POST-HARVEST OF AGRICULTURAL CROPS

AGH-441

BRIEF DESCRIPTION

- Limitations and scope of post-harvest of agricultural crop
- Criteria and harvesting techniques
- Drying and Cooling
- Cleaning, sorting and grading
- Grinding (size reduction) and minimal processing
- Packaging and Storage
- Post-Harvest Pests and Diseases
- Quality Management and Food Safety, Standards: SNI, ISO, Codex, Evaluation
- Post-harvest handling techniques in food crops: Cereals and Tubers
- Post-harvest handling techniques of horticultural crops: fruits, vegetables and flowers
- Post-harvest handling techniques of plantation commodities: aromatic plant, oils and sap.

REFERENCES


Course Contract

- Title of Course: Post-harvest of Agricultural Crops
- SKS: 3(2-1), Course: 14 x, Practicums: 12x
- Objective: After finishing this course, students will be able to explain the techniques of post harvest handling of agricultural crops
- Lecturer:
  - Crops: Sugiyanta, Heni Purnamawati
  - Horticulture: Bambang SP, Slamet Susanto, Dewi Sukma
  - Plantations: Ade Wachyar, Supijatno, Haryadi
  - Practicum: Juang Gema Kartika, Dewi Sukma, Heni Purnamawati, Supijatno, Adewachyar, Nandang Hasanudin, Sapti, Sefa, Irman
- Grade Proportion: Mid Test 40 %, Final Test:35 %, Practicum: 25 %
- The presence of course: full (permit case by case)
- The presence of practicum: full
LIMITATION OF POST-HARVEST

- Post-harvest: all activities from harvesting to be material which are ready to be consumed.
- Post-harvest primer: all activities from harvest to raw material which are ready to be stored, sold or processed further.
- Post-harvest secondary: all processing activities of agricultural product up into finished materials or ready to eat.

SCOPE OF POST-HARVEST

- DETERMINING HARVEST AND HARVEST
- CLEANING, sorting and grading
- MATERIAL HANDLING
- DRYING, COOLING
- MILLING (SIZE REDUCTION)
- PACKING AND STORAGE
- QUALITY MANAGEMENT

<table>
<thead>
<tr>
<th>Year</th>
<th>Harvestes Area (ha)</th>
<th>Productivity (ku/ha)</th>
<th>Production (ton)</th>
<th>Growth (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>11.488.034</td>
<td>45,38</td>
<td>52.137.604</td>
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<tr>
<td>2004</td>
<td>11.922.974</td>
<td>45,36</td>
<td>54.088.468</td>
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<tr>
<td>2005</td>
<td>11.839.060</td>
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<td>54.151.097</td>
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<td>2006</td>
<td>11.786.430</td>
<td>46,20</td>
<td>54.454.937</td>
<td>0,56</td>
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<tr>
<td>2007</td>
<td>11.757.845</td>
<td>46,89</td>
<td>55.127.430</td>
<td>1,23</td>
</tr>
</tbody>
</table>

Losses : 16 % : 8.820.389 ton

IMPORTANT REASON OF POST-HARVEST

- To maintain production both quantitative and qualitative
- To sustain agriculture product in both distance and time dimension because harvest crops usually seasonal and cultivated only in certain ecological.
- Post-harvest technology needed to match between the commodity with a machine tool so that can be operated efficiently.
- Agricultural wastes that can be utilized and provide value-added economy.
- Suppress loss of both quantity and quality
- Secondary post-harvest handling (processing technology) can make the material ready to be consumed, easily transported and more useful.
CRITERIA FOR HARVEST

- Agronomic yields are economically valuable crops.
- Cereals: seed
- Crops: tuber
- Vegetables: leaves, fruits, flowers, roots, stems
- Fruit: fruit
- Criteria for harvest: the weight or the maximum number and maximum quality
- Cereals: physiological ripe: when dry weight seeds are no longer increase.
- Rice: cooking milk, full of ripe, yellow cook, cook to death.
- Criteria for an optimum harvest: a minimum water content, maximum milled rice yield, head rice yield maximum.
- Criteria for the corn, when has emerged the black layer

