Emergency Drying of Grains and Oils







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Cloud School

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CONTENTS

01 Emergency Drying

02 Stationary Grain Dryer

03 Mobile Grain Dryer

04 In-bin Drying

05 Practical Application Cases

01

Emergency Drying

Background— Why Emergency Drying matters?

Current State of Global Post-Harvest Grain Losses

- Global post-harvest grain loss rate is approximately 13.3%. (FAO, 2023)
- Losses are mainly concentrated in the post-harvest drying stage.



New Challenges Posed by Extreme Weather

- High-moisture grain, if not dried promptly, can heat up, germinate, or develop mold within hours
- Post-harvest losses intensify → reduce market supply → hurt farmers' incomes → threaten food security

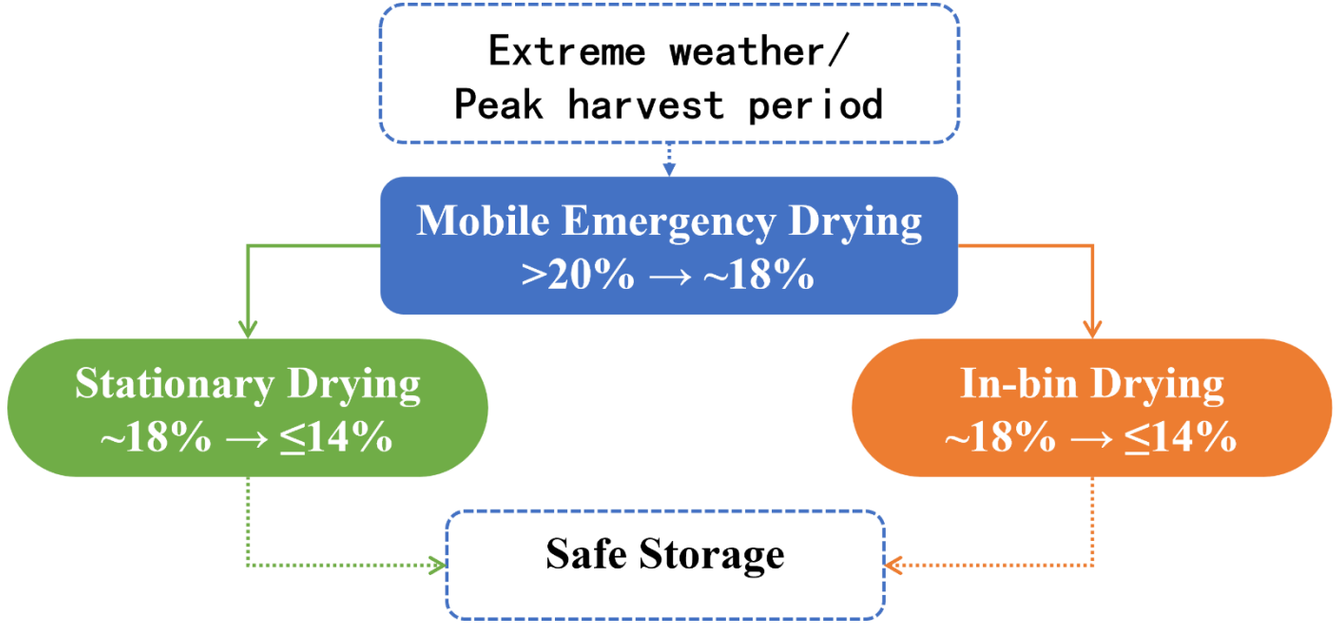


Major Pain Points in Grain Drying

- Fixed infrastructure: Immobile, unable to respond to sudden disasters or provide cross-regional drying support;
- Experience-based operation: Relies on manual judgment, resulting in unstable drying quality and poor consistency.

What is emergency drying? - To save time, prevent mold, and ensure quality

Emergency drying is a systematic solution that coordinates mobile dryers, stationary grain dryers, and in-bin drying systems. During extreme weather or peak harvest periods, mobile dryers rapidly reduce high-moisture grain to approximately 18%, after which stationary dryers or in-bin systems complete the drying process to safe storage moisture levels. The three modules operate in sequence, forming a complete "rapid reduction → deep drying/in-bin tempering → safe storage" chain that ensures loss reduction and quality preservation from field to storage.

