Biosecurity risk pathways in New Zealand's commercial poultry industry

A questionnaire survey delivered in conjunction with nationwide sero-surveillance for notifiable avian influenza quantified the frequency of routine biosecurity practices in three sectors of the commercial poultry industry. The survey identified potential disease risk pathways in all sectors, particularly layer enterprises. Biosecurity measures that reduce the impact of both endemic and exotic diseases are suggested for adoption.

In June 2006, MAF Biosecurity New Zealand (MAFBNZ) conducted a cross-sectional serological survey of commercial poultry enterprises stratified by geographic region and industry sector, as phase one of an ongoing surveillance programme for notifiable avian influenza (NAI)[(1)]. The sample frame was defined as those farms registered with the Poultry Industry Association of New Zealand (PIANZ) or the Egg Producers Federation of New Zealand (EPF), and for phase one included the free range layer, caged (including barn) layer and broiler categories. The two-stage survey was designed to detect a farm-level prevalence of avian influenza antibodies of 5% and a within-epidemiological-unit prevalence of 30%, with 95% confidence. The sample, randomly selected from the PIANZ/EPF database and stratified by geographic region, included 54 broiler farms, and 42 farms from each of the caged (including barn) layer, and free range layer sectors.

A questionnaire delivered in conjunction with the sero-survey sought to identify and quantify the frequency of routine biosecurity practices in these three sectors of the poultry industry.

Methods

As part of farm sampling, a veterinarian (layer sectors) or company bleeder (broiler sector) interviewed the farm owner or manager and completed a short questionnaire on biosecurity practices. The questionnaire was designed to be relevant, and easy to administer and interpret. Its 20 questions related to domestic and wild birds on the farm, proximity to waterfowl habitat, water sources and their treatment, biosecurity practices associated with feed protection, personnel, vehicles, equipment movement, and disposal methods for birds and farm manure and litter. The questionnaire data sheets were stored together with the spatial, demographic and laboratory testing information for each farm in MAFBNZ's Incursion Response System (IRS) database. Responses were put into Microsoft Access (Microsoft Corporation, 2002) for analysis by sector.

Results

The questionnaire was completed for all 138 farms selected for the sero-survey. In general all questions, apart from a request to estimate the distance in metres to the nearest waterfowl habitat, had complete answers.

Industry sectors

Key demographic, management and employee parameters for the farms surveyed in the three targeted sectors are summarised in Table 1.

Table 1: Summary parameters for surveyed farms by sector

	Broiler	Caged/barn layer	Free range layer
Total PIANZ/EPF[1] registered farms (= sample frame of commercial enterprises)	184	72	64
Number farms surveyed (% of commercial sector)	54 (29%)	42 (58%)	42 (66%)
Epidemiological units[2]	202	140	45
Broiler birds (total)	4,813,558	10,500[3]	750[4]
Layer birds (total)	Nil	1,740,673	244,756
Mean commercial poultry per farm (median; range)	89,140 (80,950; 11,890-254,000)	41,445 (22,000; 85-458,000)	5,827 (2,000; 40-56,000)
Mean commercial poultry per epidemiological unit (median; range)	23,830 (22,450; 11,890-54,052)	12,433 (7,417; 85-30,533)	5,439 (1,875; 40-56,000)
Mean employees per farm (excludes owner), (median; range)	1.85 (2; 0-3)	8.02 (6; 0-27)	2.42 (2; 0-15)
Mean employees in contact with commercial poultry (excludes owner), (median; range)	1.12 (1; 0-3)	3.32 (3; 0-15)	1.91 (2; 0-10)

[1] PIANZ = Poultry Industry Association of New Zealand; EPF = Egg Producers Federation (of New Zealand)

[2] The farm was considered the epidemiological unit for free range layer farms as each flock is considered to have a similar risk of exposure to avian influenza virus if present in the farm environment. However, for free range farms that comprise one or more locations at least 1 km apart, each farm location was treated as a separate epidemiological unit. For broilers and caged/barn layers, the individual shed/barn was considered the epidemiological unit as on-farm biosecurity measures will influence the spread of low pathogenic avian influenza virus under these management systems

[3] One caged layer farm with 13,000 layers also managed a flock of 10,500 broilers, which were not selected for sampling

[4] One free range layer farm with 1,100 layers also managed a flock of 750 broilers, which were not selected for sampling

Risk pathways for disease introduction and dissemination

Potential contact with other domestic birds: No broiler farms reported any other domestic bird species (commercial or non-commercial) present on the property. One caged/barn layer and one free range layer enterprise managed commercial broilers on the same site as layers (Tables 1 and 2). One caged layer enterprise reported having a goose on site, and three free range layer enterprises reported the following domestic birds on site: 12 caged/aviary birds, 10 guinea fowl and four bantams. No emus, ostriches, ducks or turkeys were reported on any of the surveyed farms. Employees on three layer farms had domestic birds at their homes.

