



มหาวิทยาลัยราชภัฏนครปฐม

9673204

Drying and Storage

Course Description

Theory of drying, sun drying, principles of air flow, drying of agricultural products by heated air, moisture content determination, relationship of moisture and temperature, equilibrium moisture content, design of dryers storage

Professional Interest Statement:

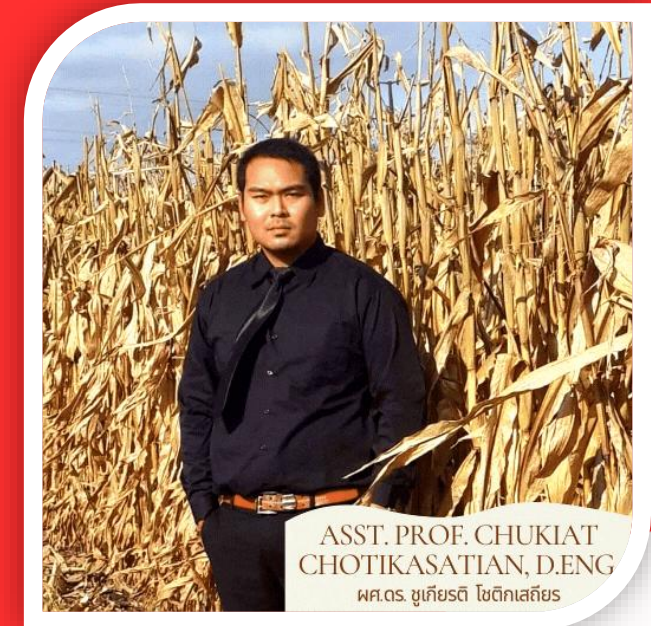
- Monitoring CO₂/O₂ concentrations to assess biological activity and reduce post-harvest losses
- Establishing verification criteria for unacceptable insect infestation levels
- Supporting fumigation and grain storage management decisions
- Developing agricultural product drying and intelligent drying systems

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Assistant Professor Dr. Chukiat Chotikasatian



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NPRU



Lecture 10 – Insect Infestation in Storage and Grain Aeration

Study Questions – Lecture 10

- 1. What types of insect pests commonly attack stored grains?*
- 2. How can insect infestation be evaluated during storage?*
- 3. How is CO_2 concentration used to estimate insect population?*
- 4. When should fumigation be applied in grain storage systems?*
- 5. Why is aeration important after fumigation and during storage?*





Lecture 10 – Insect Infestation in Storage and Grain Aeration

Outline – Lecture 10

1. *Importance of Stored-Product Insects*
2. *Types of Insect Infestation*
3. *Postharvest Losses*
4. *Insect Monitoring and Evaluation Methods*
5. *CO₂-Based Insect Population Estimation*
6. *Fumigation and Management Strategies*
7. *Aeration in Grain Storage*



Importance of Insect Control

Drying slows deterioration,
but two major threats
remain:

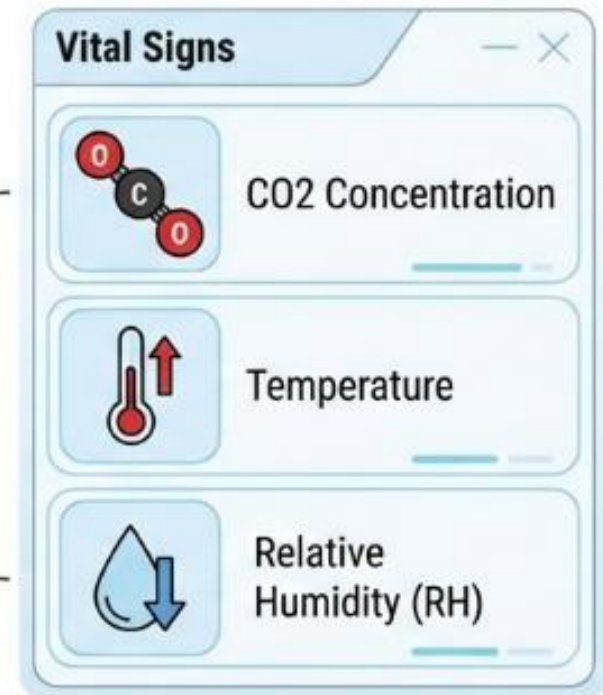
1. Insect Infestation
2. Poor Management

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- Insect infestation is a major factor causing the degradation of grain quality and quantity during storage

Key
Monitoring
Variables for
Aeration
Planning



Types of Stored-Product Insects

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Tribolium castaneum



Oryzaephilus surinamensis



Cryptolestes ferrugineus



External Feeders: Attack the outside surface of grains, Feed on broken or damaged kernels

Examples: Red flour beetle (*Tribolium castaneum*), Saw-toothed grain beetle (*Oryzaephilus surinamensis*), Flat grain beetle (*Cryptolestes ferrugineus*)



Sitophilus oryzae



Rhyzopertha dominica



Sitophilus zeamais



Sitotroga cerealella



Internal Feeders: Larvae develop inside the grain kernel, Damage is not visible from the outside

Examples: Lesser grain borer (*Rhyzopertha dominica*), Rice weevil (*Sitophilus oryzae*), Maize weevil (*Sitophilus zeamais*), Angoumois grain moth (*Sitotroga cerealella*)

Reference: Zhu et al., 2022, p. 2



Periods of Insect Infestation



Occurs ~2 weeks prior to harvest. Insects migrate from storage facilities to nearby fields to infest standing crops.



The Vector: Dirty Machinery.

Lack of sanitation on equipment transfers pests from previous jobs directly into new grain.



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Infestation may occur during:

Pre-harvest

During harvest

Post-harvest

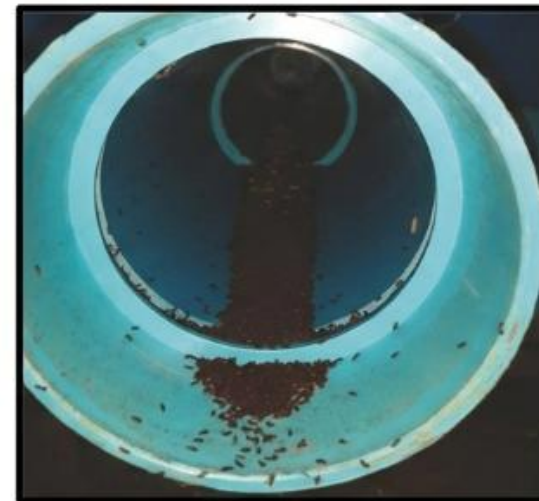


Figure 10.3: Residual insects inside aeration equipment.

