Controlling Avian Flu and Protecting People’s Livelihoods in the Mekong Region

Epidemiological Investigations of HPAI H5N1 in Viet Nam

Dirk Pfeiffer and Ricardo Soares Magalhaes
RVC London

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# Acknowledgements

## People
- V Nam †
- D Dung †
- Lai Thi Kim Lan †
- Hoan Dinh Quoc
- J Otte ¥
- J Gilbert ¥
- D Pfeiffer *
- B Wieland *
- D Roland-Holst ^

## Institutions
- * The Royal Veterinary College, Epidemiology Division Department of Veterinary Clinical Sciences, UK
- † Ministry of Agriculture and Rural Development, Department of Animal Health, Ha Noi, Vietnam
- ¥ Food and Agriculture Organization of the United Nations, Pro-Poor Livestock Facility, Rome, Italy
- ^ UC Berkeley, California, USA
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• Field Investigations
  ✓ Patterns of farm gate trade in smallholder poultry farms of Northern Vietnam
  ✓ Traceability of smallholder poultry

• Modelling of surveillance data
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  ✓ Social network analysis of market traders and communes

• Spatial Risk Modelling
  ✓ An analysis of the spatial and temporal patterns of HPAI occurrence in Vietnam using national surveillance data

• Animal Health Risk Assessment
  ✓ Assessment of H5N1 risk and the importance of wild birds
  ✓ Quantitative assessment of the risk posed by live bird imports for the introduction of HPAI H5N1
Field Investigations

Patterns of farm gate trade in smallholder poultry farms of Northern Vietnam
Material and Methods

- Rapid Rural Appraisal of 21 smallholder commercial poultry farmers held in Phuc Tien commune, Phu Xuyen district in the Ha Tay province in Northern Vietnam.
- **AIM:** obtain baseline information regarding the trade activities of smallholder commercial poultry farms with a farm size between 100-1,000 heads.
- Information collected by the research team, through individual interview and group discussions of all farmers.

- Survey conducted at 11 markets currently authorized to trade live poultry
- **AIM:** obtain baseline information regarding trade activities of live poultry traders operating at each market.
- Individual interview based on a structured questionnaire
- Information collected by the market inspector Individual interview based on a structured questionnaire
Farm gate trade frequency of finished and unfinished poultry
Farm Gate Trade Frequency by Farm Type

Unfinished

Finished

(a)

(b)

May-Oct  Nov-Jan  Feb  Mar-April

Mixed Flocks
Duck Flocks
Chicken flocks

May-Oct  Nov-Jan  Feb  Mar-April

Mixed Flocks
Duck flocks
Chicken flocks

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Farm Gate Destinations

(a) Unfinished

(b) Finished

Chicken

Ducks

Mixed

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Some Other Findings

- 90% of poultry into markets originating from three provinces (Ha Tay, Ha Nam and Ha Noi).

- Predominant farm size of poultry originating from Ha Tay, Ha Nam and Ha Noi is between 100 - 2,000 heads.

- Poultry types sent to markets include white chicken (commercial breed), local chicken (native breed), duck and muscovy duck farms.
Field Investigations

Traceability of smallholder poultry
Study Design

**Poultry Farm**

- Commune animal health worker

- Non-RFID poultry tags

- Poultry

- Poultry baskets

- RFID Basket tags
  - Weighting of baskets

**Live Bird Market**

- Poultry traders

- Market inspector

- Poultry

- Poultry baskets

- Reader A

- Reader B

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Areas of Traceability Study

Map of districts of Ha Tay and Ha Noi provinces where Part I of the traceability study could be conducted.
# Number of Birds Tagged by Farm Type

