Perishable Food Supply Chain Visibility
Problem: food waste

In the United States, food waste is between 30–40 percent of the food supply. This figure corresponds to 133 billion pounds and $161 billion worth of food per year.

In the EU it is now law that EU countries must halve per capita food waste at the retail and consumer level by 2030 and reduce food losses along the food production and supply chains.

Wasted food is the single largest category of material placed in municipal landfills and represents nourishment that could have helped feed families in need.

Additionally, water, energy, and labor used to produce wasted food could have been employed for other purposes.

Why Waste? Spoiler alert: desire for freshness, fear of food poisoning
Every manager of perishable products has three questions

1) How fresh is my stock?
2) How long will my stock stay fresh?
3) Are there any problems with my stock?
Invisibility = guess work

Due to a lack of visibility about the condition of perishable stock

- **Stock Forecasts** are inaccurate
- **Actual Availability of Goods** is poor
- Forced to keep **Inventory Levels** high

Increased Food Waste
Supply Chain Visibility

FreshSurety

Dashboard
Control Cards
Inventory
Reports

Inventory

<table>
<thead>
<tr>
<th>PLU-Code</th>
<th>Variety/pack</th>
<th>Quantity</th>
<th>SSCC-18</th>
</tr>
</thead>
<tbody>
<tr>
<td>4246 Berries</td>
<td>Strawberry/pint</td>
<td>22 X 108</td>
<td>(00)101123131 000023720 3</td>
</tr>
<tr>
<td>4246 Berries</td>
<td>Strawberry/pint</td>
<td>15 X 108</td>
<td>(00)101123131 000021456 3</td>
</tr>
<tr>
<td>4246 Berries</td>
<td>Strawberry/pint</td>
<td>22 X 108</td>
<td>(00)101123131 000021675 3</td>
</tr>
<tr>
<td>4228 Berries</td>
<td>Strawberry/quart</td>
<td>18 X 108</td>
<td>(00)101123131 000022153 3</td>
</tr>
<tr>
<td>4228 Berries</td>
<td>Strawberry/quart</td>
<td>10 X 108</td>
<td>(00)101123131 000022153 3</td>
</tr>
</tbody>
</table>

Support
support@freshsurety.com
+1 321-209-8699
www.freshsurety.com
A berry producer in California has an order for 22 pallets of strawberries to be delivered to Florida (5-7 days trip).

A look at the Dashboard Freshness Status shows that 50% of his stock will make the trip (green strip) and 50% will not (yellow & red strip).

The order should be filled with the > 5 days remaining stock.

Without this tool the produce supplier would blindly fill the order resulting in spoiled product arriving at the customer.
At a Distribution Center produce managers have selected a policy to maintain an *Average Freshness Level of 40 cartons* (non-conforming/bad cartons) per 1000 cartons.

**Task:** the Distribution Center must fulfill orders for 200 cartons with the established above *Average Freshness Level*.

Since only 100 cartons will be available on Day 1 with the established quality level or better (green & yellow) the Distribution Center must wait another delivery - Day 2 to finish the orders for 200 cartons due to lack of stock with desired quality.

(On Day 1, 100 cartons, in red color meaning that berries quality do not match the established quality/freshness level.)

Without this tool produce managers would blindly fill the order resulting in poor quality product to the customer.
Use Case #3 (Inventory Level)

New FreshSurety Exclusive Tool: Freshness Score

At the same Distribution Center where produce managers have selected a policy to maintain an *Average Freshness Level of 40 cartons* (non-conforming or bad cartons) per 1000 cartons.

An incoming truckload of strawberries with this Freshness Score is at the dock.

Its Freshness Score is predicted to get drastically worse in 3 days causing the *Average Freshness Level* for the entire stock of strawberries to violate the Distribution Center policy.

