

# Fruit quality losses within fresh fruit supply chains: Digital twins can reveal what we cannot see!

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## 1 Introduction

30% of fresh produce gets lost/wasted along its journey from farm to retail

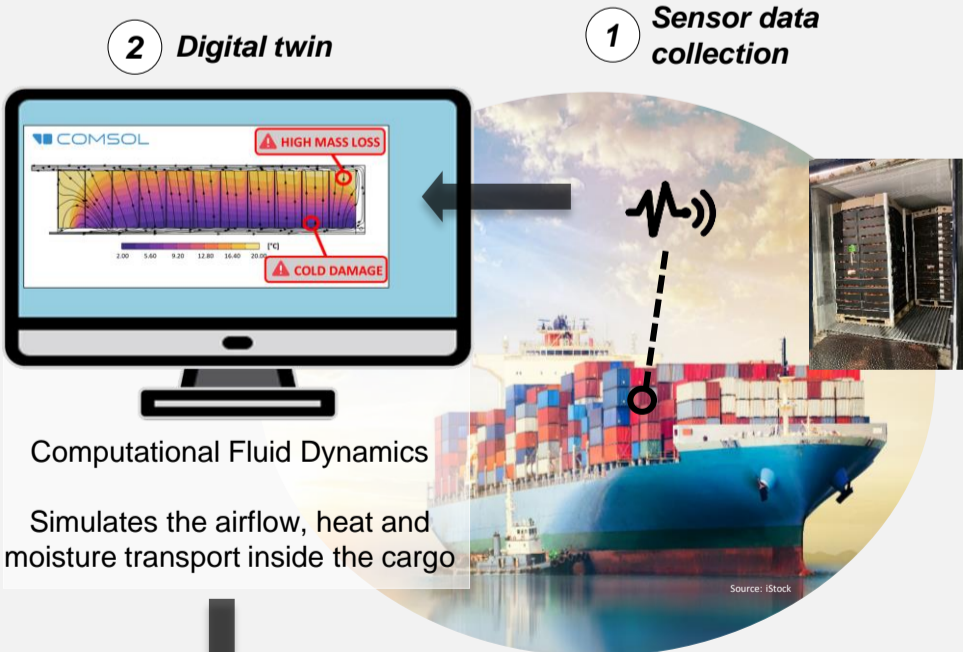
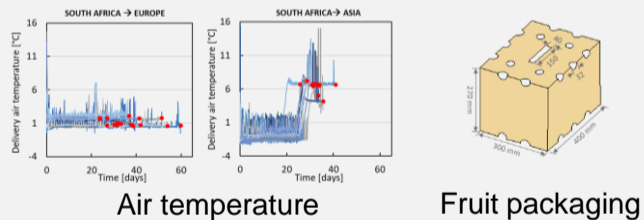
1.3M tons/year of South African oranges are exported using refrigerated containers

Optimal conditions (T & RH) must be applied during transport to prevent fruit quality loss. But what happens with the fruit during transport?



## 2 Method & materials

Using multiphysics modeling, a digital twin of a refrigerated container fully loaded with orange fruit was developed. This digital twin translates measured sensor data (30 shipments from South Africa to Europe and Asia) into actionable metrics to map where fruit quality is lost along the supply chain.