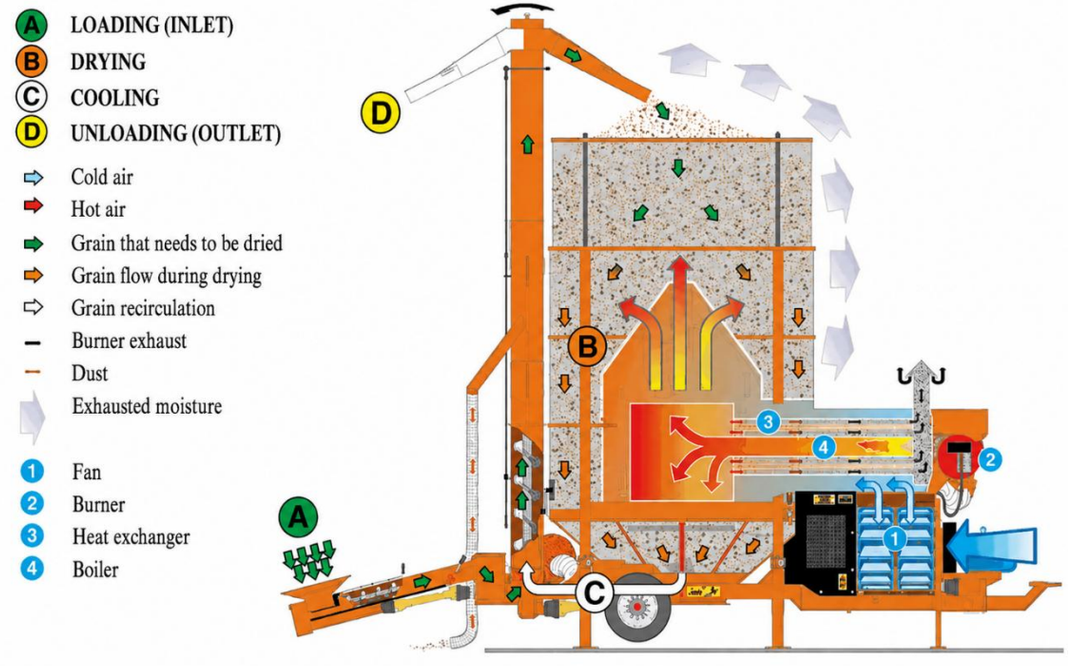


02

Stationary Grain Dryer

Stationary Grain Dryer

Definition: A permanently installed, high-capacity drying system that serves as the backbone of routine grain drying operations, also responsible for deep-drying grain to long-term safe storage moisture levels after initial moisture reduction by mobile dryers.



Three-stage drying sequence:

1 Drying section

Grain kernels are heated and moisture evaporates.



2 Tempering section

Internal and external temperatures and moisture levels equalize, ensuring uniform moisture reduction.



3 Cooling section

Grain is cooled to storage temperature and then discharged through the outlet.



Stationary Grain Dryer Types

Dryer Type	Tower Dryer	Recirculating Dryer	Rotary Drum Dryer	Fluidized Bed Dryer
Features	High capacity, continuous operation	Uniform drying, ideal for rice	Versatile, suitable for multiple crops	High efficiency, excellent uniformity
Suitable Scale	Large grain depots, drying centers	Small to medium cooperatives	Small to medium mills	Seed processing, specialty crops









Grain Dryer Classification by Airflow Direction

Co-current drying

- Hot air and grain flow move in the same direction.
- High-moisture feed meets hot dry gas at the inlet → high driving force → rapid drying. Low-moisture material meets cool moist gas at the outlet → low driving force → slow drying.
- This design suits heat-sensitive dry materials requiring high final moisture, provided the wet feed tolerates intense drying without cracking or case-hardening，such as rice paddy and soybean.



Grain Dryer Classification by Airflow Direction

Counter-current drying process

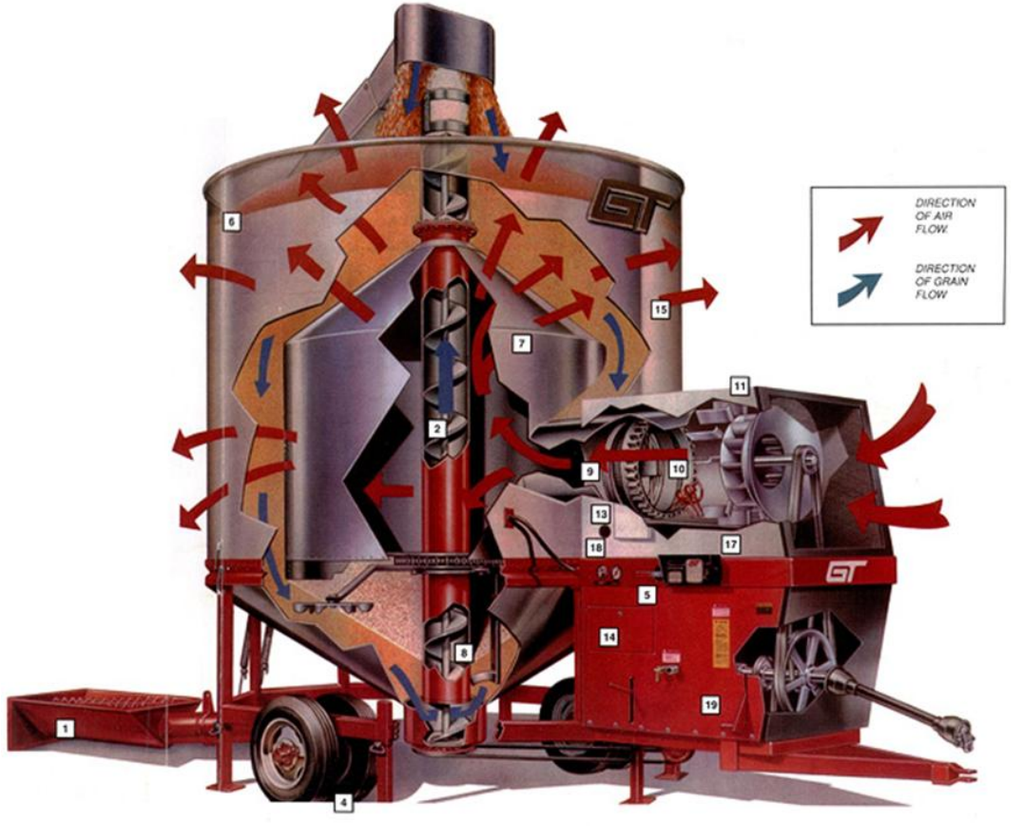
- Hot air and grain flow move in the opposite direction.
- Wet feed at the inlet meets cool moist gas → low driving force → gentle drying. Dry material at the outlet meets hot dry gas → high driving force → rapid drying. This results in a relatively uniform drying rate throughout the system.
- This design applies to heat-tolerant dry materials requiring very low final moisture, provided the wet feed cannot endure aggressive drying, such as corn.



