Make Your Fertilizer Warehouse Store Dollars and Your Applicator Spread Costs

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Bill Fitzwater Cooperative Chair
Issues

• Agribusinesses are examining larger scale warehousing
• Fertilizer manufacturing industry is shifting overseas
• Future of NH3?
• OSU recommendations are shifting to spring application
OSU Agronomist are Changing Approach
2 LB. NITROGEN/BUSHEL OF WHEAT” MAY
BE WRONG
Gordon Johnson and Bill Raun, July 2003

• Before: multiply the yield goal by 2, subtract soil test N and apply the difference as fertilizer
• Current: no nitrogen except for N-rich strip– nitrogen is applied at top dress time
OSU Fertilizer

Warehouse/Application Research

- What does it cost to warehouse and apply fertilizer?
- Is our current structure of warehouses efficient?
- Would a large scale central warehouse reduce costs?
- Are we using equipment efficiently?
- Impact of shift away from NH3 to Urea and/or UAN
- Application costs in large vs small fields
Approach

- Model fertilizer acquisition, transportation, storage and application
- Use actual agribusiness information for data on fertilizer volume, application acreage, warehouse locations, transportation distances, and current equipment compliment
If you were to build your entire fertilizer department from scratch what would it look like?
Economic Engineering Model

- Determine fixed and variable costs of warehouses, trucking and application
- Design a system to deliver fertilizer needs of an example agribusiness firm
- Compare to existing system
- Investigate impact of changes in product form, warehouse location, transportation costs, etc.
Example Situation

- 210,000 acres
- 95 or 70 lbs of N and 25 lbs of P2O5
- Source: Enid, Woodward, Port of Catoosa
- 7 warehouse locations
- 75% 110 acre fields
- 25% 60 acre fields
- 5 miles warehouse- fields
Example Situation

- Large warehouse cost: (20,000 tons dry, 10,000 UAN)
  - Construction cost: $198/ton dry $227/ton UAN
- Small warehouse cost (4,000 tons dry, 2,500 UAN)
  - Construction cost: $567/ton dry $648/ton UAN
- NH3 warehouse-$20,000/65 ton tank: $300/ton
- Dry applicator: 60 ft- $200,000
- UAN applicator: 75 ft- $200,000
- NH3 applicator $15,000
Product Costs Used in Model

- NH3: $300
- DAP: $256
- UREA: $240
- UAN: $165
Cost and Capacity Estimation

Applicator operating were estimated from American Society of Agricultural Engineers (ASAE) machinery standards

- Fertilizer Transportation costs were calculated using distances and commercial freight rates or tender truck costs

- Machinery capacities were adjusted to account for breakdown probabilities and travel times to-and-from fields

- Warehouse values were depreciated over 40 years using straight line-method, other warehouse costs were calculated as percentages of warehouse construction values
Results: Warehouses

Existing
- 9 NH3
- 5 Dry
- 9 Liquid

Model
- 7 NH3 locations
- 5 Dry locations
- 5 liquid location

Least cost structure was somewhat more centralized compared to current structure
Results Equipment

Existing
- 8 dry rigs
- 8 liquid rigs
- 92 NH3 trailers

Model
- 7 dry rigs
- 10 liquid rigs
- 53 NH3 trailers

Case Agribusiness Used Applicators Very Efficiently but Farmer Controlled Equipment is Inefficient
Fertilizer System Costs

Source
Field
App. Variable
Whs. Fixed
App. Fixed

Applicator Fixed

60%

9%
6%

11%

14%

Warehouse fixed costs
Results: Fertilizer System Costs

- Source to warehouse: $9.13/ton
- Warehouse fixed costs: $15.02
  - $24/ton out of product margin
- Tender truck: $0.28/acre
- Application: $0.50/acre
- Applicator fixed costs: $2.82/acre

$3.60/acre to cover all application related costs
Alternative Systems

- BASE: Fall P2O5, NH3 Spring UAN
- UREA/UAN: Fall P2O5, Urea Spring UAN
- UREA only: Fall P205 and Urea
- UAN only: Fall P205, Spring UAN
Fertilizer Form Had Minor Impact on Least Cost Warehouse Location

