Epidemiological and economic implications of HPAI vaccination in developing countries

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Introduction and rationale

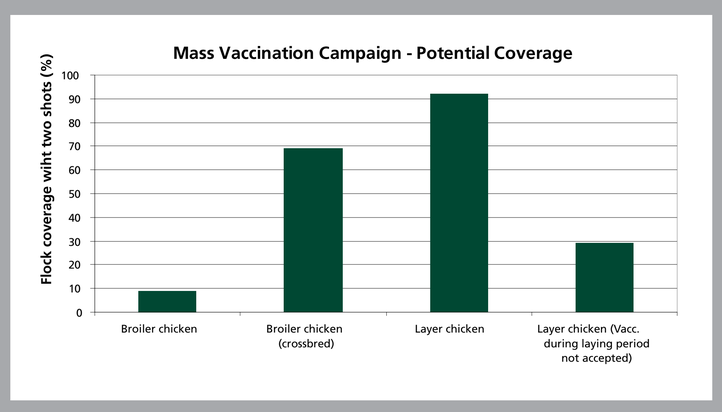
Vaccination campaigns have become an important tool in the management of HPAI in a number of countries with large poultry sectors and to some extend reduced the number of human cases in the short-term. However, the disease continues to maintain itself in the poultry populations indicating a need to review and reassess the achievements of HPAI vaccination.

Vaccines

- Two HPAI vaccinations are required to achieve satisfactory protection.
- Vaccine becomes fully effective between 13 to 21 days after the first dose in any poultry species.
- Cold chain requirement to maintain vaccine quality poses a delivery challenge.
- Sampling and testing requirements for seroconversion, virus and serum identification represent a challenge for the capacity of most laboratories in developing countries.
- 'Field' protection rate of vaccinated poultry varies between 55 to 63% for ducks and 37 to 76% in chicken

Vaccination coverage in poultry production systems

- Poultry production system characteristics can be used to identify the maximal achievable vaccination coverage with mass vaccination campaigns.
- The average lifespan of birds, origin of replacement birds, existence of a health programme and the contact rate between flocks are usually rather similar for flocks of the same type of production system.
- Weaknesses of previous risk assessments has been the lack of data on production systems, relying only on flock size as a proxy for risk and disease management.



A very limited flock coverage can be achieved with mass vaccination campaigns delivering two shots at a point in time within 14 days. High turn over rates of short lived broiler flocks result in a low flock coverage, waning after a few days due to slaughtering. It is recognized that most layer flocks vaccinate birds before point of lay and are reluctant to revaccinate during egg laying periods. Therefore the maximal achievable vaccination coverage with a two shot campaign does not exceed 29%.

CHICKEN PRODUCTION SYSTEMS

System	Lifespan (weeks)	Replacement	Contact rate	Housing	Health programme in place
Breeder (parent & grant parent)	~64	Bought	High cages	Confined,	yes
Layer	~70	Bought	High cages	Confined	yes
Broiler (white)	~5	Bought	Moderate confined, floor	Mainly	?
Broiler (crossbred)	~17	Bought	Moderate confined, floor	Partly	?
Mixed/ Backyard	~66	Home bred	Low	Scavenging	no

