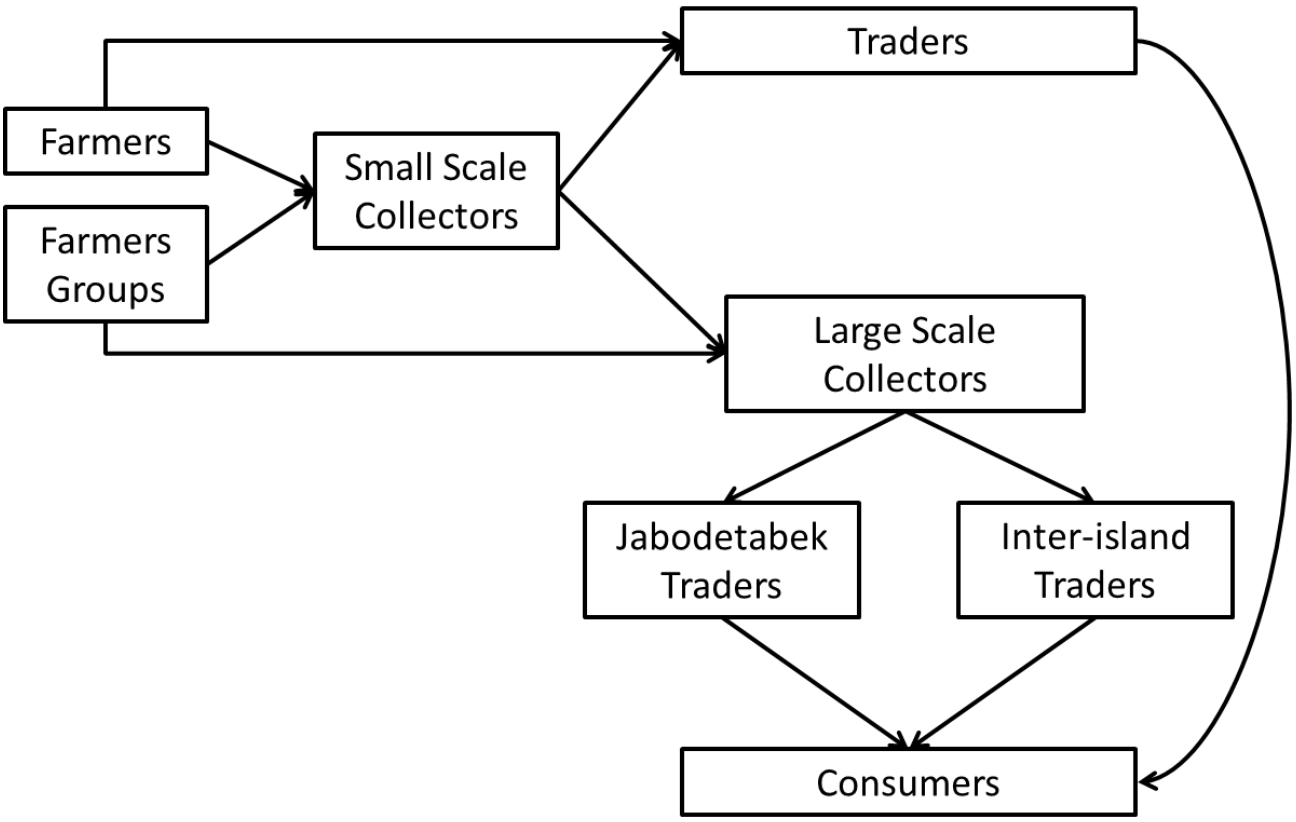
a) A=1 person; B=2-9 person, dan C=many>10 person (at area that discussed)

b) (1)= buy and sell;
(2)= transfer if goods;
(3) =transportation;
(4)= storage;
(5)= processing;
(6) =funding;
(7) =standardization;
(8) =financing

Example. Flowchart of Supply Chain Obtained in Desk Study and Pre-Survey



Example. Enhanced Flowchart of Supply Chain Obtained in Focus Group Discussion



FOCUS GROUP DISCUSSION

INTERVIEW

-Method: In-depth interview
-Tools: questionnaires
-Respondents: actors of chili supply chain (farmers, collectors, traders, retailers, etc)

Information target (farmers): Identity of respondents, types/varieties of chili, production volume, farming costs, postharvest activities, postharvest losses, causes of losses.