- **Processing:** Residual pests in mills/cleaners.
- **Transport:** Contaminated sacks and containers.
- **Storage:** Pests hiding in ducts and crevices.

Type of Agricultural Losses

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Insect infestation and prolonged storage cause various types of losses:

Direct Losses

Weight loss: Caused directly by insects feeding on the grains

Germination loss: Reduction in seed viability over time

Nutritional loss: Depletion of lipids and carbohydrates, accelerated by temperature-dependent enzymes causing oxidation and rancidity

Quality loss: Overall degradation of the physical and chemical state of the grain

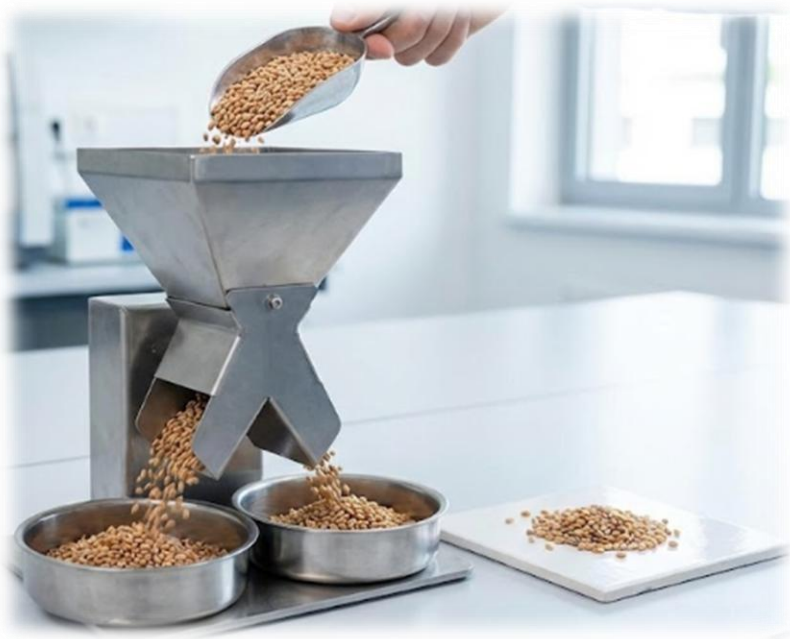
Indirect Losses

Financial (Money) loss: The economic consequence of reduced quantity and degraded quality



Percentage of Weight loss

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Riffle divider

$$\% \text{ Weight loss} = \frac{(UN_d) - (DN_u)}{U(N_u + N_d)} \times 100$$

Where:

U is the total weight of undamaged grains

D is the total weight of damaged grains

N_u is the number of undamaged grains

N_d is the number of damaged grains

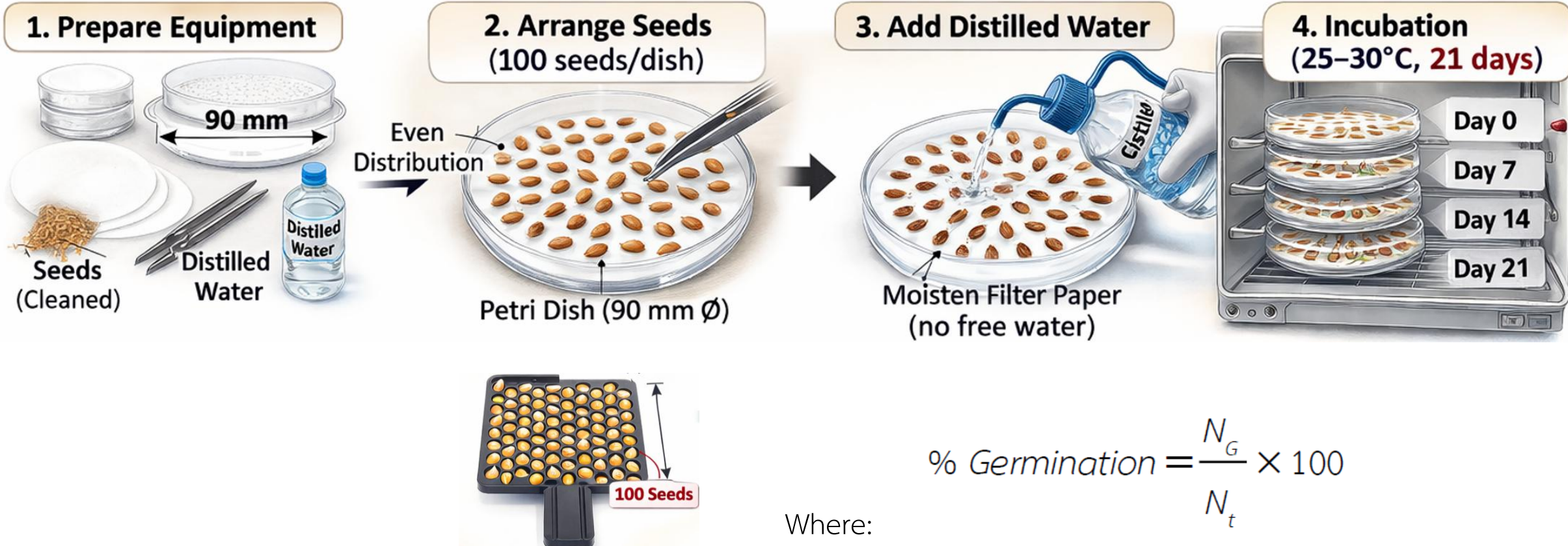
Reference: Ngatia & Kimondo, 2011, p. 254



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Germination Loss

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$$\% \text{ Germination} = \frac{N_G}{N_t} \times 100$$

Where:

