Food safety and antimicrobial resistance research: a One Health perspective

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International Livestock Research Institute

EPI Seminar Series
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Outline

• International Livestock Research Institute
• Food safety in LMIC and case studies in South-East Asia
• AMR / EIDs
• One Health use for this and conclusion
CGIAR Research Centers

CGIAR research is carried out by the 15 Centers, members of the CGIAR Consortium, in close collaboration with hundreds of partners, including national and regional research institutes, civil society organizations, academia, development organizations and the private sector.
International Livestock Research Institute
(www.ilri.org)

Improved food and nutrition security for health

ILRI’s mission is to improve food and nutritional security and to reduce poverty in developing countries through research for efficient, safe and sustainable use of livestock — ensuring better lives through livestock.
ILRI Resources

- Staff: 670
- 130 scientists from 40 countries
- 56% of internationally recruited staff are from 22 developing countries
- 34% of internationally recruited staff are women.
- Large campuses in Kenya and Ethiopia
- Regional or country office in 14 countries
- $80 million/year
Main campuses: Nairobi, Kenya and Addis Ababa, Ethiopia

Offices in 14 other countries
Where are we active in the region?

- CRP A4NH: Agriculture for Nutrition and Health
- CRP CCAFS: Agriculture, Food Security and Climate Change
Food Safety
Food safety is integral to the SDGs

Food safety is integral to:

1. No Poverty
2. Zero Hunger
3. Good Health and Well-Being

Food safety (practice) contributes to:

5. Gender Equality
6. Clean Water and Sanitation
8. Decent Work and Economic Growth
11. Sustainable Cities and Communities
Domestic costs may be 20 times trade costs

‘Productivity Loss’ = Foodborne Disease DALYs x Per Capita GNI

Cost estimates for 2016 (US$ billion)

- Productivity loss: 95
- Illness treatment: 15
- Trade loss or cost: 5 to 7

Illness treatment = US$27 x # of Estimated foodborne illnesses
Trade loss or costs = 2% of developing country high value food exports

Based on WHO/FERG & WDI Indicators Database
Research approach: what do we do to understand and improve food safety?

• Situational analyses of food safety

• Capacity building on risk-based approaches

• Proof of concept: participatory risk assessment

• Pilot testing interventions
**Approach: risk analysis or risk-based decision making**

**Hazard vs Risk**

- **Hazard identification**
  - What harm does it cause?
  - How does harm depend on dose?
  - Can it be present in food?
  - Can it cause harm?

- **Hazard characterization**
  - How and to what extent does it get from source to victim?

- **Exposure assessment**
  - What is the harm?
  - What is its likelihood?

- **Risk characterization**

- **Risk communication**

- Participatory methods fit well
Pork value chain and safety in Vietnam: from research to interventions
Issue of pork value chain and food safety in Vietnam

- **Large pig production** (30 million heads) mainly produced by 2.5 mio small scale farms (70%)
- **Pork is the main ASF (60%)** in Vietnamese diet “fresh” pork preferred
- Food safety among the **most pressing issues**, more important than education or health care
- Modern food safety legislation but **weak enforcement**
- Risk perception towards **chemical hazards** is important, issue of **risk communication**
- Food exports relatively well managed but **deficits in domestic markets.**

Nguyen-Viet et al, 2017
Microbial and Chemical Risk Assessment

• *Salmonella* risk pathways developed for producers, slaughterhouse and consumers, quantitative microbial risk assessment (QMRA) risk for consumer
• Chemical risk assessment: antibiotic residues, banned chemicals, heavy metals

PigRISK project (2012-2017)
Food safety risk assessment along the pork value chain