<table>
<thead>
<tr>
<th></th>
<th>Dry</th>
<th>Liquid</th>
<th>NH3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
<td>5</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>DAP Urea/UAN</td>
<td>7</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>DAP Urea</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAP/UAN</td>
<td>5</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>5</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>
Fertilizer Form Does Not Impact Applicator Fleet*

<table>
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<tr>
<td>Base</td>
<td>7</td>
<td>10</td>
<td>53</td>
</tr>
<tr>
<td>DAP Urea/UAN</td>
<td>7</td>
<td>10</td>
<td></td>
</tr>
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<td></td>
<td></td>
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<td>10</td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>8</td>
<td>8</td>
<td>92</td>
</tr>
</tbody>
</table>

*Except for fall only system which eliminates liquid applicators
# Fertilizer System Costs on a Per Acre Basis

<table>
<thead>
<tr>
<th></th>
<th>Source to Warehouse</th>
<th>Warehouse to Field</th>
<th>Application Variable</th>
<th>Warehouse Fixed</th>
<th>Applicator Fixed</th>
<th>Total Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base</strong></td>
<td>$0.79</td>
<td>$0.55</td>
<td>$1.00</td>
<td>$1.30</td>
<td>$5.63</td>
<td>$9.27</td>
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<tr>
<td><strong>Urea/UAN</strong></td>
<td>$1.35</td>
<td>$0.66</td>
<td>$0.98</td>
<td>$1.44</td>
<td>$5.58</td>
<td>$10.01</td>
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<tr>
<td><strong>Urea only</strong></td>
<td>$1.33</td>
<td>$0.69</td>
<td>$0.59</td>
<td>$0.73</td>
<td>$2.63</td>
<td>$5.97</td>
</tr>
<tr>
<td><strong>UAN only</strong></td>
<td>$1.55</td>
<td>$1.08</td>
<td>$0.99</td>
<td>$1.59</td>
<td>$5.58</td>
<td>$10.79</td>
</tr>
</tbody>
</table>

*Base model does not account for the farmer’s cost of applying NH₃*
## Fertilizer System Costs on a Per Ton Basis

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<tr>
<td><strong>Base</strong></td>
<td>$9.13</td>
<td>$6.35</td>
<td>$11.55</td>
<td>$15.02</td>
<td>$65.04</td>
<td>$107.08</td>
</tr>
<tr>
<td><strong>Urea/UAN</strong></td>
<td>$11.18</td>
<td>$5.47</td>
<td>$8.12</td>
<td>$11.93</td>
<td>$46.21</td>
<td>$82.90</td>
</tr>
<tr>
<td><strong>Urea only</strong></td>
<td>$11.66</td>
<td>$6.05</td>
<td>$5.17</td>
<td>$6.40</td>
<td>$23.05</td>
<td>$52.32</td>
</tr>
<tr>
<td><strong>UAN only</strong></td>
<td>$9.08</td>
<td>$6.32</td>
<td>$5.80</td>
<td>$9.31</td>
<td>$32.67</td>
<td>$63.18</td>
</tr>
</tbody>
</table>

*Base model does not account for the farmer’s cost of applying NH3
## Fertilizer System Costs

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<th>Applicator Fixed</th>
<th>Total Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base</strong></td>
<td>9%</td>
<td>6%</td>
<td>11%</td>
<td>14%</td>
<td>61%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Urea/UAN</strong></td>
<td>13%</td>
<td>7%</td>
<td>10%</td>
<td>14%</td>
<td>56%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Urea only</strong></td>
<td>22%</td>
<td>12%</td>
<td>10%</td>
<td>12%</td>
<td>44%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>UAN only</strong></td>
<td>14%</td>
<td>10%</td>
<td>9%</td>
<td>15%</td>
<td>52%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Applicator fixed costs are the major cost component.
### Agribusiness’s Application Cost/Acre