Grain Dryer Classification by Airflow Direction

Cross-current drying process

- The drying medium passes vertically through the material layer.
- Both the temperature and humidity of the gas undergo significant changes as it enters and exits the material bed. This configuration requires the material to be heat-tolerant and capable of withstanding rapid drying, such as wheat and rape seed.



Optimal Drying Parameters by Crop Type

Stationary grain drying removes moisture through heat evaporation and aeration, with key parameters including air temperature, airflow rate, initial and final moisture content, and grain layer thickness. The table below summarizes the optimal drying parameters for major crops to ensure both efficiency and quality.

Crop	Optimal Air Temp	Safe Storage MC	Key Points
Rice	40–60 °C	≤14.0%	Control crack percentage; avoid overly rapid drying
Corn	80–120 °C	≤14.0%	High temperature acceptable; avoid scorching
Wheat	60–80 °C	≤12.5%	Protect protein quality
Soybean	40–50 °C	≤13.0%	Low temperature, slow drying to prevent cracking
Rapeseed	60–80 °C	≤9.0%	High moisture content; may require multiple drying passes

03

Mobile Grain Dryer

Mobile Grain Dryer

◆ **Definition:** A mobile dryer is a transportable grain drying system designed for rapid deployment and field-based operation during extreme weather events or peak harvest periods. It serves as the first responder in the emergency drying system, rapidly reducing high-moisture grain (>20%) to an intermediate moisture level (typically around 18%) to prevent spoilage and buy time for subsequent deep drying or in-bin drying.



◆ Unlike stationary dryers, mobile dryers are designed for field transfer and cross-region operation, enabling a "dry where needed" rapid-response model.

Core Advantages vs. Stationary Dryers

Increased drying rate

Achieve rapid and safe moisture reduction for high-moisture grain, eliminating the risk of heat-induced mold growth, with drying rates of ≥2%/h for rice, and ≥3%/h for corn and wheat.

Easily relocated and deployed across regions

Break through geographical restrictions, respond quickly to disasters, and achieve flexible scheduling and operation across multiple regions.

Digital control of drying parameters

Real-time monitoring of the entire process, precise adjustment of parameters, ensuring quality and meticulous management.

Key Technology Highlights of Mobile Grain Dryer

Modular Design and Adjustable Storage Cylinder

To enable rapid response, modular combination design supports quick on-site assembly. The height of the storage hopper can be adjusted as needed, facilitating convenient loading and unloading while ensuring safety during transportation.



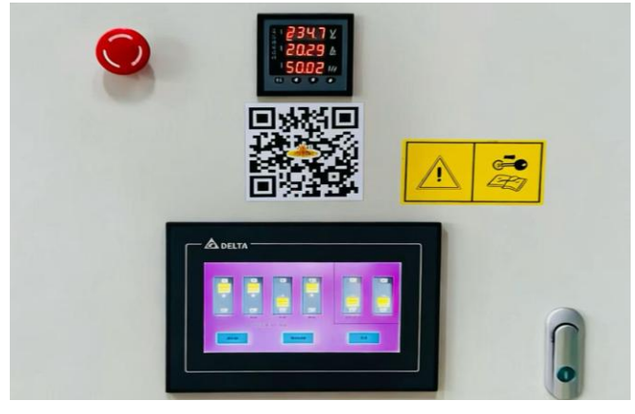
Modular combination design

Multi-Energy Coupling System

Integrate an efficient air-source heat pump and a diesel/biomass pellet combustion engine to establish a stable and reliable multi-energy supply system.