Sinh Dang et al, 2017
## Risk assessment

### QMRA for salmonellosis

<table>
<thead>
<tr>
<th>Age and gender groups</th>
<th>Estimated annual salmonellosis incidence rate (Mean (90% CI)) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children (under 5 years old)</td>
<td>11.18 (0 – 45.05)</td>
</tr>
<tr>
<td>Adult female (6-60 years old)</td>
<td>16.41 (0.01 – 53.86)</td>
</tr>
<tr>
<td>Adult male (6-60 years old)</td>
<td>19.29 (0.04 – 59.06)</td>
</tr>
<tr>
<td>Elder (over 60 years old)</td>
<td>20.41 (0.09 – 60.76)</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>17.7 (0.89 – 45.96)</strong></td>
</tr>
</tbody>
</table>

The annual incidence of foodborne salmonellosis in the Asian region including Vietnam was 1% (range 0.2-7%)  

### Chemical risk assessment: minimal risks  

*Dang Xuan Sinh et al, 2017, Hanh Tran et al, 2017*
Costs per treatment episode and per hospitalization day for foodborne diarrhea case were US$ 106.9 and US$ 33.6 respectively.

51.3%: Indirect cost (costs of times to patient, their relatives due to the patient’s illness)

33.8%: Direct medical costs

14.9%: Direct non-medical costs (patient and their relatives)
Serological prevalence and factors associated with human trichinellosis and cysticercosis in Hoa Binh Province, Northwest Vietnam

- 300 participants with blood samples in Hoa Binh.
- ELISA for trichinellosis and cysticercosis (Demeditec® and apDia®).

**Knowledge of participants about diseases**

**Trichinellosis**

**Cysticercosis**

- Positive case
- Suspected case
Investments in FS can save lives and $$$

• 94 million people
• Cases of foodborne diseases by *Salmonella* in pork at 17%: 16 million get sick
• Cost $107 to treat a case: if 1/3 looks for medical treatment, $570 million (0.26% GDP)
• Intervention to reduce 20% burden: $340 million SAVED from total population
Interventions (Safepork project 2018-2022)

- Farm level: Simplified VietGAHP/GAP reduced AMU / AMR
- Slaughterhouse: ozone machine, no floor slaughter
- Markets: branding, better hygiene
- Consumer: reduced cross-contamination, hygiene
- Nudges
1. Actionable evidence on FBD burden associated with animal source foods (ASF)
2. Pilot incentive-based approach to improving food safety among ASF traders
3. Cambodian-led Theory of Change for improving food safety
4. Gender and equity research
5. Building capacity in food safety risk assessment, management, communication
1. Risk profiling
   1. Scoping visits
   2. Systematic literature review
   3. Risk profiles
   4. Training in risk ranking
   5. Stakeholder prioritisation

2. Generate evidence on FBD
   Five Urban Survey Study

3. Develop & test solutions for wet markets
   RCT intervention

Gender

Impact

TOC

Nutrition
Generate Evidence on FBD

Risk profiling

1. Scoping visits
2. Systematic literature review
3. Risk profiles
4. Training in risk ranking
5. Stakeholder prioritisation

Five Survey Study

1. National traders hazard survey
2. Urban household consumption
3. Urban household nutrition
4. Urban hospital COI
5. Quantitative RISK Assessment
International, peer-reviewed journal publications between 1990 and June 2017

n=25

1 Jan 1990 - 31 Dec 2000

1 0 1 1 0 0 1 1 1

which foods???

• Foods associated with FBD: noodles, rice, seafood, dog meat, water spinach, rice wine, raw game meat
• Foods associated with chemicals: sausage, dry fish, seafood, noodles and meat balls produced from beef and pork;
• Catering foods at big events

which hazards???

