Progress Report Meeting November 20th, 2020

Technology-Enabled, Rapid-Response Fresh Food Supply Chains (TERRa-Fresh) Workshop on Cold Chain Issues

Facilitated by Pat Phelan and Jim Kallof

Arizona State University

FFAR

NM State University

ILPIL International Logistics & Productivity Improvement lab

Objective of the Workshop

- In this workshop we will talk about cold chain issues for small growers and we will introduce the concept of the mini-container and its benefits for small growers and the enactment of future technologies (for instance driverless logistics).
- We will present the state of the project and where we are going. Part of the presentation will deal with energy/carbon footprint issues.
- Pat Phelan and Jim Kallof will facilitate the workshop. I will oversee the organization of this workshop with the help of Sergio Lopez.

Activities

9:50 – 10:45 AM **Workshop on Cold Chain issues and mini-containers.**
Facilitated by Pat Phelan and Jim Kallof
Zoom Link: https://asu.zoom.us/j/83865883671

Agenda Draft

9:50 AM Introduction of Overall Concept and Design Issues, Pat Phelan

10:05 AM Logistics Implications, J. Rene Villalobos

10:20 AM Other applications of mini-containers, Jim Kallof

10:30 AM Discussion on food safety issues, Chaddy Robinson

10:40 AM Next steps, Pat Phelan, Jim Kallof and Rene Villalobos

Introductions

Patrick Phelan
Professor of Mechanical and Aerospace Engineering
Arizona State University

Jim Kallof
Dircks Logistics

Chadelle “Chaddy” Robinson
Associate Professor of Agricultural Economics and Agricultural Business
New Mexico State University

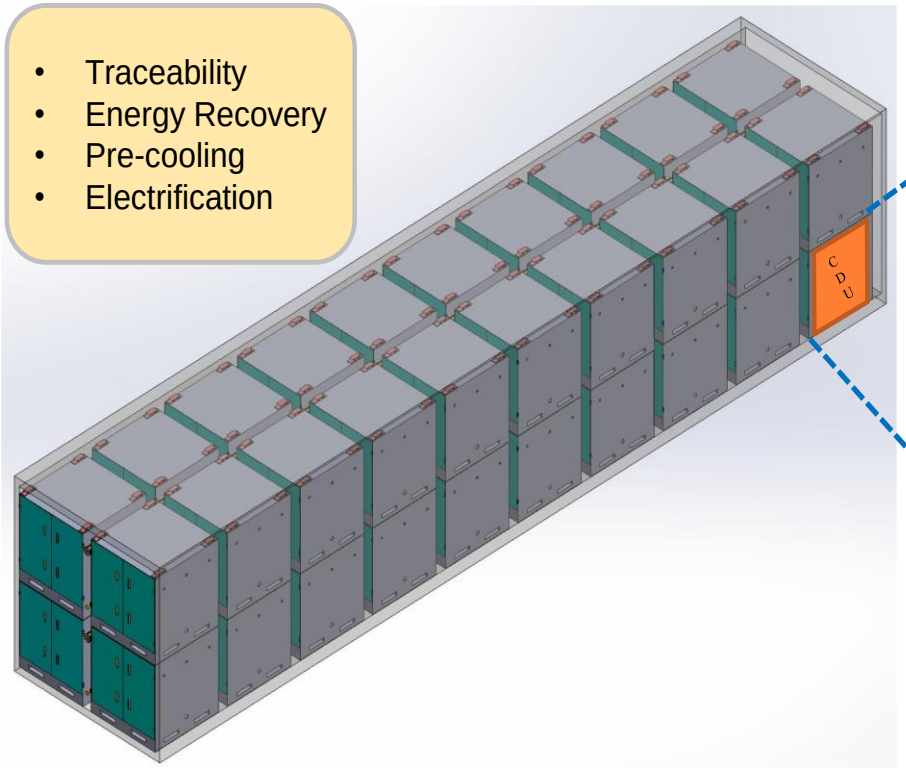
Sergio Lopez
Student, Mechanical Engineering
Arizona State University

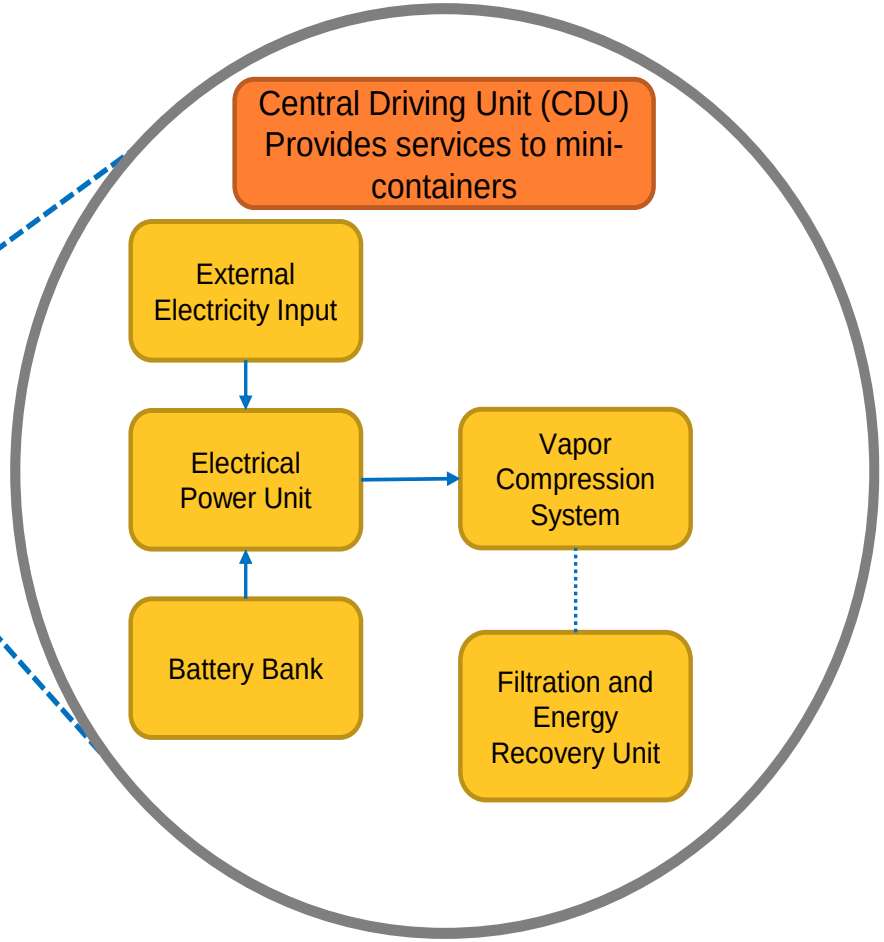
Motivation: Why Do We Need to Improve the Cold Chain?