N_G is the number of seeds that germinated within 21 days

N_t is the total number of seeds placed in the petri dish

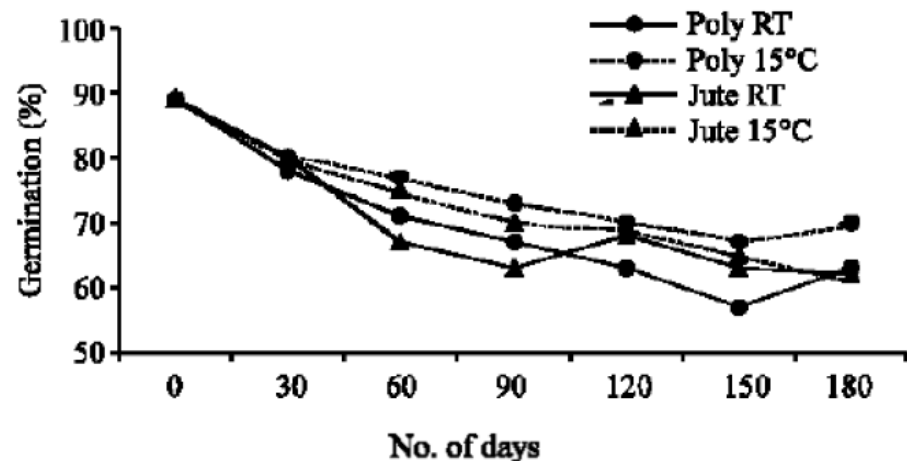
Reference: Lazim & Ramadhan, 2019, p. 2,295



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Nutritional Loss & Quality Loss

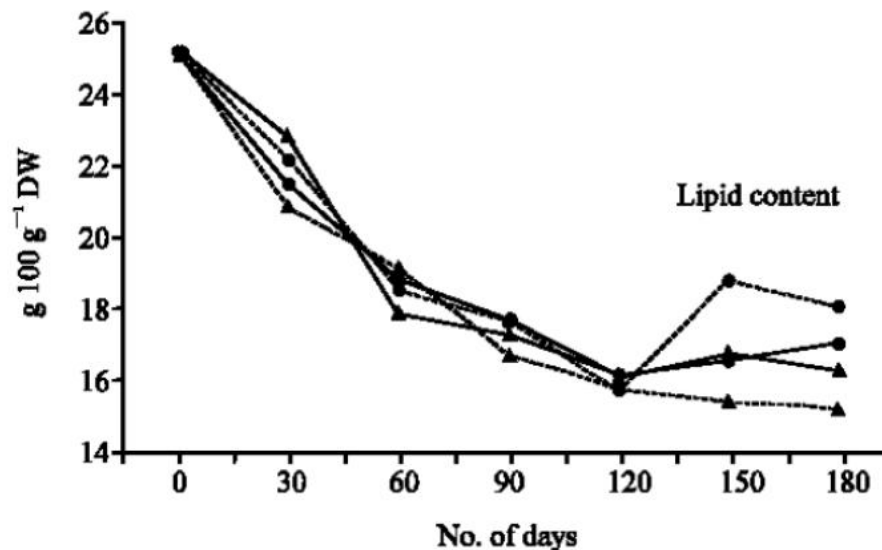
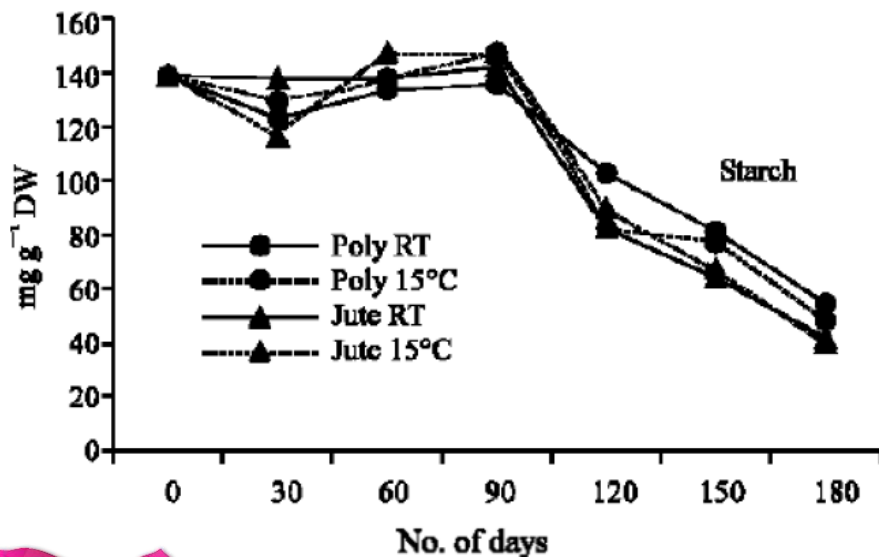
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Nutritional loss of soybean within
180 days

RT: room temperature

Seed deterioration cannot be completely stopped once it has begun; however, it can be slowed down significantly under appropriate conditions



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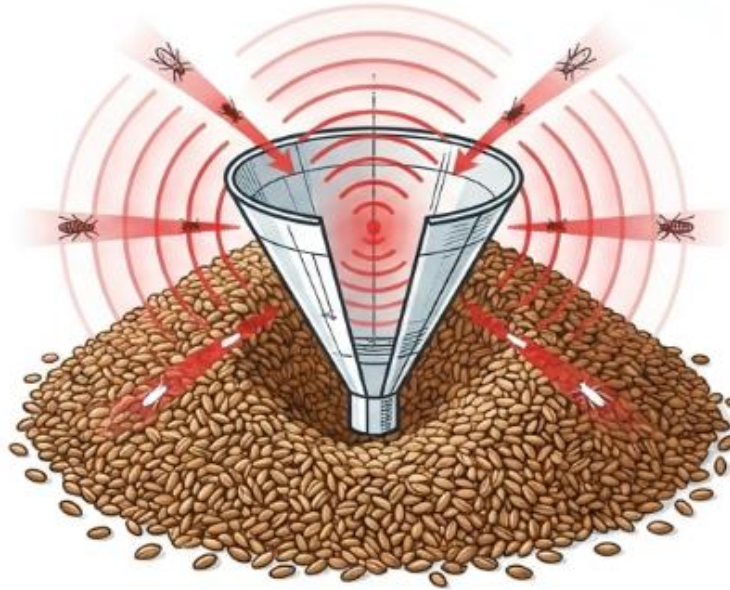
Reference: Sharma et al., 2007, pp. 502-505

Infestation Assessment: Pheromone Traps

Goal: To predict population spread and species to plan management.

