

Hog Feet Color Improvement (Under NDA)

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## Background

Clemens Food Group (CFG) is the 5<sup>th</sup> largest pork processing facility in the US. They have two major facilities located in Hatfield, PA and Coldwater, MI. The Coldwater facility produces darker hog feet than the Hatfield facility. CFG has sponsored this project as an opportunity to increase the market value of the Coldwater product problem.

By implementing a solution to reduce the darker coloration of hog feet in the Coldwater plant, revenue and profit margins for the company could increase. The product can be sold for normal/higher value if the hog feet are lighter in color.

## Pork Processing

To address the color difference between two production lines of hog feet, it's essential to understand the processing steps, which generally include stunning, exsanguination, scalding, singeing, bunging, evisceration, trimming, rinsing, and chilling [2]. The flow may include all these processes.

- **Stunning** renders the hog unconscious and insensible to pain
- **Exsanguination** is the removal of blood from the hog's carcass by severing major arteries
- **Scalding** (Figure 1) immerses or sprays the carcass with hot water or steam to remove and loosen hairs on the carcass
- **Singeing** (Figure 2) removes excess hair by exposes the carcass to intense flames and assists in surface sterilization
- **Whipping** (Figure 3) mechanically removes excess hair with rotating bristles
- **Bunging** loosens and secures the rectum to prevent contamination in evisceration
- **Evisceration** is the removal of internal organs
- **Trimming** removes any inedible or defective tissues
- **Rinsing** removes any residual materials
- **Chilling** rapidly reduces the temperature of the carcass to inhibit bacterial growth



Figure 1: Scalding



Figure 2: Singer

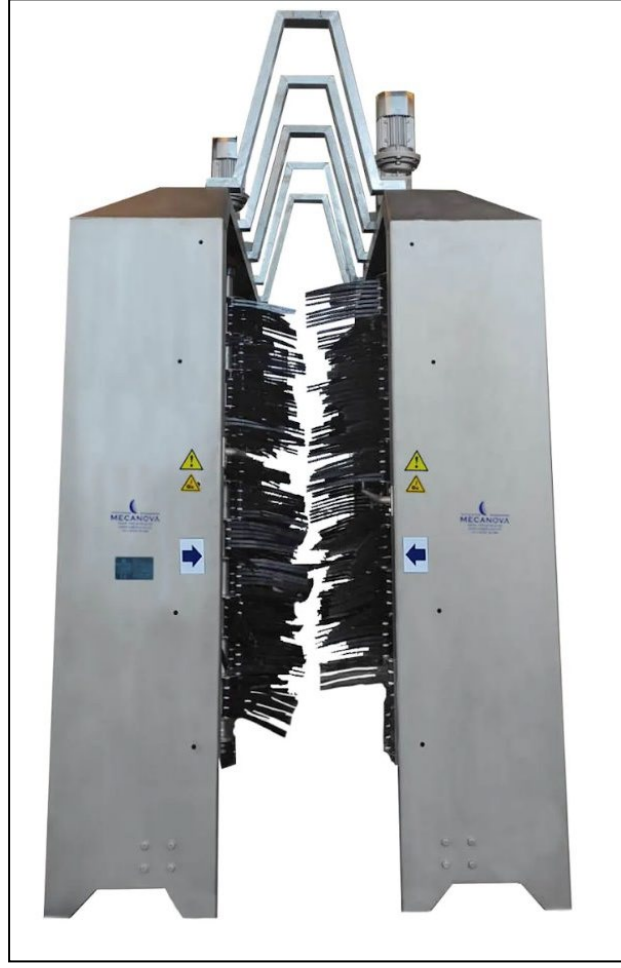


Figure 3: Whipper

## Problem Statement

The project aims to explore and implement practical solutions for improving the overall lightness of hog feet, to minimize the color variations from one plant to another, improving their visual quality and marketability to consumers. The processes suspected as contributors to the color variation are the scalding, singeing, and/or whipping.

