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AUTHORS: Delabouglise, A; Dao, T H; Truong, D B; Nguyen, T T; Nguyen, N T X; Duboz, R; Fournié, G; Antoine-Moussiaux, N; Grosbois, V; Vu, D T; Le, T H; Nguyen, V K; Salem, G; Peyre, M

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When private actors matter: information-sharing network and surveillance of Highly Pathogenic Avian Influenza in Vietnam

Delabouglise A.[a,b], Dao T.H.[c], Truong D.B.[d], Nguyen T.T.[e], Nguyen N.T.X.[d], Duboz R.[a,f], Fournié G.[g], Antoine-Moussiaux N.[h], Grosbois V.[a], Vu D.T.[c], Le T.H.[d], Nguyen V.K.[e], Salem G.[b], Peyre M.[a,e]

a – CIRAD, AGIRS Research Unit, Campus international de Baillarguet, 34398 Montpellier Cedex 5, France

b – Paris Ouest University, CNRS Research Unit LAVUE, 200 Avenue de la République 92001 Nanterre Cedex, France

c – Hanoi University of Agriculture, Trau Quy, Gia Lam, Ha Noi, Vietnam

d – Nong Lam University, Faculty of Animal Science and Veterinary Medicine, linh Trung, Thu Duc, Ho Chi Minh City, Vietnam

e – National Institute of Veterinary Research, 86 Trung Chinh, Dong Da, Ha Noi, Vietnam

f – Asian Institute of Technology, Box 4, Klong Luang, Pathumthani 12120, Thailand

g – Royal Veterinary College, Veterinary Epidemiology, Economics and Public Health research center, Royal College Street, London NW1 0TU, United Kingdom

h – Liège University, Tropical Veterinary Institute, Place du 20-Août 7, 4000 Liège, Belgique

Corresponding author

Alexis Delabouglise

CIRAD AGIRs Research Unit

Tac 22/E Campus International de Baillarguet

34398 Montpellier Cedex 5, France

email : alexis.delabouglise@gmail.com / alexis.delabouglise@cirad.fr

Phone: +33 4 67 59 38 29

Abstract

The effectiveness of animal health surveillance systems depends on their capacity to gather sanitary information from the animal production sector. In order to assess this capacity we analyzed the flow of sanitary information regarding Highly Pathogenic Avian Influenza (HPAI) suspicions in poultry in

Vietnam. Participatory methods were applied to assess the type of actors and likelihood of information sharing between actors in case of HPAI suspicion in poultry.

While the reporting of HPAI suspicions is mandatory, private actors had more access to information than public actors. Actors of the upstream sector (medicine and feed sellers) played a key role in the diffusion of information.

The central role of these actors and the influence of the information flow on the adoption by poultry production stakeholders of behaviors limiting (e.g. prevention measures) or promoting disease transmission (e.g. increased animal movements) should be accounted for in the design of surveillance and control programs.

Keywords

Disease Reporting; Social Networks; Vietnam; H5N1 virus; Private Sector; Participatory Research; Influenza

Abbreviations

HPAI: Highly Pathogenic Avian Influenza

PP: Proportional Piling

1. Introduction

The performance of public surveillance systems depends on their ability to access health information from the animal husbandry sector. Therefore, among the requirements for effective surveillance networks, the acceptability of the system (i.e. willingness of actors to participate in the system) is of particular importance (Hoinville, 2011).

Highly Pathogenic Avian Influenza virus (HPAI) (H5N1) is present in Vietnam since the first epizootic in 2003. Notification of any HPAI (H5N1) suspicions to veterinary authorities is mandatory (MARD and MOH, 2011). The case definition of HPAI (H5N1) suspicion in poultry is based on a 5% mortality in one poultry flock over 2 days along with specific symptoms such as cyanosis, swelling of the head and diarrhea (Department of Animal Health, 2011). This case definition is common with velogenic Newcastle Disease also circulating in Vietnam (OIE, 2014). Despite strong coverage of veterinary authorities in the field at all levels (village , commune, district and province), under-

reporting of HPAI suspicions has been recognized by the authorities as a major limitation in the effectiveness of any HPAI (H5N1) control programs in place (Minh et al., 2011).

In order to ensure acceptability and sustainability of the surveillance and control programs, accounting for the needs of all stakeholders becomes critical. In order to do so, a good understanding of health information sharing pathways between stakeholders is essential. Network analysis has been widely applied to study complex socio-economic interactions such as the spread of influence and knowledge (Jackson, 2008; Wasserman and Faust, 1994). In the field of animal health, this method has been mainly used to identify actors contributing the most to the spread of contagious diseases through live animal trading networks (Fournie et al., 2013; Rasamoelina-Andriamanivo et al., 2014; Vallee et al., 2013). Participatory Epidemiology methods proved efficient in gathering reliable information while addressing questions related to the perception of local actors on animal disease issues (Catley et al., 2012).