Smart Control & Safety System

Real-time collection and intelligent control of parameters of temperature, humidity, moisture, and feed rate.



Real-time monitoring and early warning system

Advanced hazard-detection system triggers instant alerts and emergency response, maximizing equipment and personnel protection.

Key Technology Highlights of Mobile Grain Dryer

Efficient Hot Air Circulation

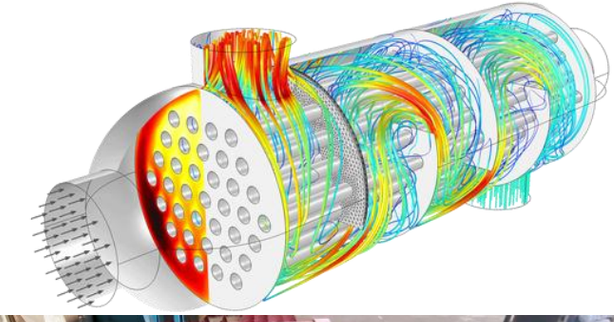
- Low-temperature, high-volume, high-pressure hot air convection + uniform air distribution structure
- Precise regulation of temperature field and wind speed field
- Adaptable to various material drying scenarios



Special fan for the core of efficient hot air circulation

High-Efficiency Heat Exchange

- Internal flow field simulation and reconstruction to reduce thermal resistance
- Maximizes contact area between materials and heat-transfer medium to enhances heat transfer and internal moisture migration
- Rapidly raises core material temperature and activates water molecule movement





Efficient heat exchanger

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In-bin Drying

What is in-bin Drying?

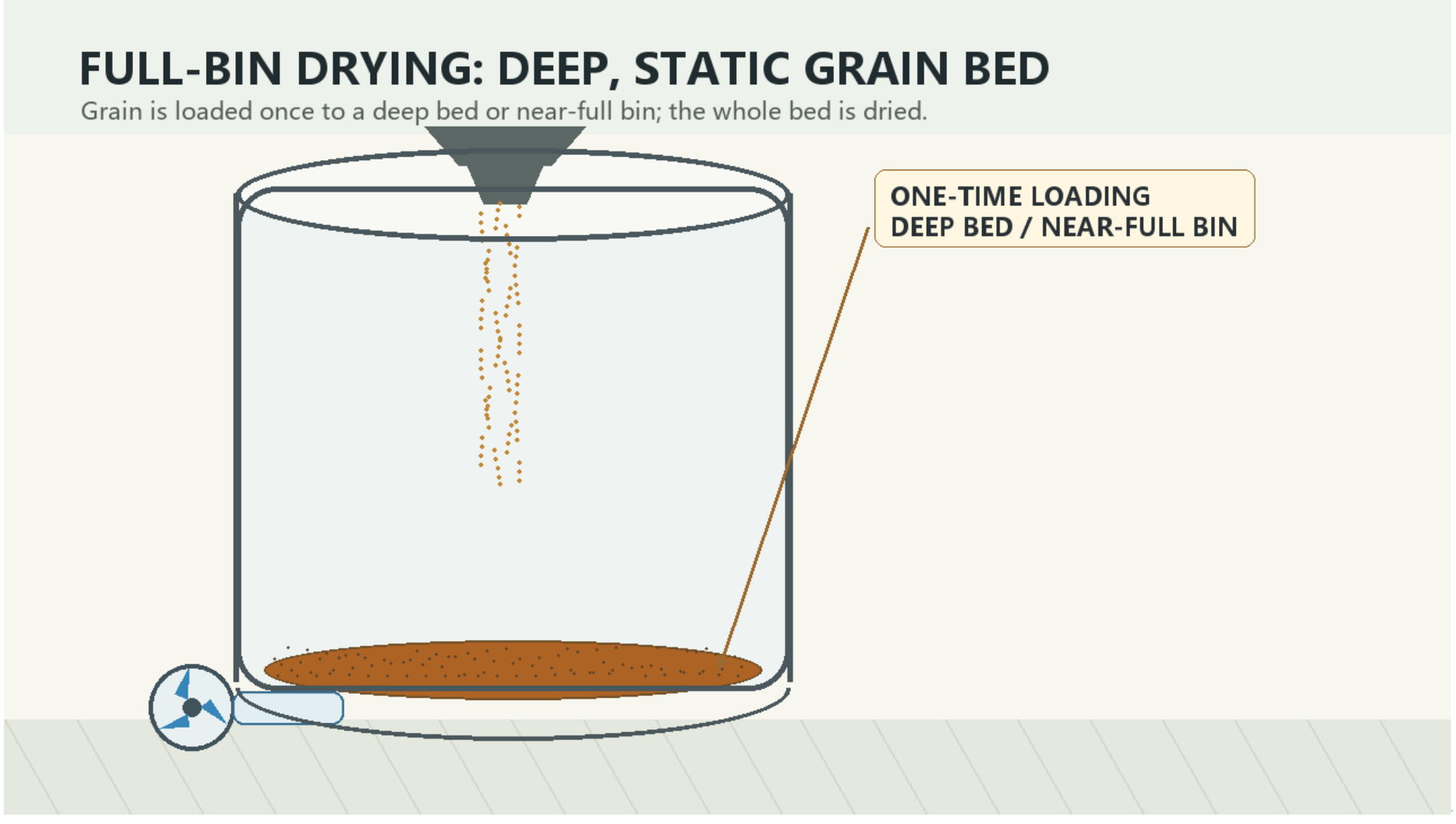
The drying process in the warehouse is achieved by ventilation, circulation and necessary heating of the grains within the warehouse.