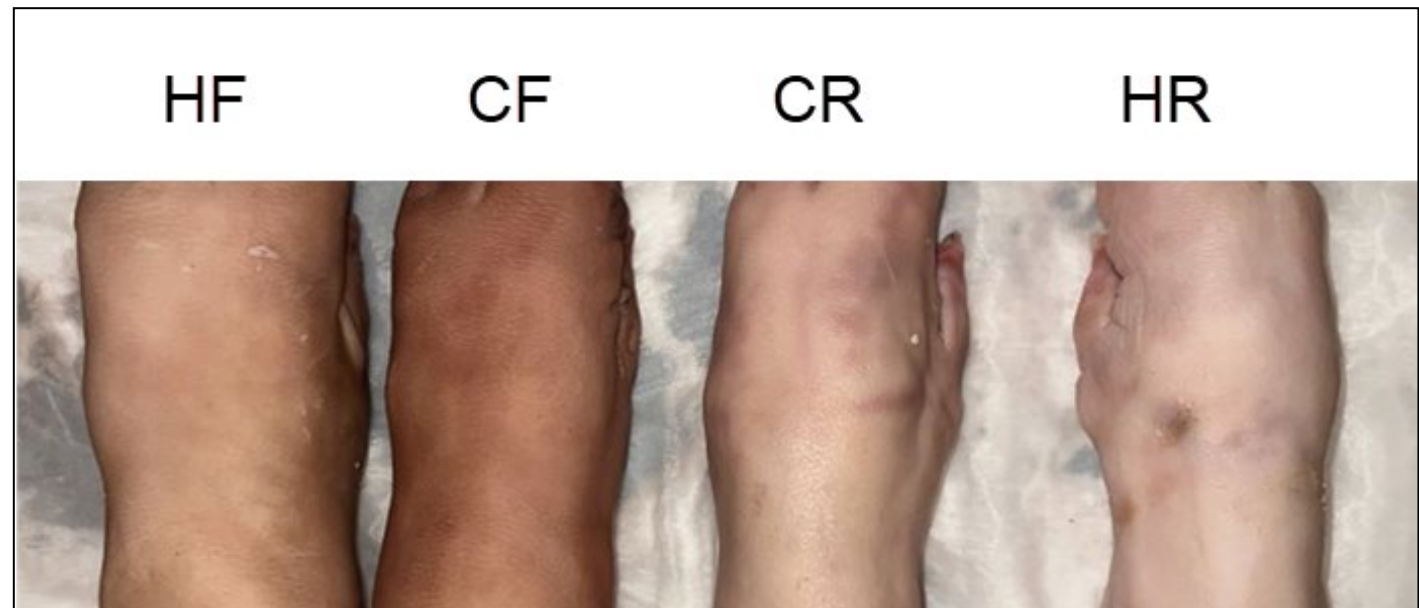


Figure 4: Hogs feet external color examples L to R Hatfield Front (HF), Coldwater Front (CF), Coldwater Rear (CR), Hatfield Rear (HR)

## Objectives

- Identify any significant differences in processing between the Coldwater plant and the Hatfield plant
- Quantify and analyze the color difference between hogs' feet produced in Coldwater and Hatfield
- Suggest a solution that will lighten the color of hogs' feet in the Coldwater plant
- Assess the amount of capital Clemens Food Group will need to invest in the proposed solution
- Calculate the return on investment of the final design implementation

## Constraints

- Inability to directly observe the Hatfield plant processes
- End date for project is April 8, 2025
- Solution implementation and testing needs to be completed within 15 weeks of the project start date
- Complying with Food Safety and Inspection Service's (FSIS) standards for pork processing [1]

## Testing

Testing needed to be completed on the hog's feet to prove there was a coloration difference between plants and to find the root cause of coloration. This occurred in two phases.