- Make small farms financially attractive to entice people to start farming operations which is needed because of the aging farm population
- Solve the ‘first mile’ problem, one of the main obstacles to provide efficient logistics services to small farmers
- Attain economies of scale by aggregating products from different growers while at the same time meeting food safety and traceability regulations
- Introduce the products into the cold chain immediately after harvest, reducing food waste and reducing the probability of food contamination
- Create instantaneous cold storage where there is no infrastructure in place
- Provide the basis for energy-efficient logistics for small harvests and market orders
- Enable carbon emissions reductions, probably through electrification

One Proposed Solution: Mini-Containers

- Traceability
- Energy Recovery
- Pre-cooling
- Electrification

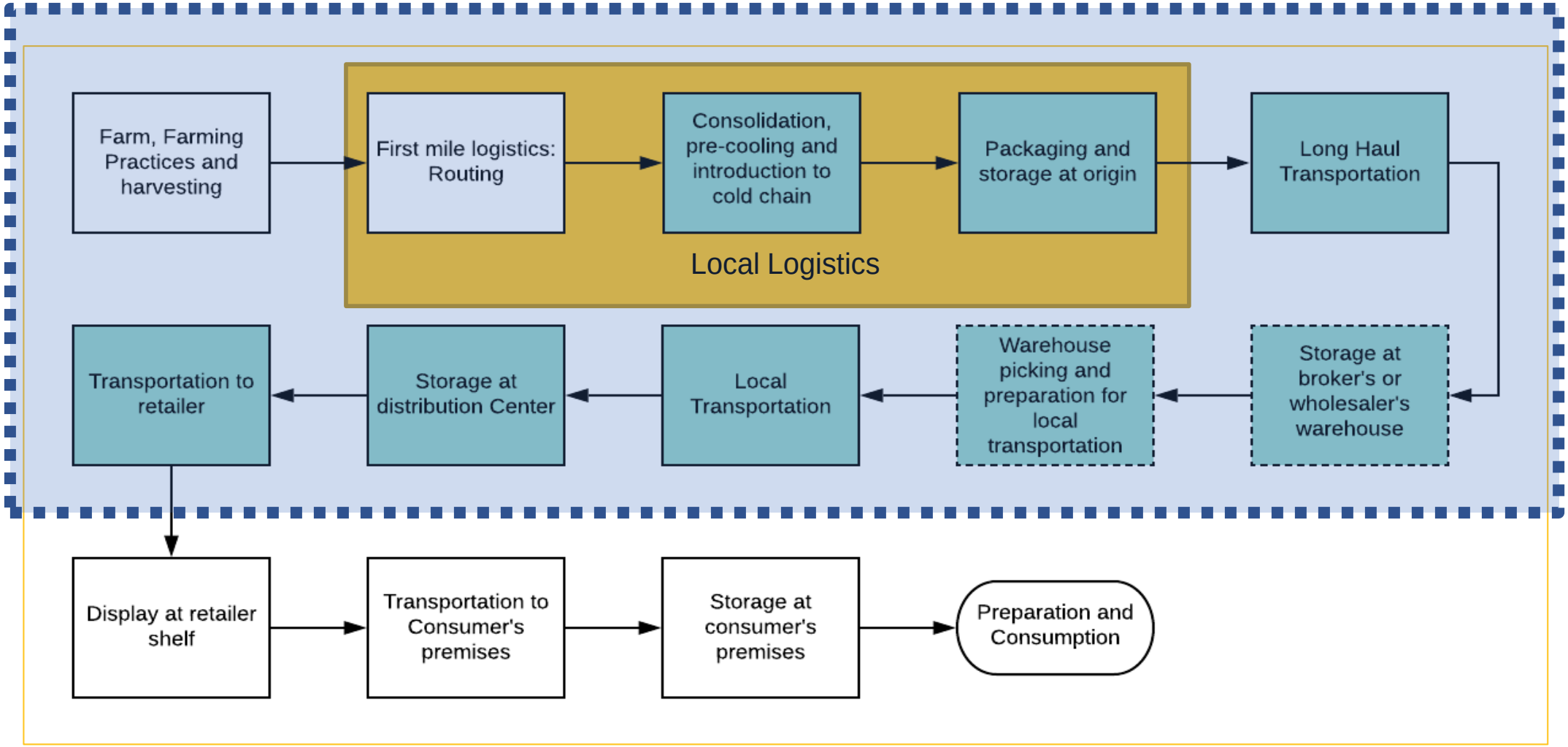




4 x 4 x 4 ft^3 containers that can be transported individually (i.e., on a pickup) or together on a trailer (as shown)

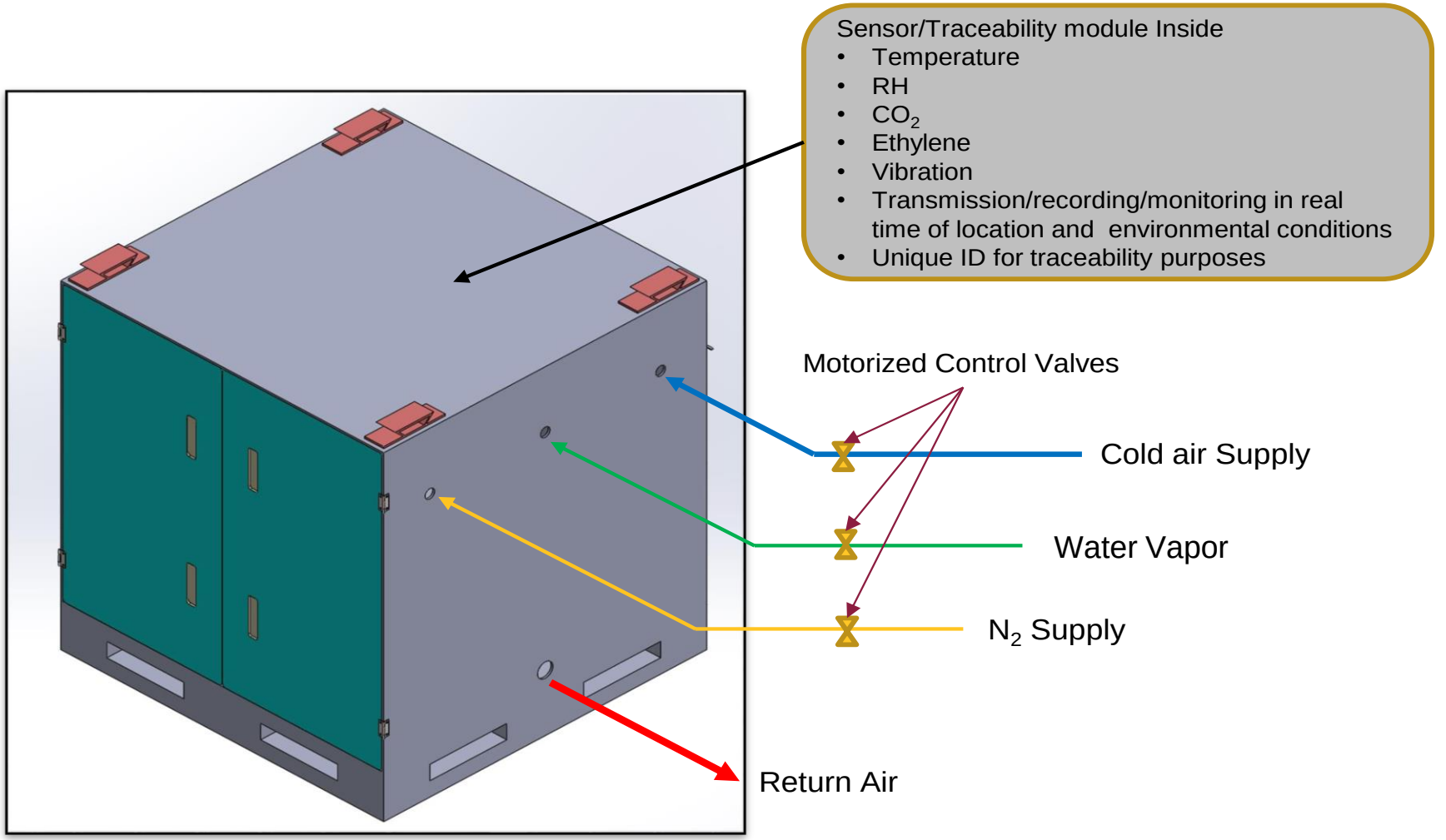
Where Do Mini-Containers Fit in the Cold Chain?

