Future of Vaccination in Warmwater Aquaculture

Lee Yeng Sheng
Sr. Specialist, Global Technical Marketing, Aquaculture
MSD Animal Health
yeng.sheng.lee@merck.com
Diseases in Aquaculture

- Aquaculture = artificial farming in high density
- Predispose stress to fish
  - Environmental – NH$_3$, NO$_2$, NO$_3$, pH, pO$_2$
  - Stocking density – 10 kg vs. 30 kg per m$^3$, competition / aggression
  - Nutrition – natural vs. artificial diet
- Development of diseases
  - Average 3-6 core diseases per fish species (tilapia?)
Effective Disease Control

- Implement biosecurity
  - Farm design and engineering controls (hardware)
  - Administrative husbandry controls (software)
  - Fish genetics and quality (seeds)
  - Incorporate effective aquaculture products
    - Probiotics / supplements
    - Disinfectants: Reduce environmental pathogen load
    - Antibiotics: Only when fish are sick, apply timely and responsibly
    - Vaccines: Gold standard, prevent fish from getting sick
Key Benefits of Vaccines

- Prevent disease
- Improve survival rates
- Improve FCR, reduce feed cost
- Increase total harvest biomass
- Improve production efficiency
- Better return on investments
- Farm economic sustainability
Economic Benefits – Farm I

CONTROL

VACCINATED

2011 data collected in LATAM

<table>
<thead>
<tr>
<th>Low Pressure Farm S. agalactiae</th>
<th>Final Production Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Survival</td>
</tr>
<tr>
<td>Vaccinated Group</td>
<td>87%</td>
</tr>
<tr>
<td>Control Group</td>
<td>78%</td>
</tr>
<tr>
<td>Difference</td>
<td>9%</td>
</tr>
</tbody>
</table>

Increase net profit of $13,260 each 100 ton
Economic Benefits – Farm II

CONTROL

VACCINATED

<table>
<thead>
<tr>
<th>High Pressure Farm S. agalactiae</th>
<th>Final Production Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Survival</td>
</tr>
<tr>
<td>Vaccinated Group</td>
<td>91.9 %</td>
</tr>
<tr>
<td>Control Group</td>
<td>76.5 %</td>
</tr>
<tr>
<td>Difference</td>
<td>15.3 %</td>
</tr>
</tbody>
</table>

2011 data collected in LATAM

Increase net profit of $21,950 each 100 ton

Proprietary
Additional Benefits of Vaccines

- Improve fish quality, better prices
- Better taste and texture
- Reduce antibiotic use (no antimicrobial resistance)
- Improve food safety (no antibiotic residue)
- Herd immunity – reduce environmental pathogen pressure
- Environmental sustainability
Herd Immunity Concept: Partial Vaccination

= disease outbreak
Herd Immunity Concept: Mass Vaccination

= disease outbreak
# Vaccines vs. Antibiotics

<table>
<thead>
<tr>
<th>Vaccines</th>
<th>Antibiotics</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Preventive against diseases</td>
<td>x Reactive treatment after infection</td>
</tr>
<tr>
<td>✓ Efficient in disease control</td>
<td>x Efficiency depends on time of treatment</td>
</tr>
<tr>
<td>✓ Does not induce bacterial resistance, environmentally friendly</td>
<td>x Chance of bacterial resistance, not environmentally safe</td>
</tr>
<tr>
<td>✓ Viral vaccines available</td>
<td>x Not applicable to viral disease</td>
</tr>
<tr>
<td>✓ No food safety concerns</td>
<td>x Food safety issues with antibiotic residues</td>
</tr>
<tr>
<td>✓ Herd immunity reduce pathogen pressure over time</td>
<td>x Transient reduction of pathogen only during treatment period</td>
</tr>
<tr>
<td>✓ Environmental and farm sustainability</td>
<td>x Not sustainable</td>
</tr>
<tr>
<td>✓ Recommended for disease control</td>
<td>x Highly regulated by many countries</td>
</tr>
</tbody>
</table>
## Types of Vaccines

<table>
<thead>
<tr>
<th>Type</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| Immersion | ▪ Easy administration  
           ▪ Application at early stages  
           ▪ Vaccines available | ▪ Relatively short duration of protection    |
| Oral      | ▪ Easy administration  
           ▪ Application at all stages | ▪ No reliable oral technology  
           ▪ No vaccine available         |
| Injection | ▪ Proven results  
           ▪ Long-term protection  
           ▪ Vaccines available | ▪ Challenging administration process       |
Vaccine Development Case Study:

