Food and Agriculture Organization of the United Nations

FMM/RAS/298: Strengthening capacities, policies and national action plans on prudent and responsible use of antimicrobials in fisheries Final Workshop in cooperation with AVA Singapore and INFOFISH

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Future of Vaccination in Warmwater Aquaculture

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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

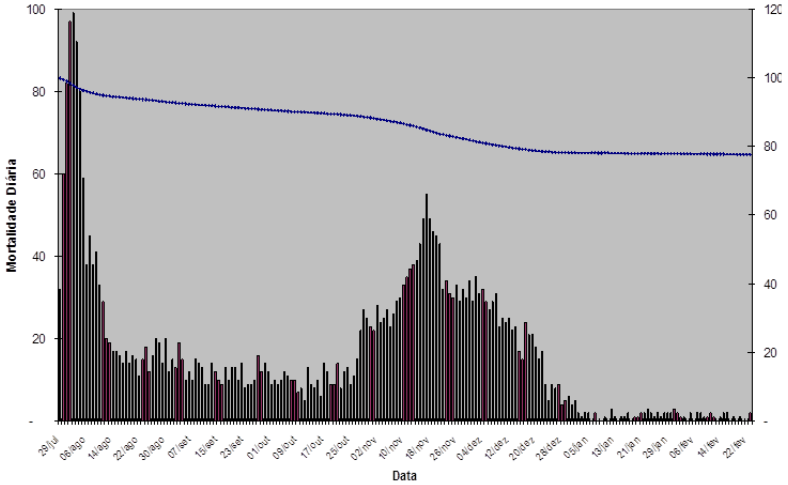
- Implement biosecurity
  - ✓ Farm design and engineering controls (hardware)
  - ✓ Administrative husbandry controls (software)
  - ✓ Fish genetics and quality (seeds)
  - ✓ Incorporate effective aquaculture products
    - Probiotics / supplements
    - Disinfectants: Reduce environmental pathogen load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

Key Benefits of Vaccines

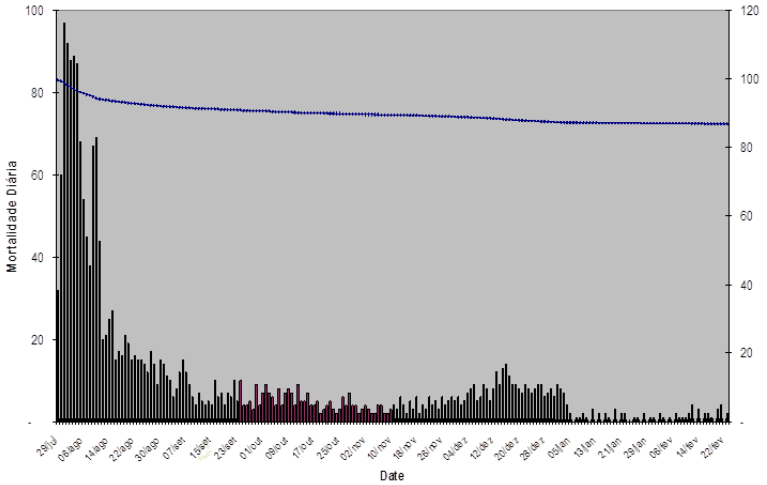
- Prevent disease
- Improve survival rates
- Improve FCR, reduce feed cost
- Increase total harvest biomass
- Improve production efficiency
- Better return on investments
- Farm economic sustainability