Mini-Containers

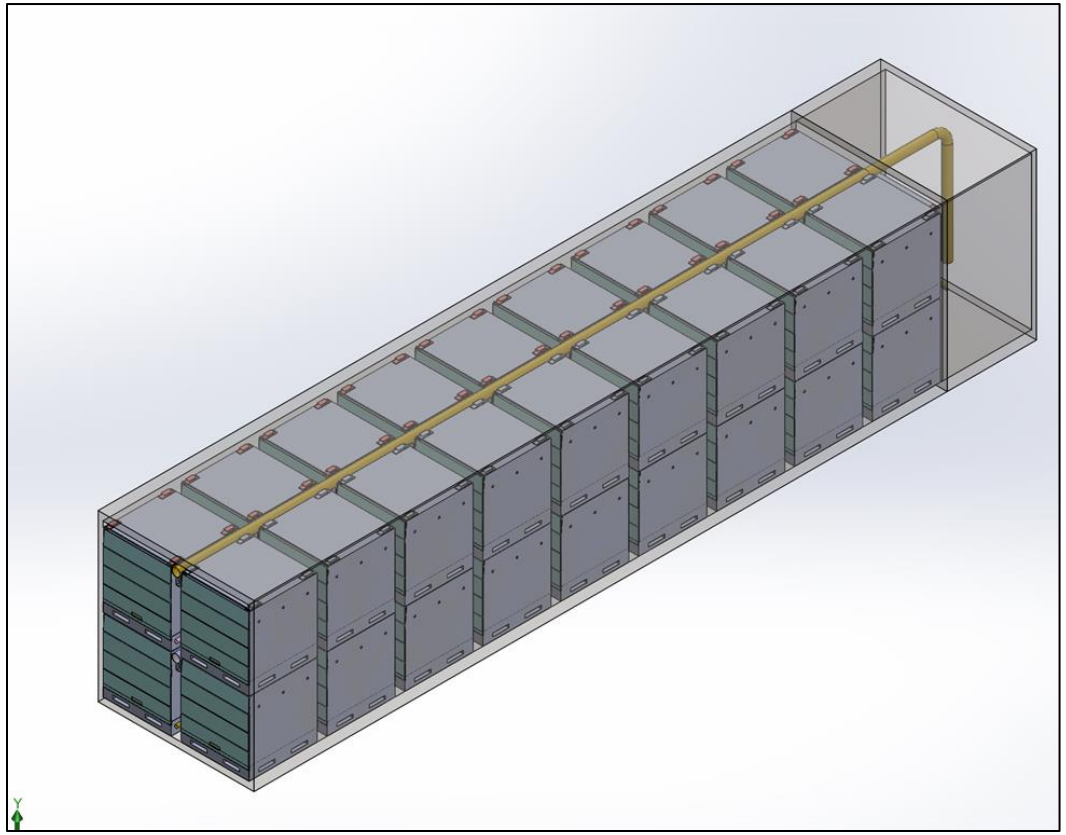


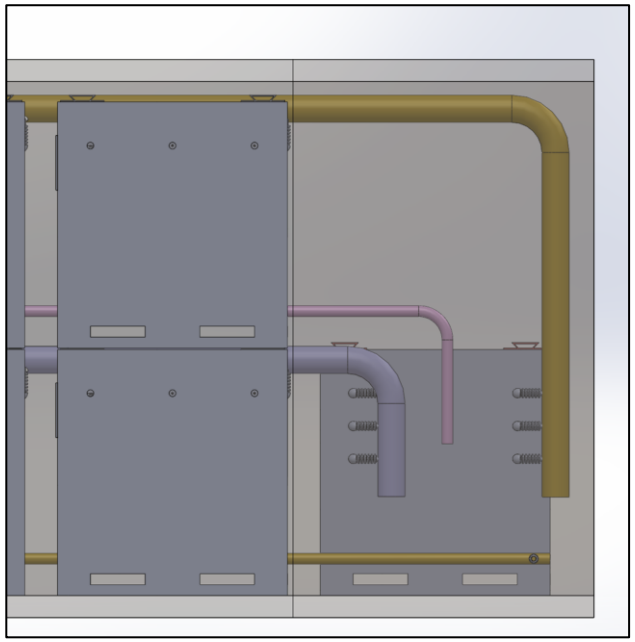
Conceptual Design of a Mini-Container (MC)

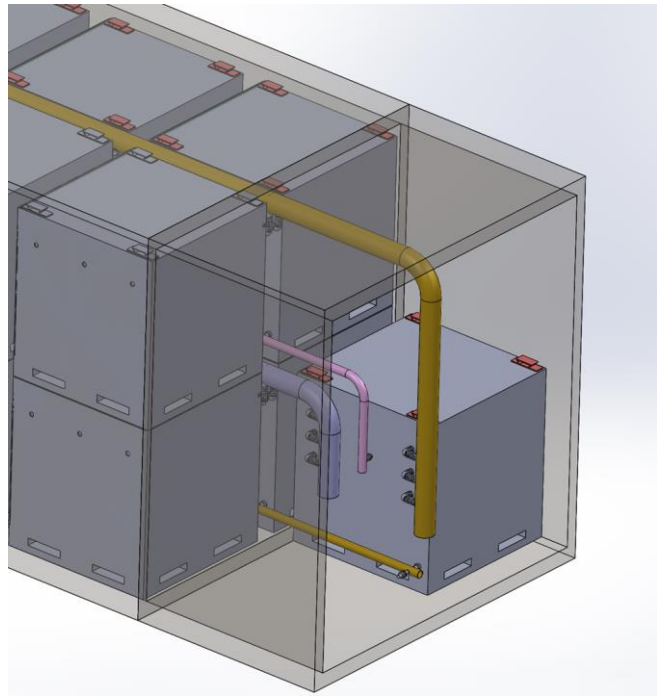
- **Only one type of produce would be stored/transported in each MC**
- **The environment for each MC would be independently controlled (temperature, RH, % ethylene, % CO_2)**
- **The contents of each MC would be traceable, and the environmental history of its contents recorded**