<table>
<thead>
<tr>
<th></th>
<th>Field</th>
<th>Apply</th>
<th>Fixed</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
<td>$0.28</td>
<td>$0.50</td>
<td>$2.82</td>
<td>$3.59</td>
</tr>
<tr>
<td>Urea/UAN</td>
<td>$0.33</td>
<td>$0.49</td>
<td>$2.79</td>
<td>$3.61</td>
</tr>
<tr>
<td>Urea only</td>
<td>$0.51</td>
<td>$0.49</td>
<td>$2.63</td>
<td>$3.63</td>
</tr>
<tr>
<td>UAN only</td>
<td>$0.54</td>
<td>$0.50</td>
<td>$2.79</td>
<td>$3.83</td>
</tr>
</tbody>
</table>

Spring UAN would increase firm’s cost by $.23/acre
### Warehouse Cost

<table>
<thead>
<tr>
<th></th>
<th>Tons</th>
<th>Shipping Cost/ton</th>
<th>Warehouse Cost/ton</th>
<th>Total Cost/ton</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base</strong></td>
<td>18,179</td>
<td>$9.13</td>
<td>$15.02</td>
<td>$24.14</td>
</tr>
<tr>
<td><strong>Urea/UAN</strong></td>
<td>25,357</td>
<td>$11.18</td>
<td>$12.92</td>
<td>$24.10</td>
</tr>
<tr>
<td><strong>Urea only</strong></td>
<td>23,960</td>
<td>$11.66</td>
<td>$6.40</td>
<td>$18.05</td>
</tr>
<tr>
<td><strong>UAN only</strong></td>
<td>35,866</td>
<td>$9.08</td>
<td>$9.31</td>
<td>$18.38</td>
</tr>
</tbody>
</table>

Product form will not have much effect on warehousing costs (UAN is cheaper but tons are higher)
# Farmers Cost per Acre

<table>
<thead>
<tr>
<th></th>
<th>Material</th>
<th>Fall Appl</th>
<th>Spr. Appl</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
<td>$24.78</td>
<td>$3.00</td>
<td>$3.00</td>
<td>$30.78</td>
</tr>
<tr>
<td>Urea/UAN</td>
<td>$30.54</td>
<td>$3.00</td>
<td>$3.00</td>
<td>$36.54</td>
</tr>
<tr>
<td>Urea only</td>
<td>$30.22</td>
<td>$3.00</td>
<td></td>
<td>$33.22</td>
</tr>
<tr>
<td>UAN only</td>
<td>$32.93</td>
<td>$3.00</td>
<td>$3.00</td>
<td>$38.93</td>
</tr>
</tbody>
</table>

Spring UAN costs $8/acre more than baseline and $2.50/acre more than fall urea. The major impact Of a shift to spring N would be on the producer
When Would a Single Warehouse be Justified?

- Unit train shipping would save $3-$4/ton
- Total warehouse personnel might be reduced
- Equipment coordination and maintenance would be simplified
Recall that warehouse ownership costs are not the major cost component.

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</tr>
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*Costs per ton
Single Warehouse Was Not Selected by Model Even When Warehouse Ownership Expense Set at $0

- Warehouse to field transportation expense and need for additional applicators offset warehouse cost efficiencies
- Did not consider locating applicators regionally with centralized warehouse
- Did not consider warehouse labor costs
$15-$17/ton savings in rail rate and labor would be needed to justify a single centralized warehouse in the case firm’s situation.

<table>
<thead>
<tr>
<th>Source to Warehouse to Fields and Applicator Ownership</th>
<th>Net Cost Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>-$0.41 $14.00 $3.15</td>
<td>$16.73</td>
</tr>
<tr>
<td>-$0.26 $13.41 $3.33</td>
<td>$16.48</td>
</tr>
<tr>
<td>-$0.17 $13.17 $4.39</td>
<td>$17.40</td>
</tr>
</tbody>
</table>
Applicator Efficiency

Large versus Small Fields

Large (110 acre)
- Dry: 87.5%
- Liquid: 80%

Small (60 acre)
- Dry: 70%
- Liquid: 62.5%

Applying in large fields is more efficient but coordination of jobs is the major issue. 14-37% of capacity is used traveling between jobs.
Implications and Future Research

• How much could we save by coordinating application scheduling?
• Would producers agree to coordination?
• What is the “fair” way to set application fees?