The aim of this study was to apply network analysis approach to understand the information sharing network in case of HPAI (H5N1) suspicion. A participatory epidemiology approach was implemented to identify the main actors involved in the information sharing networks of HPAI (H5N1) suspicions in Vietnam and to investigate the patterns of information sharing between the actors.

2. Material and Methods

2.1. Study areas.

Rural communes from two Provinces of Vietnam were selected according to their HPAI (H5N1) risk level and poultry production characteristics: Hải Dương province, in the Red river delta, Northern Vietnam, was classified as high risk by the Department of Animal Health of Vietnam and with high density of semi-commercial chicken broiler farms (General Statistics Office of Vietnam, 2012). Đồng Nai province, in Southeast Vietnam, was classified as low risk and with numerous large-scale duck and chicken broiler commercial farms.

2.2. Sampling frame

In each study area, participants were contacted with the help of veterinary authorities and commune or village officials. Focus group interviews were conducted with poultry farmers belonging to different production types present in the study area: backyard poultry farmers (flock size: <100 animals), small

broiler chicken farmers (flock size: 100-1000 animals), large broiler chicken farmers (flock size: >1000 animals), large broiler duck farmers (flock size: >1000 animals). This first step aimed at investigating the information delivered by farmers in case of HPAI suspicions in their farms. Each focus group comprised 7 to 20 farmers of the same production type. Then other categories of actors where progressively included in the sample using the snowball sampling approach (Sadler et al., 2010). New categories of actors mentioned by the participants were included in the sampling. For each new category of actor, participants were asked to mention names of individuals they considered critical contacts. Then these critical contacts were asked for an interview. Individual interviews of selected poultry farmers (n=4 per focus group) were also performed. Some of the selected critical contacts refused to be interviewed, the proportion of refusals varying from 0 to 40%. Critical contacts who refused the interviews were replaced by other actors of the same category, practicing their activity in the same area.

2.3. Data collection

Data were collected by teams of 2 to 5 researchers and veterinary students. Interview team members were previously trained using participatory epidemiology approaches.

In the first phase of the study, semi-structured interviews and proportional piling (PP) (Mariner and Paskin, 2000) were conducted with focus groups of poultry farmers to identify the names of the poultry diseases that farmers perceived as causing the highest and quickest mortality in poultry flocks. Proportional piling consisted in asking participants to draw circle corresponding to items like disease names and distributing 100 counters in each circle (according to rate of mortality and rapidity of the disease). Participants were then asked an estimate of the rate of mortality and duration of diseases which were given the highest scores. Disease names participants associated with at least 50% mortality in poultry flocks in less than 5 days were used to refer to HPAI (H5N1) suspicions in subsequent interviews. Using the disease suspicion definition, participants were asked to identify the different types of actors they exchanged information with when this event occurred. The relative likelihood of information exchanges was quantified using PP technique: participants were asked to distribute 100 counters within circles representing the different categories of actors they had previously listed. Participants were also asked the reasons of the information exchanges and the

differences in priority given to each one. They also were asked if they were interested in receiving such information and if so the reason why they considered such information useful. In the northern study area, individually interviewed participants were also asked the names and location of the individuals they shared information with. In the southern study area, they were also asked to estimate the number of day between the time they would get the information and the time they would transmit it.

2.4. Data analysis.

Directed weighted networks were built using categories of actors as nodes and exchanges of information about suspicions as links between nodes (Jackson, 2008). Links were weighted according to the results of the PP on the relative probabilities of information sharing between the different categories of actors. The category which received the highest score was considered to be contacted with certainty whereas the others were given relatively less priority. All scores were divided by the highest score, such that the category which ranked first then had a score *p* of 1, and other categories had a score ranging from 0 to 1.

Several individuals or groups of individuals from a given category were separately interviewed, generating several estimations of the relative probability of information-sharing between 2 given categories of actors. These variations in the estimation of each probability were taken into account by building all possible resulting adjacency matrices and calculating all possible resulting measures of centrality.

Two types of links were considered: i) the transmission of information by a given farmer on disease suspicions happening in his farm (primary information), this information was considered of good quality, and ii) the transmission of information from a given actor on disease suspicions happening in other farms (secondary information), which was considered of lower quality (loss of precision).