Information target (other actors of chili supply chain):
the identity of the respondent,
supply information (supplier, volume, purchase price),
handling activities,
market (marketing objectives, volume, selling price),
cause of losses and
required technology

SURVEY LOCATION AND SAMPLE SIZE DETERMINATION

1. Method of determining location/respondent

a. Determine 1-3 locations for survey and measurement of losses in the region/sub district, select the ones with the higher chili production.

b. Select the respondents with random sampling.

2. Behavior and number of respondents

a. Farmers

- ✓ Homogeneous : The number of respondents, 20-30 respondents
- ✓ Heterogeneous : Needed more respondents, (≥ 30 respondents)

b. Small scale collectors

The number of respondents is determine based on the number of small scale collectors in the area. Try to select those who collect in the surveyed area for farmers.

c. Large scale collectors

The number of respondents is determine based on the number of large scale collectors in the area. Try to select those who collect in the surveyed area for farmers.

If there is no large scale collector in the village, select a large scale collector in the village around the surveyed are for farmers.

d. Retailers

Respondents are retailers in the local market/Agribusiness Sub Terminal (STA) in each production center area. The number of respondents is all retailers in the local market/STA.

e. Trader in central market

Respondent is a trader in the central market where the chili from the surveyed area is distributed to. One or two respondents, preferably from different locations of central markets (different range of distance/transportation duration), would be sufficient.

MEASUREMENT AND CALCULATION OF LOSSES

QUANTITY LOSSES

Quantity losses is defined as the weight loss caused by storage time or transportation.

a) Weigh the harvested chili (subtract the weight of the packaging material), record as initial weight
b) Weigh the delivered chili in the end of supply chain (in this case is central market), record as end weight
c) Calculate the percentage of weight loss as follows:

$$\frac{\text{Initial weight - Final weight (kg)}}{\text{Initial weight (kg)}} x100\%$$

MEASUREMENT AND CALCULATION OF LOSSES

QUANTITY LOSSES

FARMER

a) From each packaging of harvested chili in the field, take samples from different spots in the packaging, at least 5 kg
b) Record weight
c) Sort to separate damaged/ decayed/green chili (use farmers' definition of unsaleable chili)
d) Record the weight of the damaged/decayed/green chili
e) Calculate the losses of each type of losses

SMALL & LARGE SCALE COLLECTOR, RETAILER, TRADER AT CENTRAL MARKET

a) Select randomly one sack of chili from the respondent (10-30 kg)
b) Sort to separate damaged/ decayed/green chili (use collectors/retailers/traders' definition of unsaleable chili)
c) Record the weight of the damaged/decayed/green chili
d) Calculate the losses of each type of losses

Percentage of quality losses =

$$\frac{\text{Weight of damage chili (kg)}}{\text{Total weight of chili sample}} x100\%$$