Table 2: Number of surveyed farms in each sector by categories of other commercial poultry and domestic birds present on the farm, including employees with domestic birds at home

	Broiler	Caged/barn layer	Free range layer
Number farms surveyed	54	42	42
Farms with commercial poultry of another sector on site	Nil	1[1]	1[1]
Farms with other domestic birds on site	Nil	1[2]	3[3]
Farms on which an employee had domestic birds at home	Nil (2 unknown)	1 (4 unknown)	2 (2 unknown)

[1] Details in Table 1
[2] One caged layer enterprise reported having a goose
[3] Three free range layer enterprises reported the following domestic birds on site: 12 caged/aviary birds, 10 guinea fowl and four bantams

Potential contact with wild birds: A higher proportion of layer farms had ponds or waterways on or forming a border to the farm than did broiler farms. Free range layer farms also had a higher prevalence of wild birds recorded in the vicinity of managed birds (Table 3). Sparrows, starlings, ducks and pukeko were reported from all three sectors. Ducks were more commonly reported by free range operators, while pukeko were more commonly reported by broiler operators. Seagulls and hawks were reported by layer producers, with seagulls predominantly and hawks exclusively seen on free range farms (Figure 2). Information on egg drop syndrome vaccination was collected, as the causative agent is an adenovirus carried by waterfowl, and use of the vaccine was considered a potential indicator of contact between wild waterfowl and managed poultry (Table 3).

Table 3: Number of surveyed farms in each sector by categories of potential contact between commercial poultry and wild birds

	Broiler	Caged/barn layer	Free range layer
Number farms surveyed	54	42	42
Farms with ponds or waterways on or forming a border to the farm	3 (5.6%)	15 (35.7%)	12 (28.6%)
Distance (m) to nearest waterfowl habitat (range and number of respondents)	333 (100-500; 3)	475 (5-2500; 18)	517 (20-2000; 18)
Farms that had vaccinated for egg drop syndrome at least once (in last ten years)	Nil	6 (14.3%)	6 (14.3%)
Farms on which wild birds were seen in vicinity of poultry sheds or runs	35 (64.8%)	23 (54.8%)	33 (78.6%)

A variety of other wild birds were reported in the vicinity of managed flocks on 11 farms including:

- two broiler farms: blackbirds, morepork (1); peacocks (1);
- three caged/barn layer farms: blackbirds, chaffinch, wood pigeon, kingfisher (1); fantails (1); swallows (1);
- six free range layer farms: fantails (1); magpies (1); variety native birds (1); mynahs (1); plovers (1); swallows (1).

Farm biosecurity measures – farm personnel movements: Biosecurity measures implemented when personnel come on to a farm prior to contact with birds were recorded in four categories: stand-down period between personnel visits to other poultry farms, footwear disinfection before entering the farm, farm specific protective clothing worn, and 'other' precautions (Figure 3). The absence of farm entry biosecurity measures in any of the first three categories was considered indicative of a risk pathway for the entry of exotic pathogens via farm personnel movements (Table 4). No farm entry biosecurity measures in the first three categories were recorded for one broiler, 16 caged/barn and 13 free range layer farms (Figure 4). Of these, 10 free range and six caged/barn layer farms recorded farm entry biosecurity measures in the fourth 'other' category, including restrictions on people access (such as gates), or a requirement to sign a register or visitors' book before entering the farm.