In order to take into consideration both types of links, Bonacich's alpha centrality measure was used as an indicator of the quantity of information each category of actor could obtain when a disease suspicion occurred (Bonacich and Lloyd, 2001). The Alpha centralities correspond to the solution to the following matrix equation:

$$x = \alpha . A^T . x + e$$

A^T is the transpose of the adjacency matrix A which only accounts for secondary exchanges. x is the vector of alpha centralities of the network's nodes; e is the vector of exogenous influences on nodes of the network that do not depend on the structure of the network and α is a parameter that corresponds to the relative importance of the network topology.

It was assumed that each node i had exogenous sources of information ei that directly came from owners of affected farms. In other words, each value ei was the indegree of the node i when only primary information delivered by affected farms was considered and e was the vector of all values ei of the nodes. The considered links of the network were the secondary information exchanges.

The value of α was chosen to be as high as possible while satisfying $\alpha < 1/\lambda max$, where λmax is the highest eigenvalues of all simulated adjacency matrices (Bonacich and Lloyd, 2001). We chose $\alpha = 0.35$.

2.5. Computing material

Data analysis was performed using R.2.15.3 software (R core team, 2014). Network graphs were built and alpha centralities were calculated using the igraph package (Csardi and Nepusz, 2006). Graphical displays of quantitative outputs were made using ggplot2 package (Wickham, 2009). Spatial representations were made using ArcMap 10.2 software (ESRI, 2011).

3. Results

3.1. Sample size

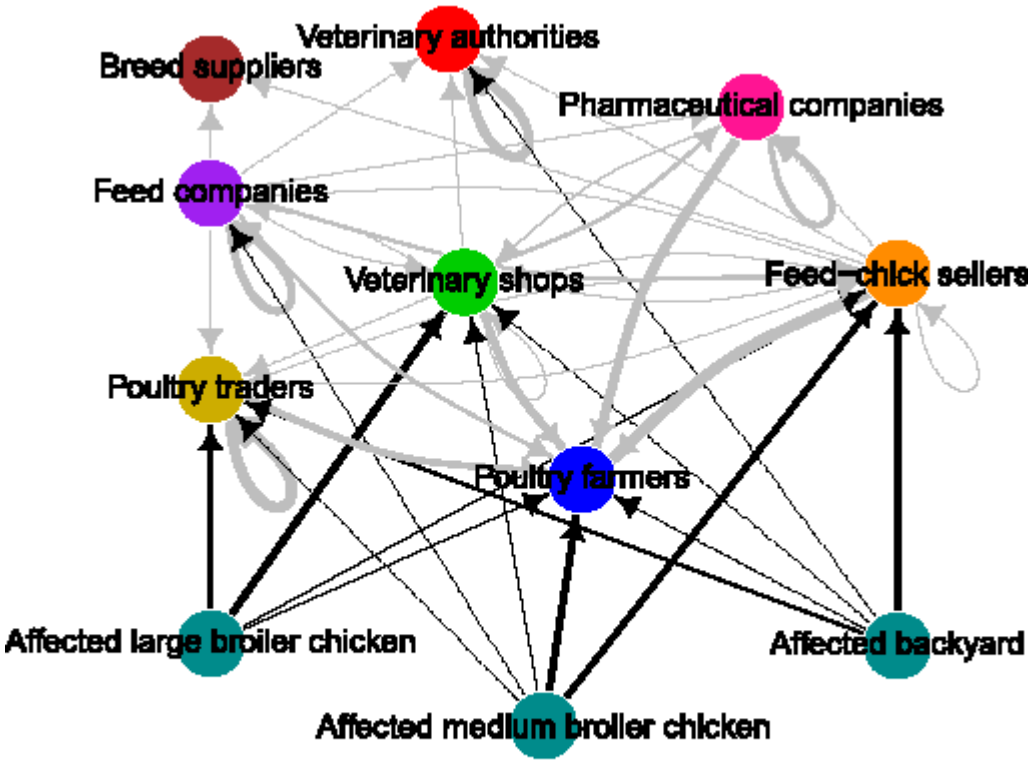
Overall, the study sample included 158 participants (North: n=94, South: n=64) from 9 categories: backyard poultry farmers (flock size: <100 animals) (North: n=40, South: n=20), small broiler chicken farmers (flock size : 100-1000 animals) (North: n=20), large broiler chicken farmers (flock size: >1000 animals) (North: n=10, South: n=17), large broiler duck farmers (flock size: >1000 animals) (South: n=10), government veterinarians (North: n=6, South: n=4) , feed and chick sellers (North: n=5, South: n=1), veterinary medicine sellers (North: n=2, South: n=4), poultry traders (North: n=3, South: n=3), veterinary technicians of feed companies (North: n=5, South: n=3) and pharmaceutical companies (North: n=3, South: n=2).

