



# Avian Influenza in swine

Case study in Vietnam

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# Cross-species transmissions between Humans, Pigs and Birds



## HUMAN STRAINS

### **H1N1**

~1930: Spanish Flu pandemic(?)  
2009: A/H1N1 pandemic

### **H3N2**

1970: Hong Kong pandemic strain  
1977: Early human strain  
*Recent human strain*

## REASSORTANTS with swine viruses

### **H1N2**

1978 and 1994 : Early Human H1N1 / Swine H3N2  
1997: Recent human H3N2 / Classical swine H1N1

### **Triple reassortant H3N2**

1998: Avian-Human-Swine

### **Triple reassortant H1N1**

2000: Avian-Human-Swine

### **Other reassortants**

*H1N7, H3N1*

## AVIAN STRAINS

### **H1N1**

1979 and 1993: Eurasian sublineage  
*Northern American sublineage*

### **H3N2**

1978: Eurasian Sublineage

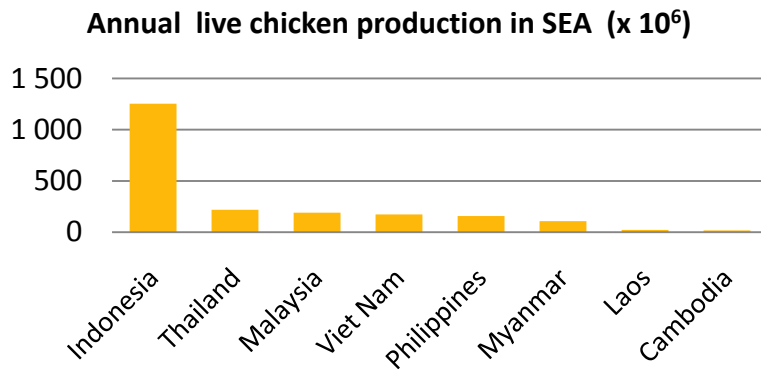
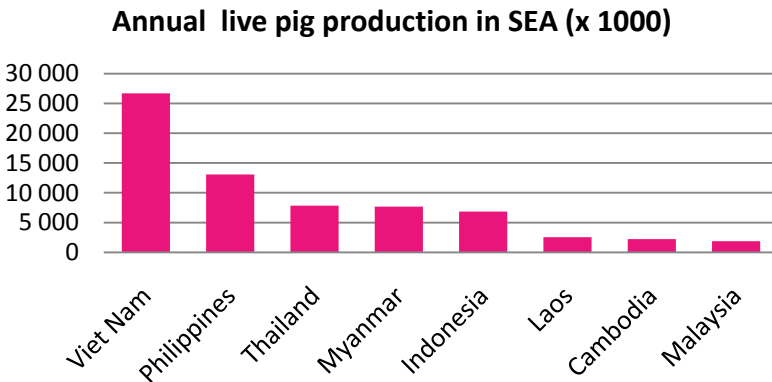
### **Other avian strains**