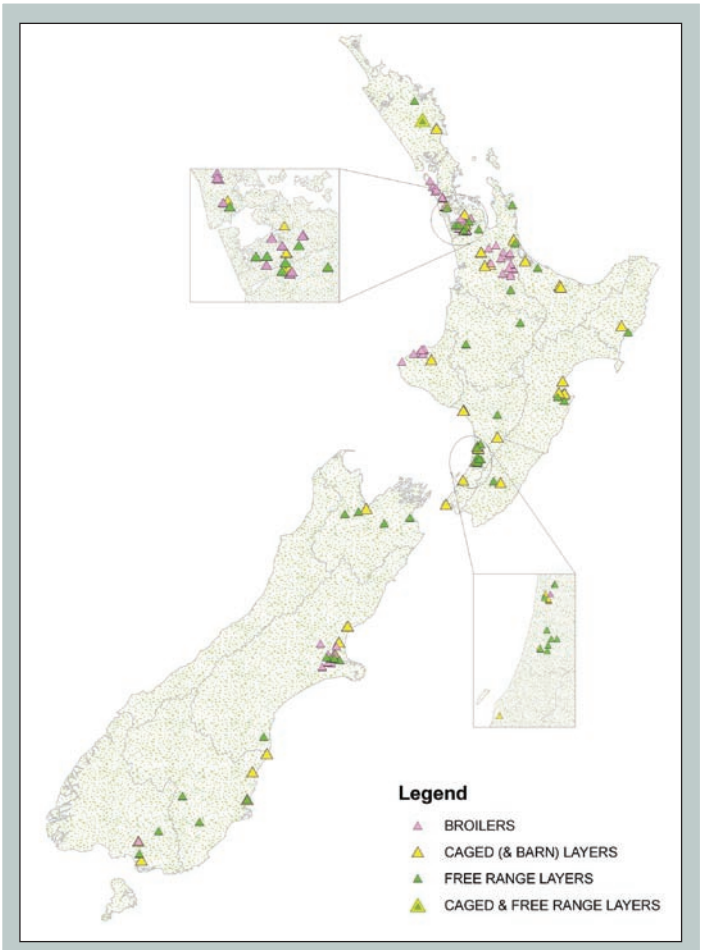

Figure 1: Location of surveyed farms by sector[1]

[1] One farming enterprise was randomly selected for sampling of both the commercial free range and caged layer flocks on site (='CAGED & FREE RANGE LAYERS')

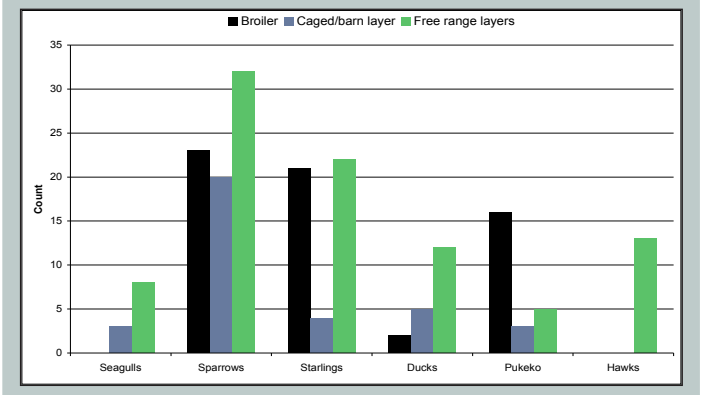

Figure 2: Number of farms in each sector reporting six common wild bird species in the vicinity of managed flocks

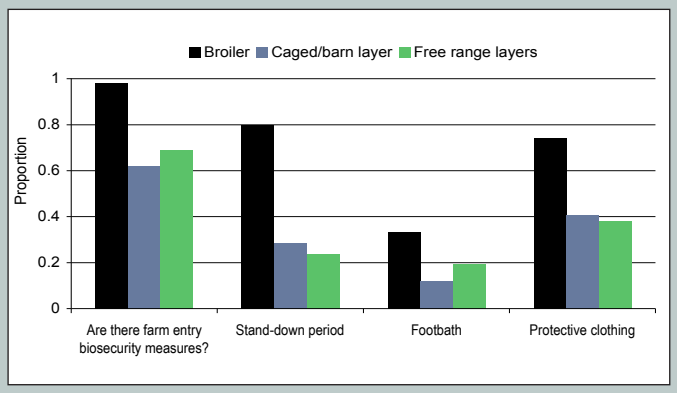

Figure 3: Proportion of farms in each sector that implement biosecurity measures associated with personnel movements on to farms prior to contact with birds, and the proportion using each of three biosecurity measures