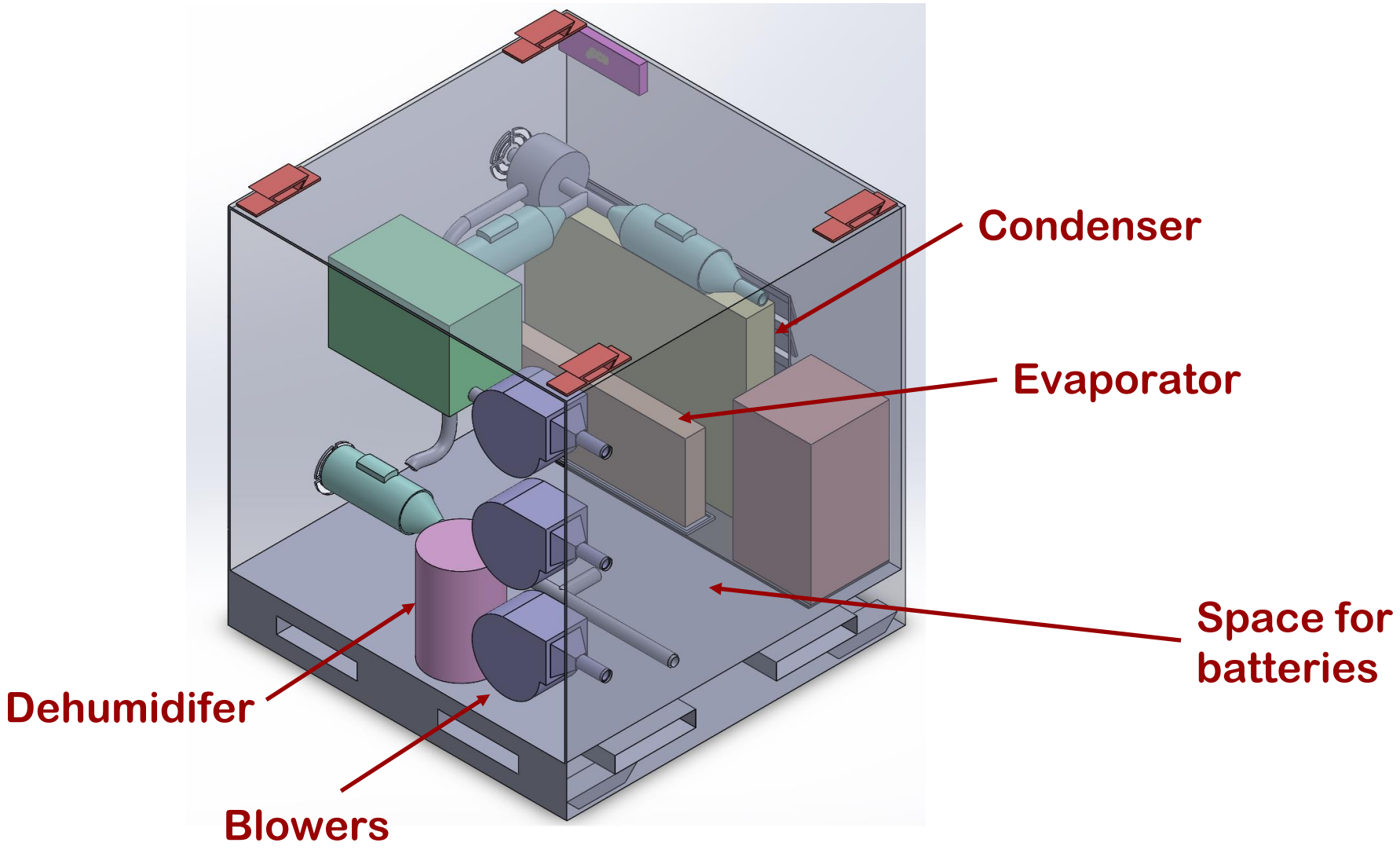
Conceptual Design of a Mini-Container (MC): Supply/Return Piping



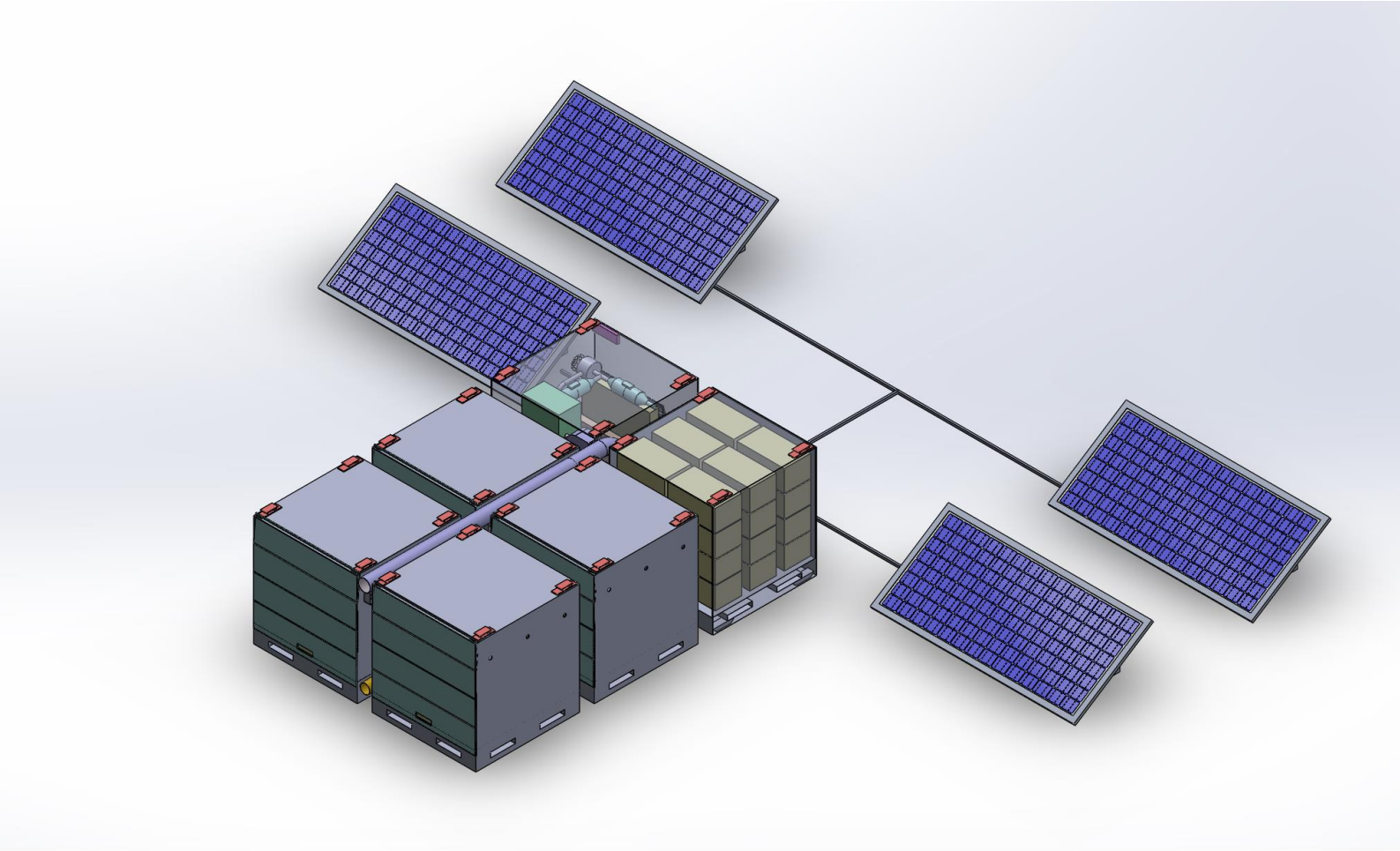




Conceptual Design of the Central Driving Unit (CDU)