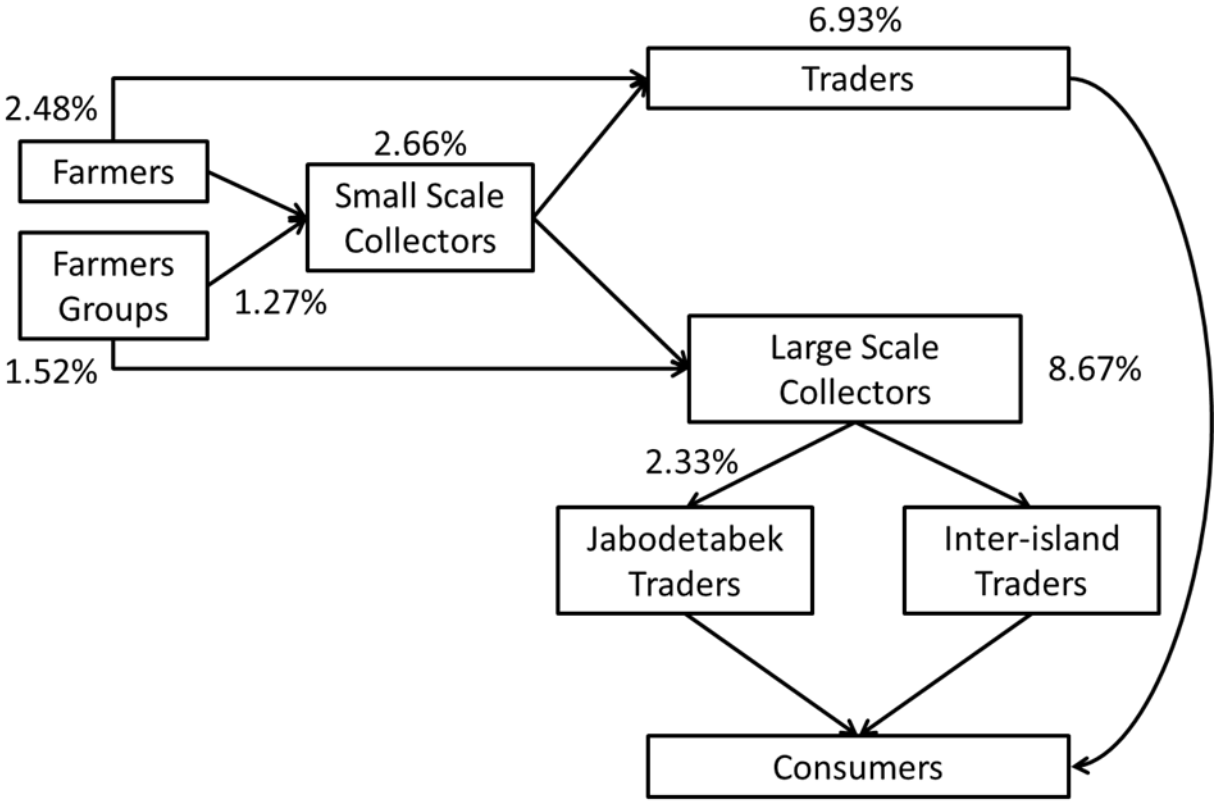
DATA PROCESSING AND ANALYSIS

1. Descriptive statistical analysis (chilli farming business data presented in tables and graphs)
   a) Compilation of all data survey / interview
   b) Analysis of compiled data with simple statistics (average, standard deviation, standard error and others) and present descriptively (tables, graphs, etc.)
2. Inferential statistical analysis: analysis of predicted middle values (average of losses and standard error (SE) of losses)
   a) Compilation of all data measurement results of losses (quantity and quality losses)
   b) Analysis of the compiled data by inferential statistics

$$\bar{x} - z_{\alpha/2}\frac{\sigma}{\sqrt{n}} < \mu < \bar{x} + z_{\alpha/2}\frac{\sigma}{\sqrt{n}} \quad \text{or} \quad \bar{x} - t_{\alpha/2(n-1)}\frac{s}{\sqrt{n}} < \mu < \bar{x} + t_{\alpha/2(n-1)}\frac{s}{\sqrt{n}}$$

EXAMPLE. DATA PRESENTATION OF POSTHARVEST LOSSES OF CHILI IN EACH POINT OF SUPPLY CHAIN

Points	Losses (%)	Standard Error
Farmers	2.19	0.67
- Individual farmers	2.48	0.76
- Farmers group	1.52	0.47
Transportation 1	1.27	
Small scale collectors	2.66	0.99
Large scale collectors	8.67	4.03
Retailers	6.93	2.98
Transportation 2	2.33	0.31