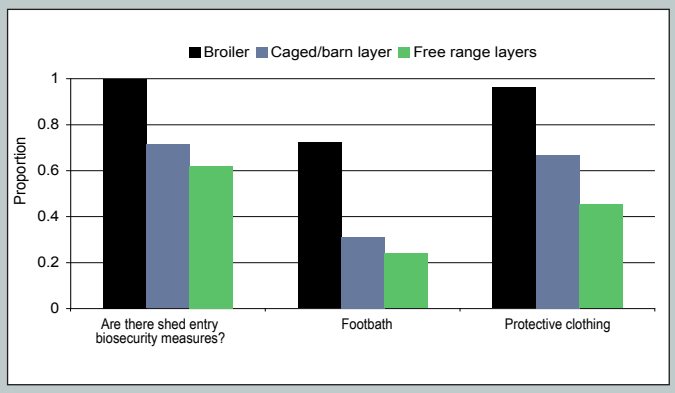

Figure 4: Proportion of farms in each sector that implement biosecurity measures associated with personnel movements between sheds, and the proportion using each of two shed entry biosecurity measures

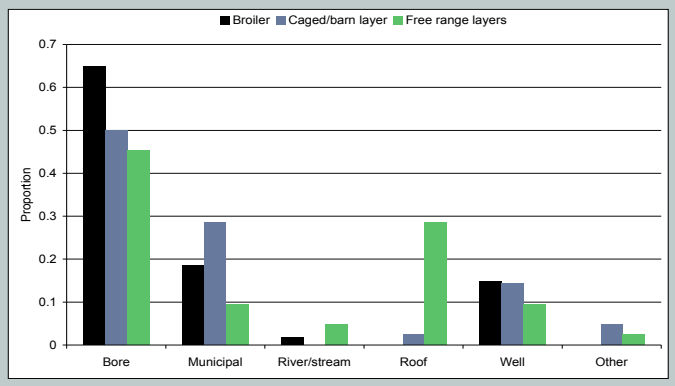

Figure 5: Proportion of farms in each poultry sector using various main water sources

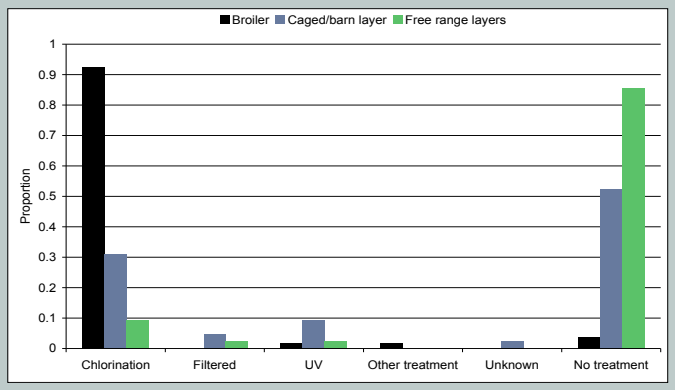

Figure 6: Proportion of farms in each poultry sector using various main water treatment methods

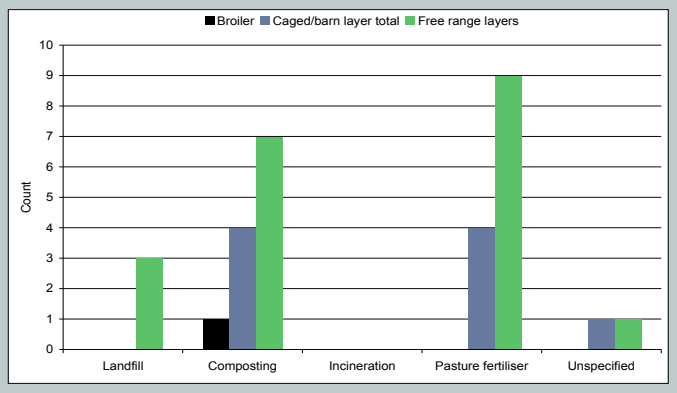

Figure 7: Number of farms in each sector carrying out on-site disposal of manure and litter, by main method used

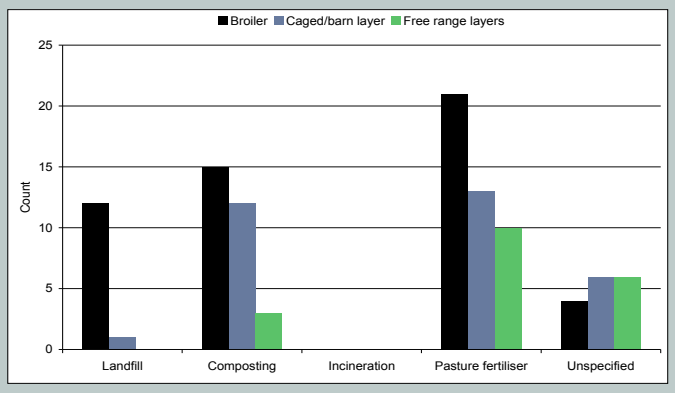

Figure 8: Number of farms in each sector carrying out off-site disposal of manure and litter, by main method used