Method: Traps utilize sex pheromones to attract pests by hijacking mating or aggregation signals.

Success Factors: Diffusion rate, concentration, trap position, weather.



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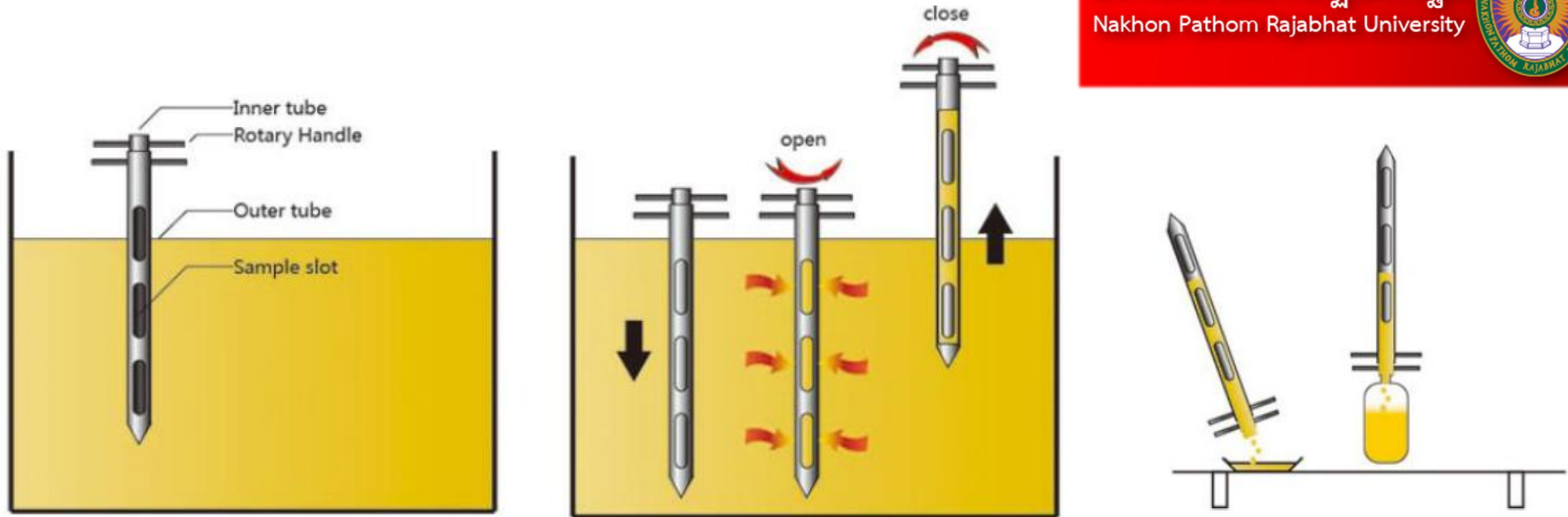


- Pheromones are released into the air at low concentrations
- Their dispersion depends on several factors, including the diffusion rate, the installation position of the trap, and surrounding environmental conditions



Infestation Assessment: Grain Trier

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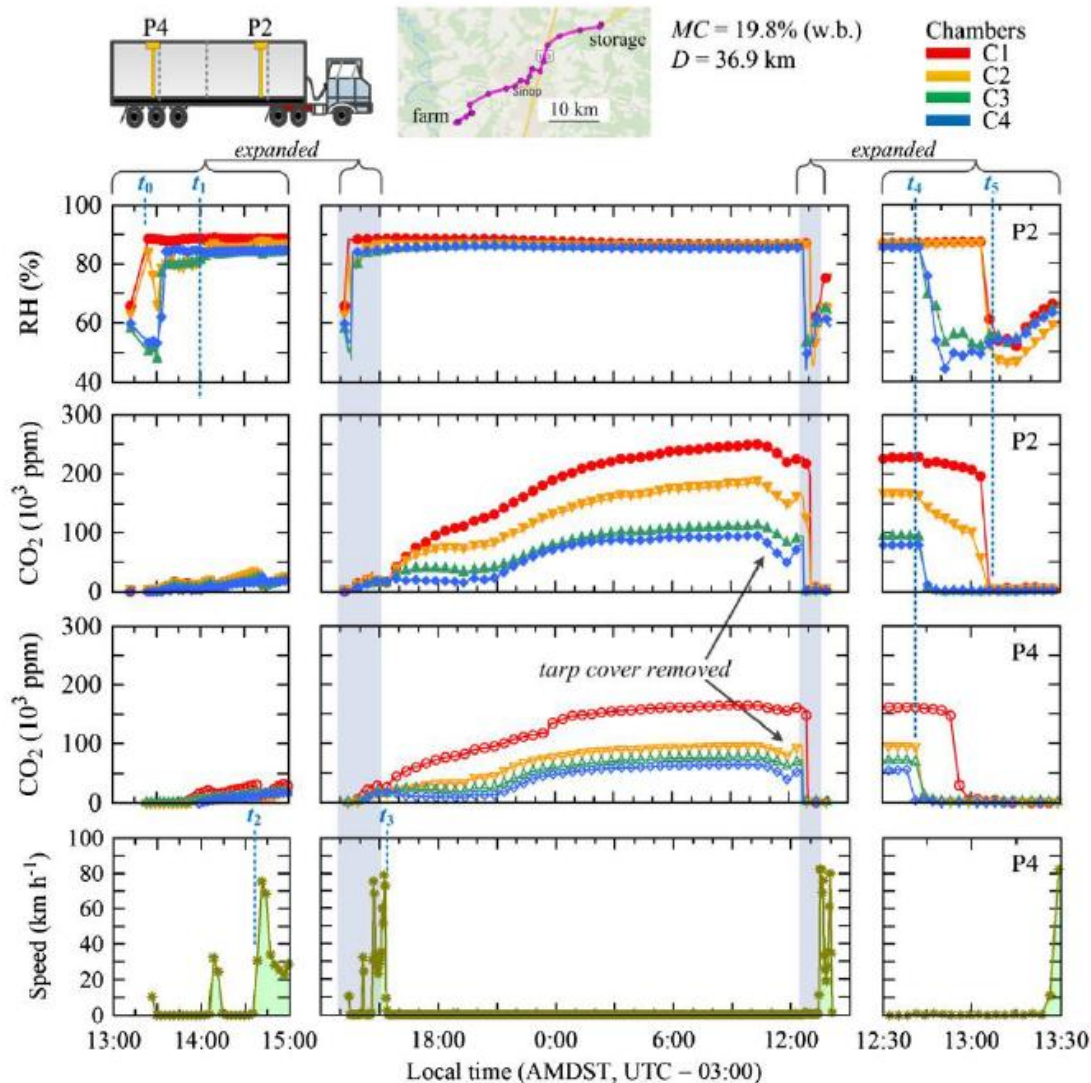
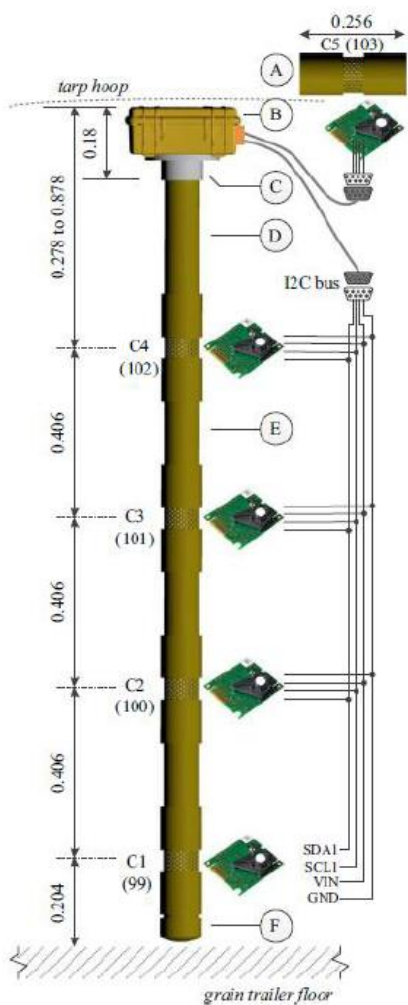