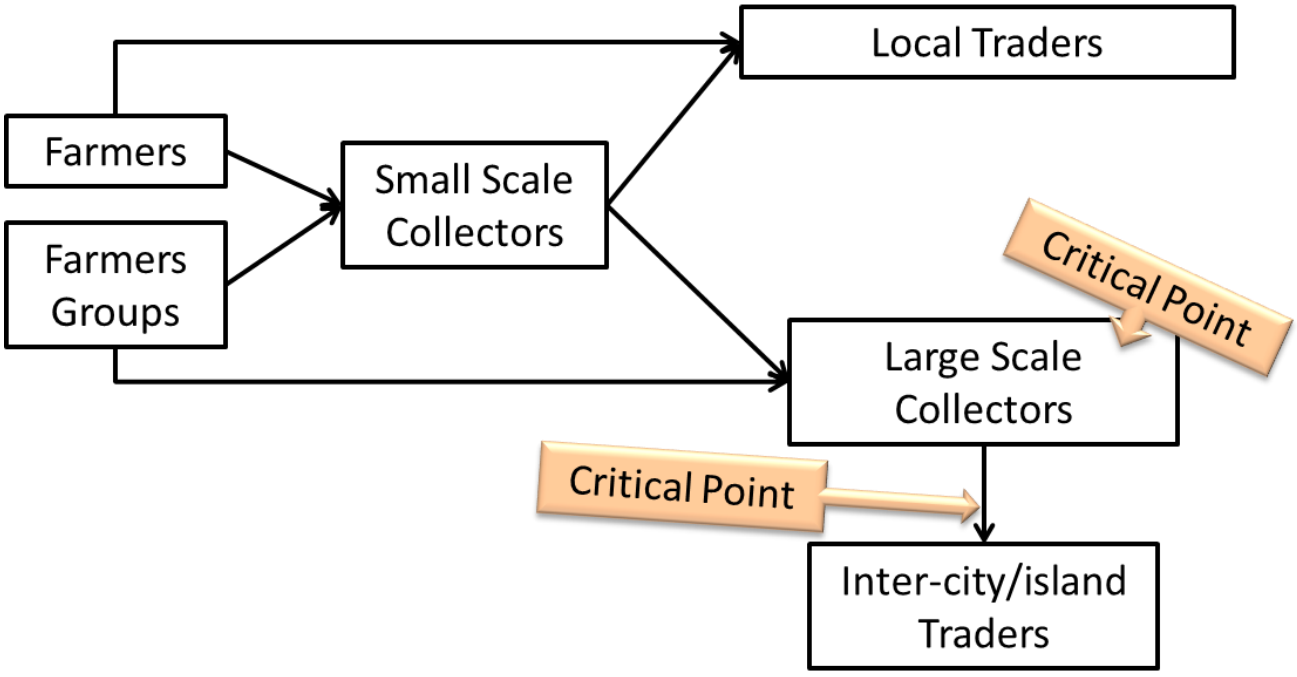

1.
Critical points in supply chain
Technology intervention for postharvest losses reduction of chili
2.
Supply chain simplification and technology intervention sites
3.
Existing Handling practice
4.
Technology intervention

Critical points of postharvest losses occurrence in supply chain may vary in different countries and different areas. However, it was found that **the longer and complicated a supply chain is, the higher PHL occurs**.

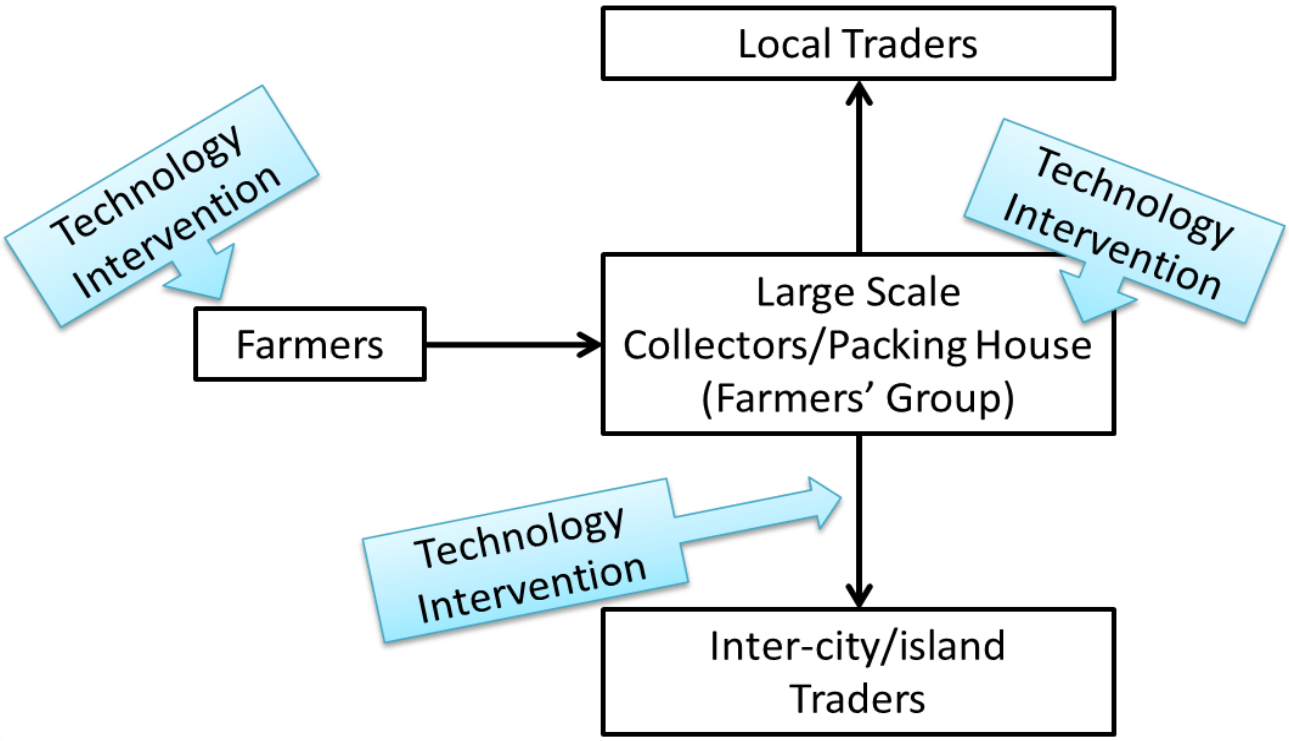
To determine critical points, see **Guidelines of Postharvest Losses Determination Standard**.