### Preliminary testing

- Used a colorimeter and visual testing to determine if Coldwater front feet are darker

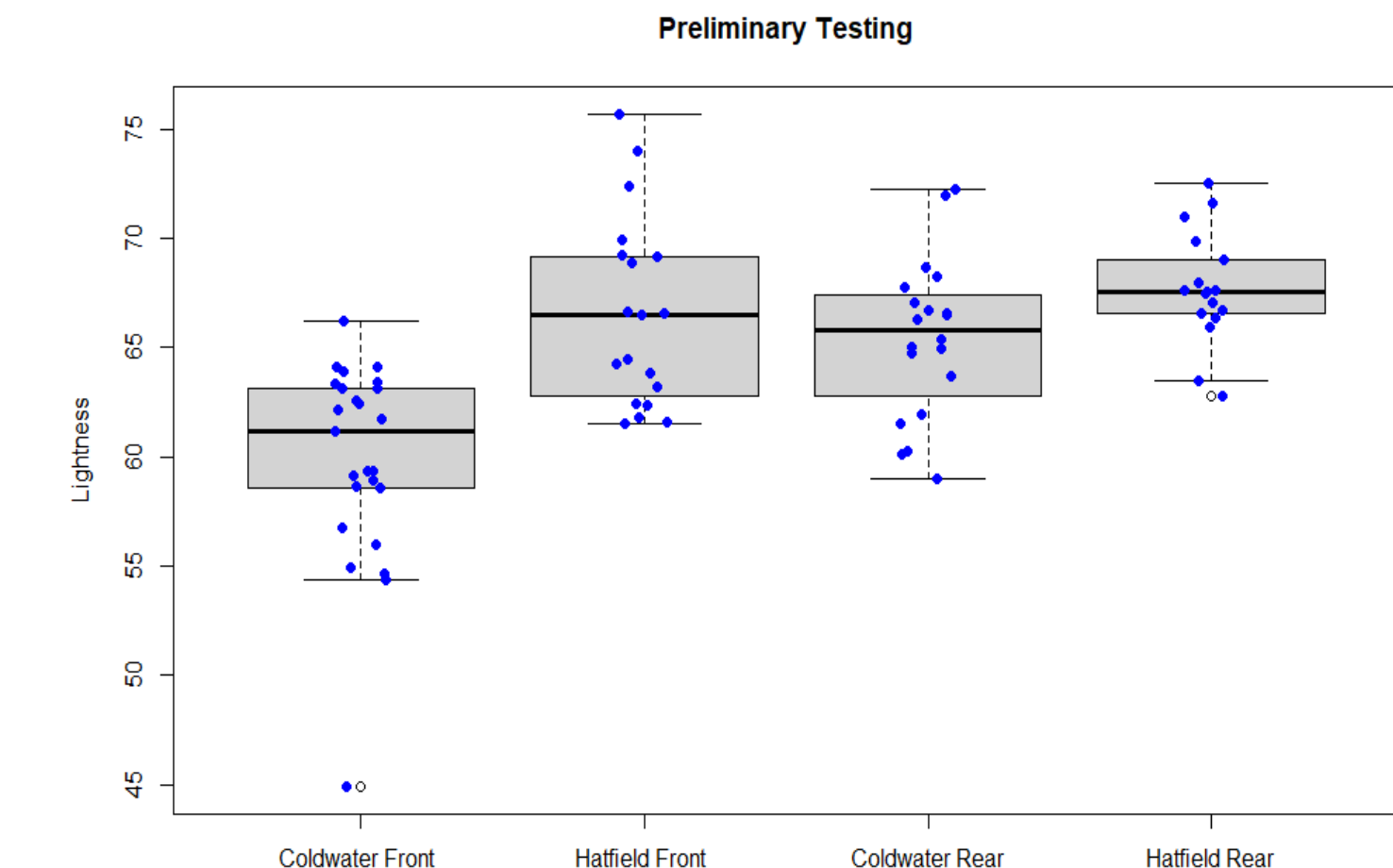


Figure 5: Preliminary Test Colorimeter Results

Table 1: Visual Testing Results

	1 - Darkest	2	3	4 - Lightest
Coldwater Front	29	11	0	0
Hatfield Front	10	26	4	0
Coldwater Rear	1	3	24	12
Hatfield Rear	0	0	12	28