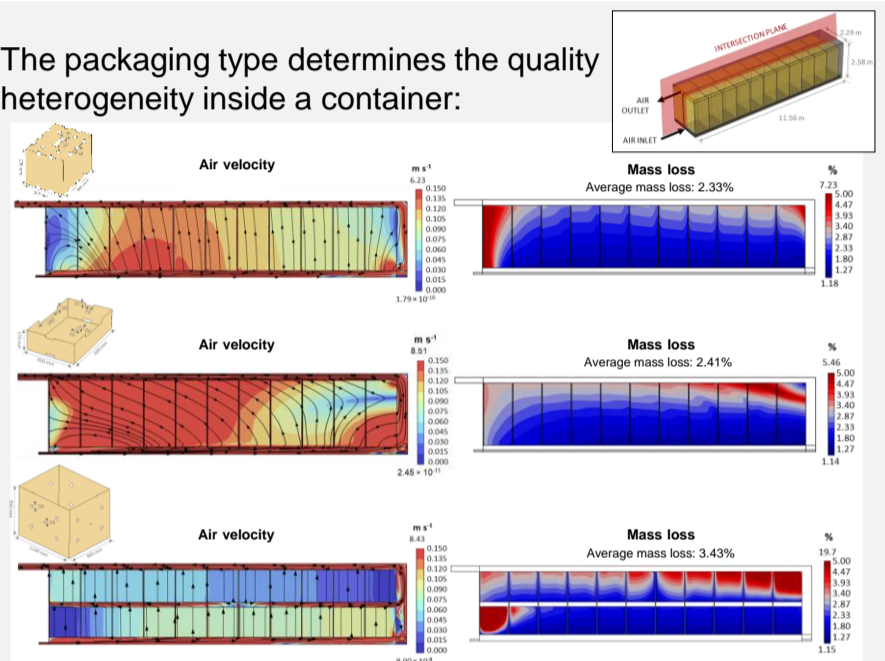
**3 Fruit quality prediction**

- Fruit taste: Sweetness ratio (TSS/TA)
- Cold damage: Chilling injury
- Mass loss: Moisture loss

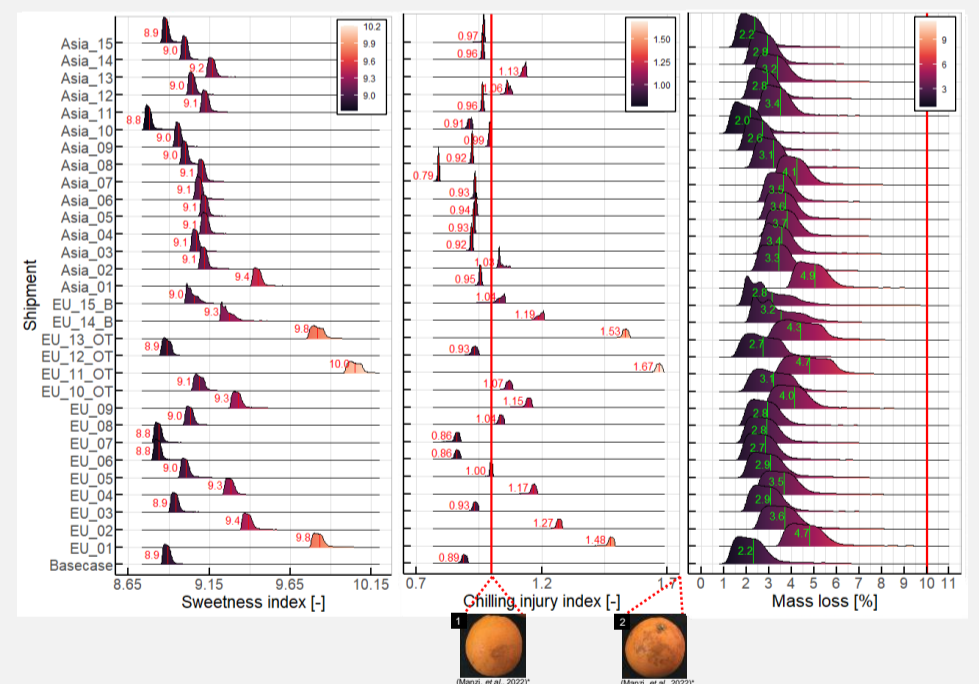
→ where and when do we expect quality issues during transport?

## 3 Results and Discussion

The packaging type determines the quality heterogeneity inside a container:



Quantification of the inter- and intra-container quality variability:



## 4 Conclusion

Fruit quality differences between shipments are much larger than within an individual shipment as a result of the varying shipping durations and applied delivery air temperatures.

- Every shipment is unique → important to monitor each shipment → large added value of deploying a digital twin
- The fruit packaging type impacts the quality distribution within a container, but not the average quality of the cargo

## 5 Transformation towards sustainable food systems

Towards data-driven, smart supply chains (First Expired, First Out strategy)

Ensure that high quality foods are being delivered to consumers (towards reduced food losses. sustainable supply chains & zero hunger)