



"Regards Croisés" sur l'Influenza aviaire

15-19 / 12 / 2008 • Montpellier • France



Rencontres scientifiques autour de deux projets de recherche :
Scientific meeting around two research projects

GRIPAVI (CIRAD, MAEE) & ARDIGRIP (AIRD)

Pestes aviaires dans les systèmes domestiques africains : projet EPIAAF

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Objective & methods

- **Objective**

- Improve understanding of epidemiology of HPAI in Africa

- **Methods**

- Standard description of HPAI situation & outbreak patterns
- Risk factor assessment for introduction, spread & persistence
 - Compare characteristics of infected and non infected sites



Implementation (1)

- **Geographical scope**

- 7 countries

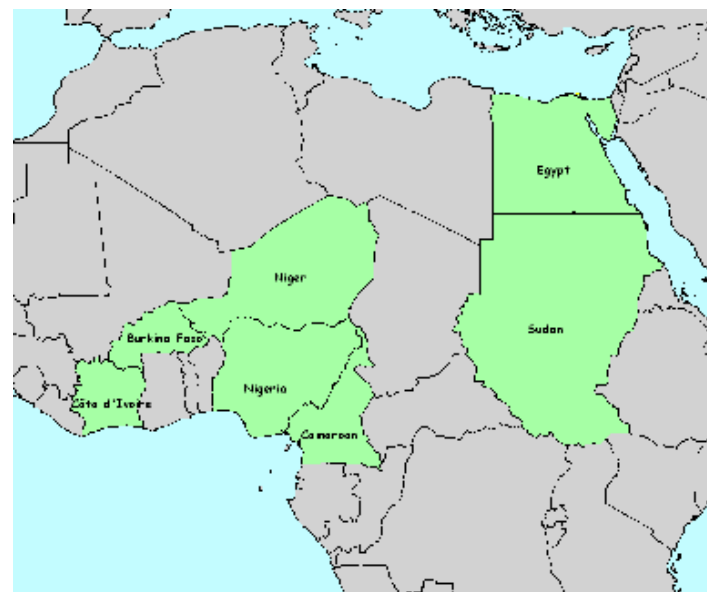
- **Budget**

- 753,500 US\$
 - Funded by FAO

- **Timeline**

- November 2007 to November 2008

- **Partners**



Implementation (2)

- **Field missions**

- 3 weeks, 4 persons, at least 3 infected & 3 non infected sites

→ *43 sites investigated*

- Standardised questionnaire

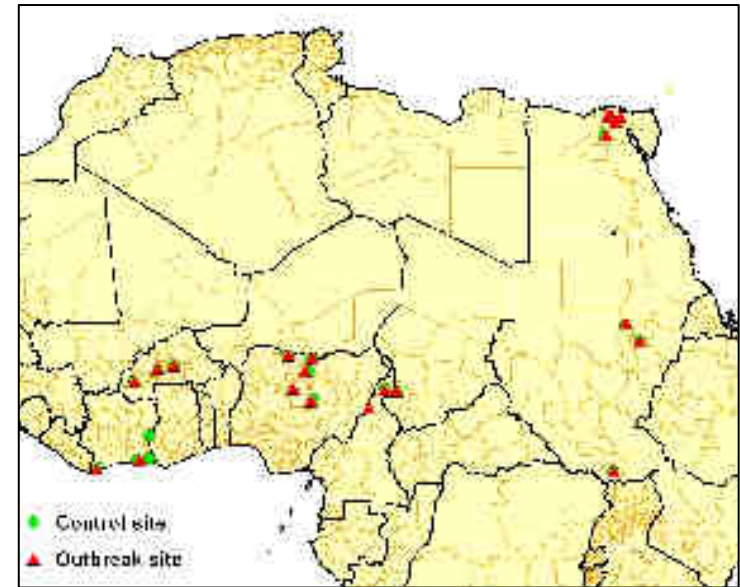
- Outbreak characteristics, risk factor data

→ *55 questionnaires completed*

- Duplicate poultry biological samples

- Tracheal swab + cloacal swab + blood

→ *3672 birds sampled*



Laboratory results

Test	# negative birds	# positive birds	total # birds tested	% positive birds
PCR for AI	3627	0	3627	0.0%
PCR for ND	3614	33	3627	0.9%
ELISA AI	Variation among & within countries			26.4%
HI ND				34.0%
HI H5	3392	108	3500	3.1%
HI H7	3495	0	3495	0.0%
AGID	314	115	429	26.8%
Comm ELISA	445	46	491	9.6%