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Reference: Fushun Bright Science and Technology, n.d.

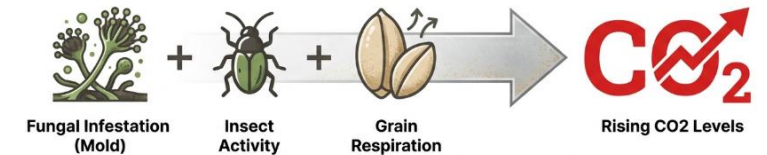
Infestation Assessment: CO₂



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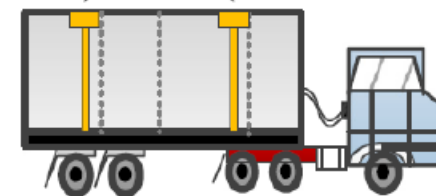


CO₂ as an Early Warning System



Advantage: CO₂ spikes indicate biological activity *before* physical spoilage is visible, allowing for timely ventilation.

Two probes per truck



Solid body truck
(*caminhão*)

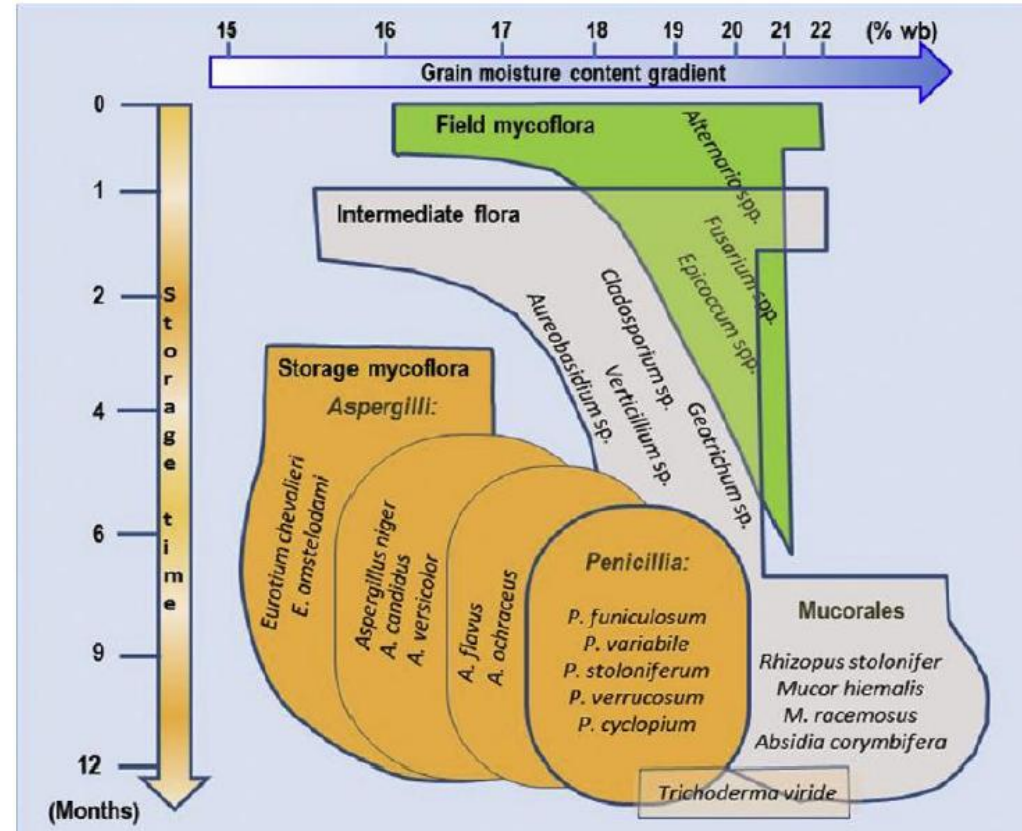
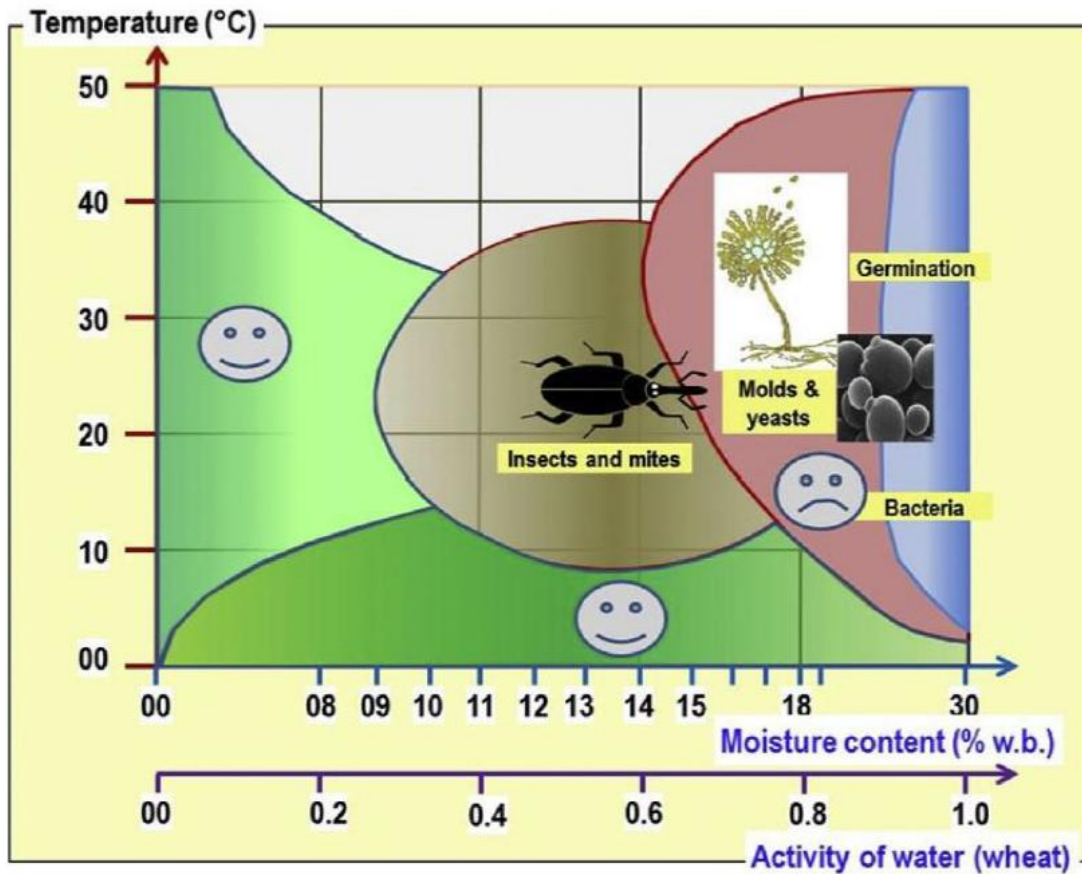
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Biological Characteristics of Grain Stored Under Different Temperature and Moisture Conditions

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Reference: Fleurat-Lessard, 2017, p. 24-27

Management and Aeration in Grain Bulks

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Environmental control is the primary defense against storage losses.

Fumigation:

Recommended when sampling detects an infestation level of 1-2 insects per kg

