Chapter 5

Contact structures of Dutch broiler and layer farms: an Avian Influenza perspective

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1. Introduction

The Netherlands is a leading exporting country of poultry (mainly chicken) meat and eggs (Windhorst, 2006). Although broiler and layer farms are situated throughout the country, they are predominantly concentrated in Gelderland, Limburg, North Brabant and the eastern part of Overijssel with two distinct densely populated poultry areas in the Gelderse Vallei and East Brabant/North Limburg. In 2003, The Netherlands experienced a large Avian Influenza (AI) H7N7 epidemic, which started in the Gelderse Vallei and spread to Brabant and Limburg (Stegeman et al., 2004). The outbreaks appeared in clusters suggesting neighbourhood spread, but also virus spread over larger distances took place (Report DG Sanco, 2003). Although airborne spread may have played a role in neighbourhood spread, in general it is assumed that for AI transmission contacts between farms by e.g. poultry, people or vehicles play a crucial role particularly before control measures are at place (Thomas et al., 2005). These contacts may spread the virus over longer distances. However, data on frequencies and distances of direct and indirect contacts of broiler and layer farms is scarce.
To gain more insight into the contact structure of broiler and layer farms in The Netherlands a questionnaire and logbook study were conducted among 16 broiler and 21 layer farms. The contact structure was investigated in a non-epidemic situation, which should be comparable to the contacts in the period between introduction and detection, the so-called high risk period (HRP). Data on contact structures between farms (frequencies, distances) as collected in this study can serve as a basis for stochastic spatial simulation models. With these models, outbreaks can be simulated and efficacy of control strategies can be evaluated, for example see Jalvingh et al., 1999 and Mangen et al., 2001 for CSF, Yoon et al., 2006 for FMD and Sharkey et al., 2007 for AI. Currently a stochastic spatial model to simulate HPAI outbreaks in The Netherlands is being developed.
For the purposes of presentation, we assume that an AI virus is introduced in a broiler or layer farm and that the HRP lasts two weeks. The type, frequency and distances travelled of contacts are presented based on this assumption. In addition, possible links between different poultry sectors and with hobby poultry were investigated as well as biosecurity measures taken.

2. Material and methods

2.1. Selection of farms

Sixty-five broiler and layer farms were selected from the 85 farms participating in the Agricultural Accountancy Data Network (BIN) of the Agricultural Economics Research Institute (http://www.lei.wur.nl/UK/statistics/Binternet/default.htm). This network collects financial and technical data of a representative sample of farms and holdings of the Dutch Agricultural Census. The administrators of the network made a pre selection of 75 farms; 10 farms were not selected as they had the same owner as other farms in the selection, were very small or because owners were not motivated or were difficult to reach. Of the other 75 farms

we approached 65 farms to obtain a reasonable number of farms of each type (broiler and layer) and each housing type (cage, barn, mixed) in the study. Each selected farmer was sent a letter inviting his/her participation in the study, followed by a telephone call a few days later. The response rate was 60% (39/65 farms). Reasons for not willing to participate were 1) too busy, 2) not interested and 3) participating in too many studies already. With farmers that indicated their willingness to take part, a visit was planned. All farm visits were done by the same person, who interviewed the farmers and filled in a questionnaire. After the interview, the farmers were asked to register all farm visitors (including private visits) in a standardized logbook for 4 weeks starting on the day of the visit. Farmers who participated in this study were paid remuneration.

2.2. Questionnaire

The questionnaire and logbook study is part of a larger study in which also Germany, Austria and Italy are participating. The questionnaire and logbook were originally designed in Germany but were translated and adapted to the Dutch situation. Before the start of the study, a pre-test was conducted with one layer and one broiler farmer. The questionnaire and logbook were adjusted taking into account the comments of the two farmers. After this adjustment, the questionnaire consisted of 63 questions, divided into the following categories: general farm information, management, feed, litter, manure, employees, biosecurity, pest control, rendering, sharing machinery, professional contacts and hobby poultry.
In total 16 broiler farms and 23 layer farms were visited to fill in the questionnaire. One layer farm turned out to be exceptionally small and another ‘layer farm’ had recently changed into a rearing farm and was therefore excluded from analysis. The final questionnaire dataset thus consisted of 16 broiler farms and 21 layer farms, which is approximately 2% of the Dutch broiler and layer farms. The farms in the survey were properly distributed over the country according to the total broiler and layer farm distribution in The Netherlands, except for the Gelderse Vallei area due to non response.