It combines the drying process with the short-term storage process, reducing the need for repeated handling.

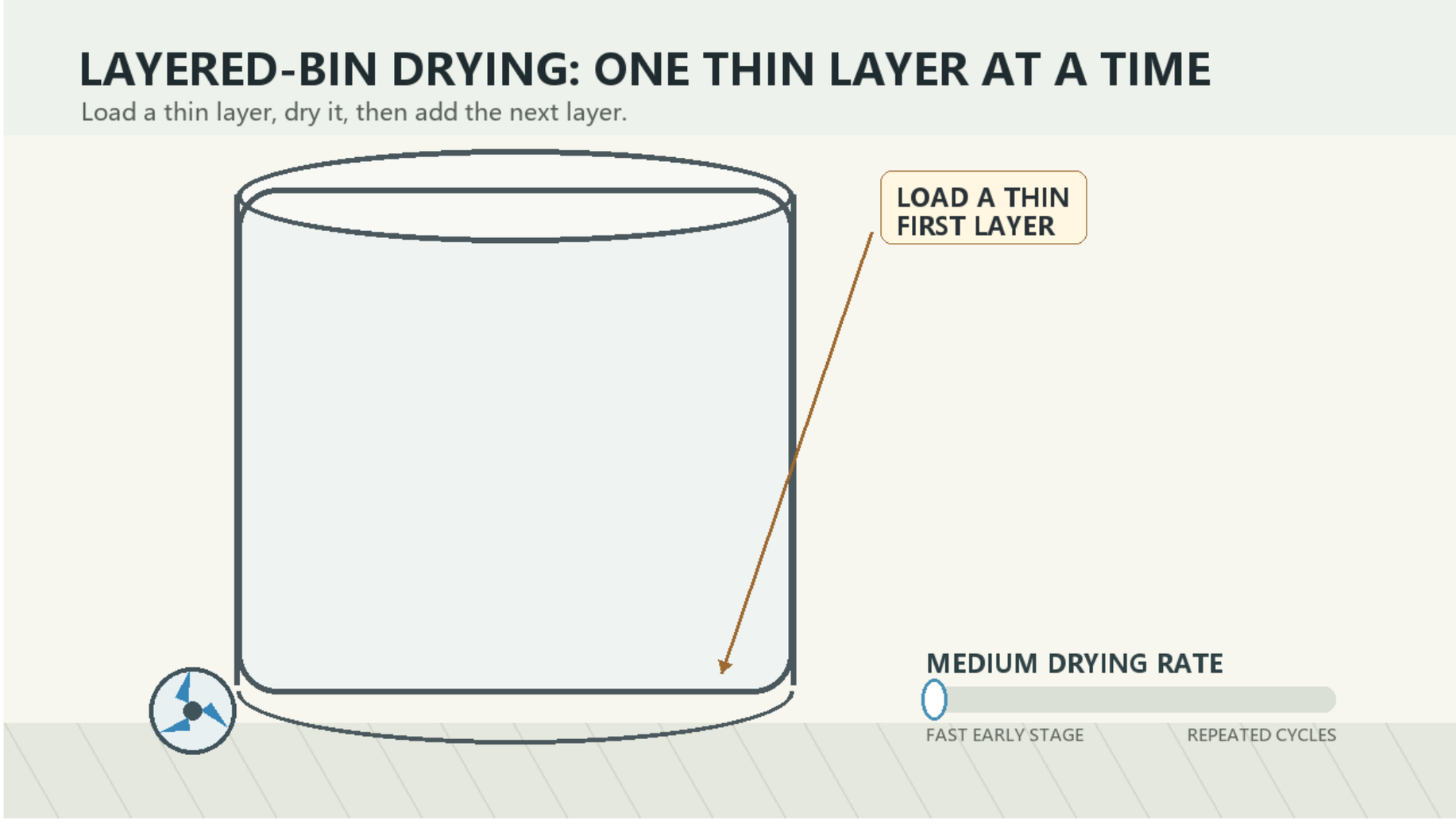
It is suitable for grains with moderate moisture content, or after emergency pre-drying, or on-farm moisture reduction of timely early-harvested grain.