Statistical results: Univariate

- **Seropositivity / Individual variables**

- AI: 3 variables significantly associated

- **AI vaccination**: Vacc (76.5%) > NonVacc (19.9%)
- **Species***: Duck (27.7%) > Chicken (19.9%)
- **Age***: Adult (18.7%) < Young (24.1%)

- ND: 2 variables significantly associated

- **ND vaccination**: Vacc (54.1%) > NonVacc (25.5%)
- **Species***: Chicken (29.2%) > Duck (11.3%)

- **Infection status / Site variables**

- 3 variables significantly associated

- **Routine ND vaccination**
- **Wild bird mortality**
- **Permanent pond in a 3km radius**

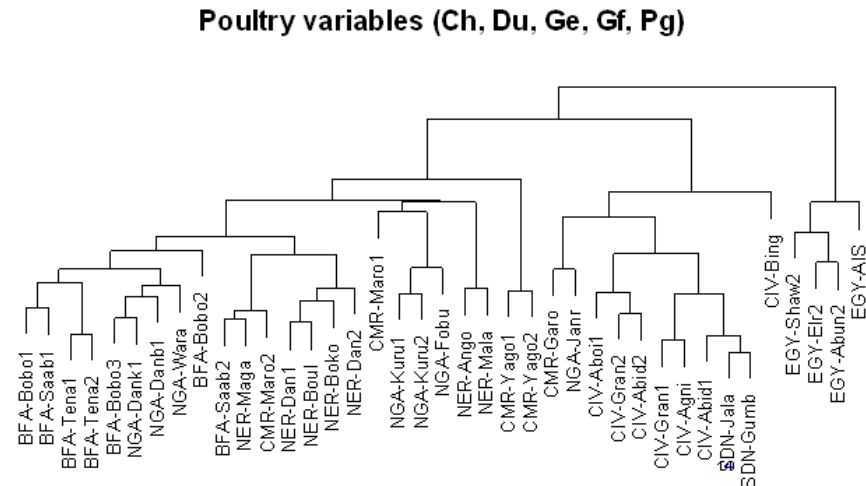


**Bias + Small #
observations**

Statistical results: Multivariate

- Clustering & Mantel correlation (distance matrices)

- Spatial correlation of environmental variables (Temp, Rain) and poultry composition but not of contact with wild bird & vaccination



- AI seroprevalence more spatially structured than ND seroprevalence
- AI seroprevalence showed strongest correlation to poultry composition

Statistical results: Multivariate

- Seroprevalence / Site variables

– AI seroprevalence ↑

{	AI vaccination ↑↑
	Chicken numbers ↓↓
	Fraction of adults ↓↓

– ND seroprevalence ↑

{	ND vaccination ↑↑
	Chicken numbers ↑↑

– Environmental predictors: less stable, significance and sign depend on incorporation of country (inter-country variability)

Discussion (1)

- **Circulation of AIV evidenced by serology...**
 - **Around 13% birds seropositive by exposure to AIV**
 - Positive AI ELISA: 26.4%
 - Correction for vaccinated animals → 19.9%
 - Correction for unperfect test → 12.0%
 - Confirmation by AGID: 13.2%
 - **Mostly circulation of LPAI strains**
 - No HI H7+
 - Only 2% of unvaccinated AI ELISA+ are HI H5+

Discussion (2)

- ... but failure to detect any AIV by PCR!!!
 - Astonishing
 - H5N1 expected in Egypt & LPAI expected given % sero+
 - Possible explanations
 - **Circulation at prevalence lower than 5%** (cf sample size)
 - Wrong period of the year (best = Jan-Feb?)
 - Limited duration of virus excretion
 - Vaccination → reduced shedding
 - Problem with cold chain maintenance or swab collection
 - Reduced Se due to pooling (not for EG and NI)
 - Similar results
 - Niger (0%; sampling during culling 2006; n=44), Nigeria (0%; survey 2007; n=4872), Mali (1.3%; survey 2007; n=223) (0%; survey 2008; n=315)

Discussion (3)

- **Introduction of HPAIV**

- Trade vs wild birds still undeciphered

- Possible role of wild birds in most sites, of trade in all sites
 - Caution with interpretation of association tests (bias, lack of power)

- No protection against HPAI by exposure to LPAI

- Seropositive % too low to ensure flock immunity
 - Very limited circulation of H5 strains

- **Persistence & spread of HPAIV**

- A role of species

- Poultry composition spatially structured & linked to AI seroprev
 - Morbidity and mortality differ among Sp (Ch > Tu > Gf > Du)

- Limited vaccination efficiency

- 25.6% of vaccinated birds are HI H5+ in Egypt, 41.9% in Sudan

- Poor poultry management

- Sale of sick birds & manure, improper disposal of dead birds, etc

Discussion (4)