Economic Benefits – Farm I

CONTROL



VACCINATED



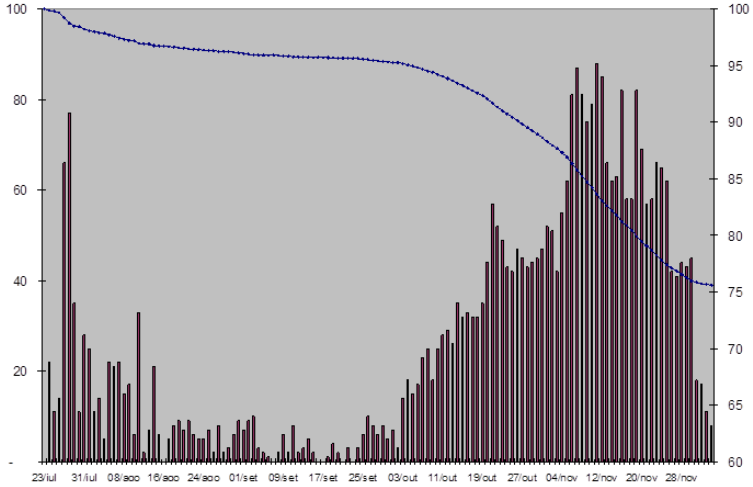
2011 data collected in LATAM

Low Pressure Farm *S. agalactiae*	Final Production Data	
	% Survival	FCR
Vacinated Group	87%	1.75
Control Group	78 %	1.96
Difference	9 %	0.21

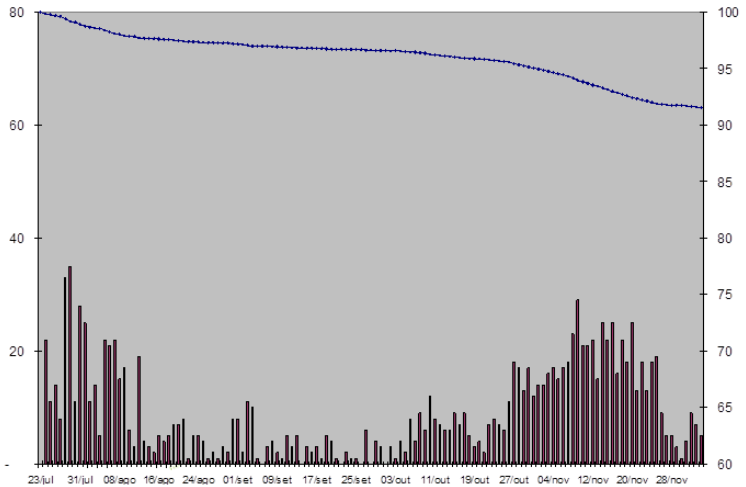
Increase net profit of $13,260 each 100 ton

Economic Benefits – Farm II

CONTROL



VACCINATED



High Pressure Farm *S. agalactiae*	Final Production Data	
	% Survival	FCR
Vaccinated Group	91.9 %	1.85
Control Group	76.5 %	2.10
Difference	15.3 %	0.25