This Guideline was prepared based on the case of Red Curly Chili in Indonesia.

CRITICAL POINTS IN SUPPLY CHAIN



SUPPLY CHAIN SIMPLIFICATION AND TECHNOLOGY INTERVENTION SITES



EXISTING HANDLING PRACTICE

HARVEST

Harvest is carried out by farmers by choosing a reddish chilli without seeing the size both diameter and length. Sortation by separating the chili physically. Chili is stuffed in sacks randomly and overloaded, causing physical damage. Physical damage included broken, wounded, loose stalks and changes in shape.

chilli plantation

harvesting container: plastic basket/bamboo bag

Chilli put in sack

Chilli in used sack

Chili Harvesting Activities

Transportation from field to collector using motorcycle. More physical damage occurred, and physiological damage due to overheating

RETAIL

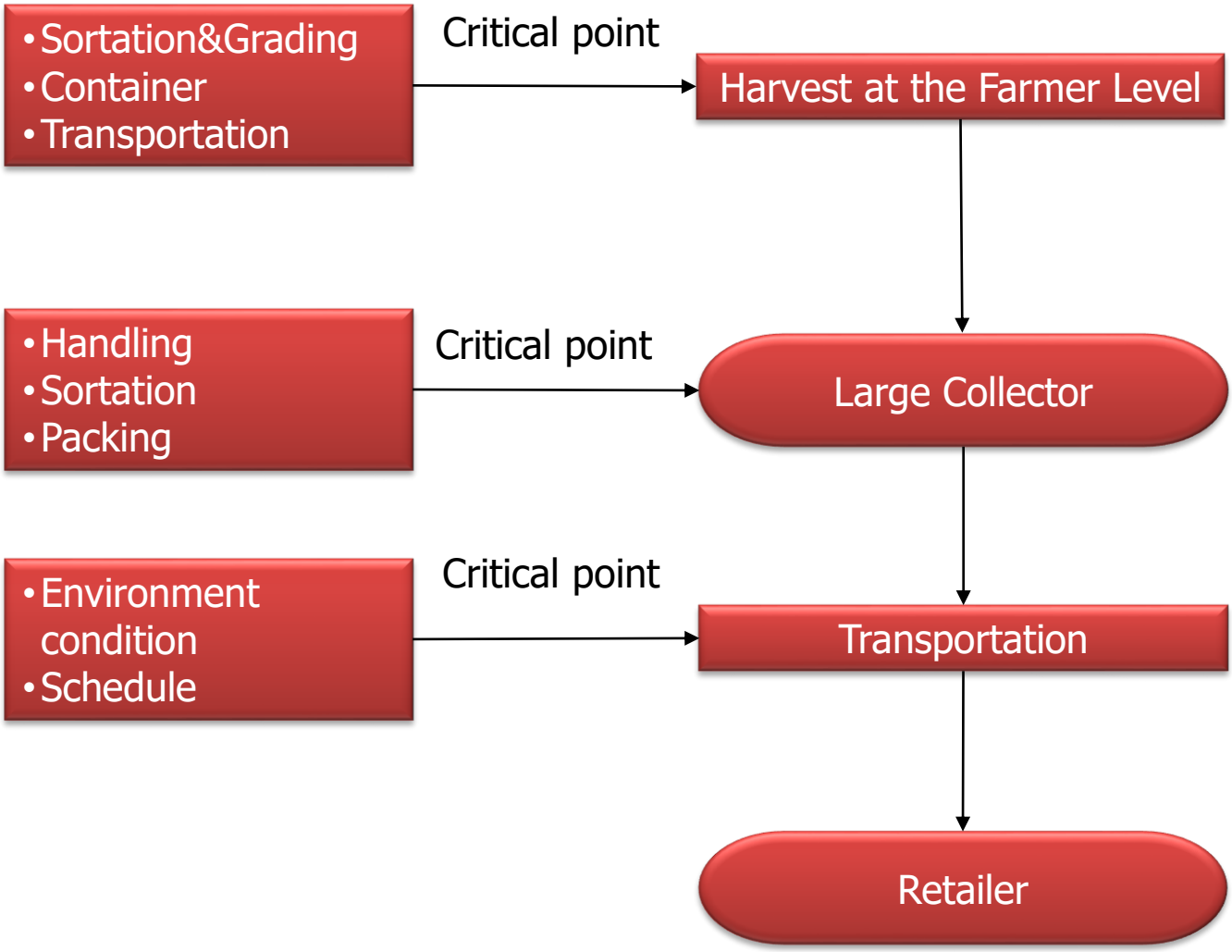
Large traders collect chili from farmers and farmer groups or small scale collectors in sacks. Activities undertaken were sorting, grading and packing.