2.3. Logbook

For a period of four weeks, the farmers recorded the following information on contacts: date and time of visit, reason for visit, access to the poultry houses (yes/no), address and type of business where they were coming from (origin) and where they were going to after the visit (destination), whether poultry was present at the origin or destination address and if yes, specification of the poultry species and whether they had access to these poultry houses. The farmers were asked to record all farm contacts, including private visits, but excluding the movements of the farmer and employees themselves as this was considered infeasible.
The return rate of the logbook was 66% (26 logbooks, 13 of layer farms and 13 of broiler farms). Reasons for not filling in the logbook were 1) filling in was too time consuming and 2) visitors did not want to fill in the addresses out of privacy reasons. The logbook of the rearing farm and one logbook of a layer farm that arrived after analysis was already finished were excluded from analysis. The quality of one of the logbooks of a broiler farm was doubtful as it had only 3 entries and no feed deliveries were registered; it was therefore also excluded from further analysis. The final logbook dataset consisted accordingly of data on 1051 contacts of 12 broiler farms and 11 layer farms.

2.4. Analysis

The data was analysed with SPSS 15.0 software. Distances (km) travelled by visitors were defined as the straight-line distance between addresses and was estimated using Google Earth © 2007 based on street names and postal codes. When only the name of the town was filled in, the centre of the town was taken for estimating distances. Distances could be calculated for approximately 90% of the contacts.
We used the following risk classification: high risk was assigned to movements of live poultry from farm to farm (e.g. reared laying hens) and movements of poultry manure to a poultry farm, medium risk was assigned to persons entering the sheds while poultry was present, other live poultry transports (e.g. day-old-chickens and broilers to slaughterhouse) and transports of poultry manure to destinations other than poultry farms, and low risk was assigned to persons not entering the sheds or only when sheds are empty, deliveries of feed, litter and other materials, egg transports and rendering trucks.

3. Results

3.1. General farm information

Data on general farm information as obtained from the questionnaire is summarized in Table 1.

Table 1. General farm information (questionnaire) for broiler and layer farms

	Broilers (n=16)	Layers (n=21)
Mean # chickens (min-max)	85,425 (24,000-190,800)	70,518 (20,000-176,120)
Mean # poultry houses (min-max)	2.8 (1-6)	2.9 (1-6)
% Farms with cage/barn/mixed housing	100% barn	19% cage, 38% barn, 43% mixed[1]
% Farms with outdoor run	0%	24% (4 covered, 1 uncovered)
% Farms all in/all out or one-age system	94% all in/all out	48% one-age system
Length production round	53 days	14 months
% Farms flock thinning once/twice	87% once (wk 5) 13% twice (wk 5, 6)	-
% Farms with mixed farming poultry	none	none
% Farms with mixed farming other	19% cattle	19% cattle, 5% sheep
% Farms with farm sale	13%	62%
% Farms with sale live poultry	19%; > 4 times/year	10%; ± 2 times/month

[1] Mixed = combinations of cage, barn and/or free range

The ‘all in/all out’ system in broiler production is comparable to the ‘single-age system’ in layer production and means that all poultry houses are empty simultaneously between production rounds. The average duration of a broiler production round (from delivery of day-old-chickens to last batch for slaughter) was 43.6 ± 2.8 days; the average duration of the empty period was 9.2 ± 2.6 days. The average duration between deliveries of young hens to a

poultry house was approximately 14 months. Three broiler farms and four layer farms kept a substantial number of cattle (100-225 cows) and one layer farm kept a considerable number of sheep (175). Other farm animals (horses, goats, donkeys and pigs) were present in small numbers; none of the farms kept other species of commercial poultry. One broiler farm sold potatoes, and another sold eggs from a non-commercial holder; 13 layer farms sold eggs. Three broiler and two layer farms sold live poultry to non-commercial holders. We did not gather information on crop farming.

3.2. Employees

More than half (52%) of the layer farms in our study had employees; all farms had one or two employees except for a 'zorgboerderij' where more than 20 employees and clients were at work. Almost all employees working on the layer farms entered the poultry houses weekly (96%). The average distance travelled from home to work was 4.3 km (range 0.1-14.0 km). Three employees (14%) also kept poultry at home. Only one broiler farm (6%) had one employee, who had access to the poultry houses, travelled 11 km to work and kept no poultry at home. Forty-eight percent of the layer farmers and 25% of the broiler farmers stated that employees and family members were not informed about avian influenza precautionary measures.