POTENTIAL VACCINATION COVERAGE WITH CAMPAIGNS

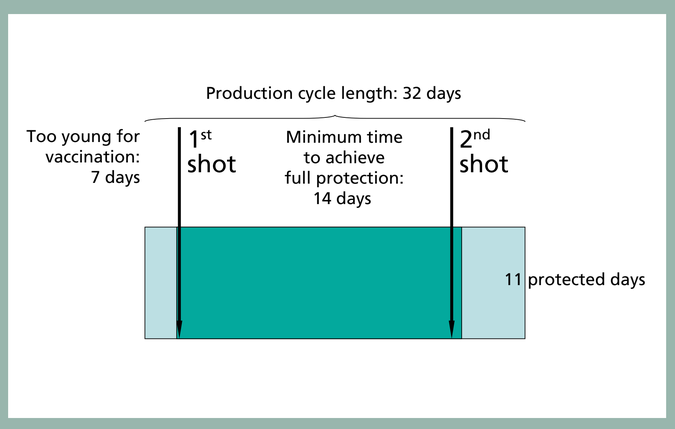
Production system	Prod. cycle length (days)	Eligible days for 2 shots within 14 days (days)	Flock coverage with 2 shots (%)	Duration after 2 shots to achieve 100% of flocks naïve
Broiler chicken	32	4	**9%**	11
Broiler chicken (crossbred)	120	92	**69%**	99
Layer chicken vacc. during laying accepted	490	462	**92%**	180
Layer chicken vacc. during laying not accepted	490	126	**29%**	133

Non-protected 'bird days'

Non-protected 'bird days' can not be avoided by any vaccination scheme as a result of time lags between first day of age, vaccination and subsequent immunity.

The proportion of protected 'bird-days' within a production cycle is especially low for short production cycles, such as 'industrial' broilers.

Only a fraction of 34 – 55% of all industrial broiler 'bird days', which usually represent the vast majority of the standing poultry population in a country or region, could be protected with an optimal vaccination scheme and 100% effective vaccine.



Financial incentives to use vaccination and alternatives

Vaccination can be seen as an 'insurance scheme' by poultry keepers. The flock owner's decision on whether to contract a 'vaccination insurance policy' depends on the vaccination costs ('insurance premium'), the expected economic loss in case of an outbreak and the perceived probability of an outbreak. Ratios of vaccination costs to outbreak losses ('breakeven outbreak risks') indicate the probability of flock infection at which expenditure on vaccination in a specific production system would be profitable for a risk neutral flock owner.

BREAKEVEN OUTBREAK RISKS

System	Vaccination required	Min. Vacc. costs per prod. cycle (US$ cents)	Max. value at risk of loss (US$)	Min. break even outbreak risk per prod. cycle (%)
Grant parent chicken hen	4	16	182	**0.1**
Layer chicken hen	4	16	4	**5**
Broiler chicken (white)	2	5	6	**1**
Chicken Flocks: Mixed/backyard	up to 4	72	33	**3**

- For (risk neutral) farmers the financial incentives to use vaccination are too low to reach high coverage levels.
- Even under high infection risk conditions such as those during the peak incidence in 2004 in Thailand, only 0.2% of all poultry farms were infected with HPAI.
- Higher vaccination incentives and subsequent coverage are only likely to be observed when the perceived private risk increases due to reports/news of surrounding outbreaks.
- For a flock of 1,000 industrial broilers the annual vaccination costs vary between 325 and 651 USD which could alternatively be spent on biosecurity
- Vaccination costs to supply a medium size live bird market with a daily trade volume of 1,000 broilers would amount to 1,151 – 1,707 USD per month, this amount could alternatively be used to improve market hygiene.

Vaccination of a backyard chicken flock would be profitable for a risk neutral flock owner, if the risk of HPAI infection for a production cycle of an average flock were higher than 3%. Since such a high infection risk level is very unlikely, the average benefits of free of charge vaccination for backyard chicken flock owners would be marginal.

Conclusion

- Vaccination campaigns can not achieve sufficiently high flock coverage in the most prevailing broiler and backyard poultry production systems
- Even with an optimal vaccination scheme and vaccine efficacy only a small fraction of broiler 'bird days', which usually represent the main proportion in the poultry sector, can be protected
- Financial incentives for farmers are not sufficient to achieve high coverage levels
- Vaccination of more valuable breeder and layer flocks is generally more profitable, but also the feasibility to upgrade biosecurity in these systems is likely to be higher than in other production systems.
- The cost-effectiveness of trade and market hygiene interventions, should therefore be taken into consideration to identify cost-effective HPAI protection options.