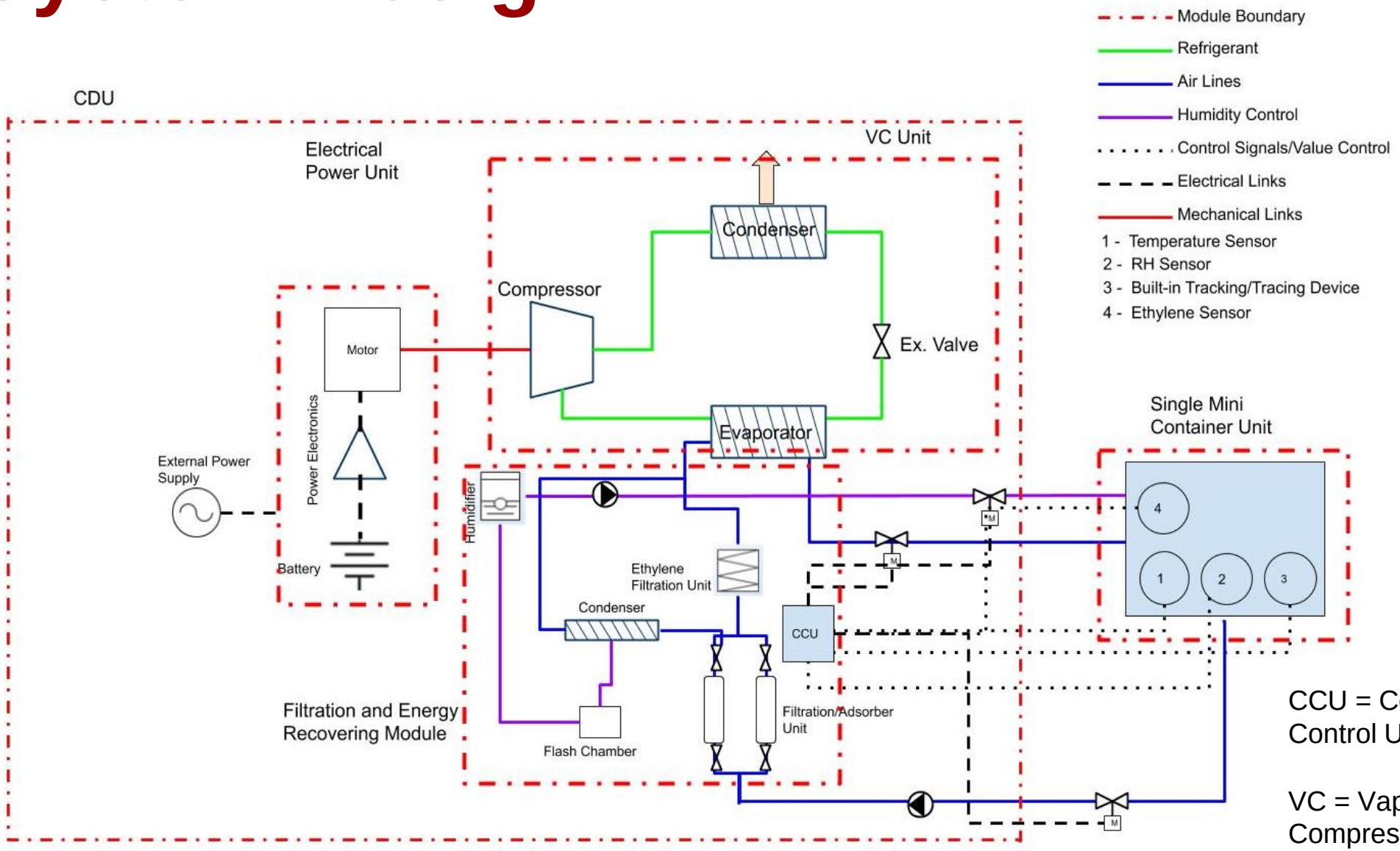
Solar Electrification Potential at the Producer



MCs + CDU (CDU = Central Driving Unit) can be stored at the farm, and solar PV can be used to provide electric power to maintain the required environmental conditions

Note: Solar PV can be supplemented with fuel-driven generators as needed.

System Design

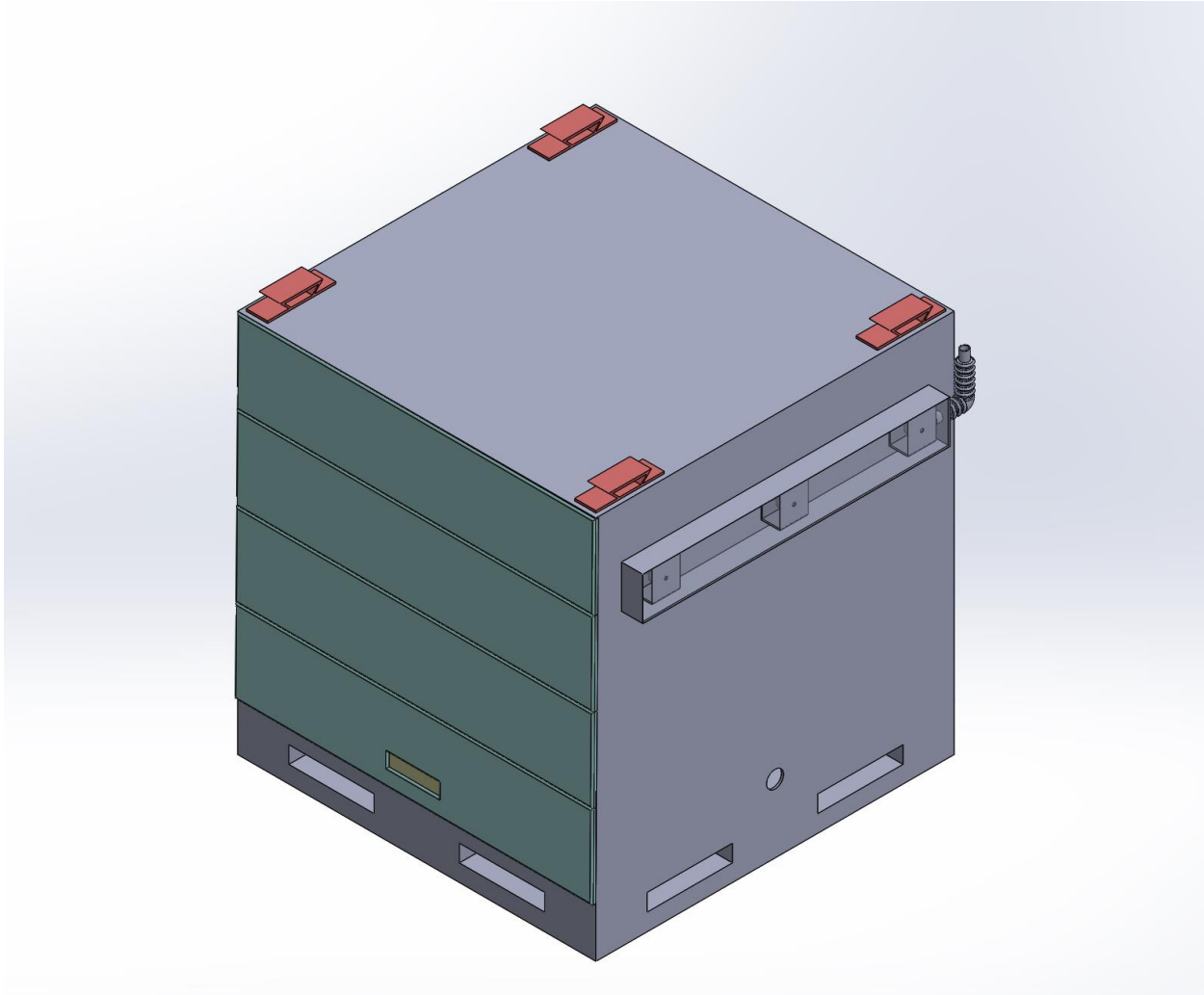


CCU = Central Control Unit

VC = Vapor Compression (Refrigerator)

Progress to Date

- Provisional patent application filed on 6/15/20 via ASU
- Excel design calculations for refrigeration & ventilation requirements
- SolidWorks drawings for major components
- Control scheme design under development based on Raspberry Pi microprocessor
- Prototype fabrication & testing to begin shortly



Smart Aggregation and Introduction to Cold Chain using Mini-Containers

Solutions

- The availability of mini-containers will allow the aggregation of small harvests of different crops from different growers meeting food regulations
- The availability of mini-containers and the CDU will allow precooling and storage of the harvested crops at the farm with minimal capital investment
- The availability of active mini-containers at the farm will allow more logistics flexibility, provide better capacity use, less food waste, and reduced energy/CO2 footprints
- The availability of mini-containers and their sensors will allow for efficient use of dissimilar vehicles for crop collection using vehicle routing planning models
- When the proper underlying market-interface decision platform and infrastructure are in place, the mini-container will allow direct farm-to-final customer transactions