- Figure 5 shows that Coldwater front feet (Figure 4 (CF)) were significantly darker than all other feet tested
- Table 1 shows that most volunteers ranked Coldwater front feet as the darkest

### Root Cause Testing

- Attempted to recreate coloration using in-spec feet
- Tested 3 possible causes of discoloration
  - Internal blood pooling
  - External blood pooling
  - Tanning
- Product was intentionally discolored by team
- Team concluded that internal blood pooling (Figure 6a) most closely matches Coldwater coloration

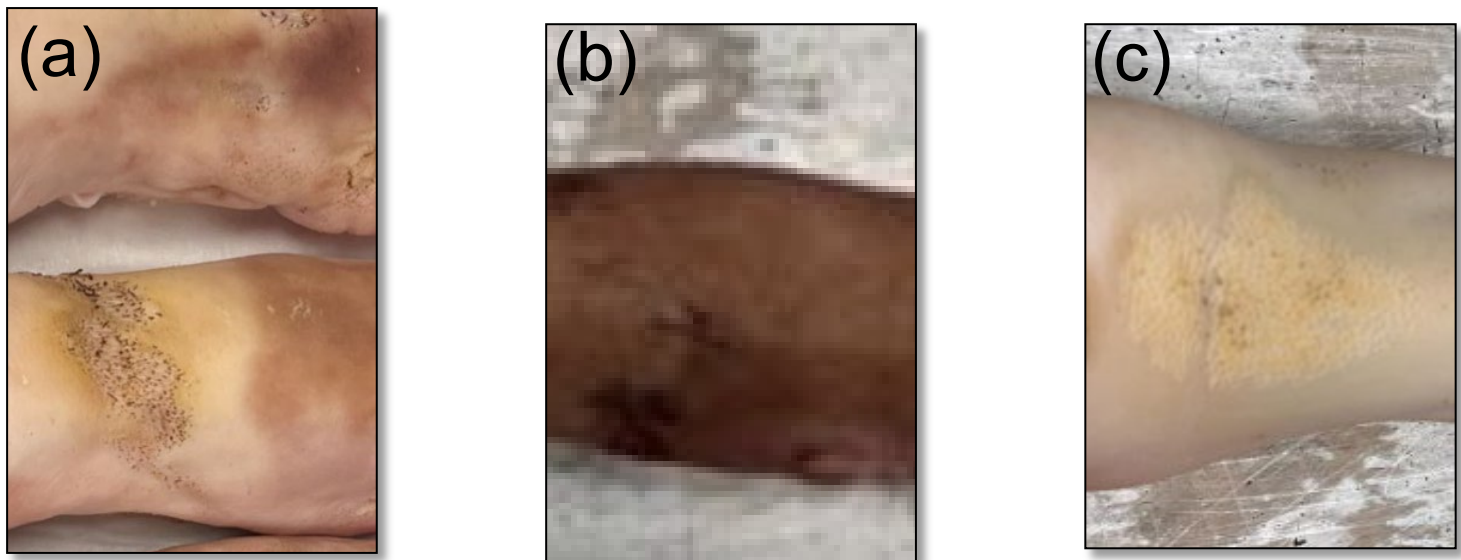


Figure 6: Intentional coloration causation test simulating (a) Internal Blood Pooling (b) External Blood Singeing, and (c) Tanning

## Design Alternatives

### Design #1: Replace vertical scalding with horizontal scalding

- Reduces the amount of time hogs are hung vertically (Figure 7), mitigating blood pooling
- Emulates the Hatfield facility process

