



Pallet-level Monitoring

Maximizing Delivered Shelf-life in the End-to-End Fresh Food Supply Chain

Produce freshness, quality, and selection are primary drivers of why people choose one store or brand over another for groceries.¹ Maintaining maximum freshness at the point of the sale to the consumer is a critical competitive competence for grocers and growers alike. Grocers must cull their fresh produce to assure an attractive presentation, but this entails a considerable loss to the grocer, typically over 10% of what they purchase.² Similarly, rejected shipments reduce the selection at the retailer and represent a big cost to the grower, typically 5%-10% of revenue.³

For fresh produce, total losses in the US are estimated at ~33% of the harvest, with supply chain and retail loss accounting for around 18%, while post purchase "plate waste" is about 15%.⁴ Lack of consistency in the end-to-end handling of produce is the primary cause of the supply chain and retail loss. Though most growers and grocers believe they are doing the best they can, a significant portion of this loss is avoidable. A different approach to temperature monitoring and freshness management throughout the supply chain can have a significant impact on the outcome.

To make a real difference in freshness, temperature monitoring needs to be done at the item/case-level or pallet-level. There are significant variations in the handling and temperatures that each pallet in a lot is exposed to. This results in significant shelf-life variations between pallets. A precise understanding of these per-pallet variations is foundational to improving freshness. Pallet-level monitoring enables a more intelligent approach to distribution—Intelligent distribution and FEFO inventory management (First Expired, First Out)—as well as providing the data needed to optimize endto-end processes for maximum shelf life. Implementing these approaches can cut losses in half for retailers and growers.

¹ For more on the competitive battle for freshness, see <u>Winning the Freshness Wars</u>

² Dana Gunders, NRDC, <u>Wasted: How America Is Losing Up to 40 Percent of Its Food from Farm to Fork to Landfill</u>

³ Pierson, Allen, and McLaughlin, MSU, *Produce Losses in the U.S. Food Distribution System*

⁴ Why Quality Consistency Matters: Reducing Waste and Maintaining Shelf Life in Our Fresh Food Supply



Contents

The Importance of Pallet-Level Monitoring	1
Environmental vs. Product Temperature Monitoring	1
Monitoring the End-to-End Process	2
Capturing the Element of Time	2
Continuous Monitoring to Achieve an Accurate End-to-End Picture	2
Translating Pallet-level Monitoring into Freshness Improvements	2
FEFO Inventory Management	3
Intelligent Distribution	4
Uniform Shelf-life Shipments	5
Shelf-life Maximizing Process Optimization	5
Advantages of Pallet-level Monitoring Over Visual Inspection	6
Solving the Freshness Challenge Requires Pallet-level Monitoring	6

The Importance of Pallet-Level Monitoring

Environmental vs. Product Temperature Monitoring

Modern produce supply chains include a lot of environmental monitoring, such as monitoring the temperature in the field, the pre-cooler, the refrigerated trailer, and the refrigerated warehouse. The assumption is that monitoring the environments in which produce has been stored and conveyed accurately captures the temperatures that the produce has been subjected to. *That assumption is wrong*. In fact, pallet-to-pallet variations happen at many steps throughout the end-to-end journey, such as:

• <u>Harvest</u>—Cut-to-cool times can vary significantly by pallet, even those from the same field, using the same process. For instance, it can take roughly 15 minutes to pick and build a pallet of lettuce in a field operation. If the crew assembles 12 pallets to fill a flat-bed truck, the first pallet

was harvested roughly 3 hours before the last pallet.
At summertime temperatures, this can result in a variation of roughly 3 days⁵ of remaining freshness
between the first and last pallets from the same load. Harvested crops often remain in the field even longer, severely impacting the freshness of product.

<u>Pre-cool</u>—In a variety of pre-cool equipment, the rate of cooling is often not uniform across all the pallets in the unit, varying by up to 4°F (2°C). Furthermore, pallets can enter pre-cool at significantly different temperatures (due to factors like different cut-to-cool times).



<u>In-transit</u>—Studies have shown that the ambient temperature is not uniform throughout most refrigerated trailers and those differences vary over the length of a journey. It is not uncommon for the temperature of two pallets in the same trailer to be as much as 12° F (6³/₃° C) different from each other.⁶

To understand the true temperatures that a product has been exposed to, it is therefore important to monitor the temperature at the product itself, rather than the surrounding environment. While case-level monitoring is possible, most produce travels from field to final destination on a pallet, and therefore the pallet is the most economical unit for measuring temperature very near the product itself.