The produce managers now have the supply chain visibility to chose:

1. Reject the load and reorder
2. Alter policy and accept the load
3. Accept the load and use stock from this load until day 3 to maintain policy
4. Accept the load at a modified price

*Because of increased supply chain visibility these produce managers can make an informed choice about the inventory!!!*
News Flash: Mycotoxin contamination

We interrupt this pitch:

Due to wet spring weather in the Mid-US, Mycotoxins, (fungal metabolites which are the most toxic substances known to man and capable of infecting all types of grains) will be at record levels this harvest, further cutting the US grain supply

Mycotoxins are invisible, odorless and tasteless, and occur in “hot spots”, making sampling difficult throughout a grain store

The only way to determine if grains or feeds contain these undesired compounds is to analyze for them which is done, (legally mandated), only at Point-of-Sale, after all costs are sunk

Leveraging FreshSurety technology, grain bins can be equipped with our spectrometers inserted into the grain at various levels throughout the gain bin detecting problems which can be fixed before contamination spreads

Our spectrometer measures Mycotoxins in real-time, temperature, air moisture and sensor location, (1/2-foot accuracy) relaying this actionable data to an operator.

Back to the regularly scheduled pitch:

Packaged into a “Ball” pressure vessel designed to pass though augers but caught by screens, it reports the sensor height in the grain bin. Proprietary radio works inside the grain bin.
Food supply chains
Return On Investment

Forecast Accuracy UP 52%
Actual Availability of Goods UP 37%
Reduce Inventory Levels 47%

For perishable food supply chains greater than 5 days, > 30% reduction in food losses
Wonder how we do it?

Our system automatically tracks perishable product, predicting freshness which helps managers to make the right decisions.

Alerts if microbial action or other problems are detected.

Our patent pending simultaneous spectrometer can be deployed in the 100’s.

We take this Gas Sensor data, temperature and water vapor data and use it to create a code for all sensors on a pallet or truck at any point predicting the future 6 days.

We then run the code though our algorithms to determine freshness and detect certain compounds that indicate problems.
Why doesn’t Time & Temperature Work?

Simple, Time & Temperature will always miss:

- Mechanical damage, over-the-road vibration & shock, rough handling, about 33% of all losses.
- Cool Down Stress about 15% of all losses
- Picking Stress, (handedness) about 8% of all losses
- Field Stress, (transport & local storage) about 12% of all losses
- Inter-Field Micro-Climate variations, about 15% of all losses

Cultivar variations (must have a laboratory established $Q_{10}$ rate per cultivar)

Why doesn’t Time & Temperature Work?

- **Wrong** 84% of the time
- **Right** 99.3% of the time

Competition

Based on time & temperature

FreshSurety

All Others
Example of Cool-down Stress

This Pallet of product did not respond well to cool down as indicated
The temperature profile was perfect

FreshSurety data from coast-to-coast transport in a modified atmosphere
Pallet was Accepted yet was a total loss within 12 hours
Example of Cool-down Stress (cont.)

The Temperature profile was perfect!
Example of Mechanical Disturbance

This Pallet of product did not respond well to mechanical over-the-road shocks.

The temperature profile was perfect.

FreshSurety Data from coast-to-coast transport. Stop in Los Angeles as shown.

Sensors mounted in the upper 1/3 of the pallet indicated the problem.

Total loss at arrival.
We are often asked if Time & Temperature freshness estimates could be improved by estimating mechanical damage using cheap Inertial Measurement Units, (IMUs).

Yes and No, because each piece of product in the truckload is an independent free-body many IMU’s are required. In fact a greater number of IMU’s would be required than the number of FreshSurety sensors normally required.

So yes it could predict mechanical damage but no since these would still miss about half the remaining problems

So why bother?
How many sensors do we need?

Our technology allows for automated real-time sampling of perishable stock.

For a 95% quality confidence level this many sensors are required:

<table>
<thead>
<tr>
<th>Number of Cartons/Flats</th>
<th>Recommended Number of Sensors for 95% Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pallet 26 to 50 count</td>
<td>8</td>
</tr>
<tr>
<td>Pallet 51 to 90 count</td>
<td>13</td>
</tr>
<tr>
<td>Pallet 91 to 150 count</td>
<td>20</td>
</tr>
<tr>
<td>Truck Load 1,201 to 3,200 count</td>
<td>125</td>
</tr>
</tbody>
</table>

Without FreshSurety technology only very low confidence level <10%, (meaningless) perishable quality inspection plans are possible.