3.3. Biosecurity

On all layer and broiler farms wearing coveralls and changing footwear was common practice. Hand washing before entering the poultry houses was done on 62% of the layer and 75% of the broiler farms. However, hand washing when leaving the poultry houses was only common practice on one layer (5%) and one broiler farm (6%).
Four layer and five broiler farms shared one or two machines with other farms. All but one layer farm had agreed with the other farm to clean the machines after use, the other farm had made no arrangements on this. On 86% of the layer farms egg trays are shared with other farms. The majority of these farms use solely plastic egg trays (89%) which are easier to clean than cardboard egg trays; one farm shared solely cardboard egg trays and another shared both plastic and cardboard egg trays with other farms.
A pest control programme for rodents was carried out regularly (>4 times per year) on all farms. A pest control programme for insects was applied on 63% of the broiler farms (in the empty period) and on 81% of the layer farms (12% regularly, 88% when required). On 71% of the layer and 19% of the broiler farms service companies were contracted for the pest control programmes.
Half of the farms had cats; on average 3 house cats and 8 free roaming cats. Only one layer farm kept 4 captive cage birds indoors.
Fourteen layer farms (67%) and nine broiler farms (56%) had stored poultry manure on the farm premises in the past 12 months. More than half of these farms (56%) had stored this manure uncovered or partly uncovered. The majority of layer farms (76%) and all broiler farms sold their manure to traders in agricultural manure or for industrial purposes. Two of the layer farms (10%) used the manure on own land and three layer (14%) and six broiler farms used it partly on own land and partly for trade.
Cleaning water which contains manure and litter particles from the poultry sheds was present at all broiler farms and on 52% of the layer farms. Most of the cleaning water was stored in the manure basement or expelled to the sewerage. On 56% of the broiler and 14% of the layer farms it was also used on own land and two layer farms (10%) expelled it in a ditch.

The premises of 20% the broiler and 43% of the layer farms were fenced in; information signs were present on 37% of the layer farms and only on one broiler farm.
The average distance to the nearest neighbouring poultry farm was 2.0 km with range [0.7 – 2.0] for broiler and 1.4 km [0.2 – 8.0] for layer farms.

3.4. Contact structure

From the results of the questionnaire we computed that layer farms had on average 14.4 ± 6.2 contacts per 2 weeks of which on average 1.7 contacts entered the sheds (excluding employees). The majority of these contacts are egg transports and deliveries of feed, litter and other materials which are considered low risk contacts. Broiler farms had fewer contacts, 9.4 ± 3.7 contacts per 2 weeks of which on average 2.9 contacts entered the sheds. Table 2 specifies for different type of professional contacts the percentage of farms with that particular contact and the mean frequencies per two weeks as obtained from the questionnaire, as well as access to the sheds and the off-farm distances travelled as recorded in the logbook. The average off-farm distance travelled (including private contacts) was 18.8 km with range [0.2-360.9] for layer farms and 16.6 km [0.1-181.8] for broiler farms. Particularly transport of broiler chickens to the slaughterhouse, some manure and egg transports and contract workers travelled over large distances. Only 1 high risk contact was found: a manure transport from a layer to a layer rearing farm. For broiler farms the medium risk contacts travelled on average larger distances (32.9 km) than the low risk contacts (11.6 km), ($P < 0.01$, Student T-test). For layer farms low and medium risk contacts travelled on average 17.6 and 21.7 km, respectively.
Based on the logbook data, 94 (23.5%) of the contacts of layer farms travelled directly to other poultry farms (including private contacts); 95% of these off-farm contacts were with layer or layer rearing farms. Egg transports and business advisors accounted for the majority of these contacts. For broiler farms 24 (12.5%) of the off-farm contacts travelled directly to other poultry farms of which 75% were contacts with other broiler farms. Similar to layer farm contacts, business advisors accounted for a large proportion of these contacts. Only two contacts with other poultry species were found: one veterinarian travelled from a broiler to a turkey farm and a pest controller travelled from a layer to a duck farm.
Approximately 16% of the 154 private contacts recorded for layer farms entered the sheds; for broiler farms only 1% of the 184 recorded private contacts entered the sheds. Twelve private contacts travelled directly to another poultry farm, six of them entered the sheds at the off-farm contact only. The average distance travelled for private contacts was 4.6 km with range [0.1-72.8]. Forty contacts of house-sale of eggs were recorded; the average distance travelled was 3.1 km with range [0.1-9.6], none of these entered the sheds.