*H2N3, H3N3*  
*H4N6, H5N1*  
*H5N2, H9N2*  
*H6N6, H7N7*

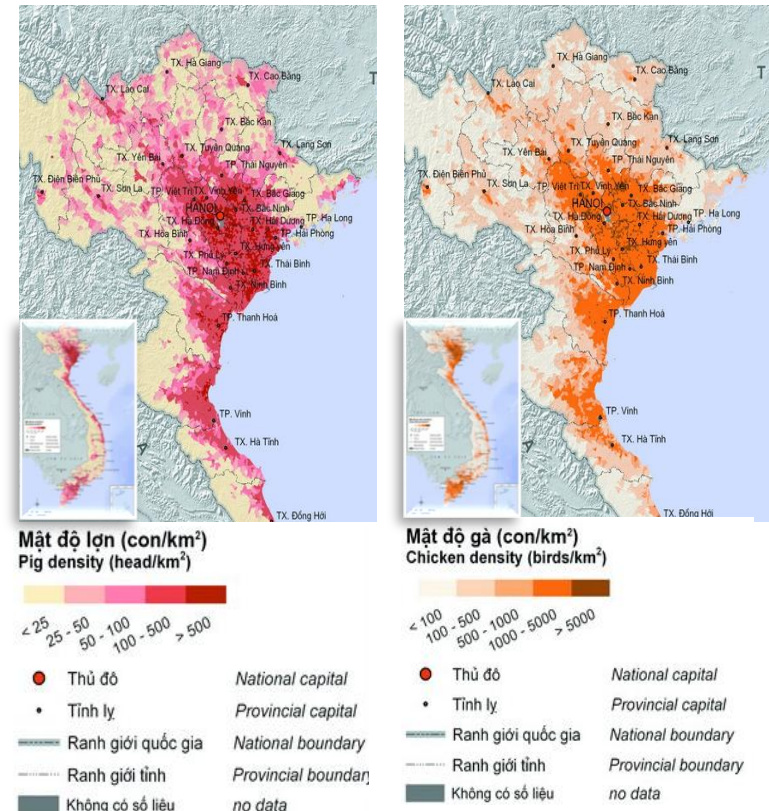
*Sporadic infection*  
*Enzootic*

# Poultry and pig production in Vietnam

## High producing levels

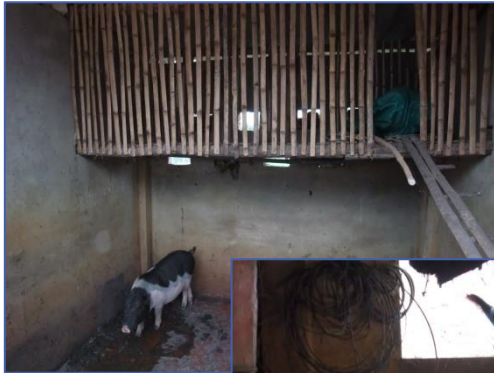


## Various population densities





# Possible contact between poultry and pigs in multi-species farms

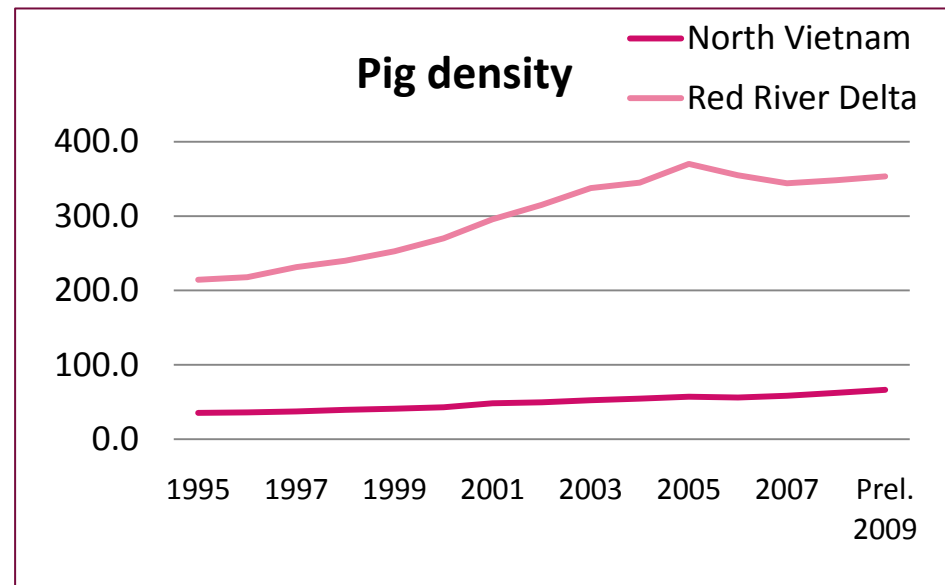
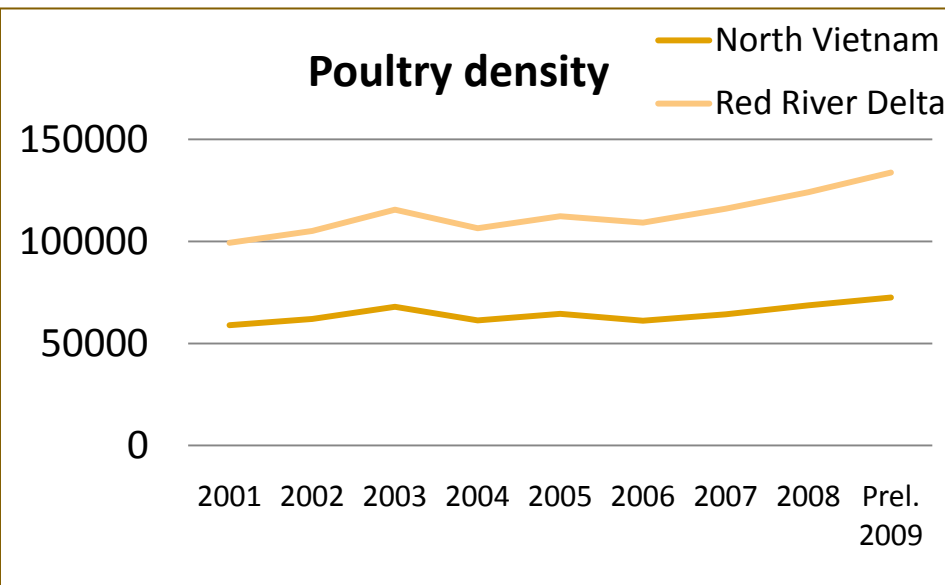
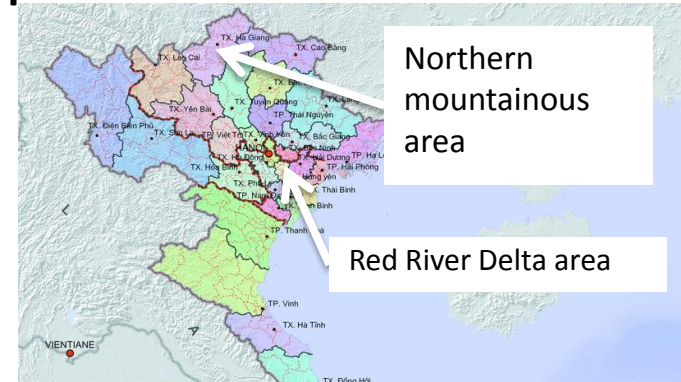