- **Wide circulation of NDV evidenced**
 - Around 25% of birds seropositive by exposure to NDV
 - Proportion of birds HI ND+: 34,0%
 - Correction for unvaccinated animals: **25,5%**
 - But only 0.9% positive by PCR
 - Severe disease → kills most infected animals
 - Wrong period (best = Nov-Feb?), limited duration of virus excretion, vaccination → reduced shedding, other (cold chain, swab, pooling)
 - Discordance between PCR positivity & clinical signs
 - PCR+ more by tracheal than cloacal swab
 - 33 PCR+: 20T, 6C, 7T+C

Conclusion (1)

- **Wide circulation of AIV & NDV in Africa**
 - Evidenced by serology
 - AI: around 13%; ND: around 25%
 - But difficult to capture by PCR
 - Somewhere between 0 and 3% for both AI & ND
- **Risk factors difficult to identify quantitatively**
 - Quantitatively: species, vaccination, age* (* for AI)
 - Doubts about other factors because of study limitations
 - Qualitatively: trade (LBM, MM), poultry management
 - Other include: usual high mortality, underreporting, asymptomatic infection & incomplete culling (Eg), low farm biosecurity, vaccination campaign



Conclusion (2)

- **3 types of HPAI epidemiological profiles in Africa**
 - **Egypt:** endemic, high seasonality, spatial [] in Nile Delta (high human density, geese, water), shift in affected unit, asymptomatic infection
 - **Nigeria:** enzootic in 2006-7, sporadic in 2008, ≠ patterns North/South, ≠ introductions, 3 clades, reassortant virus
 - **Other:** sporadic, introduction most likely by transboundary trade, lack of spread ← unfavorable environment & individual practices?
- **Further research needed**
 - **EPIAAF related:** verify viral charge in duplicate samples, run EPIAAF analyses on a larger # of observations in Nigeria
 - **General:** poultry census, trade flows, vaccination efficiency, genetic resistance of local poultry breeds, virus survival in the environment, seasonality, socio-economic impact



Thank you for your attention!



Statistical results: Univariate

- **Seropositivity / Individual variables**

- AI: 3 variables significantly associated

- **AI vaccination**: Vacc (76.5%) > NonVacc (19.9%) (OR=13.1; p<0.001)
- **Species***: Duck (27.7%) > Chicken (19.9%) (OR=1.54; p<0.001)
- **Age***: Adult (18.7%) < Young (24.1%) (OR=0.73; p=0.002)

- ND: 2 variables significantly associated

- **ND vaccination**: Vacc (54.1%) > NonVacc (25.5%) (OR=3.44; p<0.001)
- **Species***: Chicken (29.2%) > Duck (11.3%) (OR=3.24; p<0.001)

- **Infection status / Site variables**

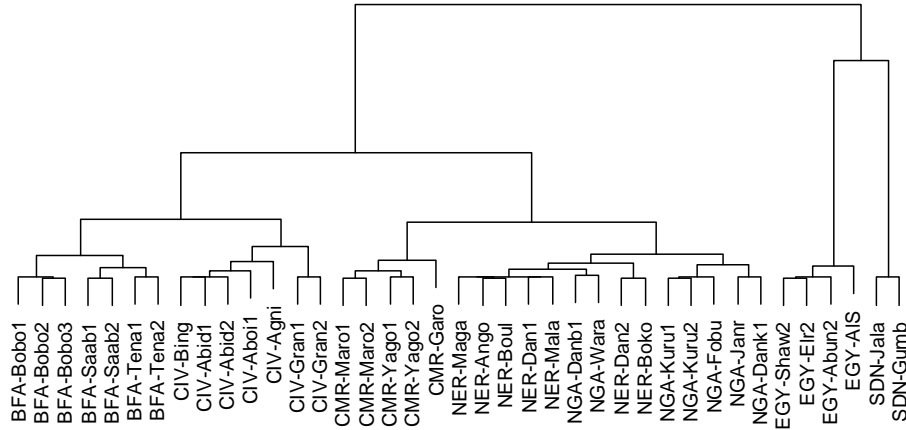
- 3 variables significantly associated

- **Routine ND vaccination** (OR=3.69; p=0.028)
- **Wild bird mortality** (OR=8.73; p=0.031)
- **Permanent pond in a 3km radius** (OR=3.50; p=0.038)