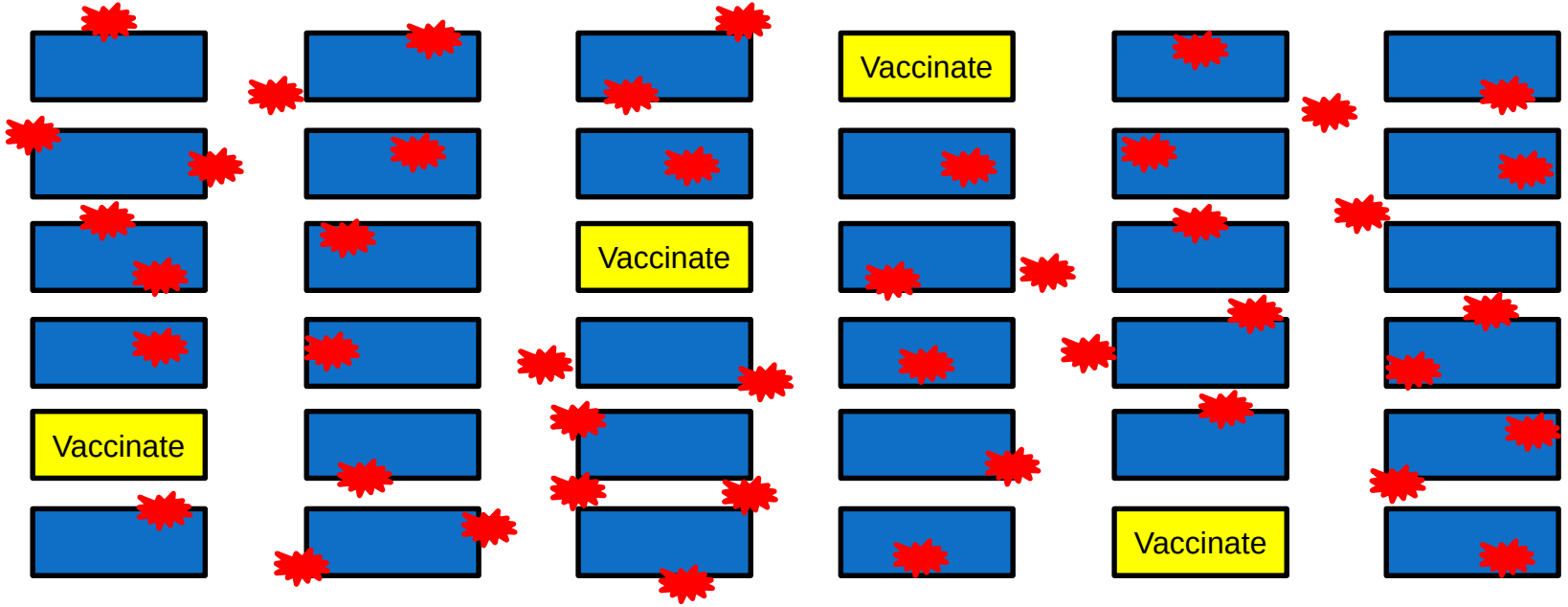
2011 data collected in LATAM

Increase net profit of $21,950 each 100 ton

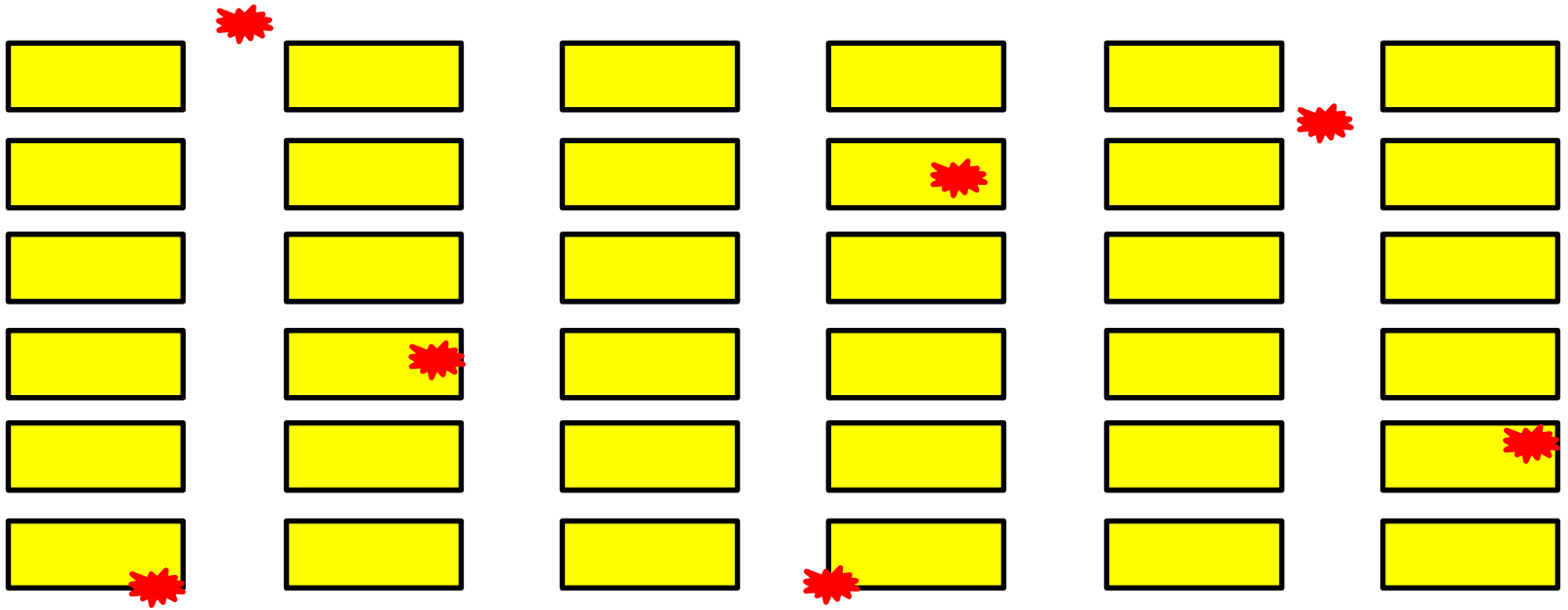
Additional Benefits of Vaccines

- 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