THE DETERMINATION OF HARVEST AND HARVEST

OPTIMUM HARVEST TIME

MATURATION AND INDEX MATURITY

DEFINITION

Mature: growth and development has been perfect / complete (meaning from the dictionary); often synonymous with ripe

Stage where the commodity is guaranteed perfect ripe process in a timely

Stage where the commodity has reached a sufficient stage of development and post-harvest and post-harvest handling (including their ripening), the least minimally qualified consumers

Horticultural Maturity: the stage of development when the plants or plant parts fulfill the requirements for use by consumers for a particular purpose

MATURATION AND INDEX MATURITY (cont)

* The types of commodities may have a maturity of horticulture at every stage of development and may be more than one phase

The initial phase of development: germination, seedling
Mid-stage of development: flowers, fruit, roots, vegetative tissues
Final development stages: seed, nut

Corn: baby, baby corn
Cucumber: baby, mature
Zucchini: flowers, young fruit, ripe fruit

INDEX MATURITY

* there is a point in the development of commodity measured
* necessary techniques to measure the maturity
* measurements can be used to determine whether the sample of commodities has matured
**MATURATION AND INDEX MATURITY (cont)**

**Why maturity index important?**
- **Trade rules**: no minimum maturity requirements are acceptable; protection of consumers;
- **Marketing strategy**: the law of demand vs offer; early vs late
- **The use of resources and manpower efficiently**: an important tool for planning, energy harvesters, early & late harvest

**Characteristics of Maturity Index?**
- Simple: easy to use, not expensive / do not need expensive tools
- Objective (measurement) vs. subjective (evaluation)
- Consistently associated with the quality and shelf life of commodities for all farmers, region, and year
- Non-destructive (if possible)

**DEVELOPMENT INDEX MATURITY**

Many terms have been used to estimate maturity:
- The time of full-blown
- Therm (heat units)
- Abscission layer
- The structure and surface morphology of the external color
- Structure and internal color
- Composition

**Strategies to develop an index of maturity:**
1. Determining the commodity changes during development
2. Looking for things that correlate well with the development of
3. Using experiments and sensory storage to determine the value of the index that determines the minimum acceptable maturity
4. Test the index system for several seasons and places

**ESTIMATE MATURITY**

**Chronology**
- Time after planting, time after full flowering
- Rarely perfect, to planning, is relatively widely used
- Is often combined with a heat unit

**Physical changes**
- The shape, size, surface character
- Regional abscission: the oldest method
- Texture: maturity followed by softening

**Chemical changes**
- Maturity followed by changes in the composition
- Widely used; less satisfactory; complicated measurement

**Estimate maturity (Cont)**

**Change of physiology**
Maturation-related changes in physiology (respiration and ethylene production). Measurement complicated and expensive; greatly vary on the same commodity.
The production of ethylene is used to index the particular maturity in apples stored at CA.

**Predict maturity**
- Predicting maturity is more complex than assessing maturity at harvest.
- Terms basics: measuring changes during development can be modeled mathematically • time to reach maturity index can be predicted
- Measurements in early development can be used to predict the maturity date of a commodity reaches the minimum acceptable
CHEMICAL CHANGES DURING MATURATION

FRUIT

Color
* Change the look, primary criteria for consumers
* The loss of green color and the appearance of red, yellow, blue
* Who was responsible in a loss of green color is lost chlorophyll (pH changes, oxidative system, enzyme chlorophyllase)
* Who is responsible for the appearance of a color other than green is the synthesis of carotenoids and anthocyanins

Carbohydrate
* Changes in starch into sugar, influencing flavors (sweet) and textures (soft), more easily acceptable to consumers
* Solving protopectin and hemicellulose polymers into simpler compounds (low BM) is easily soluble role in water weakens the cell wall. The rate of degradation of the pectin compound is directly related to softening.