<table>
<thead>
<tr>
<th>ASSUMPTIONS</th>
<th>WHITE CHICKEN</th>
<th>LOCAL CHICKEN</th>
<th>DUCK</th>
<th>MUSCOVY DUCK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of farms to be enrolled in the study</td>
<td>36</td>
<td>3</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>Expected number of outgoing batches per farm throughout the study period</td>
<td>4-6</td>
<td>5-7</td>
<td>6-8</td>
<td>5-7</td>
</tr>
<tr>
<td>Expected number of birds per outgoing batch</td>
<td>300</td>
<td>30</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Expected proportion of birds to reach the primary receptor market (%)</td>
<td>5</td>
<td>1</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Required number of birds to be tagged per outgoing batch per farm</td>
<td>121</td>
<td>18</td>
<td>132</td>
<td>132</td>
</tr>
<tr>
<td>Total number of birds to be tagged</td>
<td>17,424 - 26,136</td>
<td>270 - 378</td>
<td>11,088 – 14,784</td>
<td>10,125 – 13,860</td>
</tr>
</tbody>
</table>
Public Awareness Campaign

Promoting Traceability for smallholder poultry

WE KNOW WHERE THEY COME FROM

1. Planning better and more bio-secure smallholder poultry farming.
2. Guaranteeing safe and clean poultry meat for consumers.
3. Building a brand name for Vietnamese smallholder poultry farmers.

Please Buy a Tagged Bird!!!!

TRACEABILITY STUDY

The objectives of the Study:

1. Better and more bio-secure smallholder poultry farming.
2. Guarantee safe and clean poultry meat for consumers.
3. To build a brand name of clean and safe poultry meat for Vietnamese smallholder poultry farmers.

Please Buy a Tagged Bird!!!!

The reasons to trust a tagged bird:

- Tagged chickens are raised in safe conditions.
- You can completely believe in quality of this poultry meat.

Introduction of the Study:

Since 2004 until now, FAO and Vietnam Department of Animal Health have been cooperating to fight bird flu. This is a pilot study, which aims to tag smallholder poultry farms to trace the history of their origin.

We have randomly selected smallholder poultry farms with flock sizes between 100 to 2000 birds. These farms are closely monitored, and outgoing birds are tagged in the legs before they are sold to the markets. Tagged birds reaching the markets are then identified and recorded by the market inspectors.

For further Information please contact:

Food and Agriculture Organization of the United Nations / Department of Animal Health, Viet Nam

Phone: 555-555-5555
Fax: 555-555-5555
E-mail: someone@example.com
Modelling of Surveillance Data

Within-flock transmissibility of avian influenza (H5N1) virus before and after systematic vaccination campaigns in Vietnam

Presented at *European Scientific Conference on Applied Infectious Disease Epidemiology* (ESCAIDE) 2007, October 18-20, Stockholm, Sweden
Material and Methods

• A total of 1019 and 114 farm outbreaks where reported between 1st January 2005 – 31st August 2005 and 11th November 2006 – 7th March 2007, respectively.
• These outbreaks where reported in 32 provinces of Viet Nam.
• For all study periods considered, about 85% (968/1133) of outbreaks occurred in the southern provinces.
• For the period 11th November 2006 to 7th March 2007 only 4 (3.5%) outbreaks occurred in Northern provinces.
Reproductive Ratio of Infection – R0

● The threshold conditions for disease spread:
  - **Deterministic approach**
    • R=1 (endemic situation)
    • R<1 – disease will not spread
    • R>1 – disease will spread
  - **Probabilistic (stochastic) approach**
    • R<1 – minor outbreaks may occur
    • R>1 – minor or major outbreak may occur

(Anderson and May, 1991; Diekmann and Heesterbeek 2000)
Incidence vs within Farm Reproductive Ratio

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### Infection Potential of Incident Farms by Farm Size

