The Batching & Mixing Processes
Presentation Outline

• Function of the batching & mixing processes
• Batching system design considerations
• Types of mixers and factors effecting mixer performance
• Testing mixers
• The importance of feed uniformity on animal performance
Introduction

• The batching/mixing processes are the heart of the feed mill…

• The objective is to bring together the ingredients called for in the formula, in the correct proportion, and blend them together creating a uniform mixture in a minimum amount of time.

• The Nutritionist’s Assumption…
NUTRITIONIST’S ASSUMPTION…

The batching/mixing process is the heart of the feed mill…
Introduction

- Larger batch sizes
- Larger mixers
- Shorter mixing times
- More ingredients
- Employee mistakes
- Speed vs. accuracy

Not every mouth full is the exact same…
Today’s Batching Systems
Batching System

[Diagram of a batching system with various components and labels indicating weights, cut-offs, jog times, and statuses for bins and valves.]
Batching System
Batching System
Batching System

• Scales
  – According to the National Institute of Standards and Technology Handbook 44, scales with capacities greater than 500 lbs. can deviate up to 0.1% of the capacity.
  – Consequently, scales need to be sized in accordance with the quantity of product being weighed.
  – Licensed feed mills need to have the scales and metering devices certified annually (CGMPs, Section 225.30)
Batching System

• Load Cells
  – Don’t operate load cells above the rated capacity
  – Adequately protect the load cell cable and don’t carry the load cell by the cables
  – Don’t allow build up of debris around the load cell and load cell mounts
  – Check for corrosion damage to load cell and mounting
  – Don’t weld near the load cell
Batching System

Deviation per Draw Control Chart (by %)
BetaRaven Feeds - St. Charles, MO (@2/2/05 8:05:27 AM)

Bin B005 (Ingredient 5)
From 12/1/04 00:00:00 To 12/9/04 23:59:59
Area B1

- Deviation %
- Mean
- LCL
- UCL

Draw Completion Time

Kansas State University | Department of Grain Science and Industry
VERTICAL MIXER

Advantages
- Low initial investment
- Low maintenance cost
- Small footprint
- Can be installed on a scale

Disadvantages
- Long mixing time
- Poor clean out
- Low inclusion of liquids
PADDLE MIXER

Advantages
- Good for fibrous and high mineral diets
- Works well with diets high in molasses

Disadvantages
- Poor side-to-side mixing action
- Dead spots in corners
RIBBION MIXERS

- Short mixing time
- Good mixing action
- Good clean out
Mixers
Low cost - Good mixing action - Mixes small batches
CONTINUOUS MIXERS

- Used to bring ingredients together in constant proportions;
- Mixtures including high levels of liquid ingredients;
- Most common are the ‘cut-and-folded screw’ and paddles.
Mixing Cycle

- Dry load
- Hands add
- Dry mix
- Liquids add
- Wet mix
- Discharge
Liquid Addition
Liquid Addition to the Mixer

• Fat Sources – inedible tallow and grease
• 77% of what is produced goes into the feed industry
• Categories
  – Beef or pork fat
  – Poultry
  – Restaurant grease
  – AV blend
Fat Quality

• Stability – rancidity
• Free of pesticides
• Certified as being negative for chick edema
• Free of heavy metals
• Free of water
Storage of Fat

• Typically, feed fats should be stored at 120-130 degrees F.
• Higher temps may be desired (180 F), but it will cost more.
• Cone bottom tanks are desirable. The fat needs to be recirculated to maintain uniform temperature
Fat Storage

• All fat lines should be heated with heat tape or wrapped heat coils
• Filters should be installed on unloading lines to prevent impurities from entering storage tanks
• Also have filters after the storage tanks
• Piping sizing is very important, work with someone who knows what they are doing!
Pumps & Meters

• Heart of the system
• Most common types of pumps in the feed industry:
  – Centrifugal pumps
  – Piston pumps
  – Gear pumps
Centrifugal Pumps

• Used with less viscous liquids
• Conveys liquids under low pressure and over short distances
• Not recommended for animal fats
Piston pumps

• Higher maintenance problems
• Only recommended for thin liquids
Gear Pumps

- Common in the feed industry
- Relatively low maintenance
- Viking pumps are very popular in the industry
- Can pump both hot and cold material, and thick/thin material
- Request durable material to reduce headaches
Know your load requirements

- What is the capacity of the system
- What horsepower pump is needed
- Electrical requirements:
  - Distance
  - Pipe heat tracing
  - Don’t use under- or over-sized motors
  - Work with your supplier to make sure the motors has adequate torque (Design B, C, D motors)
Disassembly Condition for Rebuilding
• Be Gentle and Control your temper!
Metering

• Problems:
  – Unsteady flow from the pump
  – Gear slippage
  – Inconsistent product characteristics
  – Pressure, volume, temperature changes
  – Frequent calibration is recommended
Records

- Liquids inventory
- Pump maintenance
- Electrical maintenance
- Spare parts
- With good records management can make intelligent decisions for good results
Testing Mix Uniformity

• Marker Selection
  – Accuracy assay
  – Assay ease
  – Cost of the assay
  – Test performed on site
  – Marker must be from a single source
# Testing Mix Uniformity