Herd Immunity Concept: Mass Vaccination



= disease outbreak

Vaccines vs. Antibiotics

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

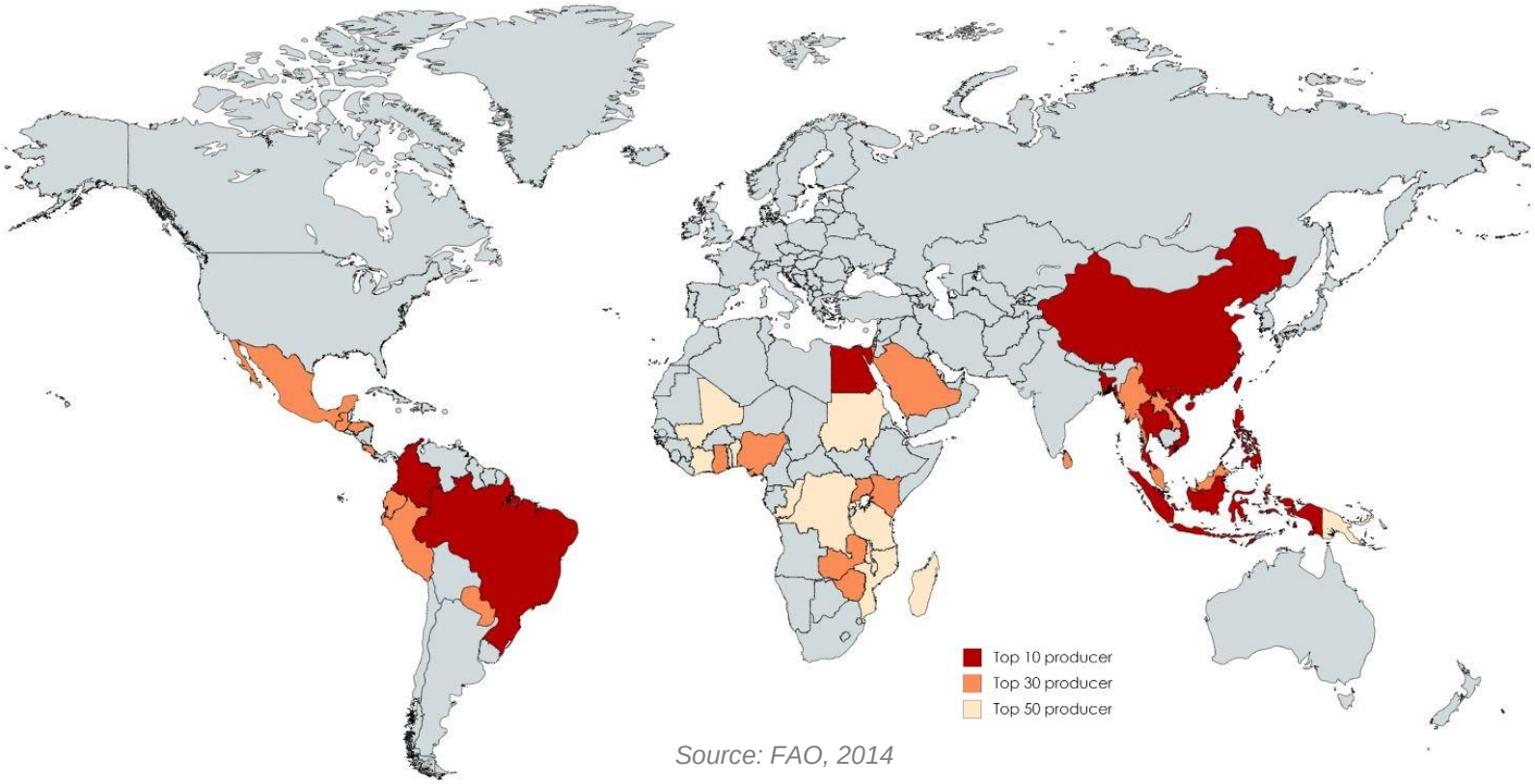
Types of Vaccines

Type	Advantages	Disadvantages
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:

