Nutritional strategies to reduce the use of antibiotics in swine

Banff Pork seminar

Prof. Leo den Hartog
Content

1. Feeding the Future
2. Antimicrobial resistance
3. Strategies to reduce use of antibiotics
4. Steering intestinal health
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Feeding the Future
Nutreco

- > 100 production plants in 29 countries and sales > 80 countries
- 10 R&D units in 7 countries
- Multinational workforce of approximately 12,000 employees

Two global company brands

Local company brands in Canada & Iberia
Trouw Nutrition Research Centres

Ingredient
Swine
Ruminants
Poultry
Agresearch
Feeding the future

Humanity needs to produce more food in the next 34 years than it has in the past 8,000 years combined

Now

- 7 billion people
- 83 kg dairy
- 37 kg meat

+ 30%
+ 53%
+ 75%

2050

- 9 billion people
- 99 kg dairy
- 50 kg meat
Opportunities & challenges

On average worldwide the productivity of farm animals is **30-40%** below their genetic potential because of suboptimal conditions and health status.
Reproductive performance of a sow

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ovulations</td>
<td>25</td>
</tr>
<tr>
<td>Fertilized eggs</td>
<td>20</td>
</tr>
<tr>
<td>Embryo's</td>
<td>15</td>
</tr>
<tr>
<td>Total born piglets</td>
<td>12</td>
</tr>
<tr>
<td>Live born piglets</td>
<td>8</td>
</tr>
<tr>
<td>Weaned piglets</td>
<td>6</td>
</tr>
</tbody>
</table>
Six critical phases in a piglet’s early life

1. Healthy sow for the best next litter
2. Follow the birth process closely
3. Colostrum - the most important piglet feed
4. Optimal usages of sow milk
5. The best start with supplemental feed
6. Easy weaning
Antimicrobial resistance
Annual deaths attributable to AMR by 2050 can exceed other causes.

Source: The Review on Antimicrobial Resistance, December 2014
Tightened legislation for the use of antibiotics in feed

- Antibiotic growth promoters banned
- Antibiotic growth promoters under discussion
- Antibiotic growth promoters can be used unlimited
Dutch results; collaboration industry and government

A ban on Antimicrobial Growth Promoters (AGPs) doesn’t automatically reduce antibiotic use; ambitious targets in combination with multi-stakeholder commitment is pivotal.

EU ban on AGPs additional multi-stakeholder measures on national level

Source: FIDIN/Sda, 2016
Antibiotic resistance is reversible

Reducing the use of antibiotics pays off: multi-resistance of *E. coli* in the Netherlands decreases: still 60% of *E. coli* is resistant to one or more antibiotics, but there is a trend-break

Source: Nethmap-Maran, 2016

- Resistance (%) to 0 - 9 antimicrobial classes among *E. coli* strains from slaughter pigs. 1998 – 2015 in the NL
- Less strains resistant to > 5 classes
- 40% strains are NOT resistant

*Source: Nethmap-Maran, 2016*
Strategies to reduce the use of antibiotics
Working together in a holistic approach

A drastic reduction of antibiotic in food production can be achieved if we move to a new farming model based on holistic and multi-stakeholder collaboration.

- Robust animals due to genetic development
- Effective vaccines supporting strong immune system
- Healthy nutrition resulting in healthy animals
- Improved hygiene and safety at farm level
Nutritional solutions in feed and health management

Feed Management
- Preservation additives
- Mineral formulation
- Raw material quality control by NIR & Mycotoxin Risk Management
- Protein digestibility analysis by measuring reactive lysine

Health Management
- Functional additives for gut health
- Nutritional solutions for LifeStart and transition periods

In order to reach:

Animal production efficiency
- Optimal performance
- Improved litter quality
- Nutritional efficiency

Secure animal production
- Healthy start
- Overcome dysbiosis
- Strong gut health & immune function
Steering intestinal health
Steering intestinal health

4 level strategy for animal protection

1. Prevent bacterial intake

2. Microbiota management

3. Improve gut integrity

4. Immunomodulation
Stimulating gastrointestinal development

**Characteristics of the gut**

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>NDM¹</th>
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</thead>
<tbody>
<tr>
<td>Length</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SI (cm)</td>
<td>708 ± 19</td>
<td>765 ± 25 *</td>
</tr>
<tr>
<td>LI (cm)</td>
<td>131 ± 7</td>
<td>146 ± 7</td>
</tr>
<tr>
<td>Weight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SI (g)</td>
<td>202 ± 12</td>
<td>255 ± 19 **</td>
</tr>
<tr>
<td>LI (g)</td>
<td>54 ± 3</td>
<td>63 ± 4</td>
</tr>
</tbody>
</table>

¹ nutrient-dense complex milk replacer (Milkiwean)