**Mean**  
\[ \text{Mean} = \frac{\sum x_i}{n} = \frac{507}{5} = 101.4 \]

**Variance**  
\[ \text{Variance} = \frac{\sum d^2}{n - 1} = \frac{501.2}{4} = 125.3 \]

**Standard Deviation**  
\[ \text{Standard Deviation} = \sqrt{\text{Variance}} = \sqrt{125.3} = 11.2 \]

**Coefficient of Variation**  
\[ \text{Coefficient of Variation} = \frac{\text{std mean}}{\text{mean}} \times 100 = \frac{11.2}{101.4} \times 100 = 11\% \]

<table>
<thead>
<tr>
<th>Sample</th>
<th>Drug (g/ton)</th>
<th>Deviation from Mean</th>
<th>Deviation Squared</th>
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<tbody>
<tr>
<td>1</td>
<td>110</td>
<td>8.6</td>
<td>73.96</td>
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<tr>
<td>2</td>
<td>115</td>
<td>13.6</td>
<td>184.96</td>
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<tr>
<td>3</td>
<td>92</td>
<td>-9.4</td>
<td>88.36</td>
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<tr>
<td>4</td>
<td>89</td>
<td>-12.4</td>
<td>153.76</td>
</tr>
<tr>
<td>5</td>
<td>102</td>
<td>-0.4</td>
<td>0.16</td>
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<tr>
<td>507</td>
<td></td>
<td></td>
<td>501.2</td>
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</table>
## Marker Comparison

<table>
<thead>
<tr>
<th>Item, %</th>
<th>Mix Time (min)</th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.5</td>
<td>2.5</td>
<td>5.0</td>
<td></td>
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<tr>
<td>DL-Methionine</td>
<td>23.86</td>
<td>14.56</td>
<td>9.47</td>
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<tr>
<td>Lysine-HCl</td>
<td>19.75</td>
<td>16.00</td>
<td>8.70</td>
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<tr>
<td>Crude Protein</td>
<td>7.73</td>
<td>7.29</td>
<td>6.86</td>
<td></td>
</tr>
<tr>
<td>Chloride Ion (as sodium chloride)</td>
<td>20.26</td>
<td>12.75</td>
<td>15.08</td>
<td></td>
</tr>
<tr>
<td>Phosphorus</td>
<td>13.72</td>
<td>6.46</td>
<td>6.27</td>
<td></td>
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<tr>
<td>Manganese</td>
<td>36.25</td>
<td>20.80</td>
<td>17.59</td>
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<tr>
<td>Microtracer™ Red #40 (count)</td>
<td>21.77</td>
<td>11.72</td>
<td>15.08</td>
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</tr>
<tr>
<td>Microtracer™ Red #40 (absorbance)</td>
<td>21.13</td>
<td>20.52</td>
<td>16.88</td>
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</tr>
<tr>
<td>Microtracer™ RF-Blue Lake</td>
<td>32.49</td>
<td>20.09</td>
<td>18.64</td>
<td></td>
</tr>
<tr>
<td>Roxarsone (3-Nitro®)</td>
<td>30.24</td>
<td>25.15</td>
<td>25.54</td>
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<tr>
<td>Semduramicin (Aviax®)</td>
<td>27.40</td>
<td>16.11</td>
<td>11.23</td>
<td></td>
</tr>
</tbody>
</table>

(Clark et al., 2007)
HOW IMPORTANT IS DIET UNIFORMITY TO THE ANIMAL?
MIX UNIFORMITY AND CV FOR CHROMIUM IN NURSERY DIETS

Mix time, min

CV, %

0 0.5 2 4

Traylor et al. 1994
DIET UNIFORMITY EFFECTS ON NURSERY PIGS

Traylor et al. 1994
MIX UNIFORMITY AND CV FOR SALT IN FINISHING DIETS

Mix time, min

CV, %

0 0.5 2 4

54 15 13 10

Traylor et al. 1994
DIET UNIFORMITY EFFECTS ON FINISHING PIGS

Traylor et al. 1994
### DIET UNIFORMITY EFFECTS ON BROILERS

<table>
<thead>
<tr>
<th></th>
<th>Salt CV (%)</th>
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<tbody>
<tr>
<td></td>
<td>40.50(^a)</td>
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<p>| | | | |</p>
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<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Average daily gain (g)</td>
<td>23.60(^a)</td>
<td>30.00(^b)</td>
<td>30.30(^b)</td>
</tr>
<tr>
<td>Average daily feed intake (g)</td>
<td>43.10</td>
<td>51.50</td>
<td>52.70</td>
</tr>
<tr>
<td>Feed efficiency (f:g)</td>
<td>1.82(^a)</td>
<td>1.72(^b)</td>
<td>1.74(^b)</td>
</tr>
</tbody>
</table>

\(^a,b\) Means within a row differ significantly (P < 0.05)
Recommendaions

<table>
<thead>
<tr>
<th>Broilers</th>
<th>CV &lt; 15%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nursery pigs</td>
<td>CV &lt; 20%</td>
</tr>
<tr>
<td>Finishing pigs</td>
<td>CV &lt; 30%</td>
</tr>
</tbody>
</table>

...based on minimal data
OTHER CONSIDERATIONS

- Quantity/criticality of ingredient (Diet Complexity)
- Nutritional consequences vs. medication delivery
- Deficiency/Toxicity Limits
- Ease of modifying process parameters
Questions