
# FROM MANUAL VENTILATION TO DATA-DRIVEN AERATION

## The new standard for grain storage performance

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Across Europe and North America, grain storage organisations are operating in an increasingly complex environment. Rising energy costs, labor constraints, stricter quality expectations and margin pressure are converging at a time when storage networks are expanding through consolidation.

Operational leaders are now tasked with managing larger volumes of grain across more geographically dispersed sites—often with limited increases in staffing or technical infrastructure. At the same time, the cost of spoilage, quality degradation and inefficiencies in energy usage continues to erode profitability.

### The multi-site challenge

As consolidation reshapes the grain storage industry, operators are increasingly managing networks of facilities rather than single sites. This shift introduces new operational complexities:

- Limited visibility across distributed assets
- Variability in local practices and performance
- Increased reliance on less experienced on-site teams
- Difficulty standardising processes at scale

In this context, one operational lever remains both critical and under-optimised: ventilation.

### The hidden cost of manual ventilation

Ventilation is fundamental to preserving grain quality. Yet, in many facilities, it is still managed using manual processes or basic tools such as thermostats or fixed schedules.

While these approaches may appear sufficient, they introduce several systemic inefficiencies:

#### 1. Increased risk of spoilage

Manual or schedule-based ventilation does not account for real-time variations in ambient air conditions or grain mass behavior. As a result, ventilation often occurs when conditions are suboptimal—leading to uneven, inconsistent cooling which poses a risk to the health of the grain.

#### 2. Energy waste

Operating fans when cooling potential is low is ineffective and results in significant energy loss. Without precise control, operators cannot ensure that every kilowatt-hour contributes to actual grain cooling.

### 3. Operational burden

Manual monitoring becomes increasingly difficult to manage across multiple sites. The results depend heavily on operator judgment and can be prone to human error. For multi-site operators, standardising best practices becomes nearly impossible when relying on individual judgment rather than consistent, data-driven logic.

The result is a gap between intended grain preservation outcomes and actual operational performance.

## A shift toward data-driven ventilation

Automated ventilation powered by data intelligence addresses these challenges by transforming how decisions are made.

Instead of relying on static thresholds or human intervention, modern systems continuously analyze ambient temperature and humidity, in addition to grain temperature profiles within silos. By combining these data streams, automated systems determine when ventilation will actually cool the grain effectively—and only activate when conditions are optimal.

This approach delivers three critical advantages:

**Precision**

- Ventilation is triggered based on the actual thermodynamic potential for cooling—not assumptions.

**Efficiency**

- Automated ventilation can significantly reduce electricity consumption and lower costs for direct impact on profitability.

**Scalability**

- Operational best practices are embedded into the system, enabling consistent performance across multiple sites without increasing workload.

By centralising data and decision-making logic, organisations can unlock strategic value:

- Monitor all silos across all sites in real time
- Apply consistent ventilation strategies regardless of location
- Reduce dependency on individual judgment
- Improve overall network performance from a centralized operational model

In essence, automation transforms ventilation from a site-level task into a network-level performance lever.

## Quantifying the impact

To validate the effectiveness of automated ventilation, Arvalis—the leading agricultural research institute in France—conducted controlled trials comparing different ventilation strategies.

The trials were carried out on Arvalis' experimental platform over two storage campaigns (2022/2023 and 2023/2024). The objective was to measure the number of ventilation hours required to reach a target grain temperature of 12.5°C, a key benchmark for safe storage. Arvalis evaluated three distinct control approaches:

### 1. Scheduled ventilation

Ventilation is activated based on weather forecasts, typically during nighttime windows (10:00 p.m. to 6:00 a.m.), if predicted temperatures remain below a predefined threshold.

### 2. Thermostat-based control

Fans activate automatically when ambient air temperature falls below a fixed threshold, and stop when it rises above it. Cooling is conducted in sequential steps (e.g., first to 20°C, then to 12°C).

### 3. Temperature-difference-based automatic control

Ventilation is triggered dynamically based on the difference between grain temperature (at its hottest point) and ambient air temperature.

Instead of a fixed threshold, this method continuously adjusts activation conditions, typically ventilating only when incoming air is 7–10°C cooler than the grain (expanded to 8–20°C in the second year).