<table>
<thead>
<tr>
<th>OUTBREAK TIMING</th>
<th>PARAMETER</th>
<th>POOLED</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-vaccination</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(1st Jan 2005–23rd Aug 2005)</em></td>
<td>( R_0 ) (Mean)</td>
<td>2.05</td>
<td>2.13</td>
<td>2.02</td>
<td>1.99</td>
<td>2.06</td>
</tr>
<tr>
<td></td>
<td>S.e.</td>
<td>0.059</td>
<td>0.74</td>
<td>0.34</td>
<td>0.068</td>
<td>0.107</td>
</tr>
<tr>
<td></td>
<td>95%CI</td>
<td>1.89-2.13</td>
<td>0.57-3.70</td>
<td>1.33-2.70</td>
<td>1.87-2.13</td>
<td>1.83-2.26</td>
</tr>
<tr>
<td></td>
<td>Obs</td>
<td>1019</td>
<td>17</td>
<td>54</td>
<td>797</td>
<td>151</td>
</tr>
<tr>
<td></td>
<td>HIT (Mean)</td>
<td>0.28</td>
<td>0.15</td>
<td>0.20</td>
<td>0.27</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td>S.e.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.0094</td>
<td>0.024</td>
</tr>
<tr>
<td></td>
<td>95%CI</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.25-0.29</td>
<td>0.31-0.41</td>
</tr>
<tr>
<td></td>
<td>Obs</td>
<td>1010</td>
<td>17</td>
<td>54</td>
<td>797</td>
<td>151</td>
</tr>
<tr>
<td><strong>During Vaccination</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(7th Dec 2006–7th Mar 2007)</em></td>
<td>( R_n ) (Mean)</td>
<td>1.85</td>
<td>1.98</td>
<td>1.74</td>
<td>1.13</td>
<td>1.09</td>
</tr>
<tr>
<td></td>
<td>S.e.</td>
<td>0.059</td>
<td>-</td>
<td>-</td>
<td>0.057</td>
<td>0.079</td>
</tr>
<tr>
<td></td>
<td>95%CI</td>
<td>1.89-2.13</td>
<td>-</td>
<td>-</td>
<td>1.87-2.13</td>
<td>0.34-1.27</td>
</tr>
<tr>
<td></td>
<td>Obs</td>
<td>1019</td>
<td>1</td>
<td>1</td>
<td>70</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>HIT (Mean)</td>
<td>0.28</td>
<td>0.14</td>
<td>0.19</td>
<td>0.18</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td>S.e.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.0094</td>
<td>0.024</td>
</tr>
<tr>
<td></td>
<td>95%CI</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.12-0.23</td>
<td>0.09-0.20</td>
</tr>
<tr>
<td></td>
<td>Obs</td>
<td>90</td>
<td>1</td>
<td>1</td>
<td>64</td>
<td>26</td>
</tr>
</tbody>
</table>
Discussion

• Outbreak farms of the initial stage of the epidemic curve have significantly higher infection potential than remainder of farms.
• Significant reduction of infection potential between pre and post vaccination outbreaks.
• Infection potential is significantly higher than unity in “vaccination era” incident farms.
• Larger farms (>3,000 heads) have significantly higher infection potential compared to smallholder commercial farms.
• Duck farms seem to have a significantly higher infection potential than chicken farms.
Modelling of Surveillance Data

Social Network of market traders and communes
Catchment Areas of Surveyed Markets
Preliminary Findings

- 2-mode network connecting traders and communes via poultry trading
- It has 310 nodes: 117 traders and 193 communes.
- There are 474 links
- 2.45 traders per commune and 4 communes per trader on average.
- Network with clear core structure with
  - 59 components are connected to the core group
  - 18 isolated components
Two-mode Network of Traders and Communes
K-core Degree of Network Nodes

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Spatial Risk Modelling

An analysis of the spatial and temporal patterns of HPAI occurrence in Vietnam using national surveillance data

Probability of Outbreaks in Northern Vietnam

based on Logistic Regression Model for 2003/4 AI Epidemic

Outbreak probability
- 0-0.1
- 0.1-0.2
- 0.2-0.3
- 0.3-0.4
- 0.4-0.5
- 0.5-0.6
- 0.6-0.7

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Probability of Outbreaks in Southern Vietnam

based on Logistic Regression Model for 2003/4 AI Epidemic

Outbreak probability
- 0-0.1
- 0.1-0.2
- 0.2-0.3
- 0.3-0.4
- 0.4-0.5
- 0.5-0.6
- 0.6-0.7
Animal Health Risk Assessments

Assessment of H5N1 risk and the importance of wild birds

Published in *Journal of Wildlife Diseases* 43, S47-S50.
OIE - Animal Health Risk Assessment

**ACTIVITIES**

- Identify hazard
- Define risk question
  - Outline pathway
  - Collect data
  - Assess risk