Common chemicals include Phosphine, Methyl Bromide, and CO_2 (often used for organic products)

Aeration Objectives:

To safely ventilate residual fumigation chemicals (e.g., Phosphine must be reduced to below 0.3 ppm)

To remove heat and moisture generated by grain respiration

To maintain low silo temperatures (ideally through night-time aeration), which slows down or halts insect development

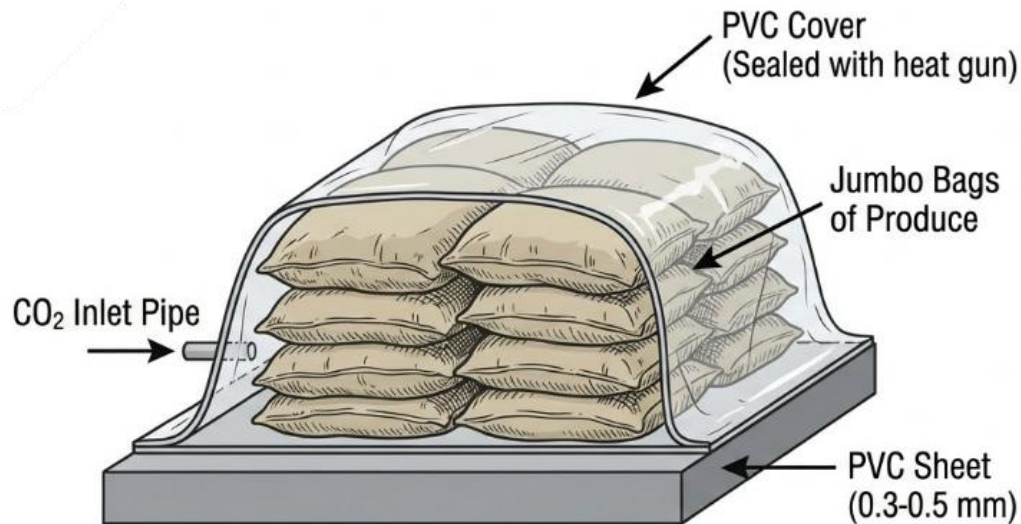
Reference: Hagstrum & Flinn (2014, p. 206)



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CO₂ Fumigation

Management: CO₂ Fumigation Setup



The stack must be hermetically sealed to maintain gas concentration.

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The Negative Pressure Test

Verifying Structural Integrity

1. Reduce Pressure to **500 Pa**



2. Wait 10 Minutes.

3. **PASS CRITERIA:**
Pressure must remain above **250 Pa**.



35%

Target CO₂
Concentration

15 Days

Required Duration

Concentration must be maintained constantly to ensure total insect mortality.