3.2. Adopted disease suspicion definition

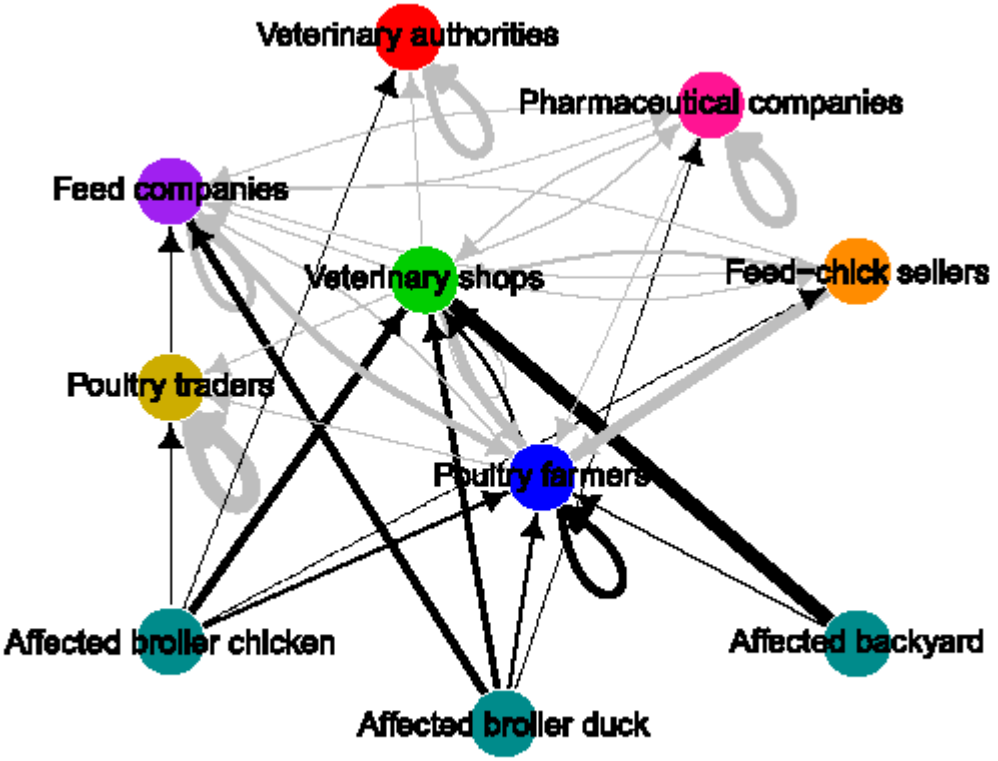
Poultry farmers mentioned several diseases names causing high mortality in a relatively short time. The adopted disease suspicion definition was defined as more than 50% mortality in one flock in less than 5 days. English translations of disease names which matched this definition were “Newcastle Disease”, “Gumboro Disease”, “Plague”, ”Black head disease”, “Epidemic disease” and “Fowl cholera” (in the northern study area), “Newcastle Disease”, “Gumboro disease” and “Flu” (in the southern study area). One of these disease names was used to refer to disease suspicions.

3.3. Private actors were the first targets of information sharing on HPAI like disease suspicions

Contacts with actors of the upstream sector (feed-chick sellers, veterinary shops or feed company technicians) were given the highest priority by farmers in case of suspicion in their farms (Figure 1). However, alpha centrality measures accounting for both primary and secondary information flows showed that other poultry farmers received equal or more information than the other categories (Figure 2). Indeed, actors of the upstream sector mentioned they would warn other poultry farmers of the occurrence of high mortality events in order to protect their customers’ income and business capacities, so they could continue to buy their products and repay their debts. Even though government veterinarians received poultry health information, mainly from veterinary shops, the official surveillance system appeared as peripheral in the information-sharing network dominated by private actors (Figures 1 and 2). Connections between veterinary shops and government veterinarians were commonly observed in both study areas, as several government veterinarians had also a private medicine selling activity.



North



South

185

Figure 1. Information-sharing networks of HPAI (H5N1) suspicion information identified in the two study areas. Colored nodes represent categories of actors. Arrows represent the directed information exchanges operated by actors of each category with other actors. Arrow widths represent the means of the relative probabilities of these exchanges. Black arrows represent the information flows from affected farmers (bottom dark green circles). Grey arrows represent the secondary information flows (occurring between other actors) (2 column-fitting image, color reproduction on the web only).