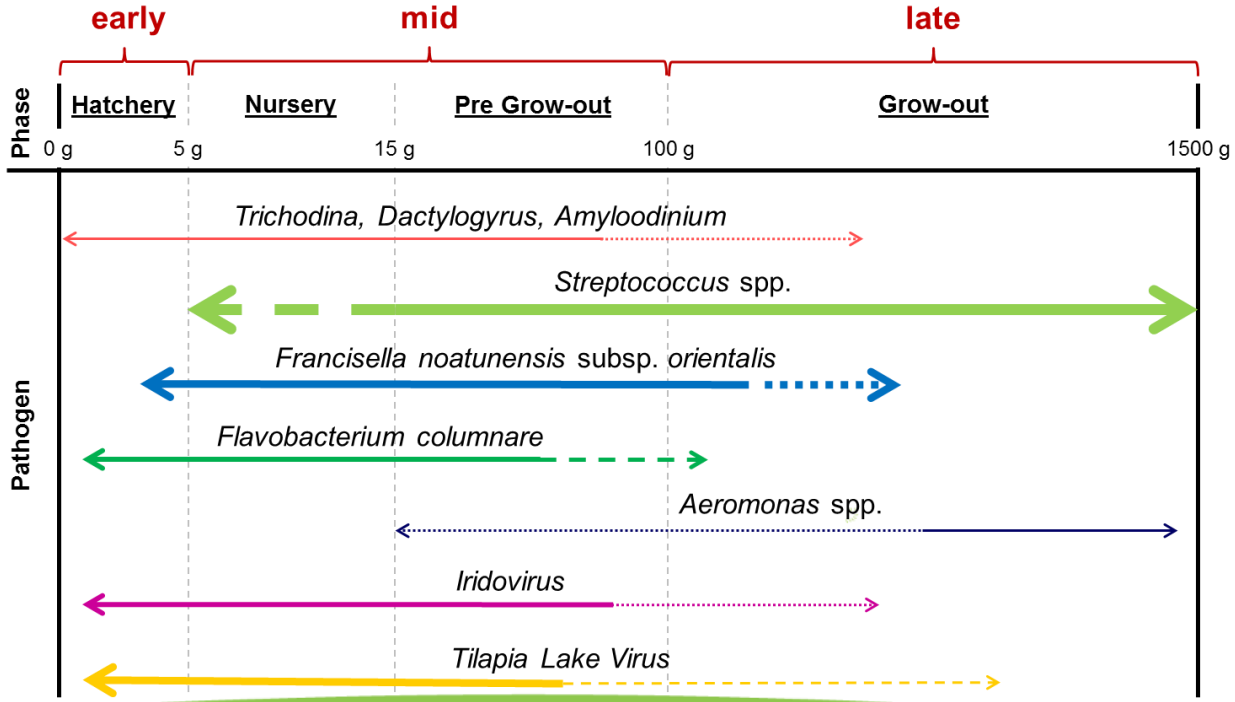
– MSD Tilapia Streptococcal Vaccines

Tilapia Strep Vaccines (market opportunities)



