VCU Workshop on Sustainable Food Access through Sensing, Data Analytics, and Community Engagement

The Role of Technology in Food Security

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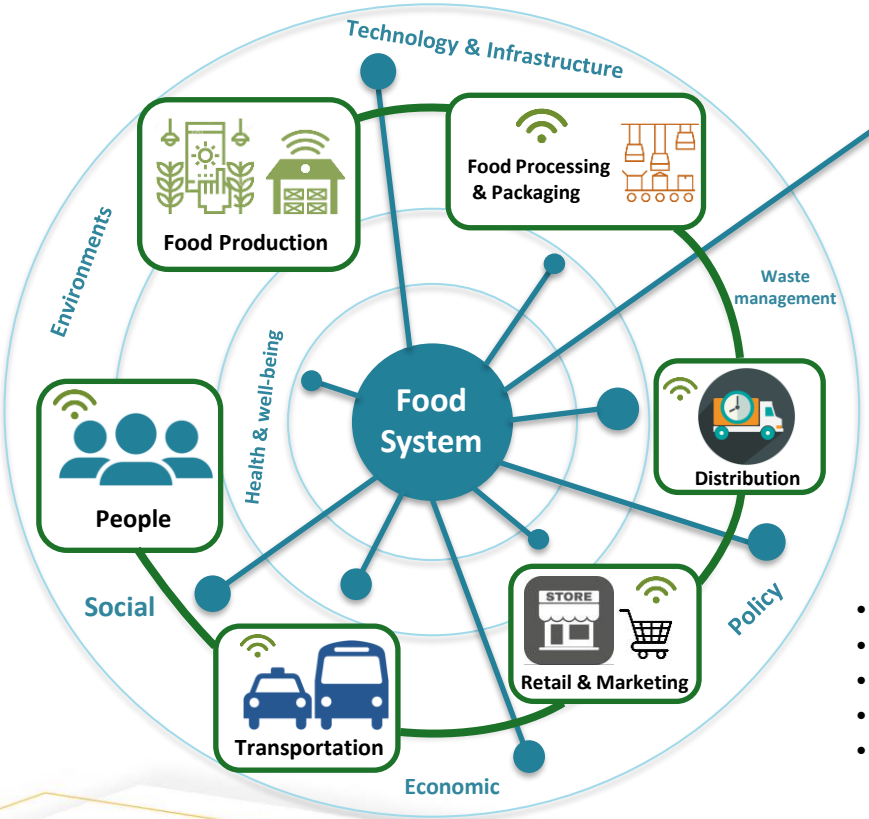
Smart City Solutions

A Connected Cyber Physical Food System



Interconnected systems of people, infrastructure, business relationships, and national policies

Not amenable to single solution

- Providing the infrastructure and expertise to support interdisciplinary research
- Improving the use of data & technology

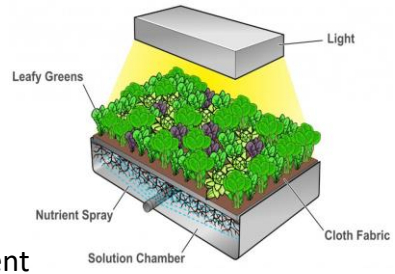
Smart Technologies and Data Analytics

- Data Collection and Analytics (Market data, GIS map data, farms locations,…)
- Model-based/Data-driven Decision Support System
- Autonomous systems applications in production, distribution, …
- Mobile information apps (place of foods, connecting people with farmers, …)
- ….

Goals: maximize healthy food access and minimize the waste and transportation costs

Smart Controlled Environment Food Production

- Smart Aeroponics
- Smart Light
- Smart Nutrition
- Smart Data
- Smart Substrate
- Smart Pest Management



95% less water than field farming

- ✓ **Indoor farming**
- ✓ **Grow without sun or soil**
- ✓ **Less environmental impact**

Three major objectives:

1) Sustainably increasing agricultural productivity and incomes
2) Adapt and build resilience to climate change
   - Use of accurate weather forecasts, granular soil data and hazard maps that facilitate decisions such what crops and variety to use, when and where.
3) Reducing and/or removing greenhouse gas emissions where possible

How Smart technology and Data Analytics can help?