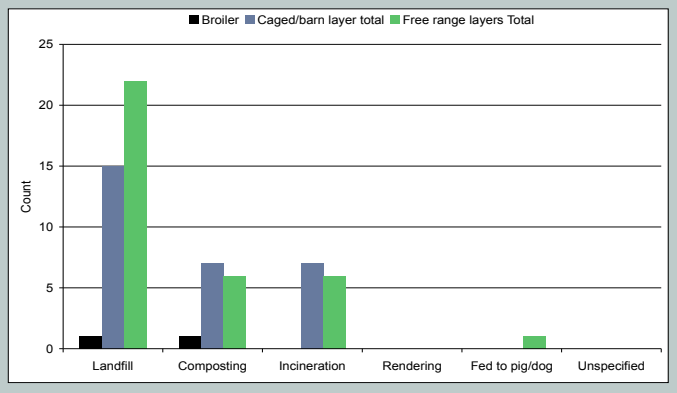

Figure 9: Number of farms in each sector carrying out on-site disposal of dead birds, by main method used

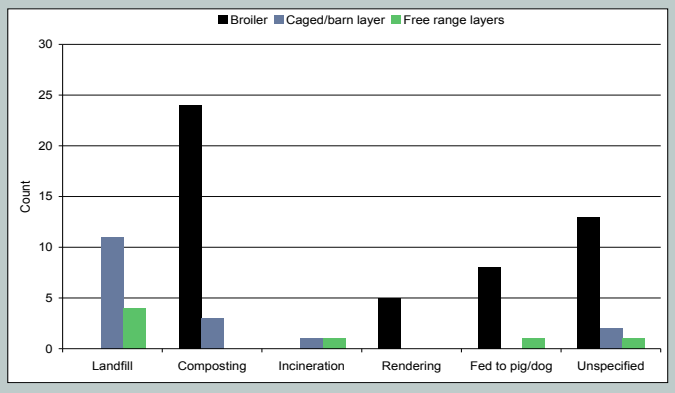

Figure 10: Number of farms in each sector carrying out off-site disposal of dead birds, by main method used

As a further assessment of personnel associated risk pathways, the manager was questioned about measures implemented when moving between sheds. Shed entry biosecurity measures were recorded in three categories: footwear disinfection between shed visits, shed-specific protective clothing worn, and 'other' precautions (Figure 4). The absence of shed entry biosecurity measures in either of the first two categories was considered indicative of a risk pathway for within farm dissemination of pathogens by farm personnel (Table 4). Shed entry biosecurity measures in categories 1 or 2 were reported for all broiler farms surveyed. No shed entry biosecurity measures in the first two categories were recorded for 12 and 16 caged/barn and free range layer farms, respectively.

Table 4: Number of surveyed farms in each sector that implemented farm and shed entry biosecurity measures

	Broiler	Caged/barn layer	Free range layer
Number farms	54	42	42
Farm entry biosecurity measures[1]	53	26	29
Risk pathway on to farm[2]	**1 (1.9%)**	**16 (38.1%)**	**13 (30.9%)**
Between shed biosecurity measures[3]	54	30	26
Risk pathway within farm[4]	**Nil**	**12 (28.6%)**	**16 (38.1%)**
Overall risk pathway – on to and within farm[5]	**Nil**	**7 (16.7%)**	**8 (19%)**

[1] Footwear disinfection, and/or a 'stand-down' period prior to farm entry, and/or use of farm-specific protective clothing
[2] The absence of footwear disinfection or a 'stand-down' period prior to farm entry or use of farm-specific protective clothing was considered indicative of a risk pathway for the entry of exotic pathogens via farm personnel movements
[3] Footwear disinfection prior to shed entry, and/or use of shed-specific protective clothing
[4] The absence of footwear disinfection prior to shed entry or use of shed-specific protective clothing was considered indicative of a risk pathway for within farm dissemination of pathogens by farm personnel
[5] The absence of biosecurity measures at the farm and shed level was considered indicative of an overall risk pathway for farm entry and dissemination of exotic pathogens by farm personnel

Farm biosecurity measures – movement of vehicles and equipment: Vehicles or farm equipment were also used on other farms in more than half the broiler farms surveyed, and all such farms reported equipment disinfection between farms. Vehicle and equipment use on other farms was much less common in the layer sectors, but less than half of those carrying out this activity reported any disinfection procedures between farms (Table 5). A risk pathway was considered to exist when farm equipment or vehicles were used on other farms and no disinfection took place prior to return or reuse (Table 5).