• Vibrio spp., Salmonella spp., Staphyloccus aureus, Bacillus cereus
• borax, formalin
Animal sourced food

Pork

In traditional Market

Chicken
Multi-pathogen survey in Cambodian traditional market

- Pork and poultry
- *Salmonella* & *Staphylococcus aureus*
- Urban focus: Phnom Penh municipal and Siem Reap province, Sihanoukville, Battambang (repeated survey) 7 - 8.2019
RESULTS

• All samples of the first round was collected for the multi-pathogen survey in Cambodian markets in 25 provinces. In total 416 samples (pork = 156, pork cutting board swabs=52) chicken (chicken meat = 156, cutting board swabs = 52) were collected. 312 shop owners were interviewed during the sampling.
• In total of 184 samples positive to *Salmonella* (36%) and 133 to *S. aureus* (32%).
• Isolates are being kept for further analysis on antimicrobial resistance.
## Cost of per episode of hospitalization of FBD by group of health facilities

<table>
<thead>
<tr>
<th>Cost</th>
<th>National Hospital (n=44)</th>
<th>Referral Hospital (n=60)</th>
<th>Regional Hosp. (n=100)</th>
<th>Community Clinic (n=62)</th>
<th>Overall (n=266)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct medical cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Amount [usd]</td>
<td>125.77</td>
<td>9.42</td>
<td>27.85</td>
<td>4.19</td>
<td>34.38</td>
</tr>
<tr>
<td>Direct non-medical cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Amount [usd]</td>
<td>40.64</td>
<td>8.36</td>
<td>26.33</td>
<td>0.30</td>
<td>18.58</td>
</tr>
<tr>
<td>Indirect cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Amount [usd]</td>
<td>21.43</td>
<td>6.38</td>
<td>10.89</td>
<td>3.08</td>
<td>9.80</td>
</tr>
<tr>
<td>Total cost [usd]</td>
<td>185.88</td>
<td>24.16</td>
<td>65.07</td>
<td>7.57</td>
<td>62.76</td>
</tr>
</tbody>
</table>
Capacity building and policy translation
Research and training partnership to assist policy and capacity building in improving food safety in Vietnam

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\textbf{A B S T R A C T}

This paper evaluated the implementation of an initiative for promoting risk-based approaches to improve food safety management in Vietnam. A Taskforce of Risk Assessment for Food Safety (Taskforce) was formed and consisted of researchers working on risk assessment and food safety, and representatives of the related ministries of Health and of Agriculture. We used the OECD Development Assistance Committee Evaluation Criteria as a framework for assessing the impact of the Taskforce with five evaluation areas – relevance, effectiveness, effi-
Taskforce of Risk assessment for food safety in Vietnam

- Linking research to policy
- Taskforce: composed by experts from universities, research institutes, policy makers from the ministries (health, agriculture)
- Risk analysis capacity development for researchers and policy makers
- Taskforce now institutionalized and sustainable
Capacity building impact: curriculum development & trainings

- Guidelines on FS risk assessment: more accessible and understandable in use in 17 universities, 7 cities
- Curriculum developed to teach 200 students per year: majority of future food safety human resources
- Trainings for veterinary and public health staff at ministry level
- Hand-on training on risk assessment for researchers, students
Policy impact: translational research for interventions in modernizing food system

- CGIAR/ILRI niche - risk assessment and policy / regulatory analysis for fresh foods in domestic markets
- World Bank convenes overall support to government: ILRI led technical works
- Upcoming projects based on WB report we led will improve food safety for 20 million people in major cities of Vietnam
- Stakeholder consultation
- Risk assessment training
Savanakhet, Laos
Foodborne parasitic disease research 10. 2017

Decision makers
Public health (MD, army health)
Scientists
Vets
Bangladesh: capacity building on risk-based approaches

Risk assessment workshop in Dhaka 22-24 October 2018: 33 participants
Research into use: Risk communication and management

- Risk communication and management problem
- Cysticercosis in schools in Bac Ninh
- African swine fever and food safety

VN police investigate mass infection of children with cysticercosis

The police are investigating the alleged use of meat from sick pigs at several schools in Bac Ninh Province as the number of children tested positive for cysticercosis has climbed to 209.

Thousands of parents in Bac Ninh Province bring children to hospitals to test for cysticercosis on March 17.