– MSD Tilapia Streptococcal Vaccines
Tilapia Strep Vaccines (market opportunities)

Source: FAO, 2014
Tilapia Strep Vaccines (disease profiling)

Pathogen:
- **Trichodina, Dactylogyrus, Amyloodinium**
- **Streptococcus spp.**
- **Francisella noatunensis subsp. orientalis**
- **Flavobacterium columnare**
- **Aeromonas spp.**
- **Iridovirus**
- **Tilapia Lake Virus**

Source: MSD Animal Health, 2017
Tilapia Strep Vaccines (epidemiology)

Source: MSD Animal Health, 2017
Tilapia Strep Vaccines (R&D)

- Develop challenge model
- Strain selection (vaccine & challenge candidates)
- Design vaccine prototype
- Safety and efficacy studies, cross-protection, shelf-life
- Develop manufacturing process, up-scale, technology transfer
- Conduct field trial
- Compile international dossier for registration
Tilapia Strep Vaccines (commercialization)

• Global RA: international product dossier
• Local RA: country-specific registration (LATAM, APAC)
• Market and awareness creation
• Small scale trials to demonstrate vaccine benefits
• Technical support and vaccination implementation
• Key to vaccination success: good biosecurity and farm management
Examples of Global Vaccine Adoption

- **Brazil (2017)**: 60 mil, 17%
- **Honduras (2017)**: 21 mil, 42%
- **Mexico (2018)**: 47 mil, 57%
- **Malaysia (2018)**: 12 mil, 21%

Legend:
- Blue: Vaccinated doses
- Red: Non-vaccinated
APAC Focus

Malaysia (2018)
- 12 mil, 21%

APAC tilapia
Indonesia (2017)
- 1.2 mil, 0%

China (2017)
- 0, 0%

Vietnam (2017)
- 1.3 mil, 15%

Vaccinated doses
Non-vaccinated
Why is it difficult in APAC??

- A fish is not a fish – too many varieties
  - Scattered scientific knowledge
  - Diluted resources

- Majority rural traditional small scale farms
  - Polyculture, poor biosecurity
  - Low awareness, do not believe in vaccines

- Only modern, industrialized farms willing to invest in vaccines
  - Good biosecurity and farm management
Why is it difficult in APAC??

- Limited regulatory partnership with industry to promote best practices
  - Conduct education and training programs for farms
  - Governmental initiatives to promote AMR alternatives
  - Subsidies and grants for small farms
  - Promote sustainable aquaculture
Norwegian Salmon Success Story

• Vaccination pioneered largely in collaboration by Norwegian government with industry players

• Vaccines widely adopted in the salmonid industry

• Almost all farmed salmon (>95%) are injection vaccinated

• Up to 7 antigenic components in a single injectable salmon vaccine
Norwegian Salmon Success Story
Current Trends in LATAM

- Rapid increase in commercial vaccine adoption rate
- Farmers are open to conduct vaccination trials
- Science-based approach to farming, embrace disease prevention
- Advantage of good environmental conditions, good quality water
- Significant market growth due to sustainable disease control
Current Trends in Africa

- Farmers are hungry for knowledge in disease control
- High demand for support on disease identification
- Gaining grounds on vaccination adoption, autogenous vaccines are available
- Main farm species = tilapia (high domestic consumption and margins)
- AMR awareness is high, seek alternatives to achieve sustainability
- Opportunities for tilapia investment, growth expected in the next 2-5 years
Current Trends in APAC

• Largest producer of fish but lowest vaccination rate
• Generally conservative farms with poor farm management and challenging water conditions (pollution)
• Low awareness of vaccines and benefits
• Dependent on cheap antibiotics to control diseases, result in poor fish quality and food safety
• Only big-scale farms able to adopt vaccination
Future Requirements of Fish Vaccines

• Total fish production volumes are much higher than many terrestrial animals

• Difficult to manipulate large fish numbers for injection vaccination

• Vaccination technology: automated fish injectors

• Oral vaccines: efficient administration via feed to all fish sizes, booster vaccination

• Multivalent vaccines: similar to salmon vaccines
Future Trends of Aquaculture Industry

- Expected surge in demand for vaccines, especially in LATAM and Africa
- Demand for multi-component vaccines in Asia with complicated disease status
- Consolidation of farms in the next 4-6 years when diseases cripple small-scale operations, unless farm invest in biosecurity and vaccines
- Global AMR and food safety movements will implement ban of antibiotic use in food fish (~ 5 years)
Thank You..

Lee Yeng Sheng
Sr. Specialist, MSD Animal Health (Singapore)
yeng.sheng.lee@merck.com