# Several subtypes of AI are circulating in Vietnam

Subtype		Species	Viral isolation rate	Serology ( %)	Reference
<b>H3</b>	H3	Chicken	-	36.2	Phuong 2005
		Duck	-	10.5	Phuong 2005
		Muscovy Duck	-	17.2	Phuong 2005
	H3N2 – H3N8	Duck	1/300 (0.3%)		Nomura et al. 2011
<b>H4</b>	H4	Duck	1/13 (7.7%)	-	Nguyen et al. 2005
	H4N6	Duck	7/300 (2.3%)		Nomura et al. 2011
<b>H5</b>	H5	Chicken	-	5.8	Phuong 2005
		Duck	-	77.6	Phuong 2005
		Muscovy Duck	-	24.1	Phuong 2005
	H5	Non vaccinated birds		10	S. Desvaux (GRIPAVI)
	H5N1	Goose	2/33 (6%)	-	Nguyen et al. 2005
	H5N2	Duck	1/13 (7.7%)	-	Nguyen et al. 2005
<b>H9</b>	H9N2	Duck	26/300 (8.7%)		Nomura et al. 2011
	H9N2	Duck	27/300 (8.7%)		Nomura et al. 2011
	H9N6	Duck	1/300		Nomura et al. 2011
	H9N13	Duck	2/13 (15,4%)	-	Nguyen et al. 2005
<b>H11</b>	H11N3 – H11N9	Duck	3/300 - 1/300		Nomura et al. 2011
<b>H12</b>	H12	Chicken	-	30.6	Phuong 2005
		Duck	-	14.4	Phuong 2005
		Muscovy Duck	-	5.2	Phuong 2005

# Materials and Methods

- **Cross-sectional surveys** in multi-species farms
  - Pig and poultry sampling
  - Virological and serological testing
- 2 different agro-ecosystems

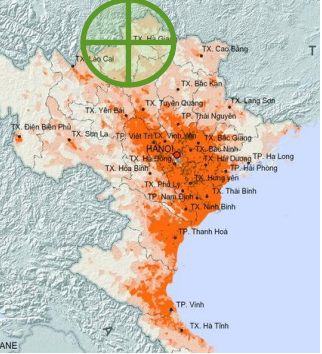


# Serological analysis

- Screening of influenza type A by ELISA
- Subtyping by HI test or pseudotyped lentiviral particle-based serological assay (for H5)

Subtype	Lineage HA	Strain
H1N1	Classical Swine	A/Swine/HK/4167/1999
	Swine Triple-reassortant	A/Swine/HK/1110/2006
	Swine Eurasian avian	A/Swine/HK/NS29/2009
	Human Pandemic	A/CA/4/2009
H3N2	Human-like (A/Sydney/5/97)	A/Sw/HK/2422/1998
	Eurasian avian-like	A/Swine/HK/1197/2002
	Human	A/OK/483/2008
H9N2	G1-like	A/Qa/HK/G1/1997
	Y280-like	A/Dk/HK/Y280/1997
H5N1	clade 1	A/Cambodia/408008/2005
H6N1		A/Teal/HK/W312/1997
		A/Duck/VN/22/2009





# Results on avian influenza in North Vietnam (2005-2006)

- Outbreaks of H5N1 HPAI
  - Seroprevalence of avian influenza type A = 7.2% [1.45; 10.5]
    - H5 = 3.25% [2.39; 4.11]
    - H9 = 1.12% [0.61; 1.63]
- ➔ AI spreads in remote areas in non-vaccinated chickens, at low frequency



Trevennec K, Chevalier V, Grosbois V, Garcia JM, Thu HH, Berthouly–Salazar C, Peiris JSM & Roger F (2011). Looking for avian influenza in remote areas. A case study in Northern Vietnam, *Acta Tropica* **120(3):160-166**.





