Decision-Support Models

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Model Features

- Agronomic Potential
- Planning Tools
  - Strategic Planning
  - Feasibility Assessment
  - Coordination: Participants Allocation and Negotiation
Why modeling?

- Mathematical Representation
- Solve Complex Problems
- Results Interpretability
- Assist Decision Making Processes
- Analyze Problem Characteristics
- Allows to simulate and predict interactions and results

HELP THE ARTICULATION OF A SUPPLY CHAIN
Agronomic Potential

- Production Yields
- Consider climate conditions
- Identify Complementary Regions
- Allocate resources and production schedules
Agronomic Potential: Regions Clustering

Cluster Identification:

- 5 Cities: 50 miles radius
- 64 weather stations
- 5 Clusters
Agronomic Potential: Complementary Weather
Planning Tools

● Opportunity Articulation Process
  ○ Identification
  ○ Allocation
  ○ Deployment

● Decision-Support Tools
Planning Tools: Strategic Planning

- Initial Profitability Assessment
- Match Market Opportunity with Production Potential
- Allocate resources: investment and tasks
- Allocate demand to Regions
Planning Tools: Strategic Planning

**INPUT**

**MARKET**
- Weekly product prices
- Weekly product demand/supply

**REGION**
- Weekly temperatures
- Weekly rainfall
- Logistic costs

**PRODUCT**
- Water requirements
- Upper/lower temp. restrictions

**OUTPUT**

**OPTIMAL CONFIGURATION**
- Product basket
- Production regions
- Wholesale markets
- Technologies

**OPTIMAL SCHEDULE**
- Planting and harvesting
- Consolidation and distribution

**OPTIMAL SELECTION**

**OPERATIONAL STRATEGY**
Planning Tools: Strategic Planning

Maximize:
\[
\sum_{j,d,m,t,c,t:t_{m}=t+h+LT_{dc}} SDC_{j,d,c,m,t}^{t_{h},t} \cdot Mpr_{j}^{t}
- \sum_{j,z,t=0} Iinv_{j,z}^{t} \cdot Cw_{z} - \sum_{j,d,h,t} Iinv_{j,d}^{t} \cdot Cd_{d}
- \sum_{t_{p},t_{h},z} WA_{z}^{t_{p},t_{h}} \cdot Cwater_{z} - \sum_{z,t_{h},d} Pack_{d, z}^{t_{h}} \cdot Ccase_{d}
- \sum_{j,d,m,t,c} SDC_{j,d,c,m,t}^{t_{h},t} \cdot CTDC_{d,c,m,t}^{t_{h},t} - \sum_{j,z,t,h} SZD_{j,d,m,t}^{t_{h},t} \cdot CTZD_{z}^{t_{h},t}
- \sum_{j,f,t,h,z,f:e \in F(z)} AddWCap_{z}
\]

Decision Variables:
\[B_{j,f,u}: \begin{cases} 1 & \text{if technology } u \text{ is made available to farmer } f \in F(z) \text{ for crop } j \\ 0 & \text{otherwise} \end{cases}\]
\[\chi_{j,f,u}^{t_{p}}: \text{Yield of crop } j \text{ by farmer } f \text{ when planted at } t_{p}, \text{ using technology } u \]
\[\text{MicroHarvest}_{j,z}^{t_{p}}: \text{Amount of crop } j \text{ harvested during } t_{h} \text{ within zone } z \]
\[\text{Pack}_{j,z}^{t_{p},t_{h}}: \text{Amount of crop } j \text{ packaged during } t_{h} \text{ planted in } t_{p} \text{ within zone } z \]
\[\text{WA}_{z}^{t_{p},t_{h}}: \text{Additional water allocated to region } z \text{ between } t_{p} \text{ and } t_{h} (\text{ if rainfall is not enough}) \]
\[\text{SLZ}_{j,z}^{t_{h}}: \text{Qty. shipped of crop } j \text{ from farmer } m \text{ to region } z \text{ at time } t \text{ harvested at } t_{h} \]

Subject to:
\[
\sum_{j,f:u \in U(z)} B_{j,f,u} \cdot Ctech_{u} \leq Cavail
\]
\[
\sum_{t_{p}} \chi_{j,f,u}^{t_{p}} \leq \text{Land}_{f} \cdot B_{j,f,u} \quad \forall f, j \in J, u \in U
\]
\[
\sum_{u} B_{j,f,u} \leq \text{CropOper}_{j} \quad \forall j
\]
\[\chi_{j,f,u}^{t_{p}} \leq \max_{j} \cdot B_{j,f,u} \quad \forall t_{p}, f, u \in T_{p}, j, f, u
\]
\[
\sum_{t_{p}} X_{j,f,u}^{t_{p}} \geq \min_{j} \cdot \sum_{u} B_{j,f,u} \quad \forall t_{p}, f, \]
Planning Tools: Feasibility Assessment

- Consider available resources: growers, logistics and transportation
- Preliminary profitability assessment
- Assess new investment allocation
Planning Tools: Feasibility Assessment
Planning Tools: Coordination

- Assign production and logistic tasks
- Define Planting and Harvesting Decisions (schedule)
- Allocate contracts:
  - Prices, volumes, time windows, cost subsidy, etc.
- Ensures the collaboration for the duration of the opportunity
Planning Tools: Coordination

Data Gathering
- Production Data
  - Land Location
  - Production Capacity
  - Resources
  - Capabilities
  - Weather Conditions

- Logistics Data
  - Infrastructure
  - Transportation
  - Costs

Pre-Negotiation
- Initial Prices
- Expected Profit/ROI

Coordination/Negotiation
- Delivery Bids
- Predicted Yields
- Price Bids
- Capacity Bids
- Price Bids

Farmers
- Production Assignment
- Planning Schedule
- Investment Required

Logistic Providers

Operational Planning
How to make this work?

- Understand the **system** to be modeled
- Input parameters
- Validate the models
- Validate results

**Interact with industry: producers, logistics and consumers**
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