Chili in used sack

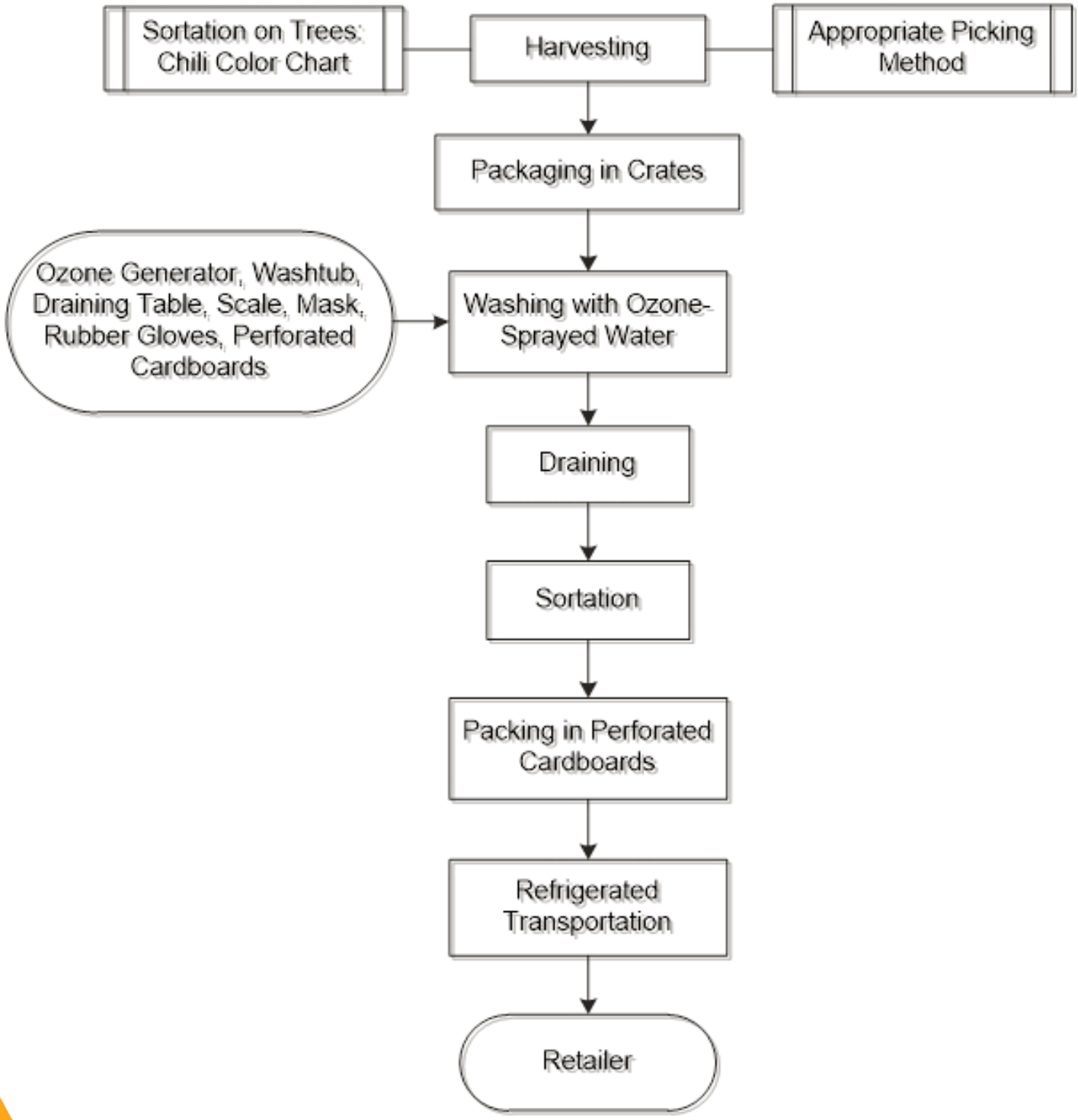
Sorting and grading chili

Chili in cardboard

Packing cardboard


•Sortation&Grading
•Container
•Transportation
Critical point
Harvest at the Farmer Level
•Handling
•Sortation
•Packing
Critical point
Large Collector
•Environment condition
•Schedule
Critical point
Transportation
Retailer

