The Economic Impact of Feed Texture on Broiler Performance

Marc de Beer, PhD
Global Head of Nutrition Services
• Trial data comparing pellets and fines
• Extended use of crumble rather than pellet
• Ideal crumble size for chicks
• Mash feeding
• Use of manual shaker sieves
Feed Texture

- Feed form plays a major role in determining performance
- Is one of the major challenges in Latin America
- High throughput requirements at the mill make it difficult to focus on feed texture
- Data suggests it would be worth it
- Should be part of any mill Quality Control program
E0507 Trial Procedures

Trial Design:

- 3 replicates of 120 day-old male broilers per pen.
- 3 nutritional treatments.

<table>
<thead>
<tr>
<th>Feed Treatments</th>
<th>Starter (0 – 10 days)</th>
<th>Grower (10 – 34 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Control</td>
<td>Crumble</td>
<td>Pellet (3mm)</td>
</tr>
<tr>
<td>2. Fines</td>
<td>Fines</td>
<td>Fines</td>
</tr>
<tr>
<td>3. Mix</td>
<td>50% Crumb:50% Fines</td>
<td>50% Pellet:50% Fines</td>
</tr>
</tbody>
</table>
## Trial Results

### Body Weight

<table>
<thead>
<tr>
<th>Treatment</th>
<th>10d</th>
<th>21d</th>
<th>31d</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Control</td>
<td>297</td>
<td>975</td>
<td>1972</td>
</tr>
<tr>
<td>2. Fines</td>
<td>264</td>
<td>797</td>
<td>1579</td>
</tr>
<tr>
<td>3. Mix</td>
<td>287</td>
<td>916</td>
<td>1835</td>
</tr>
<tr>
<td>P Value</td>
<td>0.016</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>
## Trial Results

### Feed Conversion

<table>
<thead>
<tr>
<th>Treatment</th>
<th>10d</th>
<th>21d</th>
<th>31d</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Control</td>
<td>1.39</td>
<td>1.53</td>
<td>1.63</td>
</tr>
<tr>
<td>2. Fines</td>
<td>1.54</td>
<td>1.67</td>
<td>1.71</td>
</tr>
<tr>
<td>3. Mix</td>
<td>1.42</td>
<td>1.60</td>
<td>1.69</td>
</tr>
<tr>
<td>P Value</td>
<td>0.003</td>
<td>0.011</td>
<td>0.008</td>
</tr>
</tbody>
</table>
Conclusion

• The results concur with more recent work showing that poor feed physical quality results in a severe reduction in broiler performance.

• Live weight reduction of 20% and FCR of 4.9%.
The Influence of feed form on male broilers

- Poor feed physical quality is an issue in the field.
- Objective was to investigate this response in a hot environment.
- Aviagen used the BARC facilities in Thailand.
1 products x 1 sex x 3 feed treatments x 8 reps = 24 pens

<table>
<thead>
<tr>
<th>Diet</th>
<th>Control</th>
<th>T 1</th>
<th>T 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starter</td>
<td>100% Crumb</td>
<td>100% Fines</td>
<td>50% Crumb/Fines</td>
</tr>
<tr>
<td>(0 to 10)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grower</td>
<td>100% Pellet</td>
<td>100% Fines</td>
<td>50% Pellets/Fines</td>
</tr>
<tr>
<td>(11 – 28)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finisher</td>
<td>100% Pellets</td>
<td>100% Fines</td>
<td>50% Pellets/Fines</td>
</tr>
<tr>
<td>(29 to 42)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The Effect of Feed Form on Broiler Liveweight and FCR (42 days)

<table>
<thead>
<tr>
<th>Feed Form</th>
<th>Liveweight (grams)</th>
<th>FCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% Crumb/Pellets</td>
<td>2638</td>
<td>1.79</td>
</tr>
<tr>
<td>50% Pellets + 50% Fines</td>
<td>2520</td>
<td>1.83</td>
</tr>
<tr>
<td>100% Fines</td>
<td>2136</td>
<td>1.90</td>
</tr>
</tbody>
</table>

Feed Form
Results

• Feed form reduced live weight by 20%.