CHEMICAL CHANGES DURING MATURATION (Cont)

3. Organic acid
* Generally, the organic acid content decreased during ripening (except bananas and pineapples)
* * sources of energy reserves in fruit

Compounds Containing Nitrogen
* The content of protein and free amino acids are low, do not play a role in determining the quality of
* The change shows the difference in metabolic activity
* Climacteric phase → amino acids decreased
* Senescent → increase in free amino acids

CHEMICAL CHANGES DURING MATURATION (Cont)

5. SCENT
* Participate in the development of optimum quality
* Synthesis of volatiles during cooking; <1% of total C
* Ethylene 50-75% volatile (main), non-scented
* Fruit aromas non klimakterik not synthesize as much as climacteric fruit

5. VEGETABLES
* Sudden changes in metabolism does not occur (except bean sprouts)
* Seeds and pods full fledged low metabolism (water content 15%)
* Seed young as fresh vegetables high metabolism; moisture content 70%; with maturation sugar -> starch, fiber, KA decreased

CHEMICAL CHANGES DURING MATURATION (Cont)

* Bulb, roots and tubers at harvest has a low metabolic rate, dormant can be extended
* Flowers, buds, stems, leaves vary in metabolic activity and the rate of deterioration, if wilted, appearance, texture and nutritional value greatly reduced
ETHYLENE IN POST-HARVEST TECHNOLOGY (Continued)

INDUCTION flowering / budding
• Flowering in pineapple crop and bulb sprouting in potatoes

RELEASE AND LOOSES OF SKIN FRUIT
• Harvest nut crop (relaxation of the skin), harvest cherry (the formation of abscission region)

DAMAGE chlorofil
• Blanch (makes pale colors) celery; degreening in citrus

FRUIT RIPENING
• Limit minimum of 0.04-1.0 ppm depending on the commodity
• In the artificial ripening process depends on the type of fruit, maturity, temperature, RH, [ethylene] and long contact with ethylene
• The concentration range 10-100 ppm
• Temperature 18-25 C; well ventilated
• Method of application: shot system (regular intervals) vs trickle / flow-through system (given continuous)

SOURCE OF ETHYLENE
• The mixture of ethylene with an inert gas explosion resistant: Ripegas 6% ethylene in CO2 w/w
• Generator ethylene: Ethanol - Water → ethylene (heated & catalyst)
• Ethepon / Florel / Cepa: highly acidic aqueous solution. If pH> 5, hydrolyzed ethylene release; application of water to the fruit (dip / spray) → microbial contamination; no special facilities
• Calcium carbide (Ca2C): if hydrolyzed slightly off acetylene and ethylene. If wrapped in paper can serve as a generator of ethylene
• Use of ripe fruit: cheap and simple. See last lecture material, many fruit producing ethylene. Auto catalytic character of ethylene.

UNDESIRABLE EFFECTS OF ETHYLENE

ETHYLENE SIMILAR COMPOUNDS AND COMPARATIVE EFFECTIVENESS

<table>
<thead>
<tr>
<th>Ethylene</th>
<th>1</th>
<th>CO</th>
<th>2900</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propylene</td>
<td>130</td>
<td>Acetylene</td>
<td>12500</td>
</tr>
<tr>
<td>Vinyl chloride</td>
<td>2370</td>
<td>1-butena</td>
<td>140000</td>
</tr>
</tbody>
</table>

UNDESIRABLE EFFECT

1. ACCELERATED SENESEN
• In green tissue, loss chlorophyll, protein, easily damaged
  • In the interest both natural and not related to an increase in ethylene

2. ACCELERATED RIPENING
• Adverse e.g. yellowing on cucumber; reduce the shelf life of fruit in general; soften the fruit