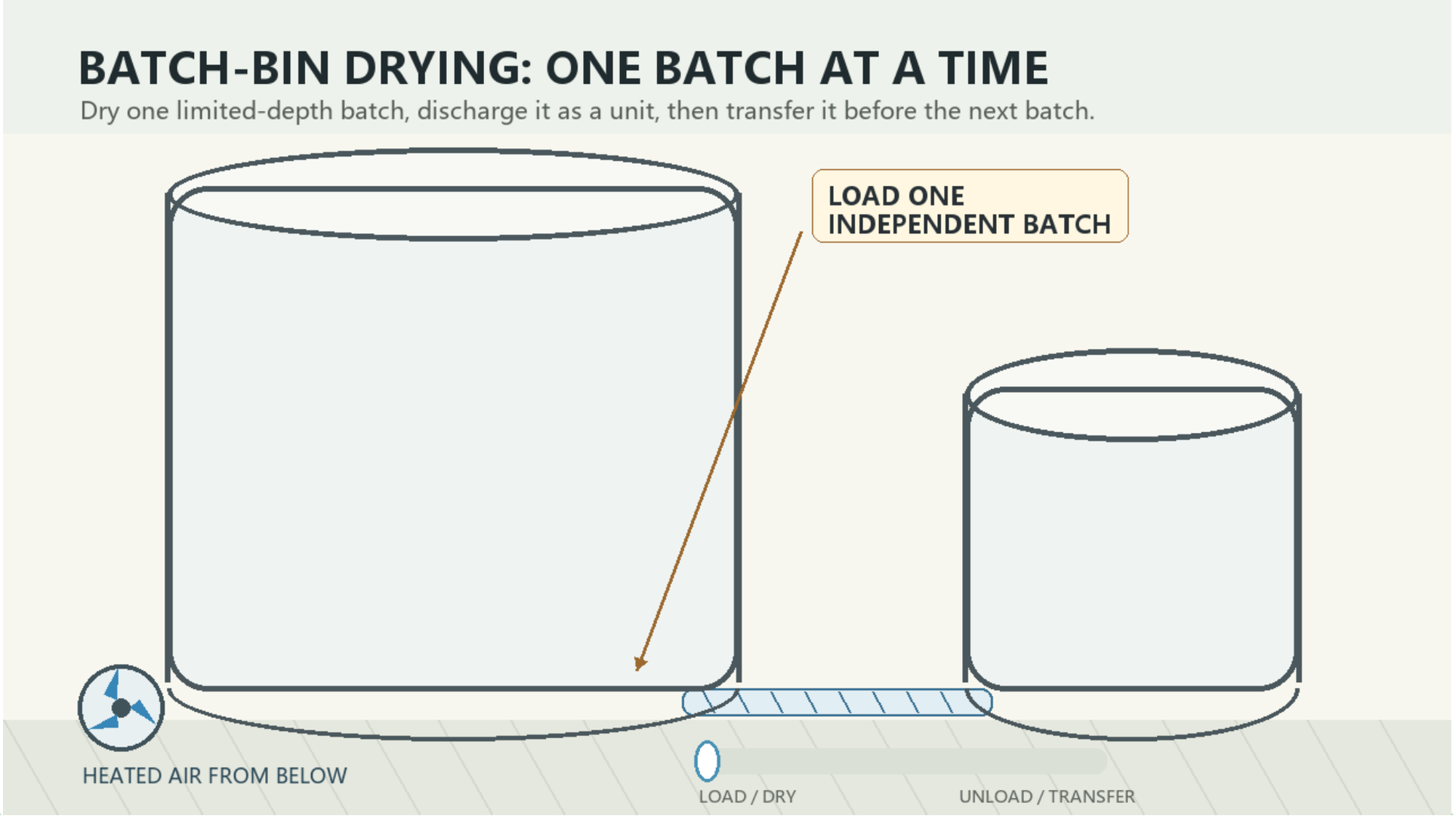
In-bin Dryer Classification: Full-bin Drying