# Results on swine influenza in North Vietnam (2005-2006)

- 2/519 positive ELISA-A
  - No subtype identified
- ➔ **Freedom from swine flu and from avian virus infection**



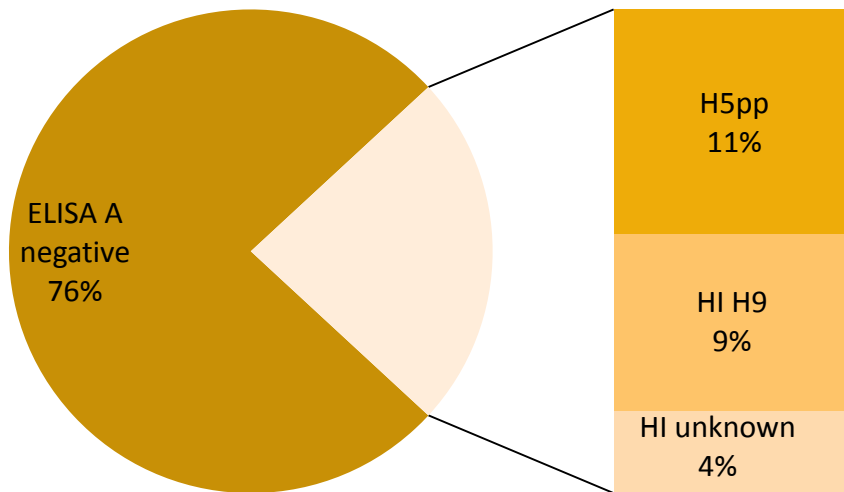
Scenario	Prior information						Cut-off	Output P freedom
	SE		SP		Pr			
	Min	Mode	Min	Mode	Max	Mode		
Low SE	50%	70%	50%	98%	20%	5%	1%	61%
							2%	93%
							<b>5%</b>	<b>100%</b>

Trevennec K., Grosbois V., Roger F., Ho Thu Huong, Berthouly–Salazar C., Chevalier V.  
 Evidence for freedom from swine influenza in a remote area of Northern Vietnam. In press in Acta Tropica



# Results on **avian influenza** in the Red River Delta (2009-2010)

- H5 seroprevalence in non-vaccinated birds ~ 10% (Desvaux et al. 2011)
- Preliminary results in multi-species farms are similar:



Poultry serology in the Red River Delta n=1078



➔ **H5 and H9 are spreading in the Red River Delta with a medium frequency**



# Results on swine influenza in the Red River Delta (2009-2010)

## H5

Time	H5pp	H5pp confirmed	Micro Neut
April 2009 (609 pigs)	0.5%	0.5%	0.5%
Abattoir 2009-2010 (460 pigs)	0.2%	0.2%	0.2%
Farm 2009-2010 (1731 pigs)	0.8%	0.2%	0.1%
<b>Total (2800 pigs)</b>	<b>0.6%</b>	<b>0.3%</b>	<b>0.2%</b>