⁵ According to one source, <u>Advances in Precooling techniques and their implications in horticulture sector: A</u> <u>Review</u>, "as much deterioration can occur in 1 hour at 25°C as in a week at 1°C." Other factors beyond the field temperature at the moment of harvest also impact the rate of shelf-life loss for produce sitting in the field or waiting to be cooled. This includes the temperature the night before, whether or not it rained in the last 48 hours, and other factors that increase respiration rates and thereby further constrain cut-to-cool time. ⁶ Nunes, Nicometo, Emond, Melis, Uysal: <u>Improvement in fresh fruit and vegetable logistics quality: berry logistics field studies</u>

Monitoring the End-to-End Process

Environmental monitoring also does not capture variations in how individual pallets are handled at each step throughout the end-to-end process. Consider for example the step of loading the reefer trailer. Often the driver has not pre-cooled the trailer; they turn on the reefer unit just before they start loading the trailer. The first pallets loaded into the trailer help to cool down the trailer, but in the process those pallets are warmed up as well. Finally, after the last pallet is loaded, the driver puts the temperature monitor into the trailer and pushes the button to start recording the temperature. The trailer's temperature recording device missed all of those events during the loading process and the dramatic variations of temperature that each pallet was exposed to.

The same types of variations and missed events happen at each process step in the end-to-end journey of each pallet of produce—whether it was how long it sat in the field, when and where it was placed in the pre-cool unit, periods of time outside cold storage during loading and unloading, and so forth. When only environmental monitoring is done, there are many missed temperature deviation events for every process step and handoff.

Capturing the Element of Time

This is not just a question of temperature, but also capturing the time spent for each pallet at each process step at various temperatures. Time is an overall critical component to determine the net effect. For instance, how long was the product subject to heat, dryness, or harsh light? Just knowing the peak temperature or an instance measurement is not sufficient to gauge the impact on the product.

Continuous Monitoring to Achieve an Accurate End-to-End Picture

Trying to stitch together an end-to-end picture from a series of separate, unintegrated environmental monitoring data does not work. Pallets must be continuously monitored from field harvest through final delivery. That is the only way to get a faithful end-to-end history of each pallet, required to accurately calculate the accumulated impact of temperature variations that the produce has been exposed to, and thereby correctly gauge delivered freshness. And *that is what really matters*.

Translating Pallet-level Monitoring into Freshness Improvements

There are several ways that pallet level monitoring can be used to improve freshness and reduce losses:

- <u>FEFO Inventory Management</u>—Inventory and stock rotation based on First Expiring, First Out optimizing for remaining freshness.
- <u>Intelligent Distribution</u>—Optimized distribution decisions, based on the remaining shelf life of each pallet.
- Uniform Shelf-life Shipments—Shipments contain pallets of similar remaining shelf life.
- <u>Shelf-life Maximizing Process Optimization</u>—Each process step optimized to maximize the shelf life of the product.

FEFO Inventory Management

Most warehouses and distribution centers (DC) use a First In, First Out (FIFO) method for determining which pallets to ship next. This is based on the false assumption that all pallets have been handled the same, and therefore the oldest pallets have the shortest shelf life and should be sent first. Lacking pallet-level visibility, all the pallets in a lot look the same and are treated the same with no opportunity to expedite and recover product with shorter remaining shelf life. Pallet-level end-to-end monitoring gives a much more precise picture of the remaining shelf life, enabling a First Expired, First Out (FEFO) approach, which is smarter and more accurate. The remaining shelf life is calculated, based on the product/pallet level data captured throughout the life of the pallet; the complete temperature history inside the pallet from the time of harvest to the present. Various shelf-life models have been developed that can be used to calculate the remaining shelf life for each specific variety of produce.⁷

In its simplest form, a FEFO approach will ship the pallets with the least remaining shelf life first, as shown in Figure 1 - FIFO vs. FEFO Distribution. In this highly simplified example, the traditional FIFO approach (shown on the left) ships pallet 1 first, since that pallet arrived first and is assumed to have the least remaining shelf life. With FEFO, that same pallet is shipped third, because two other pallets have shorter remaining shelf life and therefore should be shipped first, even though they arrived at the DC later than pallet 1.



FIFO Distribution

'Simple' FEFO Distribution





⁷ For example, <u>A generic model for keeping quality of vegetable produce during storage and distribution</u> describes parameters for shelf-life models for 60 different fresh fruits and vegetables. <u>Improvement in fresh fruit and</u> <u>vegetable logistics quality: berry logistics field studies</u> reviews several existing shelf-life models for berries.

Intelligent Distribution

Intelligent distribution improves on the simple FEFO approach by adding intelligence about the destinations. Specifically, decisions are made matching the remaining shelf life of each pallet to the transit time and consumption velocity of each destination. Pallets with the lowest remaining shelf life will be sent to the destinations that require the least transit time and/or have the highest velocity of consumption.⁸ Longer shelf-life pallets are sent to destinations that are further away and/or slower in consuming the product. Other attributes can be factored into an intelligent routing algorithm, such as the importance, type, and/or meticulousness of each customer or contractual shelf-life obligations. For example, food services (restaurants, cafeterias, food processing) require less shelf life than grocery retailers.⁹

Figure 2 – *Simple FEFO vs. Intelligent Distribution*, shows that a simple FEFO approach sends pallet 2 and pallet 4 to Destination 1, since those two pallets have the least remaining shelf life, and Destination 1 was the next shipment to be sent. Intelligent Distribution understands that Destination 1 should not be sent any produce that has less than nine days of shelf life left (4 days in transit + 5 days consumption velocity). So it sends those two pallets to Destination 2, which is closer and has a higher consumption velocity.