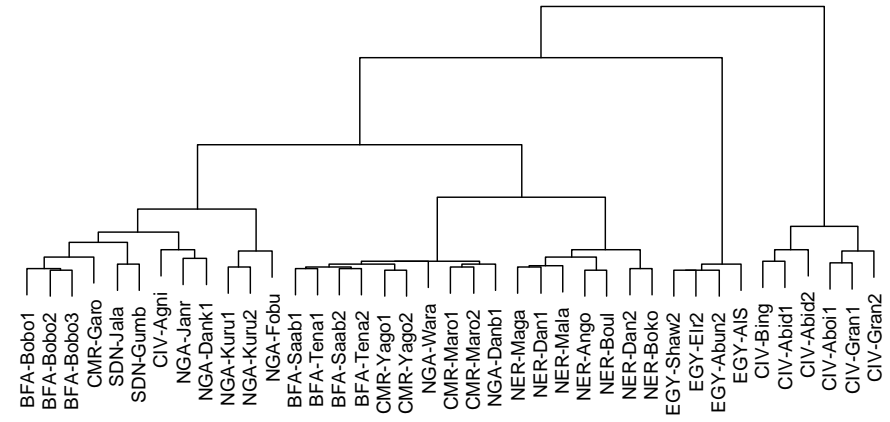


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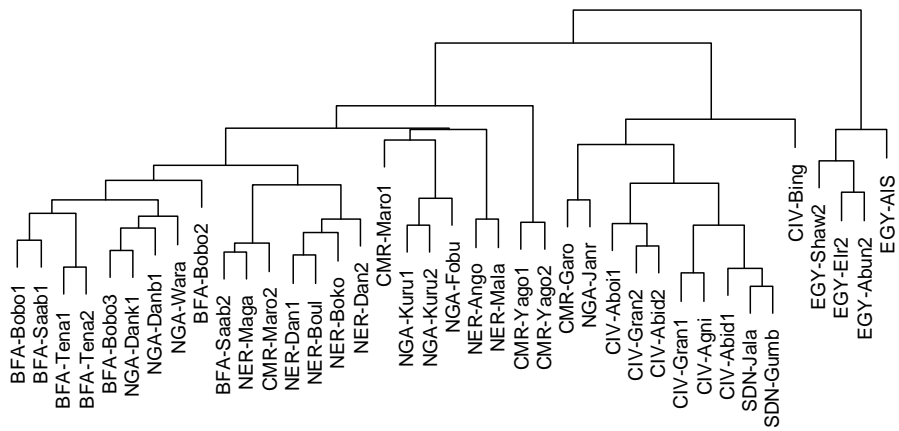
Geographical variables (Xcoord, Ycoord)



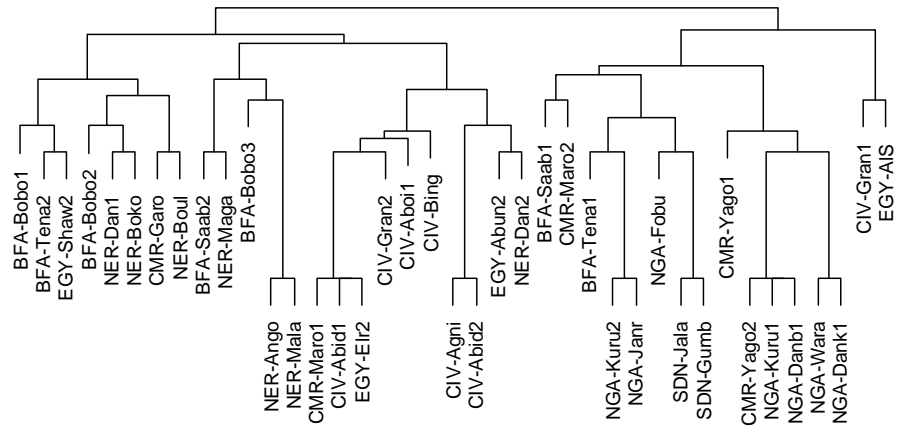
Environmental variables (Trng, Tmin, Tmax, Ra, Ramin, Ramax)



Poultry variables (Ch, Du, Ge, Gf, Pg)



Possible WB contacts



Variables	Mantel correlation	p
1. Geography vs. Environment	0.511	< 0.001
2. Geography vs. Poultry	0.501	< 0.001
3. Geography vs. WB-related variables	0.041	N.S.
4. Geography vs. Vaccination	0.082	0.079
5. AI serology vs. Geography	0.230	0.020
6. AI serology vs. Environment	0.316	< 0.001
7. AI serology vs. Poultry	0.483	<0.001
8. AI serology vs. WB-related variables	0.149	0.002
9. AI serology vs. Vaccination	0.053	0.238
10. ND serology vs. Geography	0.074	0.281
11. ND serology vs. Environment	-0.012	N.S.
12. ND serology vs. Poultry	0.069	0.24
13. ND serology vs. WB-related variables	0.061	0.117
14. ND serology vs. Vaccination	0.131	0.012