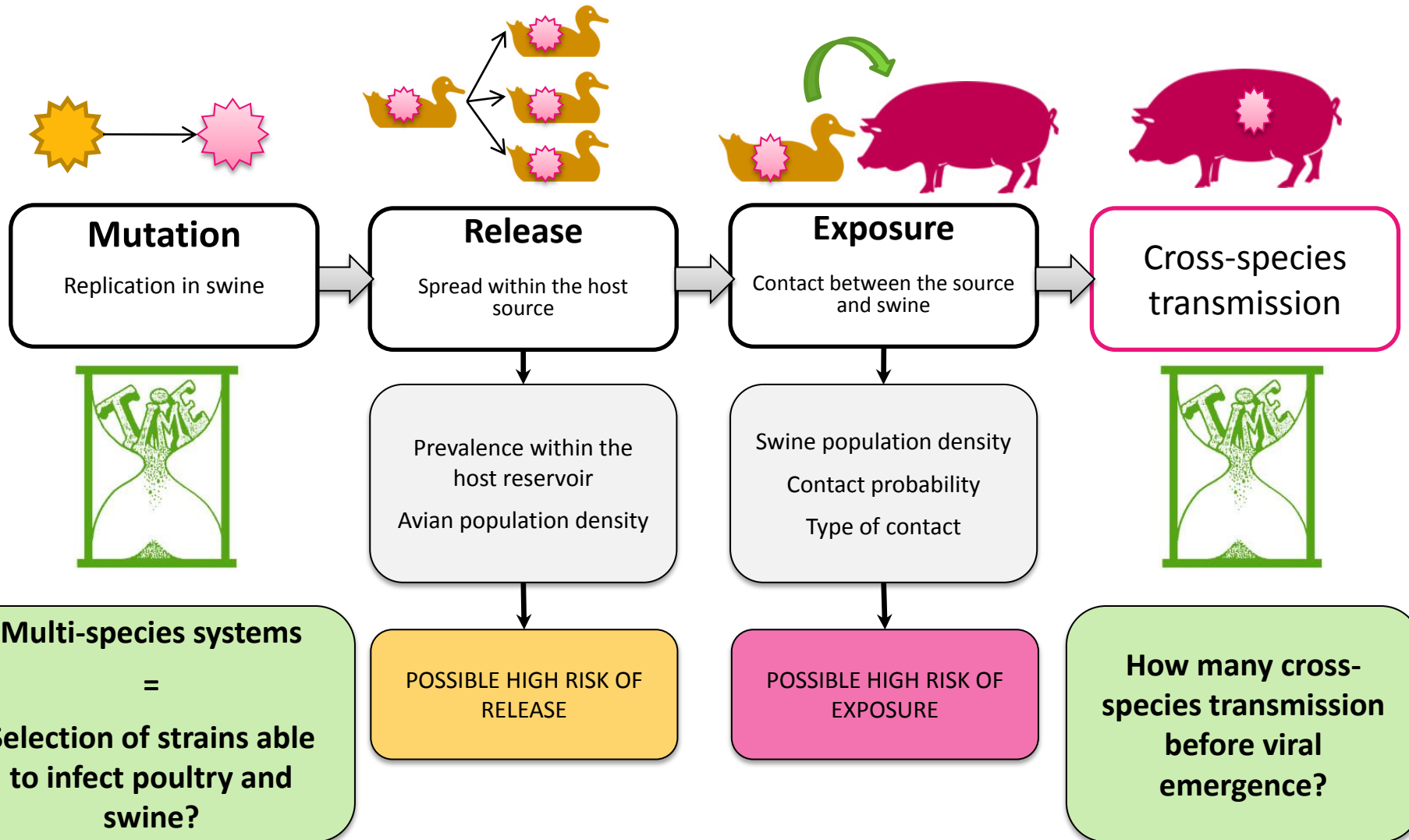
## H9

Time	HI H9	HI H9 confirmed	Micro Neut
April 2009 (609 pigs)	0.2%	0.0%	0.0%
Abattoir 2009-2010 (460 pigs)	2.4%	2.4%	0.4%
Farm 2009-2010 (1731 pigs)	2.3%	1.9%	0.1%
<b>Total (2800 pigs)</b>	<b>1.8%</b>	<b>1.6%</b>	<b>0.1%</b>

➔ H5 and H9 infect occasionally pigs but there is no evidence of spread within swine population

# Perspectives

## Concept of cross-species infection





Shall we wait when pigs will fly?



Thank you!



# References

- Nomura N, Sakoda Y, Endo M, Yoshida H, Yamamoto N, Okamatsu M, Sakurai K, Hoang NV, Nguyen LV, Chu HD, Tien TN & Kida H (2011). Characterization of avian influenza viruses isolated from domestic ducks in Vietnam in 2009 and 2010, *Arch Virol*.
- Phuong DQ 2005, 'Seroprevalence study on avian influenza in rural poultry of Thai Binh province and characterization of the environmental survival of the agents involved', *The Royal Veterinary and Agricultural University, Dyrlaegevej*
- Nguyen DC, Uyeki TM, Jadhao S, Maines T, Shaw M, Matsuoka Y, Smith C, Rowe T, Lu X, Hall H, Xu X, Balish A, Klimov A, Tumpey TM, Swayne DE, Huynh LP, Nghiem HK, Nguyen HH, Hoang LT, Cox NJ & Katz JM (2005). Isolation and characterization of avian influenza viruses, including highly pathogenic H5N1, from poultry in live bird markets in Hanoi, Vietnam, in 2001, *J Virol* **79(7):4201-4212**.