• FCR was less severely affected; reduced by 6%.
The Influence of Fine Particles in the Feed on Broiler Performance

Quentin et al., 2004
An improvement in P.D.I of 10% equates to;
Approximately +1g of ADG.
+10% increased PDI = 2.1(USc) cents/bird
Use of Crumble for Extended Periods

Summary

Crossville
Feed Stations

- Record feed intake through the lifetime of the bird.
- Individual feed consumption data;
  e.g. quantity, frequency and duration.
Feed Form Affects Feeding Behaviour

Feed Intake (g/bird/day)

Age in Days

Feed Intake (g)

Pellet Fed

Crumb Fed
Feed Form Affects Feeding Behaviour

Meal Duration (s)

Age in Days

Duration (s)

Pellet Fed

Crumb Fed
Feed Form Affects Feeding Behaviour

Meal Size (g)

Age in Days

Meal size (g)

Pellet Fed

Crumb Fed
Feed Form Affects Feeding Behaviour

% Occupancy of Feed Places

Age (days)

% Occupancy

Pellet Fed

Crumb Fed
3. 50%:50%

1. Control

2. Fines
Particle Size Preference in Chicks from 0-10 Days

Summary

Albertville
2007
Starter and Grower diets were separated into 4 fractions

<table>
<thead>
<tr>
<th>Fractions (mm)</th>
<th>&lt;0.82</th>
<th>0.82-2.00</th>
<th>2.00-3.18</th>
<th>&gt;3.18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Intake Results

Intake Day 1-10

Grams

3.18 mm + 2 to 3.18 mm 0.816 to 2 mm Fines (<0.816 mm)
Effect of Starter Crumble Size on Broiler Performance to 9 Days

Summary

Albertville
2008
• Starter diet was sieved into 3 fractions
• All particles larger than 3.18 mm were removed

<table>
<thead>
<tr>
<th>Starter</th>
<th>Fractions (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0.82</td>
<td>0.82-2.00</td>
</tr>
<tr>
<td></td>
<td>2.00-3.18</td>
</tr>
</tbody>
</table>
9 Day BW

9 Days BW

grams

<0.82 0.82-2.00 2.00-3.18

194 215 234
9 Day Feed Intake

9 Days Feed Intake

grams

<0.82 0.82-2.00 2.00-3.18

188 195 204
9 Day FCR

9 Days FCR

- <0.82: 0.967
- 0.82-2.00: 0.908
- 2.00-3.18: 0.871
9 Day Uniformity

% CV

<0.82: 11.49
0.82-2.00: 7.49
2.00-3.18: 9.94
Influence of Mash feeding on Broiler performance

Thailand 2008
Trial design

- 1 sex * 3 energy * 4 feed forms * 8 replicates
  - Energy: 100%, 95%, 90%
  - Feed form: fine, medium, coarse mash, pellet
  - all treatments started on good crumble
Trial design

- BARC – Thailand
- 8 replicates
- 16 birds/pen
# Milling Trial Diets and Feed Forms

<table>
<thead>
<tr>
<th></th>
<th>Screen size (mm)</th>
<th>Grinder speed (rpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse Mash</td>
<td>6.5</td>
<td>1420</td>
</tr>
<tr>
<td>Medium Mash</td>
<td>3</td>
<td>1420</td>
</tr>
<tr>
<td>Fine Mash</td>
<td>2</td>
<td>2800</td>
</tr>
<tr>
<td>Pellets (3 mm die)</td>
<td>3</td>
<td>2800</td>
</tr>
</tbody>
</table>
Sieve analyses Growers

Particle Size

- > 3 mm
- 2 - 3 mm
- 1 - 2 mm
- < 1 mm

Pellet
Coarse Mash
Medium Mash
Fine Mash

95
94
48
94
48
37
3

Highest feed intake was achieved on the pelleted product. When energy is reduced, birds will aim to compensate feed intake but this is not possible on the mash products.
Best liveweight was achieved on Pelleted diet. When energy is reduced birds are not able to compensate feed intake and therefore reduced liveweight.
Feed Conversion 35 Days (males)

Corrected to 2 kg

- **FCR**
  - Pellet
  - Coarse Mash
  - Medium Mash
  - Fine Mash

**Table with P values**

<table>
<thead>
<tr>
<th></th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (E)</td>
<td>0.001</td>
</tr>
<tr>
<td>Physical Quality (PQ)</td>
<td>0.001</td>
</tr>
<tr>
<td>E * PQ</td>
<td>0.001</td>
</tr>
<tr>
<td>SEM</td>
<td>0.011</td>
</tr>
</tbody>
</table>
Abdominal Fat 35 days (males)

<table>
<thead>
<tr>
<th>Wings (% Lwt)</th>
<th>Tmt</th>
<th>Energy (E)</th>
<th>Physical Quality (PQ)</th>
<th>E * PQ</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.95</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.0024</td>
</tr>
<tr>
<td>1.94, 1.90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.81</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.70</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.48, 1.44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.27</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Energy Level as % of Recommendation 2007
Litter Moisture at 35&36 days (males)