3. INDUCTION OF LEAF DAMAGE
• Leaves dark or dead, on leafy plants; russet spotting on lettuce

4. FORMATION ISOKUMARIN
• It causes a bitter taste in carrots; [ethylene] 0.5 ppm in 2 mg

5. BUDDING
• Adverse on commodities consumed like potato

6. ABSCISSION ON LEAVES, FLOWERS AND FRUIT
• The problem for houseplants

7. HARDENING NETWORK
• Stimulate lignification asparagus, reduce edible parts

8. DAMAGE INDUCED PHYSIOLOGICAL
HOW TO OVERCOME UNDESIRABLE EFFECTS OF ETHYLENE

A. ELIMINATE SOURCES ethylene
1. VENTILATION
   * Switch the air with fresh air from outside (assuming unpolluted)
   * Forklift electric; engine does not idle in the store

2. DISPOSAL WITH CHEMICALS
   • KMnO4 (Purafil) oxidizes ethylene to CO2 and H2O
   • have a high surface area, impermeable to gas
   • UV light to produce ozone (toxic), can damage the ethylene
   • Activated charcoal absorbs ethylene (lab scale)
   • Oxidizer catalytically at high temperature and catalyst
   • System bacterial, bacterial ethylene as a substrate

3. STORAGE HIPOBARIK / LOW PRESSURE
   • * Level of ethylene is reduced; complicated and expensive methods

B. INHIBIT EFFECTS ETHYLENE

CONTROLLED ATMOSPHERE
* [O2] is low and [CO2] reduces high respiration rate, ethylene production, operation of ethylene and metabolic processes

COMPOUND SPECIFIC ANTI-ETHYLENE
* Compounds inhibiting ethylene labor Ag + (silver thio sulfate / STS), 2.5-norborneadiena

ETHYLENE BIOSYNTHESIS INHIBITORS
* Network produces ethylene; biosynthesis can be inhibited
* Amino oxy acetic acid (AOA); amino ethoxy vinyl glycine (AVG) inhibits the enzyme ACC synthase, only lab scale; very EXPENSIVE

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Harvest Criteria

Varies depending on the type of commodity

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<th>Harvest Criteria</th>
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<tr>
<td>Leafy and Fruit Veg.</td>
<td>Horticultural Maturity, Physiological Maturity, Ripeness</td>
</tr>
<tr>
<td>Carrot</td>
<td>Size of root</td>
</tr>
<tr>
<td>Raddish</td>
<td>Days from planting</td>
</tr>
<tr>
<td>Potato</td>
<td>Drying foliage</td>
</tr>
<tr>
<td>Garlic and Onion</td>
<td>Drying of tops, neck tissues begin to soften</td>
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<td>Sweet Potato</td>
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Harvesting system

Purpose:
- Gathering the harvest
- Appropriate level of maturity
- Minimize damage and loss
- Fast
- Cheap

Harvest manual (hand harvesting)
(Fruits, Vegetables, Flowers)

Advantages Hand Harvesting
1. Humans can accurately select maturity
   - Grading to be accurate
   - Allows harvesting stages
2. Minimal crop damage
3. Harvesting can be improved by increasing labor
4. Investing is not expensive

The problem in hand harvesting
1. In some countries, not all year round availability
2. If workers strike in the period permanen
3. Labor regulations
4. Need training
5. Maintaining productivity

Planting with Machine
Advantages:
1. The potential for rapid harvesting
2. Work atmosphere better harvest
3. Problems salaries and reduced labor
Problems in the use of machines for harvesting

1. Workers should be well-trained
2. Surgical error will cause huge loss
   - Damage to the machine
   - Damage to crops
3. Regular engine maintenance should be performed
4. Tanaman growth should match the machine design
   (eg: - the tree should be short
   - The stem should be long enough
   etc.)
5. Planting pattern should be adjusted
6. Choice commodities grown to be limited

7. Not able to select harvest
8. High levels of crop damage
9. Expensive
10. The capacity of processing and handling can not afford menimbangi many commodities are harvested
11. Equipment becomes obsolete before the investment return (loss)
12. Social impact
13. Need new cultivars that allows the use of harvesting machines