The role of biosecurity in aquatic animal health

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Concerns of aquatic animal health

- Losses of production
  - Diseases kill
  - Diseases inhibit growth
- Public health risks
  - Antimicrobial resistance
  - Zoonosis
- Risks to product safety
  - Drug residue
- Risks to trades
  - Transboundary spreading
  - Quality of products
- Wild ecological risks
  - Pathogen spreads into wild
  - Pathogen mutates
- Environment risks
  - Drug residue exists in environment
- Risks to sustainability
  - Prevention costs increase
  - Negative voices to the industry
  - Investment depresses
Conditions for aquatic animal disease
Risk models of disease in aquaculture system
Concept of biosecurity

● Definition of biosecurity
  ■ Target:
    ▪ Aquatic animal population
  ■ Objective:
    ▪ To reduce the risk of introduction, establishment and spread of pathogenic agents
  ■ Means:
    ▪ A set of management and physical measures

● Guiding from risk analysis
  ■ Hazard identification
  ■ Risk assessment
  ■ Risk management
  ■ Risk communication
Biosafety vs Biosecurity

● Safety vs Security
  ■ Safety is about the condition of the subject
    ▪ Food safety: Is the food safe or harmful
    ▪ Biosafety: The safety of pathogenic microbes or alien species or GMO
  ■ Security is about the condition of the system related with the subject
    ▪ Food security: Food problems that may cause social instability
    ▪ Biosecurity: Agriculture system imperiled by organisms

● Two concepts are confused due to translation in China
  ■ Biosafety = Biosafety + Biosecurity > Biosecurity
  ■ Biosafety: safety of pathogenic microbes + animal health + alien species + GMO
  ■ Biosecurity: Animal health

● BSL-IV vs BSG-4
  ■ BSL-IV: Biosafety level IV – P4 laboratory
  ■ BSG-4: Biosecurity grade 4 – Disease free compartment
## Why should biosecurity be raised?

<table>
<thead>
<tr>
<th></th>
<th>Disease control</th>
<th>Health management</th>
<th>Biosecurity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ideological basis</strong></td>
<td>Disease based</td>
<td>Aquaculture based</td>
<td>Risk based</td>
</tr>
<tr>
<td><strong>Application body</strong></td>
<td>Aquaculture establishment</td>
<td>Aquaculture establishment</td>
<td>Aquaculture establishment and AAHS</td>
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<tr>
<td><strong>Working object</strong></td>
<td>Disease</td>
<td>Farmed species</td>
<td>Aquaculture system</td>
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<tr>
<td><strong>Final goal</strong></td>
<td>To prevent disease</td>
<td>To obtain farmed products</td>
<td>To reach disease free status</td>
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<tr>
<td><strong>Practical pathway</strong></td>
<td>Prevention and treatment of disease</td>
<td>Good aquaculture practices</td>
<td>Biosecurity plan and SOPs</td>
</tr>
<tr>
<td><strong>Judgment</strong></td>
<td>Disease occurrence</td>
<td>Aquaculture benefit</td>
<td>Surveillance plan</td>
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<tr>
<td><strong>Strategy &amp; technology</strong></td>
<td>Emphasis of Technology</td>
<td>Technology and strategy</td>
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<td><strong>Integration</strong></td>
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<td>Partial emphasized</td>
<td>Highly emphasized</td>
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Definition of aquaculture system based on manageability

- **Country**
  - Integral aquaculture industry under management of a government with laws and regulations

- **Province**
  - Provincial aquaculture industry under provincial disease control services

- **Zone**
  - A contiguous hydrological system with a distinct health status

- **Establishment**
  - Aquaculture establishment
  - Compartment
Key issues for study on biosecurity

● Key scientific issues
  ◦ Fundamental theory for biosecurity
  ◦ Prevalent mechanism of disease in system
  ◦ Elements and pathways of disease risks
  ◦ Effects of aquaculture processes on pathways of disease risks

● Key technological issues
  ◦ Methods and protocols of biosecurity
  ◦ Disease surveillance scheme for aquaculture system
  ◦ Risk assessment of disease risks in aquaculture system
  ◦ Determination of critical control points of disease risks and the control measures
  ◦ SOPs of biosecurity plan of aquaculture establishment
  ◦ Intelligentization platform for biosecurity
Relationship of biosecurity and other technologies for AAH

Biosecurity system
- Disease surveillance
- Immunological prevention
- Microbiological control
- Ecology management
- Environment management
- Good aquaculture practices
- Control with Medicines

Genetic selection
- SPF breeding
- Disease-resistant breeding

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Constitution of biosecurity system

- **A subject**
  - International organism, Competent authorities of a country or local government, establishment

- **Targets**
  - Aquaculture country or region, aquaculture system, aquatic animal populations

- **Standards**
  - International agreement and standards, national or local legislation and standards, enterprise standard operation procedures

- **Plans**
  - International plan, industrial arrangement and surveillance / contingent plan, enterprise biosecurity plan

- **Actions**
  - International: Meetings, WAHIS, proficiency testing, PVS evaluation, international assistances
  - National / local: Surveillance / reporting / prevention / control / extermination, capacity building, training
  - Enterprise: Implementation of biosecurity plan and audit

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Biosecurity framework worldwide

International
WTO
FAO OIE

International agreements and recommendations

Regional
EC, NACA, etc.