Expected logistics environment for fresh products, post Covid-19

- In the short term
  - People staying at home, thus:
    - Less consumption in the food service industry
    - Shift of consumption to supermarket chains
    - Less consumption of high-priced alternatives
    - Migration of some food-service suppliers to other markets
    - Increased use of direct-to-consumer sales
- In the long term
  - Increased use of direct-to-consumer sales
  - Use of autonomous freight vehicles and other automated logistics alternatives (AGVs in cross-docks, robotic arms, delivery drones, etc.)
  - Totally automated supply chain based on **physical internet** principles around a minimum standard unit that can be used for aggregating and splitting volumes according to market and supply chain conditions

First Mile Logistics Problems

- **Harvest sizes too small to fill a full truck**
- **Very often regulations mandate that harvests from different growers cannot be consolidated in the same freight vehicle**
- **Lack of logistics agents with focus on harvest aggregation**

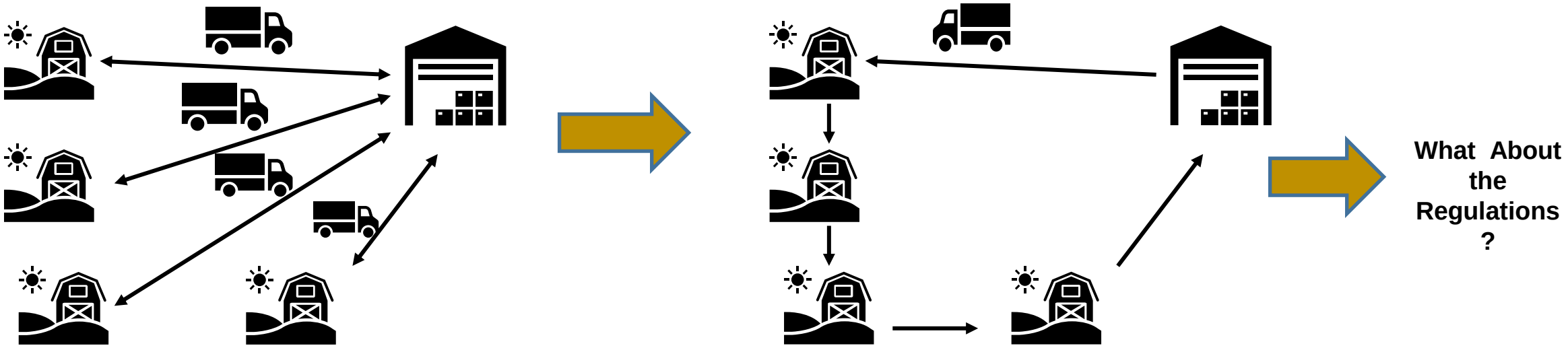
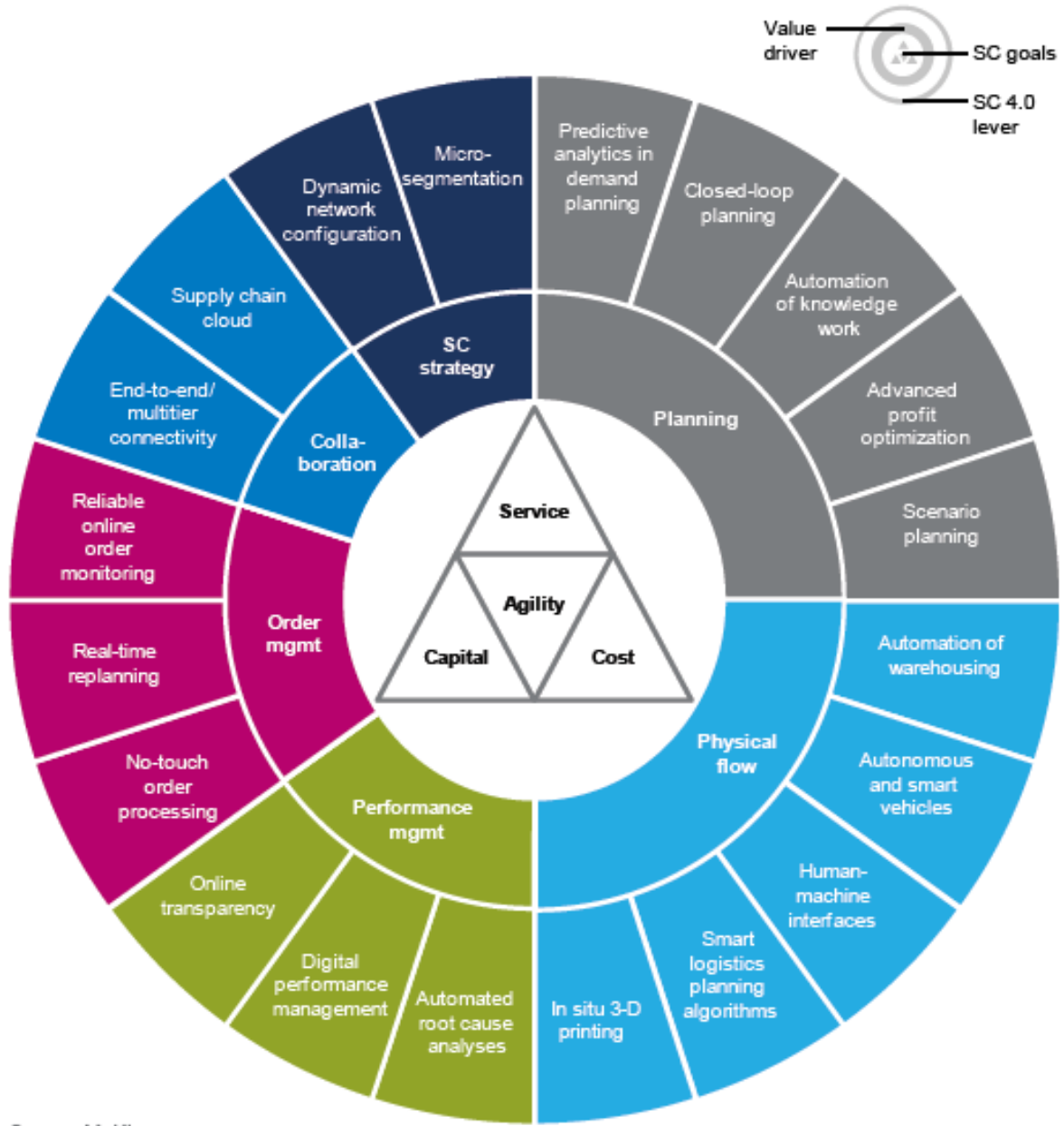
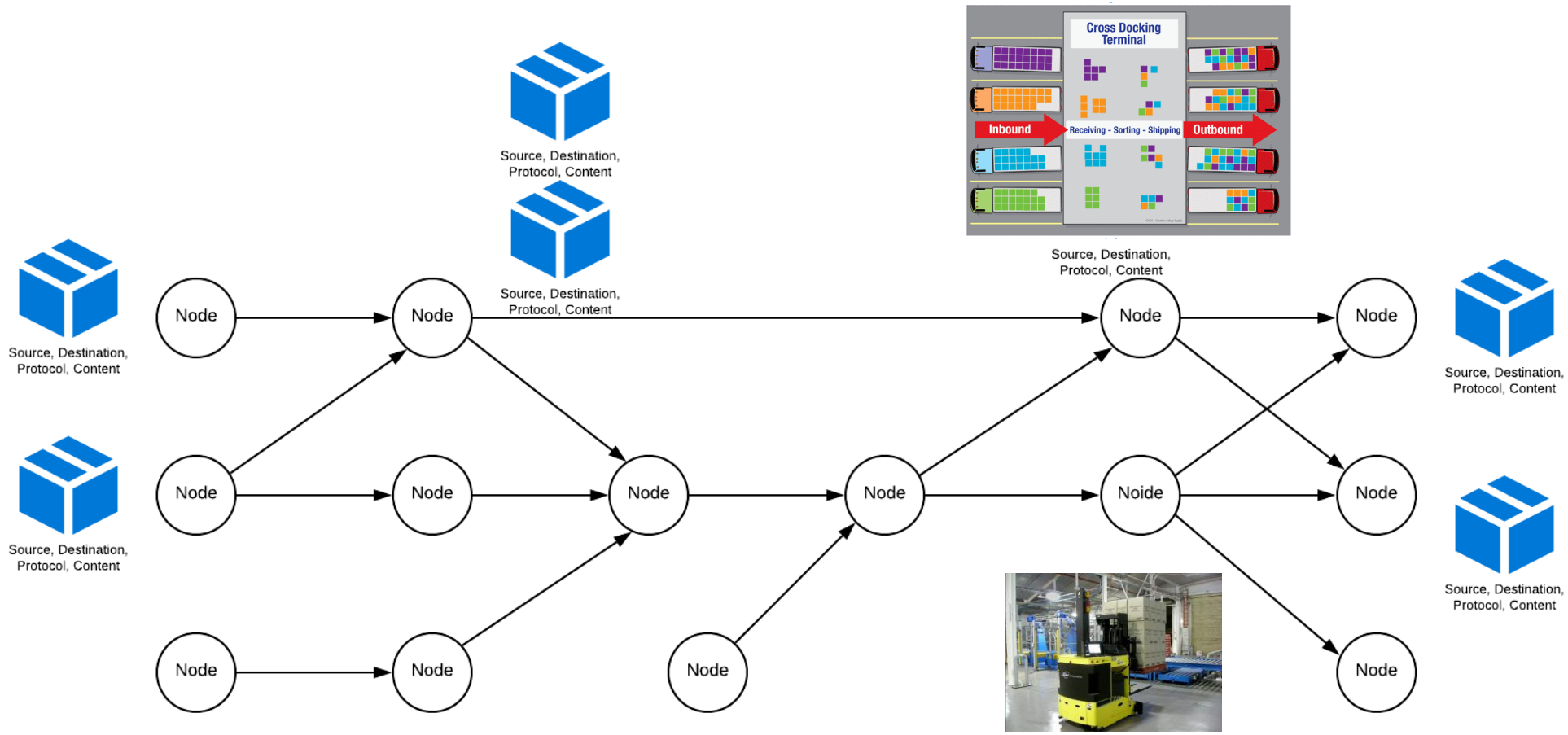