3.4. Information sharing differed between study areas and scale of poultry production

Veterinary shops had a relatively higher centrality in the network in the South Vietnam study area whereas feed-chick sellers were more central in the North (Figures 1, 2). The high concentration of large scale farms in Đồng Nai province (South) was associated with the implementation of veterinary shops and an easy access to these shops by all farmers. In the North Vietnam study area, feed-chick sellers also supplied medicines directly to the farm whereas veterinary shops were at distant location from the farms (more than 3 kilometers) (Figure 3). As a result backyard and small scale commercial farms contacted more feed-chick sellers than veterinary shops, whereas large scale commercial farms contacted more veterinary shops, in order to get a better service (owners of veterinary shops were graduated veterinarians). Broiler duck farmers participating in the South Vietnam study area were more likely to contact feed companies because of the existence of production contracts linking them.

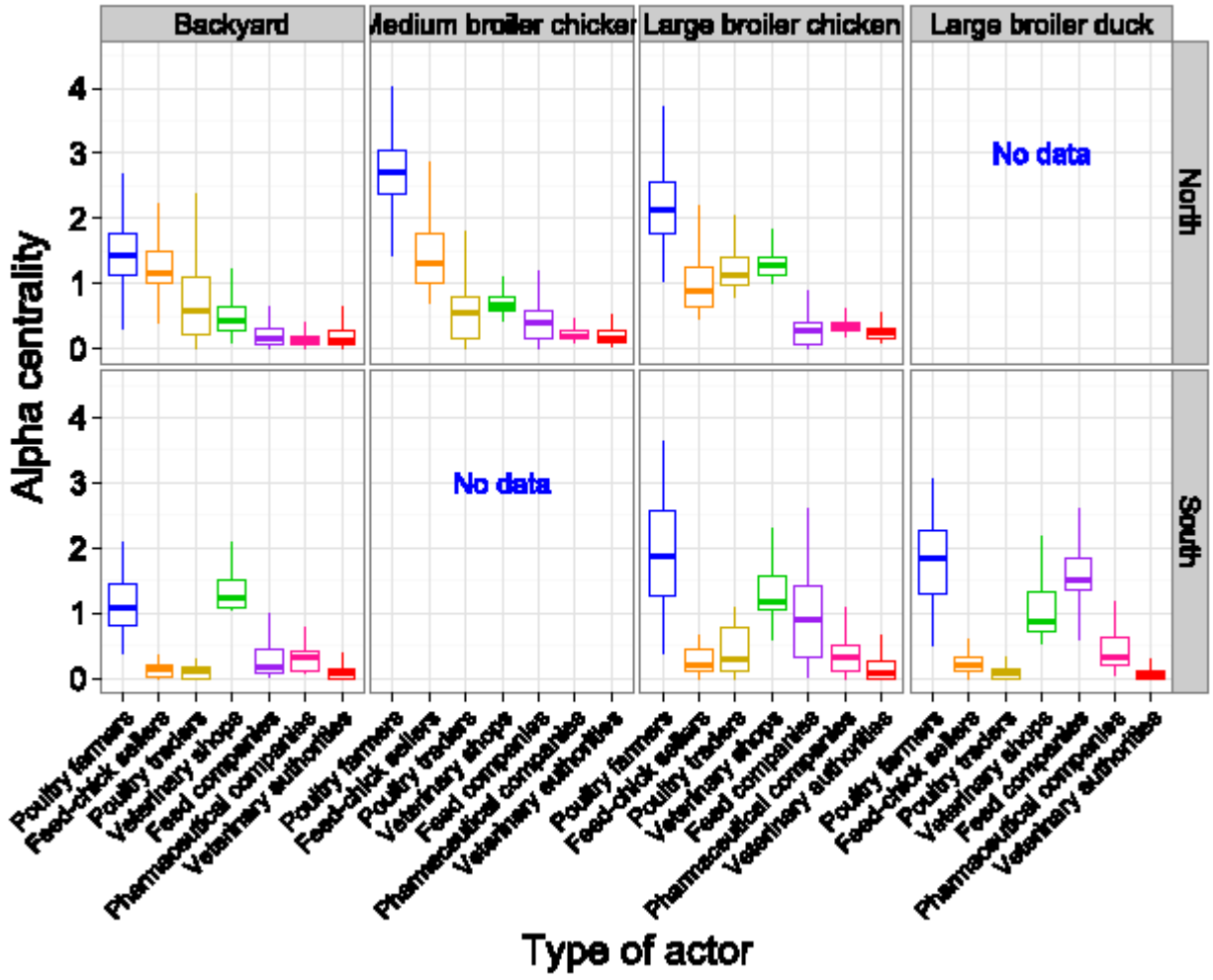


Figure 2. Box-and-whisker plots of alpha centrality measures of categories of actors, when both primary and secondary information flows are taken into account. These results were computed from the weighted directed networks of categories designed from the participatory investigations. Different results are displayed according to the primary source of information (production type of affected farm) and the study area (North and South) (2 column-fitting image, color reproduction on the web only).

