Objective of Talk

- Provide an industrial perspective on typical supply chain problems, issues addressed, and solution approaches.
Dow AgroSciences PURPOSE

Science Serving the Needs of the Growing World
Our Operations Span the Globe

Worldwide presence

Facilities in more than 40 countries and products sold in more than 130 countries

Approximately 9,000 employees worldwide
Dow AgroSciences: Overview

### 2015 Sales by Geography

<table>
<thead>
<tr>
<th>Region</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMEAI (1)</td>
<td>43%</td>
</tr>
<tr>
<td>ASIA PACIFIC</td>
<td>18%</td>
</tr>
<tr>
<td>LATIN AMERICA</td>
<td>11%</td>
</tr>
<tr>
<td>NORTH AMERICA</td>
<td>28%</td>
</tr>
</tbody>
</table>

### Value Proposition

- Significant technology-driven growth, led by biotech innovations and novel Crop Protection products
- Developing Seed capabilities
  - R&D productivity and collaboration accelerate innovation
  - Bolt-on Seed acquisitions
- Discovery pipelines filled with high-value solutions and proprietary formulations for the next 10 years

### 2015 Key Financial Highlights (dollars in millions)

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$6,381</td>
</tr>
<tr>
<td>Operating EBITDA</td>
<td>$859</td>
</tr>
<tr>
<td>Operating EBITDA Margin</td>
<td>13.5%</td>
</tr>
</tbody>
</table>

(1) Europe, Middle East, Africa & India
# Crop Protection Pipeline Full with High-Value Solutions

<table>
<thead>
<tr>
<th>Name</th>
<th>Discovery</th>
<th>Development</th>
<th>Est. Launch*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Launched within 5 years</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enlist Duo™ Herbicide</td>
<td></td>
<td></td>
<td>2015-2018</td>
</tr>
<tr>
<td>Arylex™ Active</td>
<td></td>
<td></td>
<td>2015-2018</td>
</tr>
<tr>
<td>Inatreq™ Active</td>
<td></td>
<td></td>
<td>2018-2019</td>
</tr>
<tr>
<td>Rinskor™ Active</td>
<td></td>
<td></td>
<td>2018-2019</td>
</tr>
<tr>
<td>Insecticide 1</td>
<td></td>
<td></td>
<td>2021-2022</td>
</tr>
<tr>
<td><strong>Launched after 5 years</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fungicide 1</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Fungicide 2</td>
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<td></td>
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<tr>
<td>Fungicide 3</td>
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<tr>
<td>Insecticide 2</td>
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<tr>
<td>Insecticide 3</td>
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<tr>
<td>Insecticide 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insecticide 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herbicide 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fungicide 4</td>
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<td></td>
</tr>
<tr>
<td>Insecticide 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herbicide 2</td>
<td></td>
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</tbody>
</table>

*Subject to regulatory approvals and other assumptions; Represents first year of commercial sales in a significant market through the year when sales are established in markets which represent 80% of the new product value. ™Trademark of The Dow Chemical Company (“Dow”) or an affiliated company of Dow.
Typical Supply Chain

RM Suppliers

Intermediate Production

Final Production

Terminal / Warehouse

Customer

N_S \sim 5-10

N_{IP} \sim 1-5

N_F \sim 1-5

N_T \sim 10

N_C \sim 1000
Typical Design Inputs

- Customer demands by location by month by product for 3-5 years
- Locations for:
  - Suppliers
  - Intermediate production
  - Final production
  - Terminals / Warehouses
  - Customers
- Modes of transport costs and capacities
- Production costs and capacities
- Lead times between echelons
- Uncertainty in:
  - Demand
  - Lead times
Typical Design Outputs

- Number, location, and size of:
  - intermediate production locations
  - final production locations
  - terminals / warehouses

- Size of:
  - raw material storage
  - intermediate storage at intermediate and final production locations
  - final product storage at final production locations
  - terminals / warehouses

- Capacity of modes of transportation between all echelons
- Staging of all of the above over next 3-5 years
## Toolbox

<table>
<thead>
<tr>
<th>Tool</th>
<th>Data Collection</th>
<th>Data Manipulation</th>
<th>Analysis</th>
<th>Optimization</th>
<th>Visualization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excel</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
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<tr>
<td>GAMS/Cplex</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Data Guru</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Supply Chain Guru</td>
<td>X</td>
<td>X</td>
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<td>X</td>
<td>X</td>
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<tr>
<td>Rapid Response</td>
<td></td>
<td></td>
<td>X</td>
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<td>X</td>
</tr>
<tr>
<td>SmartOps</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tableau</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
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</tbody>
</table>
## Examples

<table>
<thead>
<tr>
<th>Problem</th>
<th>Issues Addressed</th>
<th>Tools Used</th>
</tr>
</thead>
</table>
| Global New Molecule Supply Chain | • Seasonal Demand  
                              | • Campaign Strategy            | • Excel  
                              |                                           | • Supply Chain Guru                     |
| Regional Sourcing Model     | • Income Taxes  
                              | • Duties                      | • Excel  
                              |                                           | • Data Guru  
                              |                                           | • Supply Chain Guru  
                              |                                           | • Tableau                              |
| Rail Fleet Optimization    | • Transportation Uncertainty     | • Excel                        | • GAMS/Cplex                     |
New Molecule Supply Chain Design

- Do we campaign produce Tech or not?
- Do we campaign produce intermediates or not?
- What impact does capacity have?
- What is the optimal inventory profile?
Global Supply Chain Possible Lanes
Demand Profile
Tech Production Profiles