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Ventilation

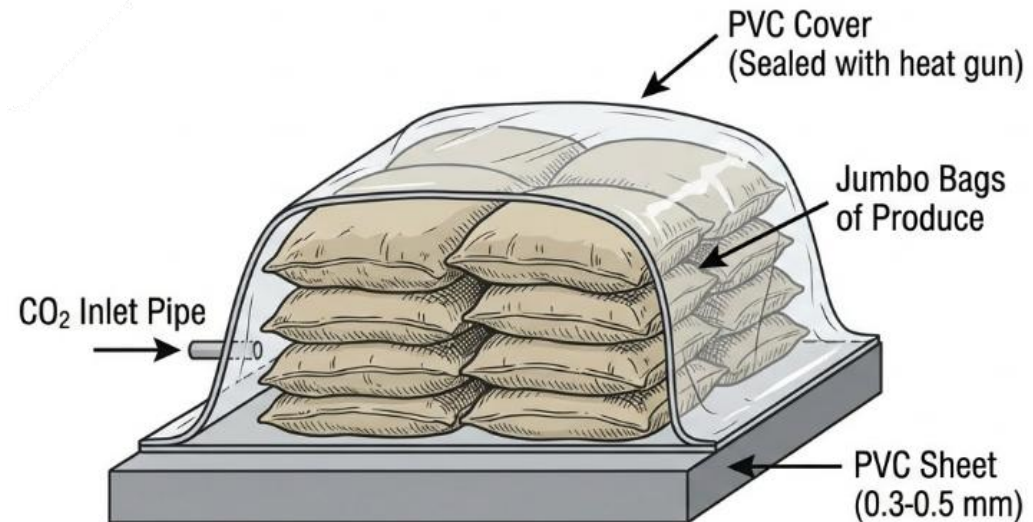
Process: Use suction fans to blow ambient air through the grain pile.

Safety Threshold

Ventilation must continue until CO₂ drops below 5,000 ppm (0.5%) before pile dismantling.



Management: CO₂ Fumigation Setup

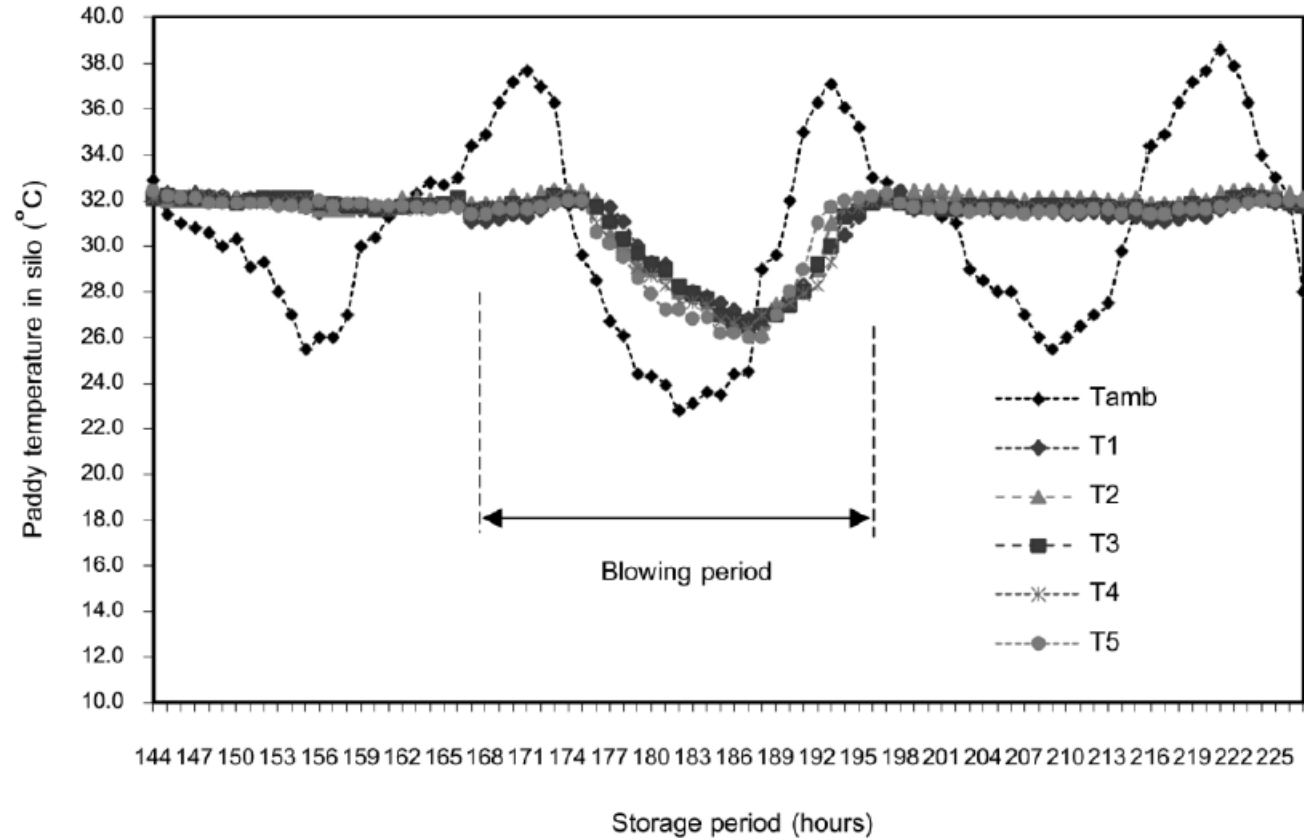
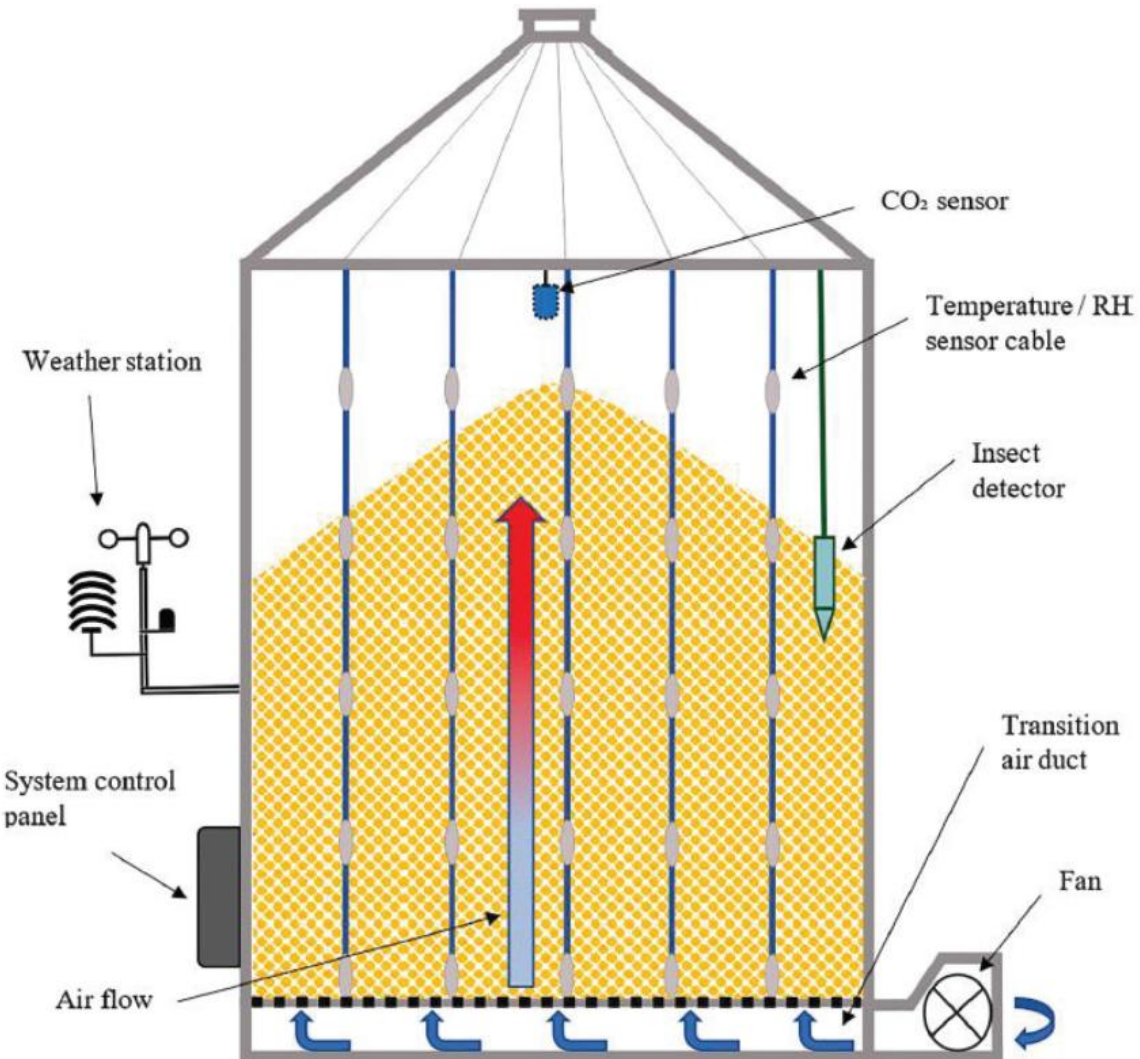