In-bin Dryer Classification: Layered-bin Drying



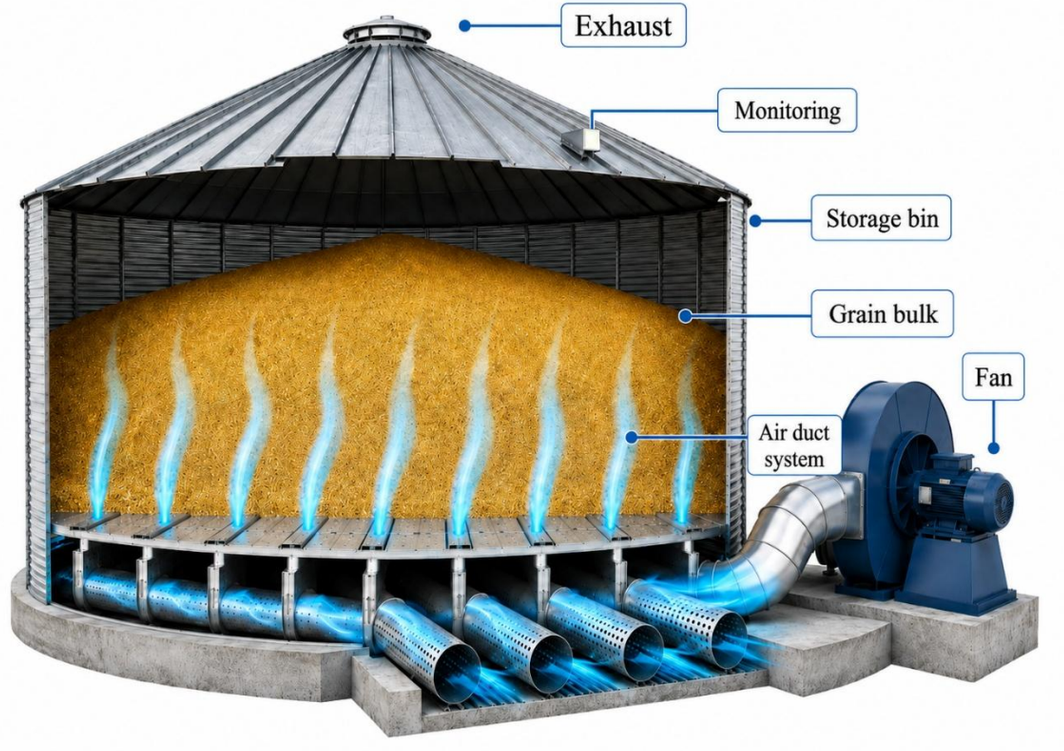
In-bin Dryer Classification: Batch-bin Drying



Equipment System for In-bin Drying

An In-store drying system is composed of:

- Storage bin or warehouse
- Air-distribution duct system
- Fan and air inlet system
- Optional heater or dehumidifier
- Exhaust and ventilation openings
- Grain condition monitoring system
- Auxiliary mold-control equipment



Fan → Duct → Grain Bulk → Exhaust → Monitoring

Typical Case - Corn Aeration-Drying Bin

A corn natural air-drying bin is a storage facility that uses natural wind and solar energy for ventilation and moisture reduction. Its primary function is to reduce the moisture content of freshly harvested high-moisture corn to a safe storage level (around 14%) through natural air drying, thereby preventing mold and achieving low-loss storage.

Air-drying bins rely on natural wind and solar energy (zero energy input) for slow drying (5–7 days on average, as compared with 20 h by mechanical dryers), producing superior grain quality but depending on weather.





Typical Case - Peanuts In-bin Drying

Solution: A detachable, low-cost sun-drying shed with turning functionality has been designed and manufactured, which can save drying floor space, reduce labor costs, and promote the healthy development of the peanut industry.

Applicable scenarios: Small and medium-sized peanut growers; Low capital investment.

Operation Analysis: Example: 1.33ha of semi-dried peanuts (with a moisture content of 20% - 25%), totaling 10 tons, requires a natural air-drying warehouse (10 tons per warehouse), occupying 6 m^2 per warehouse. The natural drying time is approximately 7 days, and there is no electricity cost for operation.