Regional regulations and agreements

National
National animal health authorities

National lows, regulations and standards

Local
Local animal health authorities

Local regulations and standards

Establishment

Vet organizations, veterinaries, aquaculture establishment

Enterprise standards and protocols

Revised from Palić, 2015
National/local biosecurity plan

- Law and planning
  - Regulation construction and implementation
  - Industry arrangement and planning
  - Zoning and compartmentalization
  - Species introduction plan
- Technical standards
  - Standards for diagnosis and surveillance
  - Disease prevention standards
  - Border controls and import regulations
  - Registration standards for AAH products
- Surveillance and control system
  - Epidemiological surveillance plan
  - Disease reporting system
  - Transboundary quarantine for species and products
  - Domestic quarantine in origin area
  - Early detection system
  - Contingency plan
- Development for AAHS
  - Aquatic CDC and team building
  - Capacity building plan
  - Aquatic veterinarian education
- Expertise and communication
  - Advisory groups and expert commissions
  - Crisis communication
  - Outbreak communication
  - Workshops of authorities, experts, and stakeholders
- Official certification system
  - Veterinary certification
  - Certification for clinics
  - Certification for quarantine
  - Certification for compartment
- Products and technologies
  - Biosecurity principals and system
  - Development of technologies for AAH
  - Development of industry of products for AAH
  - Technology training
  - Extension and application
Basic biosecurity conditions

- A disease specific concept on a country or zone level
  - A set of conditions applying to a particular disease, and a particular zone or country, required to ensure adequate disease security

- Key aspects
  - The disease is compulsorily notifiable to the Competent Authority
  - An early detection system is in place
  - Import requirements for the disease are in place.

From OIE Aquatic Code, 2017
Early detection system

● Definition
  - Rapid recognition of signs of suspicious disease
  - Rapid communication to the Competent Authority
  - To activate rapid investigation by AAHS

● Characteristics
  - Broad awareness of the characteristic signs of diseases
  - AAH professionals trained in recognizing suspicious disease
  - Obligation of AAH professionals to report suspicious disease
  - Ability of AAHS to undertake rapid investigation
  - Laboratories for diagnosing diseases

● Remote diagnosis system in China
  - [http://www.adds.org.cn](http://www.adds.org.cn)
  - Activation of rapid investigation by AAHS may need to be enhanced

From OIE Aquatic Code, 2017
Contingency planning

- Legal powers
  - Establish legal provisions needed for the implementation of a contingency plan

- Crises centre
  - Have the responsibility for the coordination of all control measures

- Personnel
  - Provide information on the staff required to undertake control measures

- Instructions
  - Provide a detailed set of instructions

- Diagnostic laboratories
  - Establish laboratories for diagnosis that can be carried out rapidly

- Training programmes
  - Be established to ensure that skills in field, administrative and diagnostic procedures are maintained

- A detailed set of instructions
  - Diagnostic procedures in reference laboratories;
  - Confirmation of diagnosis;
  - Instructions to AAH personnel in the field;
  - Instructions for treatments of dead aquatic animals;
  - Instructions for sanitary slaughtering;
  - Instructions for disease control at the local level;
  - Instructions for quarantine areas and surveillance zones;
  - Provisions for controlling movements of aquatic animals in established zones;
  - Disinfection procedures;
  - Fallowing procedures;
  - Surveillance methods for establishing eradication;
  - Re-stocking procedures;
  - Compensation issues;
  - Reporting procedures;
  - Provisions for raising public awareness.

From OIE Aquatic Code, 2017
Norwegian experiences: Integrated biosecurity plan

- Strict legislation
- Industrial layout
- Veterinary services
- Surveillance plan of epidemiology
- Disease notification and monitoring
- Quarantine in hatcheries
- Treatment for disease and dead fish
- Disinfection measures
- Management for live fish carriers
- Management of slaughter houses
- Fallowing of farms
- Vaccination
Biosecurity plan on farm level

- Farm construction and planning
- Training program for personals
- Traceability system
- Disease surveillance project
- Biological risk assessment
- Disinfection management
- Water treatments for inlet and outlet
- Management of seed introduction
- Management of feeds and inputs
- Farming management
- Disease diagnosis and control
- Contingency plan
Biosecurity grades based on implementation of biosecurity plan on farm level

- **BSG1**  Diagnosis based treatment
  - Control according to diagnosis or contingency plan only, without surveillance and risk assessment

- **BSG2**  Surveillance based prevention
  - Planed control with improved facilities and managements according to partial population based surveillance, inadequate risk assessment

- **BSG3**  Risk analysis based control
  - Integral control under guidance of risk analysis, inadequate traceability system