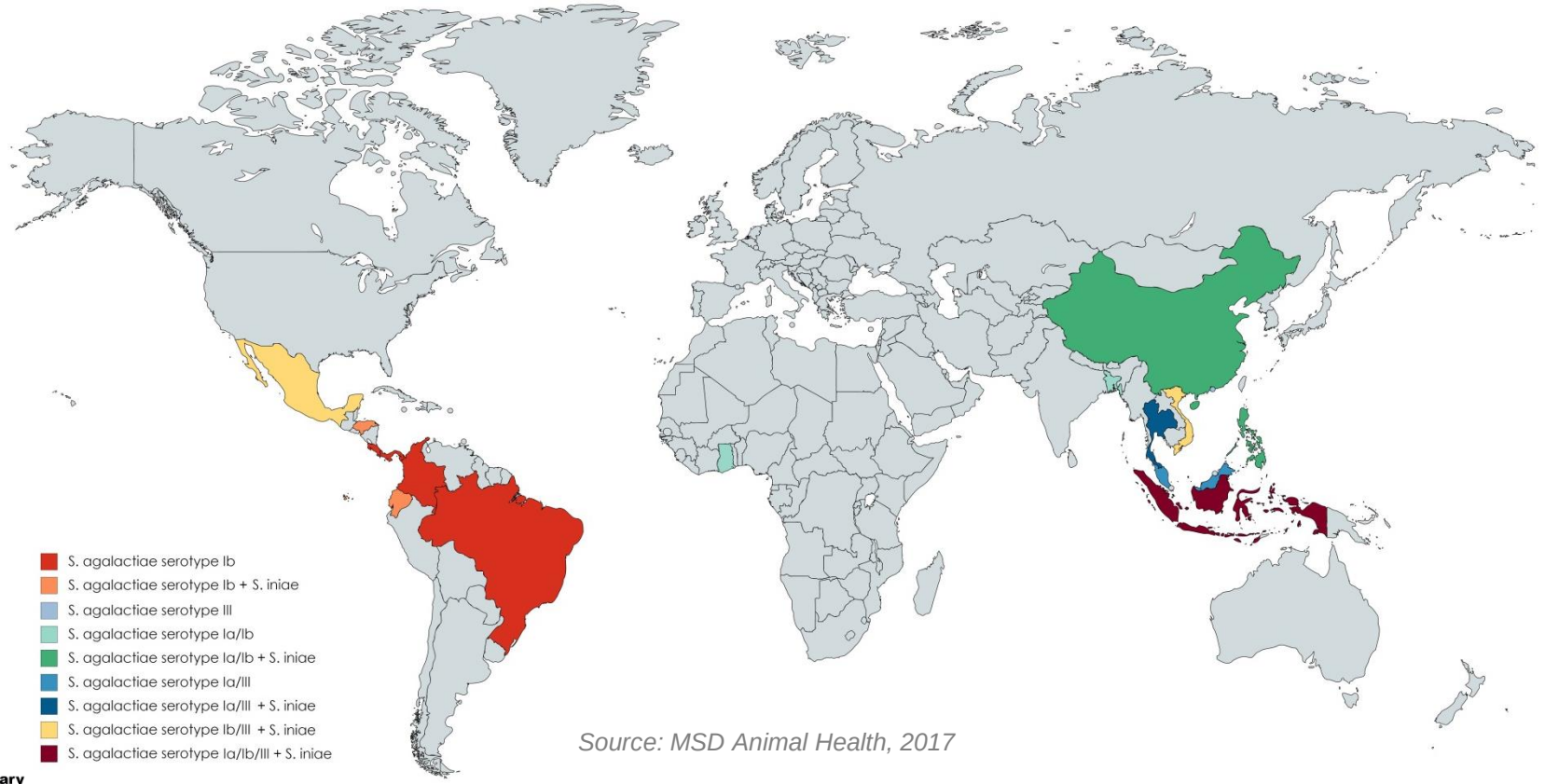
Source: FAO, 2014

Tilapia Strep Vaccines (disease profiling)