The stack must be hermetically sealed to maintain gas concentration.



Grain Aeration & Aeration Strategy

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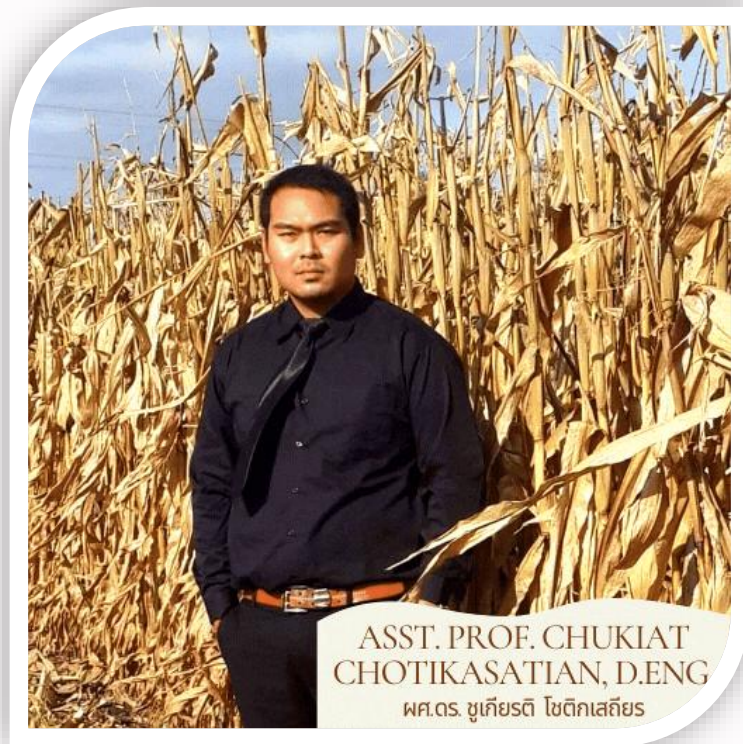
Summary

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1. Stored-product insects significantly affect grain quality and quantity
2. Monitoring methods include traps, sampling, and CO₂ analysis
3. CO₂ increase can estimate insect population
4. Fumigation should be applied based on infestation threshold
5. Aeration is critical for temperature and moisture control
6. Proper storage management reduces postharvest losses





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Thank you very much for your kind attention.

Questions?

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Study Questions – Lecture 10

1. *What types of insect pests commonly attack stored grains?*
2. *How can insect infestation be evaluated during storage?*
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Assignment – Lecture 10

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1. Explain how CO₂ concentration relates to insect respiration.
2. When should fumigation be applied?
3. Why is nighttime aeration recommended?
4. How does temperature affect insect development?

04

Reference: Loewer et al., 1994, p. 217



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References

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- Zhu, L., Ma, Q., Chen, J. & Zhao, G. (2022). "Current progress on innovative pest detection techniques for stored cereal grains and thereof powders." **Food Chemistry**, 396, 133706.

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