Energy Levels as % of Recommendation

Pellet
Coarse Mash
Medium Mash
Fine Mash

35 Days
36 Days

P<0.01, no interaction on ME& Feed type
Total Water Intake to 49 days (males)

<table>
<thead>
<tr>
<th>Energy Level as % of Recommendation 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
</tr>
<tr>
<td>Tmt</td>
</tr>
<tr>
<td>Energy (E)</td>
</tr>
<tr>
<td>Physical Quality (PQ)</td>
</tr>
<tr>
<td>E * PQ</td>
</tr>
<tr>
<td>SEM</td>
</tr>
</tbody>
</table>
Conclusions

• Physical feed quality:
  – Pellets: best performance
  – Coarse + Medium Mash very similar
  – Fine Mash: poorest performance

• Energy reduction:
  – Birds will aim to increase feed intake
  – Increase feed intake not possible when energy is 90% (all treatments)
  – Effect of energy reduction biggest on Fine Mash treatment
How is Physical Feed Quality Measured?

- Pellet Durability Index
- Sieve analyses
Pellet Durability Index (PDI)

Percentage pellets by weight that survive a standardised durability test (eg Holmen test)
Sieve analyses
Physical Feed Quality

• PDI and Sieve analyses difficult to assess on farm
• To overcome subjective opinions
  – Manual Shaker
    • Crumbles
    • Pellets
    • Mash
1. Take a representative sample:
   - Generally from hopper closest to the feeders
   - If a long augur is used to supply feed into the hoppers
     - Sample should be taken from feeders
   - Take samples from 3 points
   - Mix samples
   - Lay out and quarter
   - Take 2 opposite quarters for testing
How to use the Manual Shaker?

2. Remove sliding lid

3. Place lid in slot of largest compartment
How to use the Manual Shaker?

4. Fill up the 3 mm compartment with feed sample
5. Remove the block and replace lid
How to use the Manual Shaker?

6. Turn sieve in length:  
   3 mm compartment at the top
How to use the Manual Shaker?

7. Shake, shake, shake
    ...
    shake rigorously
as the fines have
to move to the last
compartment

At least 1 minute
How to use the Manual Shaker?

8. Stop shaking and return sieve to original position
How to use the Manual Shaker?

9. Read off values of each section
10. Calculate percentages in each section:
   • Add total of values in all 4 sections (= TOTAL)
   • Divide value in each section by TOTAL to produce percentage

Or use the spreadsheet provided with the shaker sieve
### Calculation of Particle Size Distribution

#### Tabular Data

<table>
<thead>
<tr>
<th>Muestra</th>
<th>Nombre</th>
<th>&lt; 3 mm</th>
<th>2 - 3 mm</th>
<th>1 - 2 mm</th>
<th>&lt; 1 mm</th>
<th>Total</th>
<th>%&lt; 3 mm</th>
<th>%2 - 3 mm</th>
<th>%1 - 2 mm</th>
<th>%&lt; 1 mm</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ave 1</td>
<td>60</td>
<td>10</td>
<td>10</td>
<td>20</td>
<td>100</td>
<td>60%</td>
<td>10%</td>
<td>10%</td>
<td>20%</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Ave 2</td>
<td>47</td>
<td>7</td>
<td>14</td>
<td>28</td>
<td>96</td>
<td>49%</td>
<td>7%</td>
<td>15%</td>
<td>28%</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Ave 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
</tr>
<tr>
<td>4</td>
<td>Ave 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
</tr>
<tr>
<td>5</td>
<td>Ave 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
</tr>
<tr>
<td>6</td>
<td>Ave 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
</tr>
<tr>
<td>7</td>
<td>Ave 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
</tr>
<tr>
<td>8</td>
<td>Ave 8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
<td>#DIV/0!</td>
</tr>
</tbody>
</table>

### Graphs

1. **Distribución de Partículas Muestra 1**
   - Tamaño de Partícula:
     - < 3 mm: 80%
     - 2 - 3 mm: 10%
     - 1 - 2 mm: 10%
     - < 1 mm: 20%

2. **Distribución de Partículas Muestra 2**
   - Tamaño de Partícula:
     - < 3 mm: 40%
     - 2 - 3 mm: 7%
     - 1 - 2 mm: 15%
     - < 1 mm: 20%
### Targets