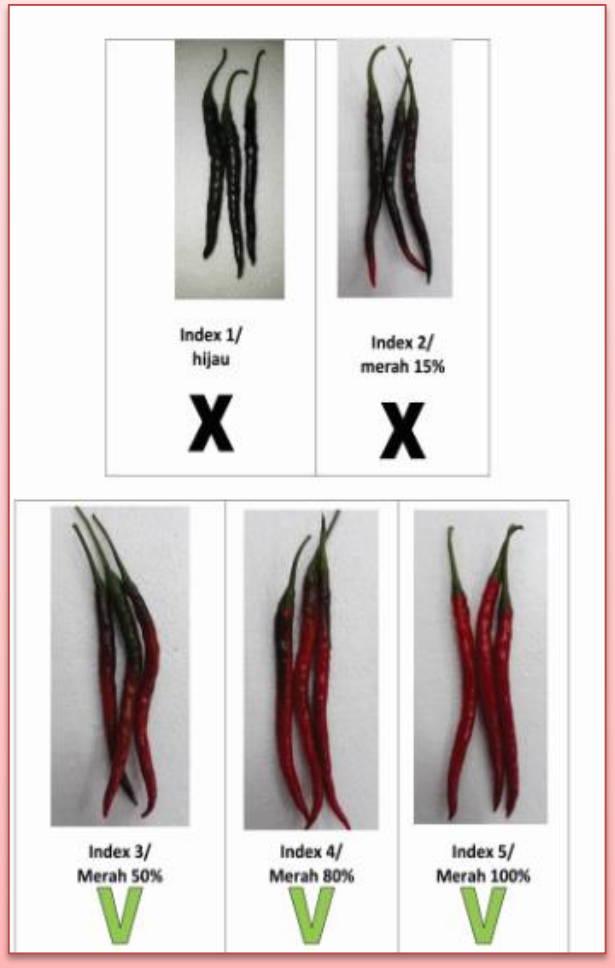
CHILI POSTHARVEST HANDLING TECHNOLOGY



HARVESTING

- Harvesting preferably in the morning. Harvesting during or just after rain is not recommended, as wet conditions favor microbial growth and enhance fruit breakdown.
- If chili must be harvested when the sun is up, the fruit should placed under shade to dissipate heat before it is packed.
- Chili to be harvested ripe, at least 50% red color should have developed (use chili color chart)

Leaves chili stalks, avoid causing wound by plucking the stalk off



Chili Color Chart

Distribution to Collector

Using crate

Plastic crates protect chili from physical damage due to their smooth surface, rigidity, and ease in handling

Transportation container (crates) and transportation vehicle

Pre-cooling

- ✓ Precooling can be employed to remove field heat
- ✓ Chili is spread over the floor that has been given a tarpaulin

POSTHARVEST HANDLING IN PACKING HOUSE

OZONE TREATMENT

Equipment: ozone generator, washing tank, draining tables/trays, scales, perforated cardboards

Personnel apparel: protective masks, rubber gloves

1. PREPARATION
   - Take off footwear before entering the treatment room
   - Fill 2/3 of the washing tank with clean water
   - Ensure operators are wearing rubber gloves and protective masks
   - Turn on the ozone generator for 1.5 hours
   - Set the adjust button to the number 75. The ozone concentration is about 3 ppm as measured by the ozone meter.
   - Weigh 20 kg of chili and put in crates

Ozone Generator
Press power and rotate to 75

Ozone flows to the wash basin
(± 1.5 hours)

2. WASHING CHILI WITH OZONE WATER

- Put the chili into the washing tank, soak for 15 minutes
- Ensure that all chilies are soaked perfectly and evenly

Chili in crates that are arranged
in the washing tank

Soak for 15 minutes

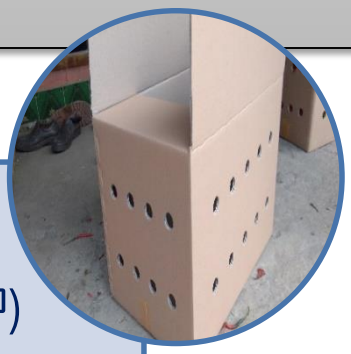
3. DRAINING

- Take chili out of washing tank and put on the draining tables/trays
- Do sortation while packing chili into perforated cardboards
- Transport chili by refrigerated and non-refrigerated vehicles