* p<0.1 ** p<0.05 *** p<0.01

Source: De Greeff et al., 2016
Mapping microbiota population

Intestinal sampling

Microbiota DNA isolation

Barcoded pyrosequencing to study the intestinal microbiota

Microflora profiling
Weaning changes diversity, with signs of dysbiosis

Pre-weaning

Post-weaning

Jejunum

Colon

Higher proportion of *Lactobacillus reuteri* post-weaning & reduced diversity

Source: Trouw Nutrition R&D, 2011
Higher microbiota diversity in fast growers

<table>
<thead>
<tr>
<th></th>
<th>Slow growing (&lt; 270 g/day)</th>
<th>Fast grower (&gt;360 g/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jejunum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colon</td>
<td></td>
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</tr>
</tbody>
</table>

Fast growers:
- Higher diversity in the jejunum
- Higher proportion of butyrate producing bacteria in the colon

Source: Trouw Nutrition R&D, 2011
Semi-high throughput *in vitro* methods to prescreen

Efficacy of feed candidates on microbiota, mucosal barrier and immunity

*In vitro* screening methods

- Microbial activity screen
- Cell integrity screen
- Immunomodulation screen

50-100 Candidates

*In Vivo* Proof of Efficacy
## Toolkit of feed additives to combine for the desired effect

<table>
<thead>
<tr>
<th>Forms applied</th>
<th>Organic acids</th>
<th>Medium Chain Fatty Acids</th>
<th>Butyrate</th>
<th>Phenolic compounds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Formic Propionic Lactic</td>
<td>Mixture of MCFA derived from plant oils Controlled release</td>
<td>Controlled release butyrate</td>
<td>Specific plant extracts as source</td>
</tr>
</tbody>
</table>

![Formic Acid](attachment://formic_acid.png)  
![Propionic Acid](attachment://propionic_acid.png)  
![Butyric Acid](attachment://butyric_acid.png)

<table>
<thead>
<tr>
<th>Targeted effects</th>
<th>Activity bacteria ↓, balance microbiota</th>
<th>Activity bacteria ↓, balance microbiota</th>
<th>Turnover epithelial cells, mucus ↑</th>
<th>Immune modulation</th>
</tr>
</thead>
</table>
Functional additives supporting the pig

Combination of functional feed and drinking water additives

pH decrease + Prevent bacterial intake

Microbiota + Gut integrity + Immunity
Feed additives improved diversity in jejunum

Microbiota profiling shows a more stable microbiota with the right functional additive

Source: Trouw Nutrition R&D, 2011
Longer villi for a healthy poultry gut

Improved gut wall strength with the right functional additive

Longer villi in duodenum

Shorter villi in control (left) and longer villi in the feed additives treatment (right)

Less villus fusion in ileum

Villus fusion for the control (left) and intact villi in the feed additives treatment (right)

Source: 1230 broilers, research farm feedmill Belgium, 2015
High performance control diet with AGP versus Milkiwean VITAL START with no AGP

*First week post-weaning*

10% higher Feed Intake
15% Higher ADG

Source: Ferguson et al, 2016
Feed additives consistently improves ADG and feed efficiency in piglets

- Meta-analyses of 9 controlled R&D studies
- Presan versus control diet without antibiotics, ZnO
- Data of in total 2310 piglets included
- No bias, all studies are included

<table>
<thead>
<tr>
<th></th>
<th>ADG, g/day</th>
<th>Feed intake, g/day</th>
<th>Feed Conversion Ratio</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>+ 5%</td>
<td>+ 4%</td>
<td>- 2%</td>
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<tr>
<td><strong>p</strong></td>
<td>&lt; 0.001</td>
<td>= 0.029</td>
<td>&lt; 0.001</td>
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*ADG, g/day: Average Daily Gain; Feed intake, g/day: Feed intake; Feed Conversion Ratio: Ratio of feed intake to ADG.*
Precision livestock farming
Precision livestock farming

- Raw material quality control
- Nutritional database
- Nutritional add-on
- Animal models
- Economic models
Variation in feed intake

Source: Trouw Nutrition R&D, 2014
Variation in feed intake

Average feed intake per piglet g/d

Days post-weaning

Source: Trouw Nutrition R&D, 2014
Early growth is key

Fast growers in nursery grow 300 g/day more as finisher pig!
Growth rate and feed conversion for fast and slow growers

<table>
<thead>
<tr>
<th>Live weight (kg)</th>
<th>Relative growth rate</th>
<th>Fast growers</th>
<th>Slow growers</th>
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<tbody>
<tr>
<td>30</td>
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<td>90</td>
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<td>105</td>
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<table>
<thead>
<tr>
<th>Live weight (kg)</th>
<th>Relative feed conversion</th>
<th>Boars</th>
<th>Sows</th>
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<tr>
<td>30</td>
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Take home message
Facing the challenge. Together.

We can reduce antibiotic use in food production globally, by applying Feed-Farm-Health management strategies.

- Optimal farm management
- Healthy nutrition and functional feed additives
- Optimal health management
Thank you