<table>
<thead>
<tr>
<th>Form</th>
<th>Starter</th>
<th>Grower</th>
<th>Finisher</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;3mm</td>
<td>Crumb</td>
<td>Pellet (3mm)</td>
<td>Pellet (3mm)</td>
</tr>
<tr>
<td>2 to 3mm</td>
<td>40%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 to 2mm</td>
<td>35%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1.0mm</td>
<td>&lt;10%</td>
<td>&lt;10%</td>
<td>&lt;10%</td>
</tr>
</tbody>
</table>
If Sieve Analyses are Not Satisfactory

• Feed manufacture in the mill
  – Grinding
  – Conditioning
  – Pelleting
  – Cooling

• Feed transport:
  – Storage and transport in mill
  – vehicle design, distance
  – discharging feed on farm

• Farm:
  – Storage and transport to feeders
  – Feeder management
Economics Exercise

- After conducting sieve analysis on a feed sample we find that we have 40% fines
- What is the economic impact of such a level of fines?
The Effect of Feed Form on Broiler Liveweight and FCR (42 days)

Feed Form

- 100% Crumb/Pellets
- 50% Crumb/Pellets + 100% Crumb/Pellets + Fines

Liveweight (grams):
- 100% Crumb/Pellets: 2638
- 50% Crumb/Pellets + 100% Crumb/Pellets + Fines: 2136
- 100% Crumbs/Pellets + Fines: 1789

FCR:
- 100% Crumb/Pellets: 1.79
- 50% Crumb/Pellets + 100% Crumb/Pellets + Fines: 1.90
- 100% Crumbs/Pellets + Fines: 1.83

Graph showing the comparison of liveweight and FCR for different feed forms.
Data

• At 42 days:
  • 400 grams less BW at 100% fines (40 grams /10%)  
  • 11 points higher FCR at 100% fines (1.1 pts /10%)  
  • If FCR is BW corrected we could assume an additional 12 points at 100% fines so total would be 23 points worse FCR at 100% fines (2.3 pts/10%)  

• Assume:
  • 100% pellet diet would be $300  
  • Whole carcasses at $1.92 /kg  
  • All samples are the same nutrient density
Exercise

Question 1

• Just based on BW:
  • Difference in BW of 400 g between 100% pellets and 100% fines (40 g /10%)
  • At $1.92 per kg WOG and 70% yield

• If you were selling 1 million whole birds/week:
  • What would be the yearly loss caused by feeding your sample feed versus 100% pellets?
### Ejercicio Económico de Calidad de Alimento

<table>
<thead>
<tr>
<th>PRODUCCION</th>
<th></th>
<th>% FINOS</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Aves / Semana</td>
<td>1,000,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aves / Año</td>
<td>52,000,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peso Faena</td>
<td>2.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kg. por Año</td>
<td>135,200,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### INSTRUCCIONES

1. Ingrese las aves producidas por semana (obtendrá las aves producidas en un año)
2. Ingrese el peso promedio final (Kg) de las aves (obtendrá las aves totales producidas en un año)
3. Ingrese el porcentaje de finos (<1 mm) obtenido en la lectura de la criba (obtendrá los kilos totales de ave perdidas por año por efecto de los finos)
4. Ingrese el precio de venta por kilo de peso vivo
5. Ingrese el rendimiento de las aves luego de la faenación
6. Obtendrá la pérdida total por año por efecto de alimentos con finos.
Question 2

- If a 100% pellet diet ($300) gave 2.6 kg at 42 days at an FCR of 1.8:
  - What would be the difference in feed costs per bird if you used your sample feed compared to the 100% pellet feed?

Question 3

- If the 100% pellet diet costs $300:
  - What would your sample diet have to be sold for to make feed cost per bird equal to the 100% pellet diet?
### Cálculo Económico de % de Finos y su Impacto en los Costos

#### Ejercicio 2

<table>
<thead>
<tr>
<th>Parámetros</th>
<th>100 % PELLET</th>
<th>60 % PELLET</th>
<th>60 % PELLET</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.A.</td>
<td>1.800</td>
<td>1.892</td>
<td>1.892</td>
</tr>
<tr>
<td>PESO VIVO</td>
<td>2.600</td>
<td>2.500</td>
<td>2.600</td>
</tr>
<tr>
<td>ALIMENTO TOTAL</td>
<td>4.680</td>
<td>4.919</td>
<td>4.919</td>
</tr>
<tr>
<td>Costo Alim/ton</td>
<td>300</td>
<td>300</td>
<td>$285,412</td>
</tr>
<tr>
<td>Costo Alim/ave</td>
<td>1.404</td>
<td>1.476</td>
<td>1.404</td>
</tr>
</tbody>
</table>