- Internet of Things (IoT) devices, robotics, and sensors
- Unmanned aerial drone applications in field monitoring and insect scouting
- Machine learning applications for optimal growing conditions
- Water and soil quality monitoring/ Remote farm monitoring
- Real-time Weather/Pest modeling, early warning systems for floods, etc.
- Accurate prediction of production yield
- Image processing technologies
- Data collection and real-time data visualizations

Agriculture Cyber-physical Systems (ACPS) or Smart Agriculture

Smart Supply Chain Management

Current Challenges in the Supply Chain

- Lack of transparency in the supply chain
- Increased waste and insufficient planning
- Goods that are lost or delayed
- Poor relationships and unhappy consumers

Why Food Traceability Technologies?

- Improve transparency in the food supply chain
- Provide high quality and safe food to consumers
- Early identification of issues
- Reduce food loss
- Reduce negative impacts on the environment
- Learn about consumer eating patterns

How can Internet of Things be useful for supply chain?

- Authenticate the location of goods at any time
- Track speed of movement and predict arrival time
- Monitor Storage Conditions of Raw Materials and Products
    - IoT devices can monitor areas like temperature, humidity, exposure to an atmosphere, light intensity and other environmental factors
- Track the quality of goods through the supply chain and reduce food waste
- Identify the problematic movement of goods & Provide contingency planning and alternative routes to speed up the transit
- Develop a food safety database to enable consumers to track the origin of food products, give feedback & make informed purchasing choices
- Provide data- and-values-driven Apps

AI in Food Waste Management

A third of all food produced for human consumption is wasted or lost globally (~ 1.3 billion tons of food a year)

- Artificial Intelligence (AI) food tracking for selling food before it becomes waste
- Vehicle routing problem with time window for perishable food products delivery
- Using machine learning techniques for facilitating cost/time-efficient food distribution
- Food delivery Apps - Linking farmers directly to consumers or kitchen for online sale of fresh produce
- Expanding cold chain facilities to cope with long distance transport of perishable food products
- Food Donate Portal: Enabling donors to post listings of available food
  - An algorithm rapidly notifies the best-matched and nearest recipient organization
  - A dashboard allows donors to track all activities.

Food Transportation and Delivery

- Autonomous Food Delivery -- Essential support to access fresh food
  - Food-Delivery Robots

    Demand for these autonomous delivery robots is significantly increased during pandemic.
  - Delivery Drones
- Food delivery Apps, grocery delivery and pick-up services
  - Examples: Instacart/Shipt/Amazon food delivery Systems
- Mobile grocery stores for increasing healthy food availability
- IoT devices and temperature control for improving food traceability & safety
- Vehicle routing algorithm with time window for perishable food products delivery

Cost Effectiveness

- ❑ The costs in a food system exist in three main domains:
  - Energy
  - Health
  - Environment

Energy and healthcare costs are the visible costs in a food chain, while the environmental impacts of a food production system are the hidden costs.

- ❑ Food systems account for 30% of the world's total energy consumption (primarily on fossil fuels)

- Renewable energy sources can be used for irrigation, primary processing, cold storage, & controlled environment food production, etc.

- New policies such as tax exemption or subsidy for supporting environment friendly farm

What's next?

Questions to be answered for Greater Richmond Region:

- What are the data needed to better understand and help address the food desert problem?
- What are the technologies and cyber-infrastructure that can help address the problem?
- How to integrate the technology into the community?
- What are the barriers? What are the concerns in this transition?
- What types of policies are needed to support future smart food system?

Breakout Session: Datasets, metrics, technology and assessment measures