TERRa-Fresh
Logistics Under Regular and Disrupted Conditions

Francisca Quijada, J. Rene Villalobos
International Logistics and Productivity Improvement Laboratory
Arizona State University
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Background

- Tactical planning based on expectations of input parameters, deployment conforms the next step
- What happens if the expected does not occur? How can it be possible to successfully fulfill contracts within a timely manner if conditions are adverse or different?
- How to take advantage of the data generated during the deployment phase, to increase product traceability & supply chain visibility?

PHASE I
Production Planning
(Tactical)

PHASE II
Planning Deployment
(Operational)

Some decisions
- Aggregation of grower production for transportation
- Fleet Routing
- Inventory at distribution nodes control
- Internal environmental control of fresh produce conditions to maximize shelf life
- Among many others…
Case Study Review

- Growers in **6 regions and 7 crops**
- Planning tools aim to identify best production/supply plan for a given contract for demand in Las Vegas
- The optimal production plan for the growers in the selected regions is analyzed for a contract **with & without the market opportunity**
- Results are **highly dependent** on the inputs used for the model & current operational conditions

<table>
<thead>
<tr>
<th>Location</th>
<th>Land Available Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albuquerque</td>
<td>60</td>
</tr>
<tr>
<td>Aspen</td>
<td>10</td>
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<tr>
<td>Las Cruces</td>
<td>30</td>
</tr>
<tr>
<td>Phoenix</td>
<td>40</td>
</tr>
<tr>
<td>Tucson</td>
<td>30</td>
</tr>
<tr>
<td>Yuma</td>
<td>30</td>
</tr>
</tbody>
</table>

Cucumbers  
Tomatoes  
Bell Peppers  
Celery  
Cauliflower  
Green Beans  
Romaine Lettuce
Aspen
Las Cruces
Yuma

Sample output: Contract fulfilment with Market Opportunity for Cucumbers

Buy from Spot Market

Produce

Target Demand Node
Some operational decisions for under a data-rich environment and fully automated logistics scheme:

- Aggregation of grower production for transportation
- Fleet Routing
- Inventory at distribution nodes control
- Internal environmental control of fresh produce conditions to maximize shelf life
- Among many others…
Sample output: Contract fulfilment with Market Opportunity for Cucumbers

Aspen
Las Cruces
Yuma

Some operational decisions for under a data-rich environment and fully automated logistics scheme:
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Potential sources of variability:
- Weather and climate (yields)
- Prices
- Demands
- Labor costs & accessibility
- Resource availability & accessibility (water & energy)
- Among others…

Buy from Spot Market

Target Demand Node

Some possible routes:
- Produce from Las Vegas to Aspen
- From Yuma to Las Cruces
- From Tucson to Las Cruces
- From Phoenix to Las Cruces

Map data ©2021 Google, INEGI United States Terms Privacy Send feedback
Example – Unexpected Yields

Scenario I: The season was extremely productive, and excess of fresh produce was harvested. What should be done with production excess?
- Sell excess at a spot price
- Send product to another market
  - Which market has higher spot prices?
  - Which market has low demand fulfilment?
  - Is it possible to monitor markets?

Scenario II: Suppose the season produced low harvest yields, not enough to fulfill demand contracts
- Buy spot product

TERRa-Fresh Spot Marketplace:
https://www.terra-fresh.com/Marketplace
Unexpected Situations and Disruptive Events

- Multiple situations can arise during the deployment of a production plan.
- Planning under uncertainty has been widely addressed.
- Complementary to planning with uncertain conditions, it may be useful to anticipate to these situations. Are adverse conditions or supply chain disruptions predictable?
- Three levels are identified:
  
  **Long-Term Trends**
  - Possible to plan and adjust
  - Climate change
  - Demographic phenomena

  **Transitory Trends**
  - Possible to plan and adjust with proper tools
  - Celery opportunity
  - Demand spikes
  - Harsh weather conditions

  **Unpredictable Events**
  - Not possible to plan, possible to adjust
  - Natural disaster
  - Social outburst
  - Pandemic
Supply Chain Monitoring Module

• Develop a system that detects anomalies, triggers alerts and create actionable recommendations to restore or improve the supply chain performance (prescriptive actions, to minimize disruptions and maximize product shelf life at delivery nodes).

• Using information provided by sensors and other real-time data sources such as cyber-enabled mini-containers

- Sensor/Traceability module Inside
- Temperature
- RH
- CO2
- Ethylene
- Vibration
- Transmission/recording/monitoring in real time of location and environmental conditions
- Unique ID for traceability purposes
Relevant Factors in the Fresh Produce Supply Chain

Demands

Inventory at Retail Locations

Climate Trends

Weather

Production → Processing/ Packaging → Storage → Distribution → Consumption

Information Rich Environment

Fresh Produce Imports

Spot Prices

https://www.terra-fresh.com/Marketplace#

Transportation Internal Conditions & Distribution Status

- Temperature
- RH
- CO₂
- Ethylene

- Vibration
- Location
- Environmental conditions
Envisioned Scheme for the Supply Chain Monitoring Module

The Supply Chain & Data Collection Devices

- WSN, RFID technology, GPS, autonomous vehicles, mini-containers, other sensors

Supply Chain Status Indicators

- Point of sale prices & Volumes
- Weather data and forecast
- Inventory Levels
- Importations & Exportation
- Transportation network performance (travel times)
- Freight location
- Road congestion
- Local news
- Fresh produce remaining shelf life
- Fresh produce environmental conditions

Anomaly Detection of Indicators

Cause & Consequence Evaluation

Supply Chain Reconfigurability

Optimal Supply Chain Deployment
Benefits of the Supply Chain Monitoring Module

- Increases in product traceability and supply chain visibility
  - Consumer awareness trends
  - Food safety
  - Competitive advantages for smaller and new participants
- Quickly reconfigurable supply chains & prediction of disruptive situations and changing environments
  - Reduction in food waste, food scarcity, environmental impacts & increase product shelf life at delivery nodes

**Producers**
- Competitive advantages generated local consumption, food safety consumer awareness, environmental footprint tracking trend
- Enjoy economies of scale

**Distributors**
- Increased supply chain visibility
- Reduce likelihood of altering the continuous distribution process
- Reduce overall distribution costs

**Consumers**
- Increased food safety
- Increased product quality
- More information available about product consumed
- Increased food accessibility
- Increased healthy food availability
Conclusions

• Overview of relevant decisions on deployment of production plans
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- Impact of potential adverse situations upon deployment of production plans
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• Supply Chain Monitoring Module aids in forecasting adverse situations and supply chain reconfigurability under unpredictable events
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- Impact of potential adverse situations upon deployment of production plans
- Supply Chain Monitoring Module aids in forecasting adverse situations and supply chain reconfigurability under unpredictable events

Hypothesis

A fresh produce supply chain operating in an information rich environment, along with the integration of the mini-containers as transportation units can increase product traceability and increase supply chain visibility

- Competitive advantages for smaller and new participants
- Participation of stakeholders → Invitation to the Small Grower Forum
Thank You

Dr. René Villalobos (rene.villalobos@asu.edu)
Research Director, Project Lead

Francisca Quijada (fquijad3@asu.edu)
PhD Student, Industrial Engineering