3.5. Actors of the upstream poultry sector propagated the information to distant places

Results of individual and group interviews showed that more than 79.0 % of information sharing between poultry farmers was between individuals from the same village (Figure 3). In contrast, feed-chick sellers and veterinary shops exchanged information mostly with actors located in other villages or other communes (respectively 62.8% and 100%) (Figure 3). Feed-chick sellers and poultry farmers spread information to farmers located in nearby communes, on distances reaching about 5 km, while

owners of veterinary shops spread information to customers located in several different districts, or several different provinces, on distances of about 50 km (Figure 4). Besides, technicians of pharmaceutical or feed companies visited customers located in areas comprising one to several provinces and companies had technicians located in a large part of the country. They all said they transmitted information on disease suspicions on such distance.

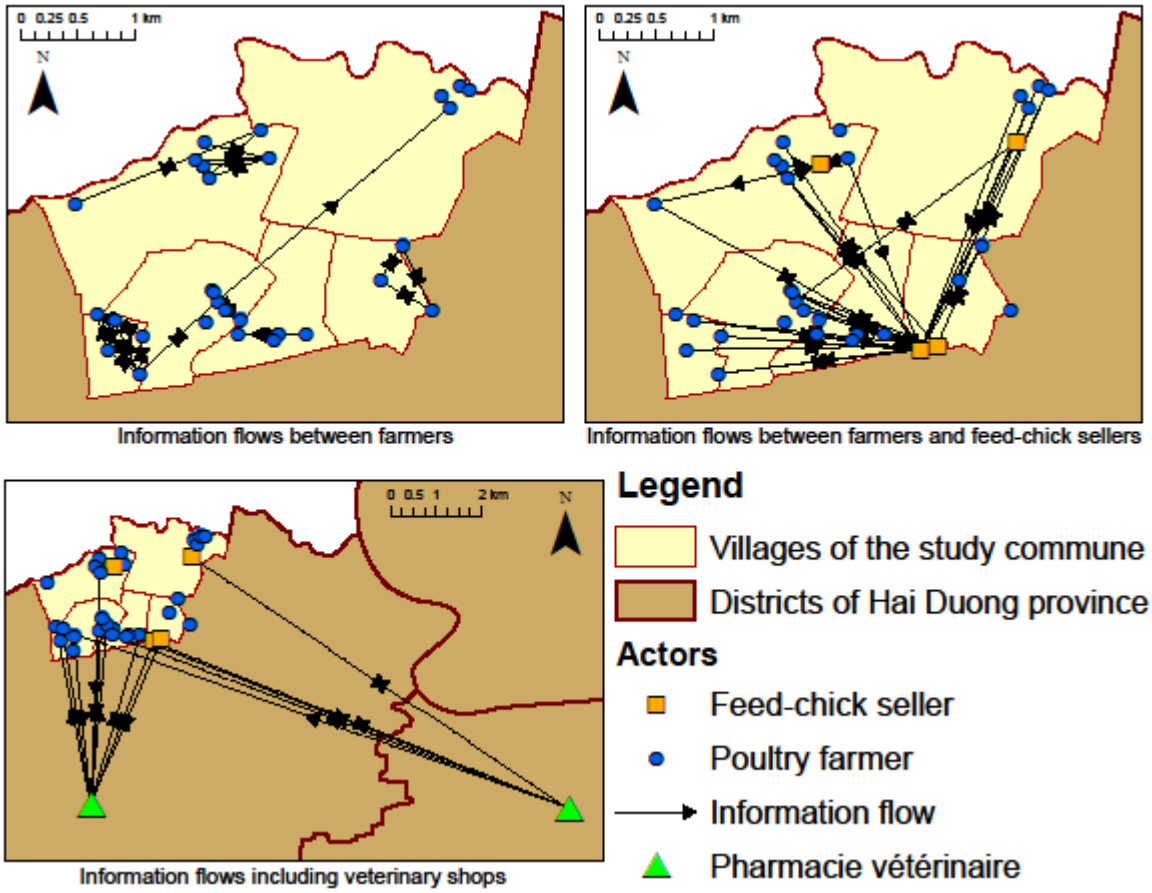


Figure 3. Spatial representation of the information flows occurring between private actors (poultry farmers, feed-chick sellers, veterinary shops) individually interviewed in the northern study area (2 column-fitting image, color reproduction on the web only).