The police in Bac Ninh Province said on March 18 that they would cooperate with the police in Thuan Thanh District to...
Antimicrobial use (AMU)
Antimicrobial resistance (AMR)
Global trends in antimicrobial use in food animals

Thomas P. Van Boeckel\textsuperscript{a,1}, Charles Brower\textsuperscript{b}, Marius Gilbert\textsuperscript{c,d}, Bryan T. Grenfell\textsuperscript{a,e,f}, Simon A. Levin\textsuperscript{a,g,h,1}, Timothy P. Robinson\textsuperscript{i}, Aude Teillant\textsuperscript{a,e}, and Ramanan Laxminarayan\textsuperscript{b,e,i,1}

Fig. 1. (A) Largest five consumers of antimicrobials in livestock in 2010. (B) Largest five consumers of antimicrobials in livestock in 2030 (projected). (C) Largest Increase in antimicrobial consumption between 2010 and 2030. (D) Largest relative increase in antimicrobial consumption between 2010 and 2030. CHN, China; USA, United States; BRA, Brazil; DEU, Germany; IND, India; MEX, Mexico; IDN, Indonesia; MMR, Myanmar; NGA, Nigeria; PER, Peru; PHL, Philippines.

Fig. 2. Posterior distributions for e.g., cattle, chickens, and pigs in OECD.
AMR/AMU research in human and livestock

Source of drugs
Advice on dosage/use
Knowledge on AMs

Source of feed and water

Disposal

Decision making

Diseases
Purpose: treatment, prevention, growth
Frequency, duration, last use (compounds)

Sale of ASF

Manure management

Production system
Species


- Annual growth 2010-2017: 5-6% per year
- Agriculture: 15% GDP
- Livestock: 20% of Agriculture GDP

DLP/ MARD (2018)

Source: D-Fish
AMU consumption for chicken and pig medicated feeds

- **77.4 mg** and **286.6 mg** of in-feed antimicrobials were used to raise 1 kg of live chicken and pig, respectively.

- **1023.5 tons**, and **42.2 and 981.3 tons** for Vietnamese chicken and pig production, respectively.

Nguyen Van Cuong et al. 2016. EcoHealth
Veterinary pharmacy, Northern Vietnam
Antibiotic sales in rural and urban pharmacies in northern Vietnam: an observational study

Do Thi Thuy Nga, Nguyen Thi Kim Chuc, Nguyen Phuong Hoa, Nguyen Quynh Hoa, Nguyen Thi Thuy Nguyen, Hoang Thi Loan, Tran Khanh Toan, Ho Dang Phuc, Peter Horby, Nguyen Van Yen, Nguyen Van Kinh and Heiman FL Wertheim

- 90% AB sold without prescription
- Dispensed by inexperienced staff
- 25% of sales is AB sales
- More rural domestic drug sales

- High demand from buyer -> public awareness campaigns
- Strong incentive for AB dispensing -> room for intervention
Key Milestones of AMR battle in Viet Nam

• **2013**: National Action Plan on Antibiotic Resistance 2013-2020
• **2013**: National Steering Committee on AMR
• **2014**: Establishment of Sub-Committees on AMR for the period 2013-2020
• **2015**: Aide-Memoire on Multi-sectoral Action to Combat AMR in Viet Nam
• **2015**: Start of Antibiotic Awareness Week
• **2017**: National Action Plan for the reduction of antimicrobial use and management of antibiotic use and control of antibiotic resistance in livestock production and aquaculture (2017 – 2020)
Signing ceremony-
Multi-sector Agreement on AMR prevention and combating in Vietnam (2015)
Events on AMR in 2016

Source: MoH, 2017
National action plan for AMU and AMR in livestock production and aquaculture

- Strengthen governance of AMR and AMU management
- Improve legal basis for AMR and AMU management
- Enforce the legislation in place
- Increase awareness of AMU and risk of AMR
- Implement good treatment and husbandry practices
- Monitor AMR, AMU and antibiotic residue
- Strengthen inter-sectoral collaboration in AMR management
Rational use of AM, reduced AMR, safer food