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

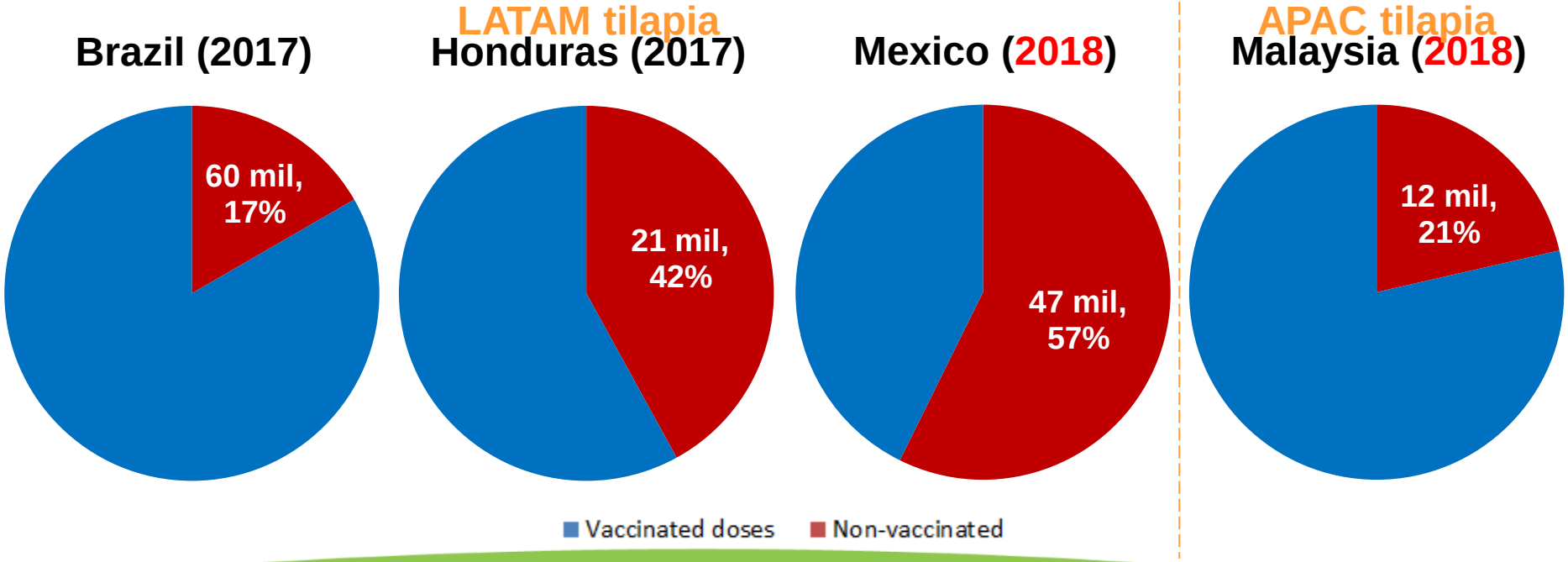
Tilapia Strep Vaccines (commercialization)