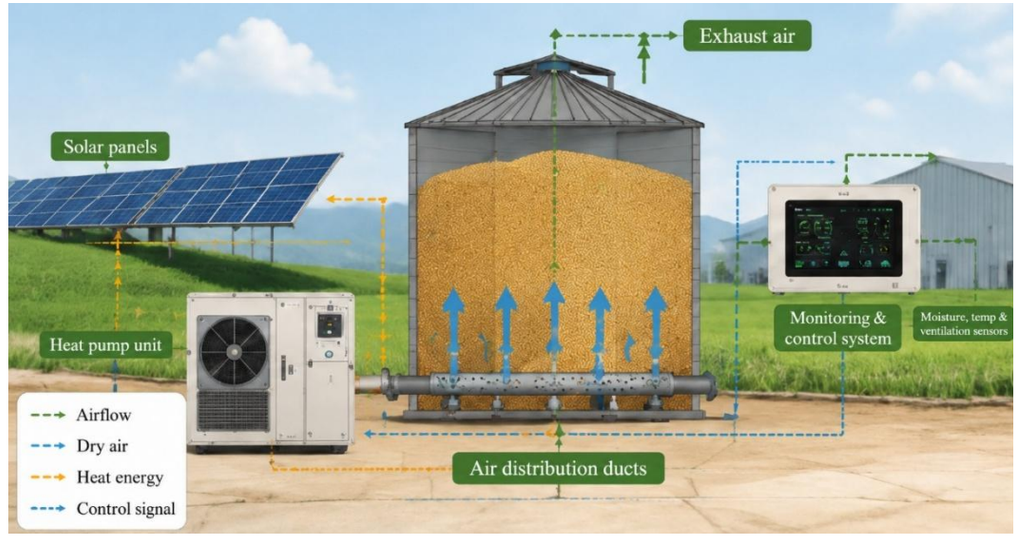




Green Energy and Low-Carbon Drying

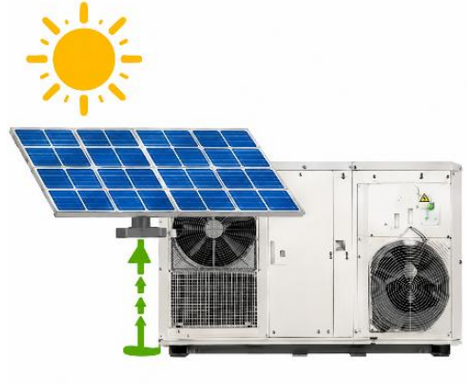
Solar-assisted heat pump system

- Uses solar energy as a supplementary heat source
- Heat pump provides stable low-temperature drying
- Suitable for humid or unstable weather conditions



Heat-pump-driven liquid desiccant dehumidification

- Removes moisture from air before it enters the grain bulk
- Allows drying at lower air temperature
- Helps preserve grain quality
- Useful when outdoor air humidity is high



Solar-assisted heat pump



Heat-pump-driven liquid desiccant dehumidification

Typical Case - Peanuts In-bin Drying

Solution: Heat-pump integrated open-/closed-loop drying technology (COP 2–3), combined with large fan circulation and heat pump/exhaust fan dehumidification, significantly shorten drying time. Unique airflow layout and dedicated material carts maximize hot air–peanut contact, reducing labor costs.



Applicable scenarios: Medium to large peanut growers, cooperatives, and enterprises; rainy weather during harvest and drying season.



Operation analysis: Example: 1.33ha of semi-dried peanuts (20%–25% moisture, 10 tons total) requires one air-source heat pump dryer (3–4 tons capacity, 20 m^2 footprint). Drying time: 10–12 hours; cost: RMB 0.2/kg peanuts.

05

Practical Application Cases

Application Case: Cross-regional Emergency Response for Extreme Weather

⚠️ **Applicable scenarios:** Activate this protocol when extreme weather (e.g., prolonged harvest rains, field flooding) leads to critical shortfalls in fixed drying facilities.

Unified resource allocation

Relying on the intelligent platform, the government takes the lead in coordinating the use of mobile drying machines within the region.

Quick mobile deployment

Ultra-low chassis trailers enable rapid transfer and on-site deployment of mobile dryers, featuring foldable/telescopic models and multi-power compatibility.



Efficient collaborative operation

Forming an emergency team, carrying out multi-machine parallel operations and centralized transportation, to maximize drying efficiency.

Application case: Emergency Drying Operation Procedure - "Two-stage Drying" Strategy

Stage 1: Initial drying

Core equipment: Mobile dryer

Flexible and mobile, it can reach deep into the fields and respond quickly to operational needs.

Objective: rapid moisture reduction

Quickly reduce high moisture content grains (40%+) to 18%-19%, to save time and prevent mold growth.



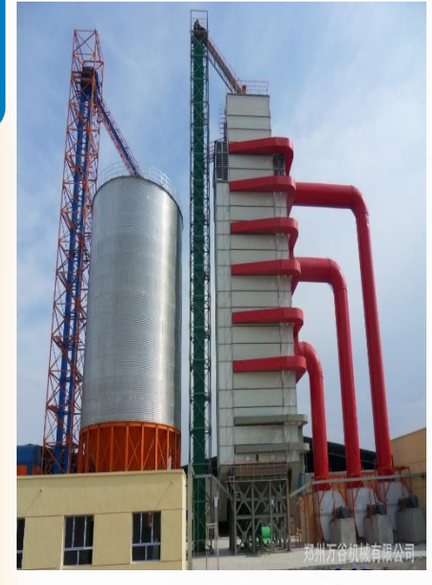
Stage 2: Secondary drying

Core equipment: Stationary dryer or in-bin dryer

stationary dryers for high-capacity, deep drying; in-bin dryers for low-temperature, gradual moisture reduction.

Objective: Reach storage standards

Reduce to safety levels, ensuring long-term quality.





Time-critical risk reduction + high batch-processing capacity = end-to-end protection across the post-harvest chain.

In conclusion:

High-moisture grains are not suitable for simply achieving "complete drying at once" under extreme weather conditions. A more reasonable approach is to carry out staged drying and ensure orderly connection.

Stage 1: Emergency rapid moisture reduction, pulling the grains out of the areas at risk of overheating, moldiness, and sprouting.

Stage 2: Deep drying in stationary dryers or low-temperature follow-on drying in the bin, using aeration, circulation, and control to reduce moisture gradually.

Stage 3: After reaching a safe storage moisture level, proceed to short-term storage, opportune sales, or subsequent processing.

An ideal system focuses on synergy—routine drying, emergency backup, and integrated drying-storage—to handle peak harvests and adverse weather.

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