'Simple' FEFO Distribution

Intelligent Distribution

Figure 2 – Simple FEFO vs. Intelligent Distribution

⁸ For example, different retail locations (DCs or stores) will have different velocities of produce sales (higher or lower inventory turns).

⁹ Food processors are high velocity and will usually process produce on the day of receipt. In contrast, the consumers purchasing produce from a retail grocer expect several days of remaining shelf life after they have purchased it from the store, where it may have already sat for a few days.

When FEFO is combined with intelligent distribution, it results in significant reductions in spoilage and losses. Figure 3 below shows that for strawberries, losses are reduced from 37% to 23% and even greater improvements for other products.



Figure 3 – Comparison of Product Loss using Traditional Approach vs. with FEFO and Intelligent Distribution¹⁰

Uniform Shelf-life Shipments

Without pallet-level knowledge of actual remaining freshness, loads may be built with significant variations in freshness from one pallet to the next pallet. In many if not most cases, the downstream distribution center may not have implemented FEFO or intelligent distribution, in which case those variations will result in some potential spoilage, since the downstream facilities assume uniform freshness for the entire shipment. Delivering uniform freshness in a shipment accommodates current downstream distribution and inventory management capabilities that typically have not been optimized for either intelligent distribution or FEFO inventory management.

Shelf-life Maximizing Process Optimization

Pallet level visibility enables the grower and others handling the product to better understand the impact of their current processes on shelf life and thereby make improvements. For example, today the loss of shelf life resulting from longer cut-to-cool times is not being measured in most farm operations. Lacking visibility into the impact of cut-to-cool time, the grower optimizes logistics efficiency instead, waiting until their truck is full before taking product from the field back to the pack house. Once the grower understands the impact in reduced shelf life, they may decide to make more frequent trips, with smaller loads, so that the product has less time at elevated temperatures.

If they similarly understand the impact of shelf-life variations between pallets, the grower might also fine tune their processes by prioritizing the pre-cool of warmest pallets first, thereby reducing those

¹⁰ Source: Jedermann, Nicometo, Uysal, Lang: <u>*Reducing food losses by intelligent food logistics*</u>

variations and achieving more consistent quality. They might also take steps to ensure more uniform pre-cooling, such as maintaining sufficient airflow through proper positioning of pallets and correctly working fans. Similarly, if truck drivers have real-time visibility on how their actions are impacting shelf life, they would be much more likely to turn the trailer's reefer unit on sooner, to be sure that it is brought down to the right temperature before loading. Similar improvements are possible at each process step in the fresh food supply chain.

Of course, shelf-life maximizing process improvements don't just happen automatically once pallet-level temperature monitoring is done. They require that the measurements and impacts of actions are made visible to the managers and workers, and that their performance metrics (and ideally compensation) are at least in part based on how they are impacting shelf life.

Advantages of Pallet-level Monitoring Over Visual Inspection

Remaining shelf life is invisible until near the end of a product's usable shelf life. That's why visual inspection often does not provide real insights into the remaining shelf life of product. Furthermore, random sampling completely misses per-pallet variations. An entire shipment may be rejected because the worst-case pallet was inspected ... or accepted because the best-case pallet was inspected. Pallet-level monitoring allows much more precision in a grocer's decision on which pallets to accept or reject.

Solving the Freshness Challenge Requires Pallet-level Monitoring

End-to-end pallet-level monitoring captures the actual conditions across the life of the product from the moment of harvest until delivery to the retailer. It encompasses all the pallet-level variations, to provide a much more realistic estimate of actual remaining freshness. With accurate actual freshness data, FEFO inventory management and Intelligent Distribution can be implemented. An example of a solution implementing Intelligent Distribution methods is ZEST Fresh with its Zest Intelligent Pallet Routing (ZIPR), which maps the spectrum of actual freshness against the spectrum of freshness needs per customer destination. This proactively *avoids* waste, by managing product at the pallet level, based on the actual freshness. Further improvements are possible by looking for opportunities at each process step in the chain to optimize processes for maximizing shelf life. When combined, these efforts have been shown to cut losses in half or more for grocers and growers, adding significantly to their bottom and top lines, as well as to the ultimate goal of end-consumer delight with the freshness of the produce.





321 Walnut Street, Suite 442 Newton, MA 02460-1927 617-762-4040

Email: <u>info@CLResearch.com</u> Web: <u>www.ChainLinkResearch.com</u>