- **BSG4**  Systemic disease freedom
  - Comprehensive biosecurity, disease free status auditable and sustainable

- **BSG5**  Official certification
  - Official veterinary certification for free compartment

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### Main technologies of farm biosecurity plans

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<tr>
<th></th>
<th>BS0</th>
<th>BSG1</th>
<th>BSG2</th>
<th>BSG3</th>
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<td>Cleaning of disinfection</td>
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<td>Water barrier</td>
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<td>Targeted prevention</td>
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<td>Disease-free larva</td>
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<td>Measures based on risk analysis</td>
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<td>Comprehensive audit system</td>
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Steps to reach BSG5

**FIGURE 1** Steps for developing, implementing, auditing, and certifying an effective biosecurity program intended to prevent, control, and possibly eradicate disease in any epidemiological unit (a tank/pond, farm, state/province, zone, region, or country).

From Palić, 2015
Different classification of biosecurity / biosafety

- **BSG and Palić’s levels (steps)**
  - BSG: implementation degrees of farm biosecurity plan, each BSG can be achieved alone.
  - Palić’s levels (steps): steps to reach a disease free compartment (BSG5), each level cannot be implemented alone.

- **BSG and BSL**
  - BSG: a set of aquaculture farm biosecurity conditions on aquatic animal health
  - BSL: Biosafety level of laboratory, which is a set of biocontainment precautions required to isolate dangerous biological agents in an enclosed laboratory facility. Each BSL can be achieved alone.
Biosecurity plan for breeding center

- Standard operating procedures
- Documentation and traceability system
- Selection of location and construction of hatchery
- Team building and training of personals
- Evaluation of pathogen risk levels
- Establishment of independent maternal families
- Determination of pathogen detection technologies
- Determination of breeding strategies
- Quarantine for broodstock candidates
  - Preliminary detection (2—5 months)
  - Secondary screening (5—12 months)
- Quarantine in cultivation of generations
  - For each batch of broodstocks
  - For each batch of larva
  - For growth-out stage
- Risk-free feed
  - Complete formula feed
    - For maturation of broodstocks
    - For larvae rearing
  - Live feed
    - SPF live feed
    - Strict quarantine / feeding tests
- Disinfection system
  - Farm/tools disinfection measures
  - Water disinfection measures
  - Disinfection measures for broodstocks and eggs
- Management of inlet water
- Management of waste water
- Third-party quarantine
- Official certification
Biosecurity plan for hatchery or nursery farm

- Selection of location and construction of hatchery
- Standard operating procedures
- Documentation and traceability system
- Team building and training of personals
- Management of inlet water
- Management of waste water
- Population based surveillance plan
  - Determine technological protocols
  - Determine targeted populations
  - Determine targeted life stages
- Risk assessment
- Third part quarantine
- Quarantine for broodstocks or postlarva
- Production management
- Low risk feed
  - Live feed
    - Quarantine
    - Disinfection
    - Quality control
  - Formula feed
    - For maturation of broodstocks
    - For larvae rearing
- Disinfection system
  - Farm/tools disinfection measures
  - Water disinfection measures
  - Disinfection measures for broodstocks and eggs
Experiences of biosecurity in shrimp breeding industry

- SPF breeding plan was proposed in the “Marine shrimp farming program” of USA started in 1984
- SPF breeding is the earliest biosecurity plan for shrimp in the globe
- After 10 years, USA successfully established SPF system for *Penaeus vannamei*
- The biosecurity system based on the standards of SPF breeding of shrimp has become international recognized basis of the development of shrimp breeding industry
- The biosecurity system for shrimp breeding has been extend to USA, Malaysia, Singapore, Thailand, Indonesia, and India
- *Penaeus vannamei* has become the globally largest species for shrimp farming
Recommended principle measures for farm biosecurity

- Build a farm with well layout for prevention of risks
- Prepare the farming with efforts on biosecurity plan
- Recondition ponds by well dredging and disinfection
- Flood ponds and reservoirs for early disinfection and fertilization
- Select postlarva by pathogen detection to avoid infection
- Use nursery culture for stocking and quarantine
- Determine stocking density according to stages and health conditions
- Use polyculture with fish for ecological prevention
- Feed Precisely with little feed and many meals
- Monitoring and control water and bottom quality regularly
- Examine survival and growth, treat according to diagnosis
- Use probiotics dominated biofloc
Establishments that biosecurity should be encouraged / supervised

- Aquatic breeding industries
  - Centers of introduction or breeding for aquatic animal species
  - National genetic breeding farms
  - Provincial genetic breeding farms
  - Hatcheries for enhancement and releasing

- Specific disease free compartments
  - Specific disease free hatcheries

- Intensified aquaculture
  - Intensified high density aquaculture
  - Industrialized aquaculture
  - Large deep see cages
  - Aquacultural factory ships

- Licensed farms
  - Licensed farms for exporting
References
5. 农业部渔业局. 全国水产技术推广总站. 2015年中国水生动物卫生状况报告. 2016, 中国农业出版社.

Thanks for attention!
Welcome for comment!

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