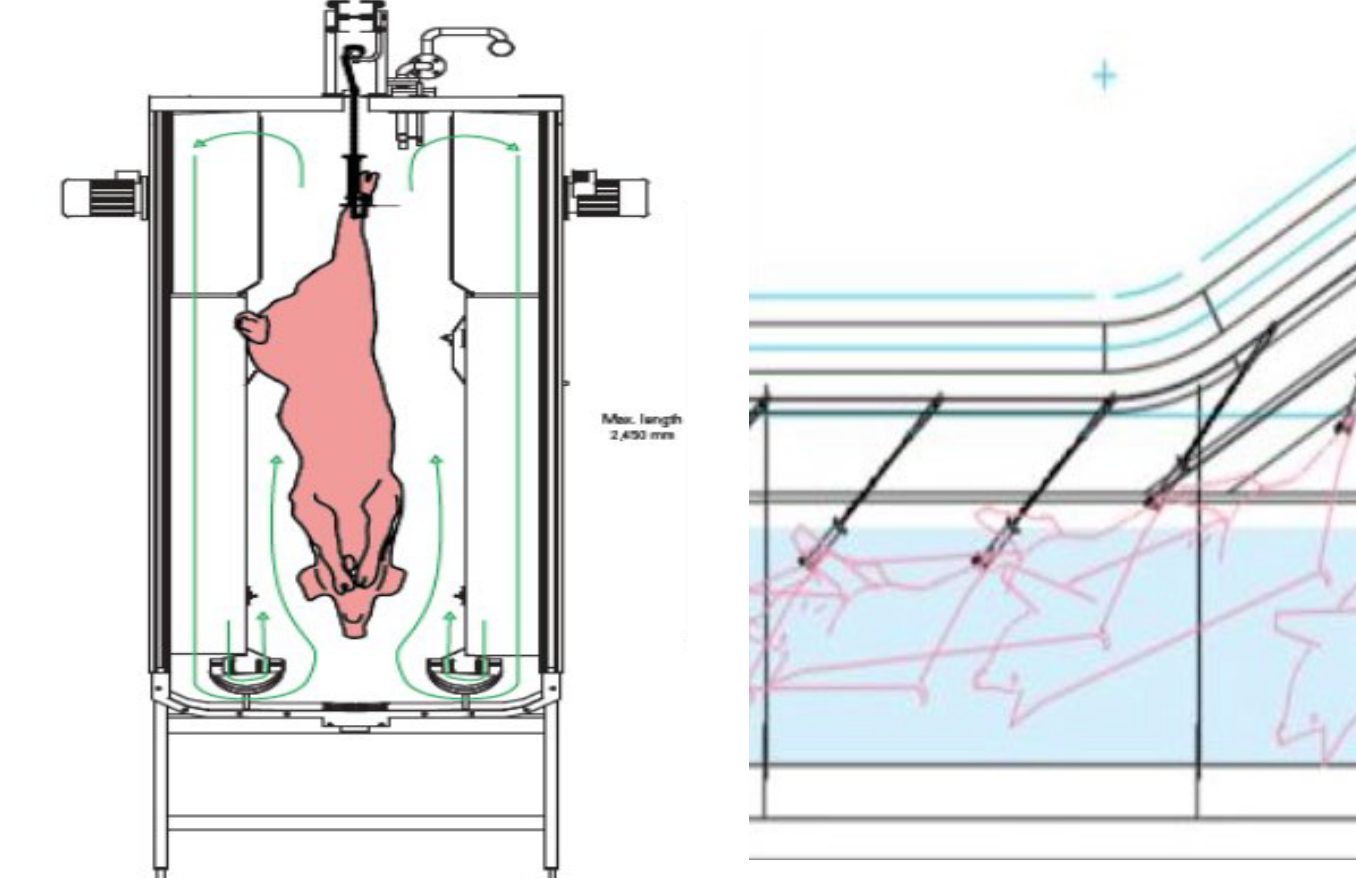


Figure 7: Vertical scalding (left) vs. Horizontal scalding (right)

### Design #2: Water Spray System

- Implemented before the singers
- Removes any external blood
- Creates temperature barrier between flame and skin (Figure 8)



Figure 8: Water spraying system

### Design #3: Mechanical Agitator

- Rotating bar with whippers (Figure 9)
- Implemented in the Coldwater vertical scalding
- Agitates the front feet as hogs pass by, working blood out of feet