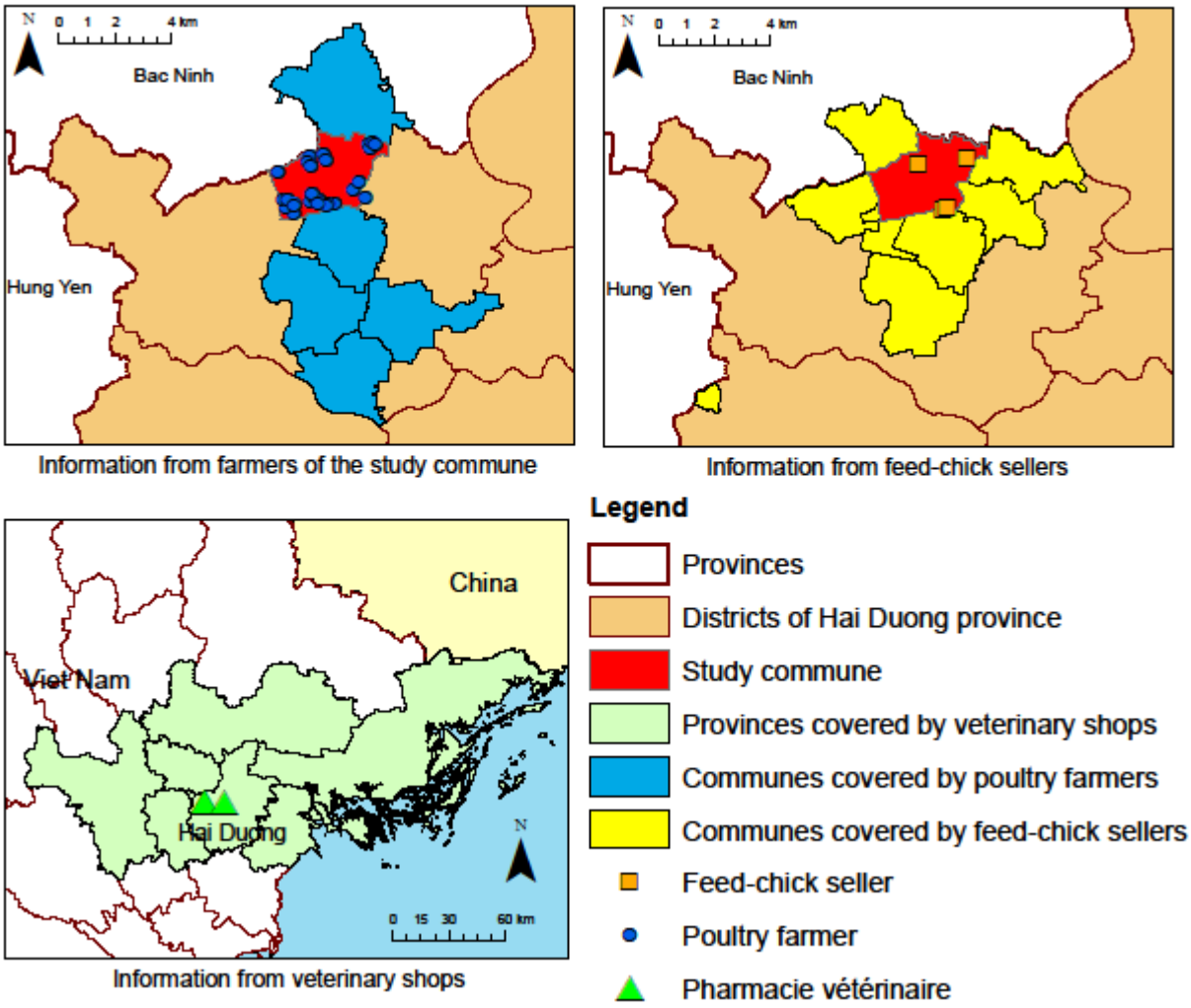


Figure 4. Spatial representation of the areas where poultry farmers receive information from interviewed poultry farmers, feed-chick sellers and veterinary shops of the northern study area (2 column-fitting image, color reproduction on the web only).

3.6. Timeliness of information sharing

In the South study area, poultry farmers said they reported the disease suspicion information to the veterinary shops within the same day they observed the symptoms in their farms. Time of primary exchanges with other actors varied between 1 day and 1 week after observation of the symptoms. Times of secondary information exchanges varied between 1 day and 1 month after the moment each actor received the information. Actors of the upstream sector (Feed-chick sellers, owners of veterinary shops, technicians of companies) said they shared the information with poultry farmers everyday whenever they met them.

3.7. Usefulness of information

241 In both study areas, all the actors showed an interest in getting information on disease suspicions.
242 Farmers used it to anticipate disease occurrence and its possible impact on poultry market prices.
243 They had three types of reactions: i) preventive measures could be implemented (with vaccination,
244 disinfection, antibiotics and isolation of animals in the northern study area, vaccination and
245 disinfection in the southern study area); ii) early sale of animals could be done before the disease
246 occurs in their farm and/or the poultry prices decrease, or iii) a speculation strategy (stocking of
247 young animals to sell them after the epizootic, when the prices are high due to a shortage of poultry).
248 Actors of the upstream sector used information to anticipate adverse effects of disease on their sales
249 and to anticipate market price variation. Poultry traders used information as an advantage in price
250 negotiation with poultry producers.