3.5. Contacts between commercial and backyard poultry

Based on the questionnaire a few contacts between backyard and commercial farms were found: a farm with hobby chickens in the backyard, a broiler farmer that sold eggs from a backyard farm, five farms that sold live poultry to non-commercial holders and three employees of layer farms that kept poultry at home. One broiler farmer visited bird shows twice a year; no poultry were purchased at these shows.

Table 2. Specification for each business contact: the percentage of farms with that particular contact (questionnaire), the mean frequencies per two weeks (questionnaire), access to the sheds (logbook) and the off-farm distances travelled (logbook).

Type of contact	% Farms with contact		Mean freq./2 wks (questionnaire)		In shed (freq. logbook)	Mean off-farm distance (km) to next contact [min-max]	
	Broilers	Layers	Broilers	Layers		Broilers	Layers
Delivery poultry	all	all	0.25	0.05	sometimes (4/8)	46.4 [12.1-71.7]	84.5 (n=1)
Unloading team	19%	71%	0.25	0.07	yes (10/10)	5.5 [1.0-11.9]	82.4 (n=1)
Transport to slaughterhouse	all	all	0.52	0.05	sometimes (2/18)	78.3 [39.6-181.8]	42.3 [4.5-82.4]
Loading team	all	all	0.53	0.07	yes (4/4)	29.1 [13.4-51.6]	no records
Other service teams	63%	all	0.48	0.37	yes (10/16)	1.7 [0.5-4.3]	4.0 [0.2-7.4]
Veterinarian	all	all	0.94	0.15	sometimes (19/24)	23.2 [0.8-92.1]	30.9 [30.4-31.5]
Manure transport	all	86%	0.63	1.49	sometimes (2/27)	4.1 [3.1-7.1]	132.8 [6.1-360.9]
Egg transport	-	all	-	5.48	sometimes (12/100)	-	38.6 [2.0-133.6]
Rendering trucks	all	all	0.97	1.23	no (0/17)	0.8 (n=1)	1.3 [0.2-3.5]
Deliveries	all	all	3.93	4.17	sometimes (1/125)	30.4 [0.8-121.5]	24.5 [0.2-55.8]
Inspectors	all	all	0.15	0.14	sometimes (1/4)	no records	17.4 [5.9-29.5]
Advisors	all	all	0.66	0.88	sometimes (24/70)	25.8 [0.6-93.6]	27.3 [1.6-106.1]
Other	88%	all	0.57	0.51	sometimes (23/83)	14.4 [0.1-66.1]	46.6 [0.1-267.1]

4. Discussion

The results of this study provide first insights into the contact structure of layer and broiler farms in The Netherlands. Since this study examined the contact structure during a non-epidemic situation, it gives an indication about the possibilities for contact-based spread of AI during the HRP and provides information for stochastic spatial simulation models.
The frequency of many professional contacts is strongly dependent on the production cycle in broiler and layer farms and therefore shows little variation between farms. Direct contact with poultry (entering poultry sheds) is generally thought to be a more likely way of AI transmission than contact with the poultry farm premises only. Contacts entering the sheds appear to be mainly those necessary for normal business operations; this may reflect increased biosecurity efforts in the Dutch poultry production sector.
Based on the contact information in the logbook, it is more likely that contact-based transmission occurs within a sector than between sectors and transmission to other species is unlikely.
Distances travelled by the contacts were highly variable and many records in the logbook were missing or unreadable. Distances travelled are regionally dependent due to location of slaughterhouses, packing stations, hatcheries, etc. Since only a low number of farms joined the logbook study and no data on the Gelderse Vallei was available, the data on distances might not be representative for The Netherlands as a whole. However, the ranges indicate that contact(s) could result in virus spread between the two distinct densely populated poultry areas in The Netherlands and that this would most likely be due to professional contacts. Private contacts, sale of farm products and employees are more likely to account for neighbourhood spread. It would be interesting to extend this study to the other levels of the poultry production chain.

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