### Key findings

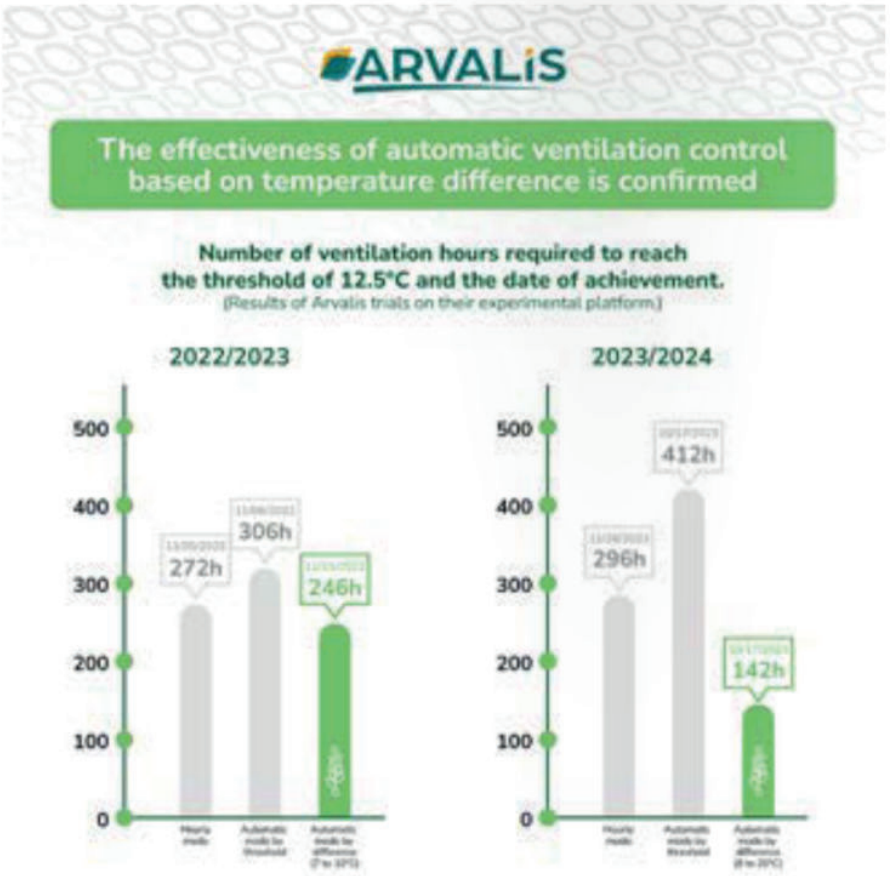
The results across both campaigns were consistent and highly revealing.

### 1. Fewer hours, better performance

Across all scenarios, the temperature-difference-based automated control consistently required the fewest ventilation hours to reach target temperatures.

In 2023/2024:

- Automated control required only 142 hours
- Thermostat control required the longest with 412 hours
- Scheduled ventilation required 296 hours




Automated control represents a reduction of up to 65 percent in operating hours compared to thermostat-based control.

Across both years, thermostat-based control required 60 to 90 percent more ventilation time than temperature-difference control.

A third year of trials during the 2025 harvest campaign, using a lower target temperature of 10°C, confirms this trend. Automated control (Javelot) required 380 hours of ventilation, compared to 692 hours for thermostat-based control, while reaching the target at the same date. Despite the different objective, these results further reinforce the efficiency of temperature-difference-based control.

### 2. More ventilation does not mean faster cooling

One of the most important insights is that longer fan operation does not equate to faster or better cooling.

While thermostat-based control sometimes achieved slightly earlier completion dates, the difference was minimal—typically no more than seven days. In addition, thermostat-based control required dramatically more energy and operating time for cooling.

### 3. Air quality matters more than activation frequency

The study highlights a critical distinction:

- Thermostat-based systems activate more frequently, including when air is only marginally cooler
- Temperature-difference based automatic control activates less often but with significantly colder air

As shown in the analysis of incoming air temperatures, the differential approach consistently injects cooler air into the grain mass, which is more effective for heat extraction.

### Beyond efficiency: The business impact

Reducing ventilation hours is not just a technical improvement—it has direct business implications.

By eliminating ineffective fan usage, operators can significantly reduce electricity consumption—often by up to 30 percent.

More precise cooling reduces the risk of hotspots, moisture migration and spoilage, thereby preserving grain value.

Storage facilities operate more predictably, with fewer interventions and less variability.

Lower energy consumption translates into reduced carbon footprint—an important factor for both regulators and customers.

### Javelot: Turning data into operational advantage

While the concept of automated ventilation is gaining traction, its effectiveness depends on the quality of data and the intelligence applied to it.

Javelot stands out by combining the following features:

- Monitoring of grain and ambient conditions to prevent drying and hotspots with instant alerts
- Advanced algorithms that determine optimal ventilation windows and automated aeration
- A centralized platform to view and manage multiple sites in real time
- Continuous performance analysis to improve ventilation efficiency over time

Once connected, storage operators gain full visibility across their network—enabling better decisions, faster response times, and consistent outcomes.

More importantly, Javelot shifts ventilation from a reactive task to a proactive, data-driven strategy—one that aligns operational efficiency with business performance.