Improve understanding of drug use and strengthen capacity in AMR / AMU surveillance

Pig health and health management practices

Veterinary drug use among pig farmers

Antibiotic resistance in pigs and antibiotic residues in pork products

Effective interventions for improving pig health management

VIDA-PIG PROJECT
Health and Antibiotics in Vietnamese Pig Production

Hung Nguyen et al. 2018
CGIAR Antimicrobial Resistance Hub launch meeting, Nairobi 21-22 February 2019
A global research and development partnership for reducing agriculture-associated antimicrobial
AMR in the CGIAR: Activity focus

Partnerships

AM use and value chains
Transmission dynamics
Interventions
Enabling policy
Capacity
EcoHealth prudent use of antimicrobial in SEA
Intervention for AMR in Vietnam

Alternatives to AM: nano-silver in Vinh Phuc/probiotics

**Treatment**
- Feed without AM
- Nano silver 0.3%/kg

30 piglets for 4 months in 6 farms

**Control**
- Business as usual
- Medicated feed with Amoxicillin, 300 ppm

30 piglets for 4 months in 6 farms

- Baseline: weight, AMR (E. coli in faeces)
- Monthly weight measurement
- Mortality, morbidity
- AMR: 4 months in faeces.
- AM residue in feeds (baseline, 3 months, pool sample), and pork
ASF situation in Vietnam

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• Prof. Phan (Vietnam National University of Agriculture, MARD)
• Dr. Pawin and Dr. Ken Inui (FAO Vietnam)
• Dr. Edward (ILRI Kenya)
ASF situation in Asia update
25 July 2019, 09.00 hours; Rome

Information provided herein is current as of the date of issue. Information added since the last ASF China situation update appears in red. For cases with unknown onset date, reporting date was used instead. FAO compiles information drawn from multiple national (Ministries of Agriculture or Livestock, Local governments and international sources (World Organisation for Animal Health [OIE]), as well as peer-reviewed scientific articles. FAO makes every effort to ensure, but does not guarantee, accuracy, completeness or authenticity of the information. The designation employed and the presentation of material on the map do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal or constitutional status of any country, territory or sea area, or concerning the delimitation of frontiers.

Overview

Hazard: African swine fever (ASF) is a viral disease affecting pigs and wild boar with up to 100% case fatality rate.

Affected Provinces:
China: Anhui, Heilongjiang, Henan, Jilin, Liaoning, Jiangsu, Zhejiang, Shanxi, Yunnan, Hunan and Guizhou, Hubei, Jiangxi, Fujian, Sichuan, Shaanxi, Qinghai, Guangdong, Gansu, Shandong and Hainan Provinces, Tianjin, Chongqing, Shanghai and Beijing Municipalities, Inner Mongolia, Ningxia Hui, Guangxi Zhuang, Xinjiang Uygur and Tibet (Xizang) Autonomous Regions and Hong Kong Special Administrative Region.
Mongolia: Bulgan, Darkhan-Uul, Dundgovi, Orkhon, Selenge, Töv Provinces and Ulaanbaatar
Cambodia: Ratanakiri, Tbong Khmum, Svy Rieng, Takeo and Kandal Provinces
Democratic People's Republic of Korea: Chagang-Do
Lao People’s Democratic Republic: Salavan, Savannakhet, Phongsaly Provinces, and Vientiane Capital

Viet Nam: Since the Ministry of Agriculture and Rural Development (MARD) confirmed its first ASF outbreak on 19 February 2019, a total of 62 provinces/cities reported outbreaks, about 3,700,000 pigs have been culled.
ASF outbreaks

Map 1. ASF situation in Asia (August 2018 to date)

Source: China: MARA, Viet Nam: WAHIS & media information, Cambodia: MAFF, Lao PDR: DLF/MAF, Other: WAHIS
1921: First discovered in Kenya

1957: First occurrence outside Africa
  - Portugal

2007: Republic of Georgia
  - Spread in Caucasus Region (Eurasia), including Russia Federation