- 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

LATAM tilapia

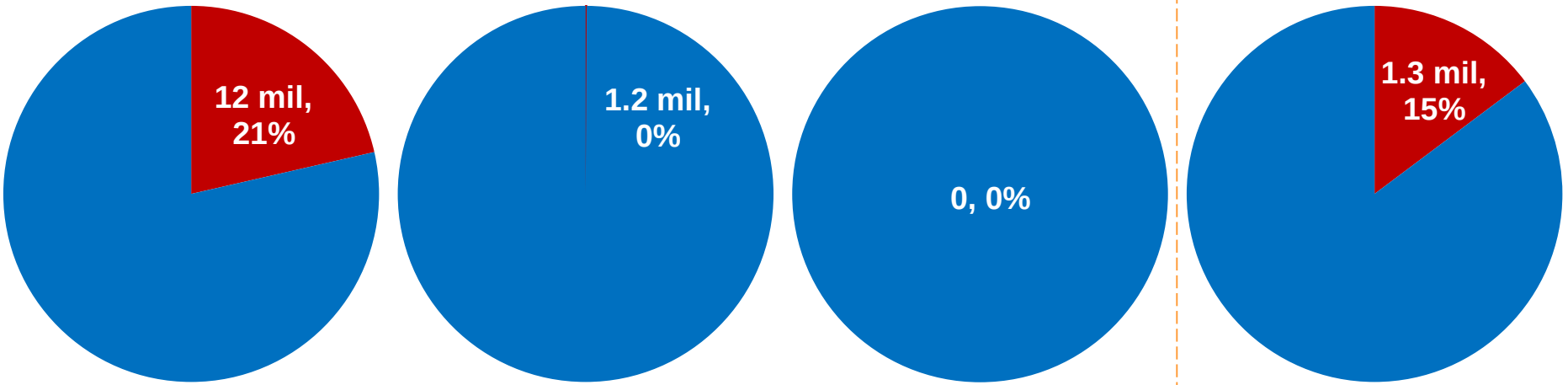
APAC tilapia



APAC Focus

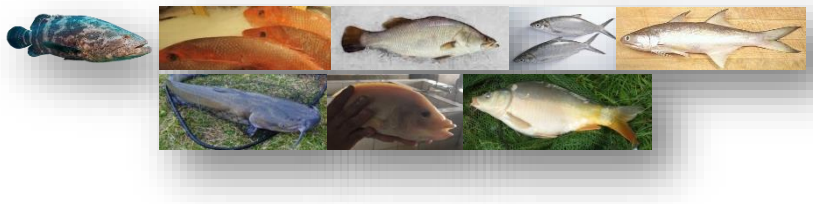
APAC tilapia

APAC barramundi



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

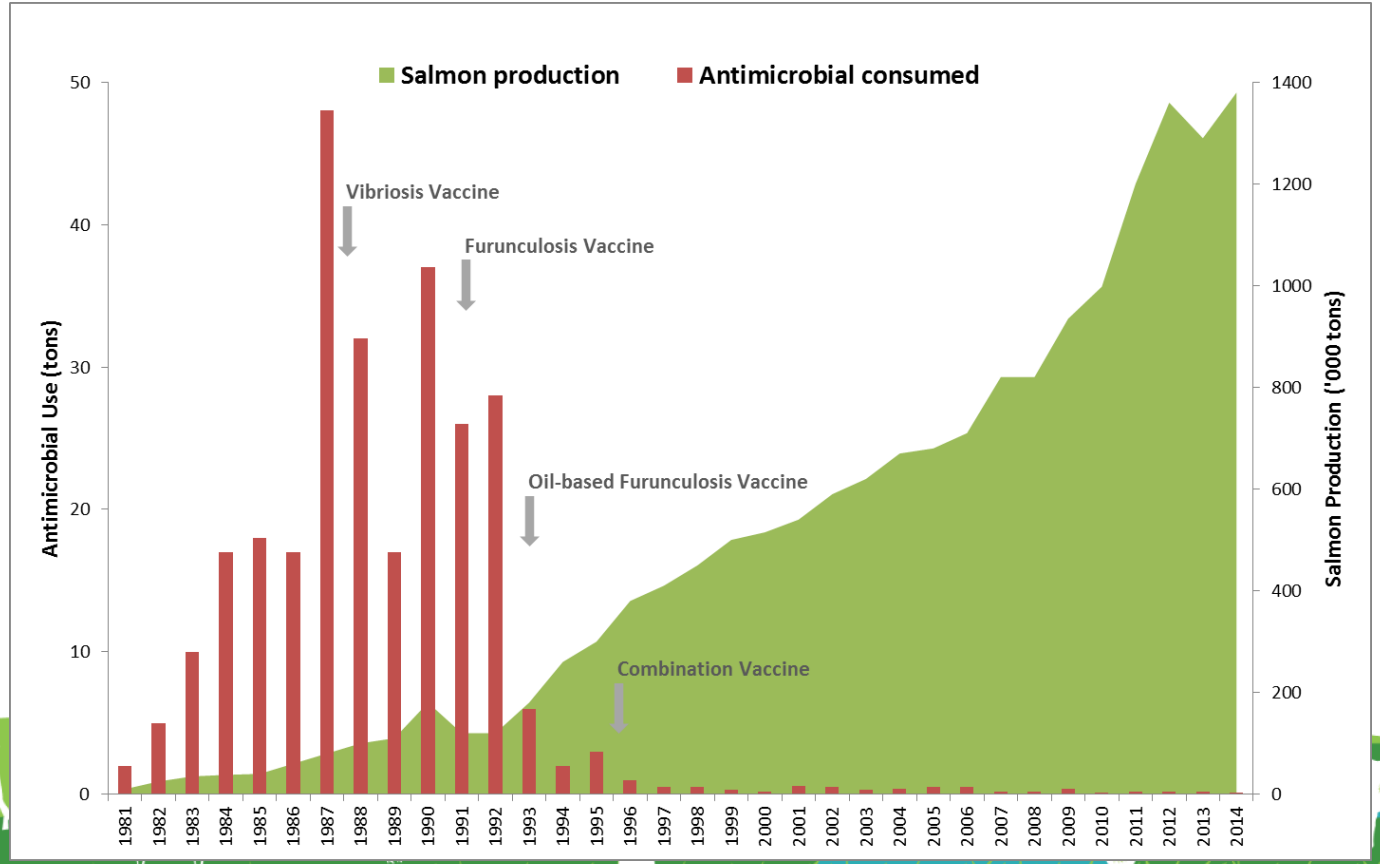
Why is it difficult in APAC??

- 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)

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