Because these plans have limited value, they are simply not performed making the condition of perishable stock invisible resulting in food waste.
Conclusions:

Time & Temperature solutions, can estimate freshness only 16% of the time

Only FreshSurety has a cheap simultaneous spectrometer with the required sensitivity to estimate freshness at a 95% confidence level

Only FreshSurety offers the ability to implement an automatic acceptance sampling plan with mathematically meaningful results rather than hope

All other competitors have repeatedly failed to predict freshness
## Sensor Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Communications</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radio #1</td>
<td>6LoWPAN</td>
<td></td>
<td>low-power mesh networking</td>
</tr>
<tr>
<td>Radio #2</td>
<td>167 - 1024 MHz</td>
<td>MHz</td>
<td>Proprietary Radio</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>7</td>
<td>cm</td>
<td>CEP</td>
</tr>
<tr>
<td>Lat, Lon</td>
<td>1</td>
<td>m</td>
<td>CEP Assisted GPS</td>
</tr>
<tr>
<td><strong>Sensor</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reprogrammable Wide-Band Simultaneous Spectrometer</td>
<td></td>
<td></td>
<td>No consumables</td>
</tr>
<tr>
<td>Sample Introduction</td>
<td>Gas/Vapor Phase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limit of Detection ethylene</td>
<td>&lt;1</td>
<td>ppb</td>
<td>C₂H₄ in N₂</td>
</tr>
<tr>
<td>ethylene Measurement Range</td>
<td>&lt;1 to 32,000 ppb</td>
<td></td>
<td>Tested in complex mixture of volatile organic compounds (VOCs)</td>
</tr>
<tr>
<td>Reversible Operation</td>
<td>Fully</td>
<td></td>
<td>Non-biofouling design</td>
</tr>
<tr>
<td>Time to Answer</td>
<td>12 seconds</td>
<td></td>
<td>Can make repetitive measurements back-to-back</td>
</tr>
<tr>
<td>Selectivity, (catalyst free)</td>
<td>1.005</td>
<td></td>
<td>(as measured by the useful separation factor points over the range C₀-C₁₂)</td>
</tr>
<tr>
<td>Stable lifetime</td>
<td>&gt; 5</td>
<td>years</td>
<td></td>
</tr>
<tr>
<td>Temperature Measurement Accuracy</td>
<td>±0.2</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Equilibrium Moisture Content (EMC)</td>
<td>± 1.6</td>
<td>Percent</td>
<td>Calculated for Corn 10 °C, 60 %RH others available</td>
</tr>
<tr>
<td><strong>Operational Environment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>-5 to 40</td>
<td>Degrees C</td>
<td></td>
</tr>
<tr>
<td>O₂</td>
<td>1.5 to 20</td>
<td>percent</td>
<td></td>
</tr>
<tr>
<td>CO₂</td>
<td>0.5 to 2</td>
<td>percent</td>
<td></td>
</tr>
<tr>
<td>Humidity</td>
<td>&gt; 99</td>
<td>percent</td>
<td>Fully saturated @ 0°C (100% condensing humidity available as a option)</td>
</tr>
</tbody>
</table>
Revealing the invisible in perishable food supply chains

info@freshsurety.com  +1 321-209-8699
FreshSurety at a glance

✓ FreshSurety is a 3-year-old Scaleup
✓ True Unicorn business model, 1st to market
✓ AI and Machine Learning (Recognized Experts)
✓ Spans Ag Tech, Food, Beverage and Logistics sectors
✓ Generating Revenue
✓ Owns Valuable Intellectual Property

Very Experienced Team

John - CEO/Technology Management 35+ years
Marc - Founder & Analytical Chemist 35+ years
Liliya - VP Finance & Food Economist 20+ years
Lawrence - VP Engineering 30+ years