Exhibit 2 **Supply Chain 4.0's improvement levers map to six main value drivers.**



Source: McKinsey

The Physical Internet implementation analogy



Comments by Jim Kallof

- Logistics environment is constantly changing and shows no signs of doing otherwise
- The Business Cycles are creating disruption
- Growers today must change the processes to remain competitive
- Challenges with our food supply and other external factors, we have the opportunity to emerge with great improvements
- Covid and Major Influences can Relate to the current health challenges within the supply chain, It can be related to the following FOUR categories;
  - The construction/engineering of the mini container for the food supply and the new -70 degree box for the transport of the vaccine
  - The unique situation of shipping small quantities that are perishable at the proper temperature
  - Reducing the critical time in transit
  - Tracking these shipments with 100% visibility

Comments by Jim Kallof

- Mini container that will provide positive options for our agricultural community
- The small grower is our focus, and our objective is to develop new tools and options to enhance their success
- In a way, we are developing a type of dedicated model to improve the ROI
- ANOTHER GOAL IS TO TURN THE INVENTORY FASTER AND REDUCE WASTE
- The economics of today are forcing farmers to implement new measures to look at the first and last mile that are typically the most expensive
-

Comments by Jim Kallof

- CAPACITY ISSUES currently we have low capacity of equipment due to high demand, this condition will be with us for the foreseeable future
- The small grower requires reliability, flexibility, tracking and proper supply

VALUE PROPOSITION

- The mini container offers a solution in many ways, transit, storage, availability
- THE ARTICULATOR HAS THE ROLE OF MANAGING AND ADAPTING
- FOR COMPLEX TRANSPORTATION AND HANDLING REQUIREMENTS SOME FORM OF DEDICATED SERVICES ARE GOING TO BE REQUIRED
- By CONSOLIDATING shipments we can reduce transportation costs Mini Container supports this option
- Eliminate part of the growers TRANSPORTATION fleet- this trade off should shows positive returns or breakeven at worst Mini Container supports this option
- Find the balance between private and shared transportation
- Utilize 3PL providers to fill the gaps that are based on a general number of stops per week