**COMPONENTS**

1. **RELEASE ASSESSMENT**
2. **EXPOSURE ASSESSMENT**
3. **CONSEQUENCE ASSESSMENT**
### EFSA Scientific Panel for Animal Health & Welfare
- Bo Algert
- Harry J. Blokhuis
- Donald M. Broom
- Ilaria Capua
- Stefano Cinotti
- Michael Gunn
- Jörg Hartung
- Per Have
- Xavier Manteca Vilanova
- David B. Morton
- Michel Pépin
- Ronald John Roberts
- José Manuel Sanchez Vizcaíno
- Alejandro Schudel
- James Michael Sharp
- Georgios Theodoropoulos
- Philippe Vannier
- Marina Verga
- Martin Wierup
- Marion Wooldridge

### EFSA Working Group on H5N1 HPAI Risk from Migratory Birds for EU
- Ian Brown
- Ron A.M. Fouchier
- Nicolas Gaidet
- Vittorio Gaberti
- Timm Harder
- Rowena Langston
- Ricardo Jorge Soares Magalhaes
- Vincent Martin
- James Michael Sharp
- Katharina Stärk
- David Stroud
- Bogdan Szewczyk
- Jan Veen
- Jonas Waldenström

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Animal Health Risk Assessments

Quantitative assessment of the risk posed by live bird imports for the introduction of HPAI H5N1 into Ethiopia
Model Pathways

RELEASE ASSESSMENT

- H5N1 infected environment
- H5N1 infected wild birds
- H5N1 infected domestic poultry

Approved Poultry Farm for Export

Transport of DOC during export

Border Inspection Post

EXPOSURE ASSESSMENT

- Ethiopia border

- Governmental Commercial Poultry Farm
- Private Commercial Poultry Farm

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Probabilities Assessed During Model Experimentation

**RELEASE ASSESSMENT**

- Probability DOC selected for export is infected, \( \alpha \)
- Probability DOC becomes infected during transportation, \( \beta \)
- Probability of low compliance at Ethiopian BIP, \( \gamma \)

**EXPOSURE ASSESSMENT**

- Probability a commercial farm is exposed to DOC, \( \delta \)

**Risk estimates:**
- Expected number of infected DOC imported per year
- Annual probability of importing infection via legal import of DOC
- Number of years between infection entries.
## Example of Data Required to Estimate $\alpha$

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>DISTRIBUTION/VALUE</th>
<th>UNIT</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Probability DOC selected for export is infected, $\alpha$</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of DOC produced by infected layer up to detection</td>
<td>RiskIntUniform(1;2)</td>
<td>bird</td>
<td>OIE, 2006; NASS, 2005.</td>
</tr>
<tr>
<td>Number of parent stock (PS) test-positive</td>
<td>RiskPert(0;0;161)</td>
<td>bird</td>
<td>Assumed: Upper value based on 0.1% of parent stock tested as positive.</td>
</tr>
<tr>
<td>Sensitivity of screening test</td>
<td>RiskPert(0.87:0.91:0.93)</td>
<td>%</td>
<td>Data section</td>
</tr>
<tr>
<td>Number of parent stock annually tested in all approved farms</td>
<td>161220</td>
<td>bird</td>
<td>Estimated: USDA, 2006; DEFRA, 2006; CBS, 2006; FAOSTAT, 2006</td>
</tr>
</tbody>
</table>
Variables Influencing the Baseline Model

Correlations for the number years between introduction of HPAI H5N1 via the legal import of DOC

- Sensitivity of screening test at the country of origin: -0.88
- Duration of transportation: -0.177
- Probability of low veterinary checks at BIP: 0.096
- Average number of contacts during transportation: -0.053
- Average annual number of DOC imports: 0.053
- Number of PS testing positive at country of origin: -0.725
Comparison of Sensitivity Spaces of Both Variables

Mean of Annual probability of importing HPAI H5N1 via DOC vs Percentage Change of Inputs

- Number of PS test-positive / Value F22
- Probability of veterinary checks and passing veterinary checks (?) / Value C49

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