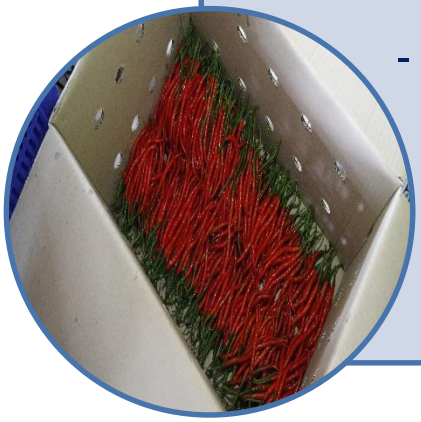
Sortation

Sortation is carried out to separate sunburn, mold infection, anthracnose disease (*pathek*) infection, rot, abnormal shape and broken chilies

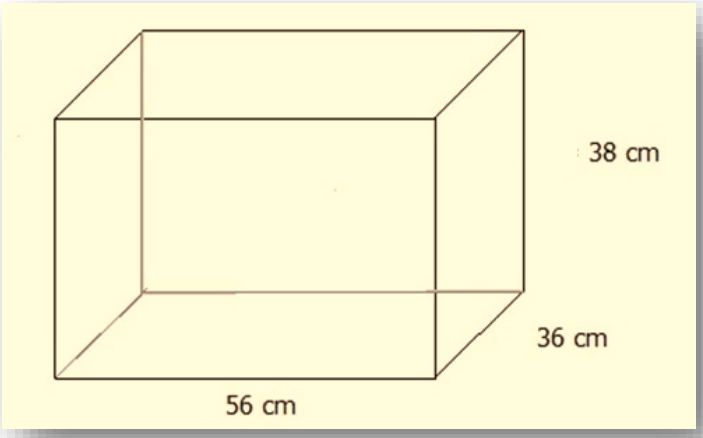
Packaging



- Application Modification Atmosphere Packaging (MAP) using perforated cardboard
- The use of perforated cardboard can maintain the freshness of chili and protect them from mechanical damage such as crack, splits, or puncture.



PERFORATION CALCULATION



Holes were put on four sides of the cardboards (front, back, right and left). Surface area for holes placement:

1). 2 x (length x height) = 2 x (56 x 38) cm^2 = 4.256 cm^2

2). 2 x (width x height) = 2 x (36 x 38) cm^2 = 2.736 cm^2

Total area of four sides cardboard = 6.992 cm^2

Perforation (circle-shaped holes) diameter (d) = 2.5 cm

Therefore, area of perforation holes:

= 3.14 x $(2.5/2)^2$ cm^2 = 4.91 cm^2

Perforation of chili pepper by 2.5% (Dondy et al., 2017), then:

2.5% x total area of the cardboard sides

= 2.5% x 6.992 cm^2 = 174.8 cm^2

Number of holes that need to be made on the four sides of the cardboard: 174.8 cm^2 : 4.91 cm^2 = 35.6 holes ≈ 36 holes

Perforation holes are made uniformly distributed on four dimensionally packed cardboard sides.

Transportation

Refrigerated car

The arrangement of cardboards in a refrigerated vehicle

- Cold chain application using refrigerated truck
- The temperature use is 12-15°C
- Combination of MAP and cold chain transportation can maintain the freshness of chili

Standard Operation Procedure

Handling Procedure	Existing Practice	Illustration	Improved Practice	Illustration
Harvest maturity	Ununiform		Uniform	
• Harvest in the morning, not during/after raining, pick with the stem attached, and pick one fruit at a time • Separate rotten/decayed/damaged fruit (only keep the fresh and healthy ones)				
Temporary Collecting	Used fertilizer plastic sacks		Crates	
• Avoid heat and rain in the field • Put cover on the ground, avoid harvested chili from touching the ground • Collecting near the harvesting location, easier to deliver				
Ozone treatment	Not done	-	Done	
• Turn on ozone generator for 60-90 minutes, let ozone sprayed into the water in washing tank • Soak chili in washing tank for 15 minutes • Drain on the draining tables				
Packaging	Non-refrigerated, stack according market tonnage	 	Refrigerated (controlled temperature), perforated cardboards, weighed 20-25 kg	

Recommendation of Chili Postharvest Handling

1. Simplification of supply chain
2. Facilitation and socialization of supply chain simplification by local government
3. Management of simplified supply chain by Farmers' Group
4. The utilization of Chili Color Chart and guidance by farmers during harvesting
5. Appropriate transportation from field to Packing House
6. The application of chili washing using ozone-sprayed water
7. The packaging of chili in perforated cardboards (6 mm thickness, 2.5% perforation)
8. Intercity transportation using refrigerated vehicle (12-15^{o}C).