251 **4. Discussion**

252 *4.1. Relevance of the method for assessing information sharing processes*

253 The data collection was based on the likelihood of information exchanges perceived by actors of
254 poultry production. Another approach could have been based on the accounting of these information
255 exchanges according to each actor's past memory. However, information flows on disease outbreaks
256 are difficult to quantify for two reasons: opposite to information on animal sales or purchases, there is
257 no records of poultry health information exchanges linked to social contacts. Then, as diseases occur
258 on an irregular basis, participants may have experienced such events at different time point before the
259 study, which would have added more heterogeneity between actors. Indeed recall biases can be high,
260 which would limit the validity of the data collected. Semi-quantification of the priority given to each
261 information sharing pathway by the participants was easier to implement and provided more accurate
262 data. Indeed it provides insight into what would happen in an actual HPAI suspicion situation, based
263 on each participant's own rational.

264 Snowball sampling was also appropriate for this type of research. It enabled to draw an exhaustive list
265 of categories of actors involved in the information sharing process (Sadler et al., 2010).

266 *4.2. Limitations of the study*

267 The main limitation of the study is its limited scale (several rural communes in one northern and one
268 southern province). However, using snowball sampling, individuals who were targeted by information

flows and who were located outside the study area also were included in the sample. Such approach enables to analyze how information is disseminated from one poultry production area to the others depending on the type of poultry production and the actors involved.

4.3. Building bridges with the private sector: where to begin?

Our results showed the central role of private actors in the HPAI suspicions information sharing in Vietnam. It confirmed previous sociological studies which emphasized the need for public veterinary surveillance systems to establish bridges with the private sector (Desvaux and Figuie, 2011). However our study also demonstrated the importance of understanding the processes of those private networks as the type of actors involved differ according to the poultry production sector characteristics and therefore the geographic location. In areas with high development of industrial and commercial poultry production, veterinary shops operated by private veterinarians are accessible to smallholder farms. However in areas with relatively lower development of industrial and commercial production, veterinary shops are less accessible and actors in close and regular contact with poultry farmers (feed or chick sellers) provide veterinary services themselves.

These local actors are the main route of transmission of disease suspicion information to distant areas. A major part of the Vietnamese poultry production is made in small-scale farming systems and most farmers cannot afford constant investments in biosecurity and prevention measures (Agrifood Consulting International, 2006; General Statistics Office of Vietnam, 2012). Information on disease suspicions is especially useful for such farmers who can adapt their preventive measures according to the type of information received. So far, only actors of the upstream sector seemed to adequately address these needs. They should be the main targets of programs aimed at diversifying information sources of public surveillance systems, using, for example, participatory surveillance (Mariner et al., 2014) or syndromic surveillance (Dorea et al., 2011). Indeed, these actors can provide information on the sanitary situation of numerous farms of their area of activity to the public surveillance system. This information which could be used in guiding deeper investigation of poultry flocks and early detection of HPAI (H5N1) outbreaks.

4.4. Relevance of the study results for HPAI control interventions

Poultry farmers were more likely to obtain information on disease suspicions compared to government veterinarians and they had a rapid access to this information. This result has strong implication in term of disease control measures. Since 2012 control measures implemented against HPAI H5N1 outbreaks in Vietnam have focused on destruction of infected flocks, disinfection and poultry movement restrictions in confirmed affected areas (NSCAI, 2012). However, farmers tend to quickly sell their adult animals or purchase young animals when facing an epizootic threat. Therefore peaks in animal movements directly follow HPAI suspicion occurrences, while veterinary authorities are not yet aware of the situation. This increase in animal movements might generate additional adverse effects for the poultry production: increased risk of disease spread and drop in market sale prices. Special programs (through financial incentives or educational campaigns) could be implemented to encourage farmers to quarantine rather than sell animals when information on disease suspicions is shared in their neighborhood.

5. Conclusion

Our study showed that information on HPAI (H5N1) disease suspicions in Vietnam is mainly mediated by private actors who enhanced other poultry farmers' awareness about potential disease occurrences. Despite their strong presence in the field, the connection between this private network and veterinary authorities seemed limited. Our results confirmed the need to build bridges between public surveillance and local private actors and highlight the importance of actors from the upstream sector i.e. medicine and feed sellers. Positive and negative effects of information spread also need to be accounted in disease control programs.

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