- Comparison of production profiles with and without campaign production of tech.
  - Allows plant to be block operated with other products
  - Not easy to implement in off the shelf package
• Comparison of inventory with and without campaign production of tech.
  ▪ Has a $0.5MM impact of working capital per year
  ▪ Most inventory is intermediate and technical material, NOT finished goods
    – Planning intermediate production is key
Global Supply Chain – Optimal Solution
Regional Sourcing Model Objective

- Determine the F&P footprint to supply Asia based on the next 10 years of forecasted demand which minimizes the “total cost”.
  - Freight Cost
  - Conversion Cost
  - Capital Cost
  - Fixed Operating Cost
  - Closing Cost
  - Inventory Holding Cost
  - Duty Cost
  - Income Taxes

Diagram:
- Technical
- Formulate
- Package
- Customer
Problem Size

- **Products**
  - 298 AI (by PP by Country)
  - 246 Planned Products (by Country)

- **Sites**
  - 18 Technical Sources
  - 30 Formulation Locations
  - 32 Packaging Locations
  - 13 Selling Countries

- **Demands**
  - 2059 Planned Product by Country by Year combinations

- **Sourcing Policies**
  - 299 T / AI combos
  - 1052 F / PP combos

- **Transportation Lanes**
  - 139 T->F
  - 262 F->P
  - 188 P->C

- **BOM**
  - 298 AI -> PP

- **Duty**
  - 456 non-zero rates by product
    - 4928 possible rates required
    - 138 country to country combos

- **Taxes**
  - 23 rates
Options Being Considered

Technical
Formulation
Packaging
Customer
Solution Approach

1. Collect inputs in Excel spreadsheet
2. Use DG to convert data files to SCG inputs
3. Set up scenarios in SCG
4. Run scenarios in SCG
5. DG to convert SCG output tables into summarized output tables
6. Analyze results in Excel and/or Tableau
“Master” Data File

- Tab for each set of inputs
DG to SCG inputs
Role and Impact on Income Taxes and Duty

Entrepreneur
- Paid for the R&D
- Produces the active ingredient
- Earns profit/loss associated with exploiting the technology in the marketplace

Manufacturer (formulation)
- Performs formulation activities
- Earns a profit margin on the formulation activities

Distributor
- Warehouses the final product
- Promotes, sells product
- Earns a margin typical of a distributor
Tradeoffs Between Duty and Income Tax

- Duty is paid at a rate determined by importing country
  - Depends on exporting country and if being re-exported
- Income Tax is paid at a rate determined by country where profit remains
- Both are a function of Legal Transfer Price (LTP)

\[
\text{Duty}_{A \to B} \approx \text{DutyRate}_{A \to B} \times \text{LTP}_{A \to B} \\
\text{Duty}_{B \to C} \approx \text{DutyRate}_{B \to C} \times \text{LTP}_{B \to C}
\]

\[
\text{Tax}_B \approx \text{TaxRate}_B \times (\text{LTP}_{B \to C} - \text{LTP}_{A \to B})
\]

\[
\text{Tax}_A \approx \text{TaxRate}_A \times (\text{LTP}_{A \to B} - \text{Mfg Cost}_A)
\]

\[
\text{Tax}_C \approx \text{TaxRate}_C \times (\text{Price}_C - \text{Dist Cost}_C - \text{LTP}_{B \to C})
\]

- Lower LTP reduces Duty paid but redistributes profit, so may increase Income Tax paid
  - Depends on Tax Rates, Mfg Costs, etc.
Scenarios Set Up and Run

- Manually generated scenarios
- Running scenario without duty and taxes custom constraint takes about **30 seconds**
- Running scenario **WITH** duty and taxes custom constraint takes **4.5 hours**
Use DG to convert SCG tables into summarized table(s)
Analyze Outputs in Tableau
Key Learnings

1. Source design controllable costs are ~25% of total modeled supply cost

2. Duty is a primary driver in the cost equation and the value of drawback is significant

3. Tax rules are complex and are an important variable of delivered cost

4. Supply Chain Guru “dynamic modeling” was a critical enabler to visualize comprehensive cost and value drivers
Rail Fleet Optimization Problem

• Inputs
  ▪ Demands requirements by week by location
  ▪ Shipping times (distribution) and costs
  ▪ Restrictions on shipments sent / received per day

• Outputs
  ▪ Number of railcars in fleet by month, quarter, semester, year, etc.
  ▪ Total logistics costs
    – Railcar lease / maintenance
    – Shipping expenses
Specific Issues Addressed

- Seasonality of demand
- Uncertainty of pest outbreak on demand
- Variability in inbound and outbound cycle times for shipping
Solution Approach

- Collect/manipulate data in Excel
- Formulate as MILP using GAMS
- Solve using CPLEX
- Display results automatically in Excel
- Perform scenario analysis to determine sensitivity of solution to uncertainty / variability
8 Rail cars did 111 shipments.  
372 Truck shipments.  
Total transportation cost $958,058
One Optimal Solution...

1st Semester - 12 Rail cars & no trucks
2nd Semester - 22 Rail cars & 12 trucks
Total transportation cost $ 653,640
Using Our Expertise for the Greater Good

- Dow AgroSciences encourages employees to use their expertise to address issues in the communities where we work

- DAS Hunger Solutions Network
  - Our mission to engage DAS employees’ passion and expertise to address the world’s issues of food insecurity and hunger
  - Our vision is to have a measurable impact on hunger in underserved communities both locally and globally
  - Engaged with the Indy Hunger Network to address food insecurity in Indianapolis
Indianapolis Food Pantry Analysis

- Determine impact of locating additional food pantries given geographic distribution of need
Analysis

Current Pantries

Current + New Pantries

% Population vs Distance (miles)

Dow AgroSciences
Summary

● Supply chain problems can be
  ▪ Global
  ▪ Regional
  ▪ National
  ▪ Local

● Look around you and see where your expertise can have an impact.
Questions?