2018 Outbreaks
  - China, Belgium (Wild boars), Hungary, Estonia, Latvia, Lithuania, Russia, Poland, Ukraine, Bulgaria, Romania

2019 Outbreaks
  - Mongolia, Vietnam, Cambodia, Laos
First detection of ASF outbreak

- On 01 Feb 2019, a household in Hung Yen province reported sick pigs with high fever and death pigs
- Hung Yen province: About 60km from Hanoi and about 217km from Tan Thanh border gate to China
First detection of ASF outbreak

- 21 sows
- Week 1 (1/21): 4.8%
- Week 2 (2/21): 9.5%
- Week 3 (3/21): 14.3%
- 4 weeks later (6/21): 28.6%
- 5 weeks later (8/21): 38.1%
- Stamping out
Farm conditions of the first ASF
Publication for ASF outbreak in Vietnam

Outbreak of African swine fever, Vietnam, 2019
Van Phan Le1,*, Dae Gwin Jeong2, Sun-Woo Yoon2, Hye-Min Kwon2, Thi Bich Ngoc Trinh1, Thi Lan Nguyen1, Thi To Ngai Bui1, Jinsik Oh3, Joon Bae Kim3, Kwang Myun Cheong3, Nguyen Van Tuyen4, Eunhye Bae5, Thi Thu Hang Vu6, Minjoo Yeom6, Woonsung Na6, Daesub Song6*

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! These authors contributed equally

Biography: Le Van Phan is D.V.M. and associate professor of Vietnam National University of Agriculture. The research area is mainly virology including swine and avian viruses.
Vietnamese ASFV strains shared 100% at both nt and aa identity when compared with Chinese ASFV strains.

Genetic characterization of ASF viruses circulating in Vietnam.
Potential risk factors for ASF in Vietnam

- Long borders with many thousand people and vehicles cross over the borders daily. Vietnam detected ASF virus in illegal pork products.
- International travels to Vietnam with million people who could carry meats and food products etc.
- Low biosecurity; no outbreaks occurred in commercial farms.
- None-zoonotic disease so that farmers could did panic selling, especially during the Tet and festival events.
- Insect vectors? (tick, lice, flies etc.)
Current control measures

• **Movement control**
  • Pigs and pig products are not allowed to move out the infected areas
  • Established more animal quarantine stations on the roads from the North to the Sought for strict movement control of pigs and pigs products

• **Biosecurity application**
  • Requested all big farms have to apply strict biosecurity measures and frequently cleaning and disinfection of all risk factors
  • Re-stock only after the outbreaks is resolved for at least 30 days

• **Risk communication and public awareness**
Conclusions (food safety)

1. Huge health and economic burden of foodborne diseases in LMIC
2. Capacity to develop food safety research in LMIC is important, risk communication need
3. Research translation to actions and policy: timely and opportunistic
4. Previous investments not in line with modern understanding, interventions successful in short term, long term, wide-reaching impacts likely require:
   • Training & technology
   • Incentives
   • Enabling environment
Conclusions (AMR and EIDs)

1. Animal agriculture uses more AM than human health does and is rapidly trending up
2. Dual challenge: access as well as excess
3. Alternative to antimicrobials is needed, prudent use, incentive
4. Risk communication
Integrated approaches to tackling health issues-related to agri-food systems

Hung Nguyen-Viet\textsuperscript{1,3} \& Delia Grace\textsuperscript{2} \& John McDermott\textsuperscript{4}

- How is it used to address food safety and AMR issues?
- OH = approach for solving cross-sectoral challenges
Acknowledgement

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- Sothyra Tum, Chhay Ty, Rortana Chea, Melissa Youth and SFFF Cambodia team
- BMZ project team
- Vietnam Food Safety report team
- ComAcross project in Laos: Vannaphone Phouthana
- Funding: ACIAR, CGIAR A4NH, World Bank, BMZ, USAID through
Bibliography