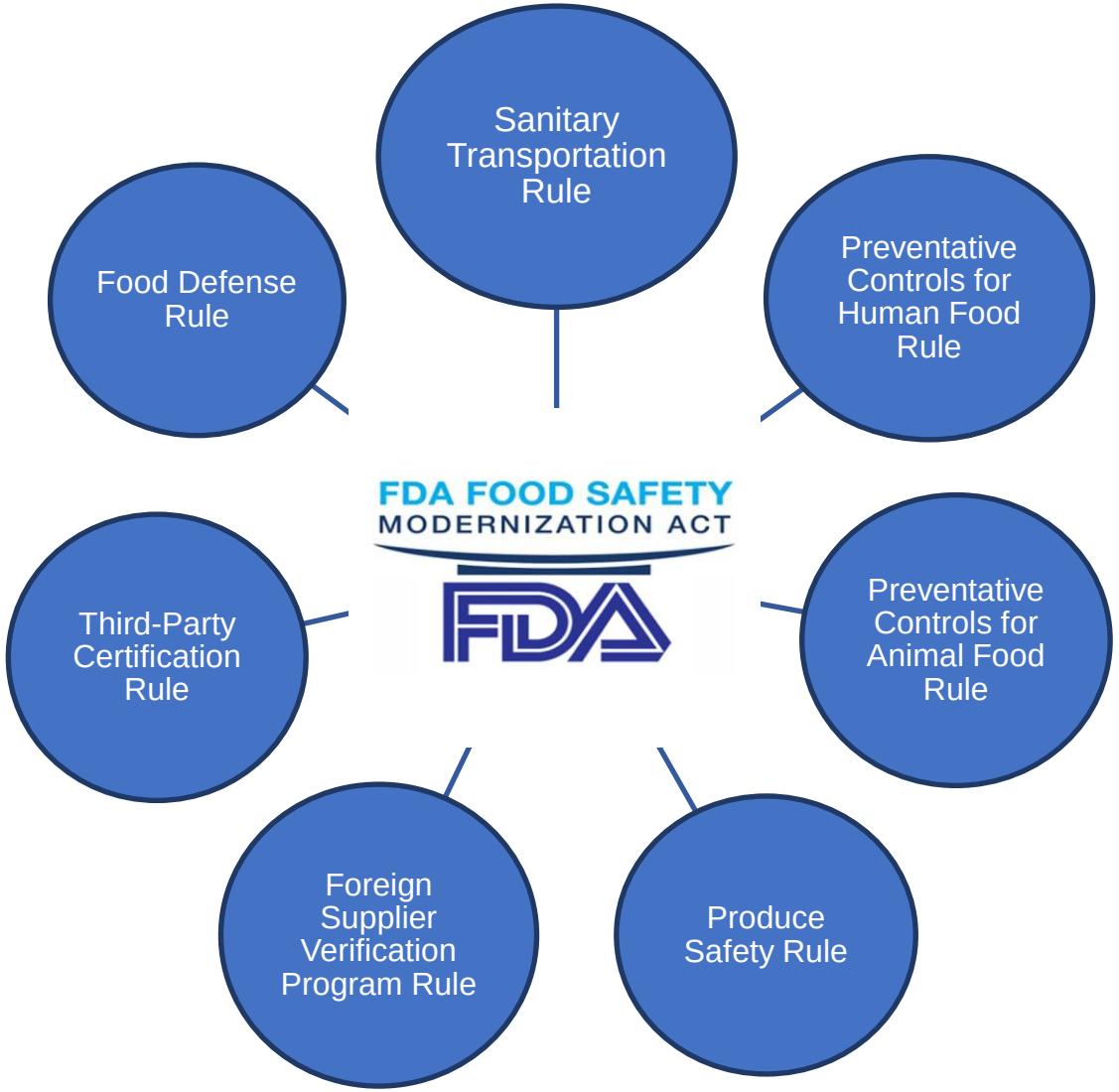
Comments by Jim Kallof

- The Mini Container should allow the loading labor function faster at the growers site Mini Container supports this option
- The Mini Container should allow the unloading labor function faster at the destination point Mini Container supports this option
- Warehouse Space- for short term overflow, may consider the utilization of 3PL (refrigerated) when applicable and/or commit to a specific amount of refrigerated space
- Food Safety & Sanitation Considerations solutions will happen Mini Container will comply
- Other Considerations-Applications
  - Store & Ship Wine & Spirits
  - Pharma products
  - Ingredients & raw materials for specific commodities
  - Off Season rent out the mini-containers

USDA

GOOD AGRICULTURAL PRACTICE
GAP

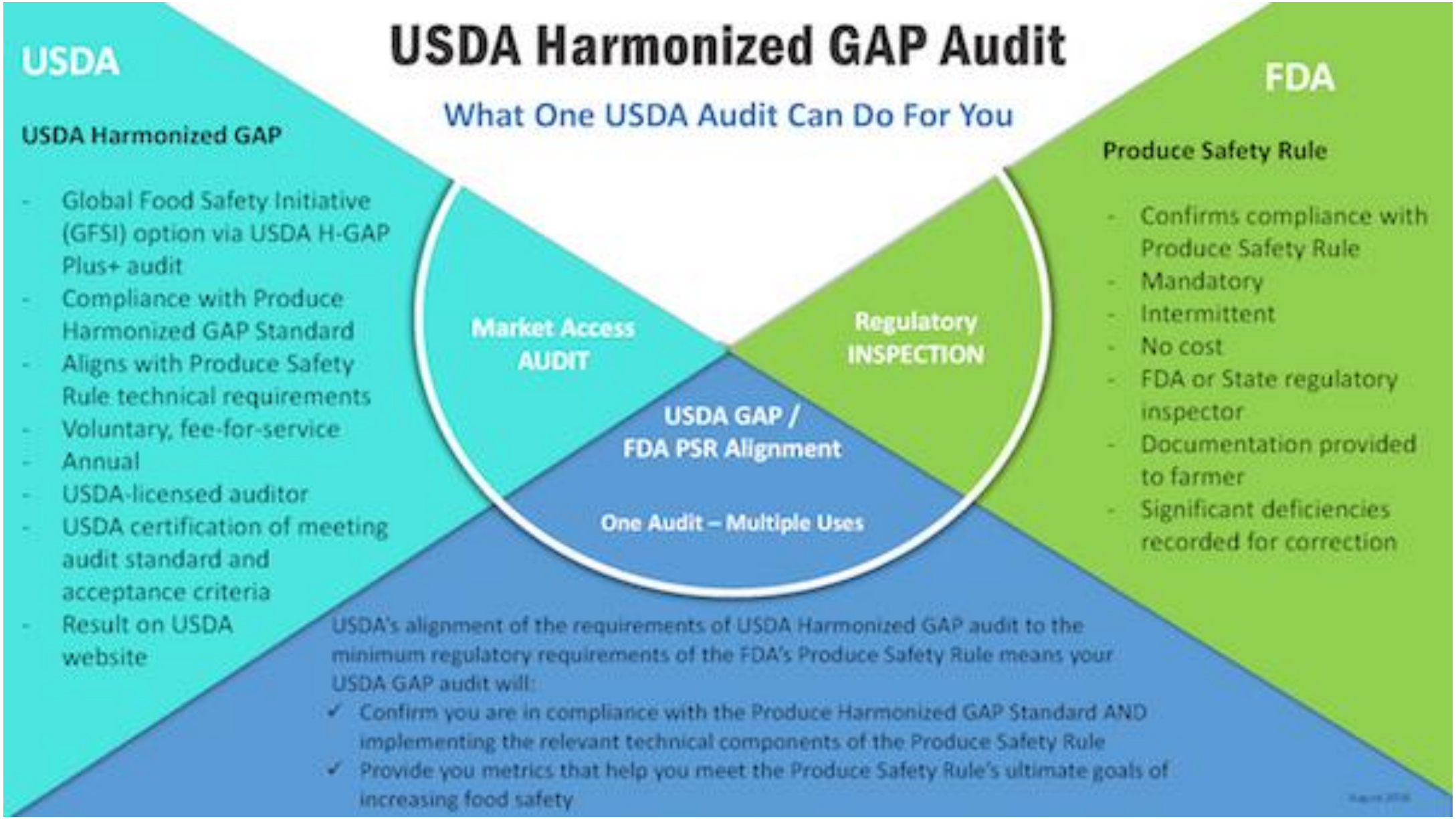
FSMA Seven Rules



FDA – FSMA Produce Safety Rule (PSA)

Six Key Requirements of PSA

1. Agricultural water, both for production and post-harvest uses
2. Biological soil amendments (e.g., compost, manure)
3. Production of sprouts
4. Domesticated and wild animals
5. Worker health, hygiene, and training
6. Equipment, tools, buildings, and sanitation


USDA Harmonized GAP Audit
What One USDA Audit Can Do For You
USDA
USDA Harmonized GAP
- Global Food Safety Initiative (GFSI) option via USDA H-GAP Plus+ audit
- Compliance with Produce Harmonized GAP Standard
- Aligns with Produce Safety Rule technical requirements
- Voluntary, fee-for-service
- Annual
- USDA-licensed auditor
- USDA certification of meeting audit standard and acceptance criteria
- Result on USDA website
Market Access
AUDIT
Regulatory
INSPECTION
USDA GAP /
FDA PSR Alignment
One Audit – Multiple Uses
FDA
Produce Safety Rule
- Confirms compliance with Produce Safety Rule
- Mandatory
- Intermittent
- No cost
- FDA or State regulatory inspector
- Documentation provided to farmer
- Significant deficiencies recorded for correction
USDA's alignment of the requirements of USDA Harmonized GAP audit to the minimum regulatory requirements of the FDA's Produce Safety Rule means your USDA GAP audit will:
✓ Confirm you are in compliance with the Produce Harmonized GAP Standard AND implementing the relevant technical components of the Produce Safety Rule
✓ Provide you metrics that help you meet the Produce Safety Rule's ultimate goals of increasing food safety