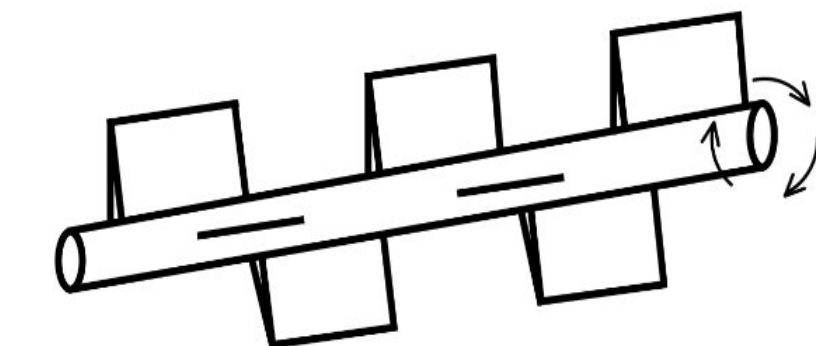


Figure 9: Mechanical Agitator

Table 2: Decision Matrix

	Weight (%)	Replace Vertical Scalding	Spray System	Mechanical Agitators in Scalding
Effectiveness	40	1.0	0	0
Maintenance	15	0.3	0.8	0.8
Cost	20	0.1	0.9	0.7
Safety	15	0.7	0.7	0.9
Ease of Use	10	0.9	0.9	0.9
Total	100	66	49.5	48.5

## Selected Design

Designs were compared using a decision matrix (Table 2). Design #1 was rated the highest and therefore chosen as the primary design. Replacing the vertical scalding with a horizontal scalding greatly outperforms the other design alternatives in terms of effectiveness, which was our highest weighted category.

Table 3 shows a comparison of the vertical and horizontal scalding produced by Frontmatec, a vendor for CFG.

Table 3: Vertical and Horizontal scalding specifications

	Vertical [4]	Horizontal [3]
Scald Method	Steam	Tank ✓
Temperature	Variable	Constant ✓
Time	7.5 min	7 min ✓
Orientation	Vertical	Horizontal
Water Usage	960 gal/day ✓	23,000 gal/day
Energy Usage	729 kW/day	546 kW/day ✓
Hygiene Level	Low Bacterial ✓	High Bacterial
Maintenance	High	Low ✓

## Economics

Table 4: Implementation Costs

Item	Value
Horizontal Scalding + Installation	\$2,250,000
H. Scalding annual operating cost	\$113,500
V. Scalding annual operating cost	\$25,400
Annual operating cost difference	\$88,100
Annual Loss due to discoloration	\$450,000
Annual Net Profit	\$360,900
Payback Period	6.3 years

- The system will create an annual net profit of roughly \$360,000 through discoloration mitigation
- It will take just over 6 years for CFG to break even after installing the system.

## Select References

- [1] USDA. (2023, June). FSIS guideline to control salmonella in swine slaughter. [https://www.fsis.usda.gov/sites/default/files/media\\_file/documents/FSIS-GD-2023-0003.pdf](https://www.fsis.usda.gov/sites/default/files/media_file/documents/FSIS-GD-2023-0003.pdf)
- [2] Brashears, M., Brookes, T., Miller, M. (2024). Pork harvest process. *International Center for Food Industry Excellence*. [https://www.depts.ttu.edu/icfie/upcoming\\_events/ICFIE\\_pork\\_harvest.pdf](https://www.depts.ttu.edu/icfie/upcoming_events/ICFIE_pork_harvest.pdf)
- [3] Frontmatec. (2019). *Pig scalding system - optimal temperature of carcasses*. Pig scalding system - Optimal temperature of carcasses. <https://www.frontmatec.com/en/pork-solutions/unclean-line/scalding-dehairing/vertical-steam-scalding>
- [4] Frontmatec. (2023). *Scalding tank for pigs & Hogs - Professional Solution*. Scalding tank for pigs & hogs - Professional solution. <https://www.frontmatec.com/en/pork-solutions/unclean-line/scalding-dehairing/scalding-tank>