Table 5: Number of surveyed farms in each sector that used vehicles or farm equipment on other farms and whether disinfection took place after such use

	Broiler	Caged/barn layer	Free range layer
Number of farms surveyed	54	42	42
Vehicle/equipment used on other farms	29	7	5
Vehicle/equipment disinfection undertaken	29	3	2
Risk pathway[1]	**Nil**	**4 (9.5%)**	**3 (7.1%)**

[1] A risk pathway for the entry of exotic pathogens was considered to exist when farm equipment or vehicles were used on other farms and no disinfection took place prior to their return or reuse

Farm biosecurity measures – water source and treatment: Each surveyed farm's main water source and water treatment method is detailed in Table 6 and Figures 5 and 6. Roof collected rain water and river, stream or spring water were considered high risk sources. An overall risk pathway for the entry of waterborne exotic pathogens was considered to exist when a high risk source underwent no treatment, or was only filtered before being supplied to managed birds (Table 6).

Table 6: Number of surveyed farms in each sector using various main water sources, and water treatment methods

	Broiler	Caged/barn layer	Free range layer
Water source			
Bore	35	21	19
Municipal	10	12	4
River/stream	1	Nil	2
Roof	Nil	1	12
Well	8	6	4
Other	Nil	2 (spring)	1 (spring)
Water treatment			
Chlorination	50	13	4
Filtered	Nil	2	1
UV	1	4	1
Other treatment	1 (Ozone)	Nil	Nil
Unknown	Nil	1	Nil
No treatment	2	22	36
Water risk pathway[1]	**nil**	**2 (4.8%)**	**13 (30.9%)**

[1] A risk pathway for the entry of waterborne exotic pathogens was considered to exist when a high risk source (roof collected rain water and river, stream or spring water) underwent no treatment, or was only filtered prior to being available to managed birds

Farm biosecurity measures – protection of bulk feed stores: Most farms protected bulk feed stores (sheds, silos, bagged feed stores) from contamination by wild birds and rodents. One broiler farm and two free range layer farms reported that feed stores were not bird-proofed, and one caged layer operation reported there was no vermin control programme in place (Table 7). A potential pathway for the entry of exotic pathogens via feed because of suboptimal storage was considered to exist if either feed bird-proofing or a vermin control programme was not undertaken.

Table 7: Number of farms in each sector that implemented measures to protect poultry bulk feed stores from contamination by wild birds or rodents

	Broiler	Caged/barn layer	Free range layer
Number of farms	54	42	42
Feed stores bird-proofed	53	42	40
Vermin control programme	54	41	42
Risk pathway[1]	**1 (1.9%)**	**1 (2.4%)**	**2 (4.8%)**

[1] A potential pathway for the entry of exotic pathogens via suboptimal feed storage was considered to exist if either feed bird-proofing or a vermin control programme was not undertaken on the farm

Farm biosecurity measures – disposal of manure, litter and dead birds: The disposal methods for manure, litter, and on-farm bird mortalities were grouped according to whether on- or off-farm disposal took place, with further categorisation by the main method in use (Figures 7–10; these figures do not include details from a small number of farmers using both on- and off-site disposal

methods). General patterns indicate a predominance of on-farm disposal of dead birds in the free range and caged layer sectors, and off-site disposal in the broiler sector. A roughly even mix of on- and off-farm disposal of manure and litter from free range layer farms contrasts with a predominance of off-site disposal in the broiler and caged sectors. Nine broiler farms reported that dead birds were removed off-site and fed to pigs. One free range operation reported off-site disposal with dead birds fed to pigs, and one reported that dead birds were boiled and fed to dogs on the farm. Biosecurity Regulations (Meat and Food Waste for Pigs, 2005) require cooking of any meat or food waste fed to pigs. A small number of farmers described off-site sale of manure and litter to contractors, mushroom farmers or market gardeners.

Discussion

A questionnaire delivered in conjunction with a national sero-survey for notifiable avian influenza has identified and quantified the frequency of routine biosecurity practices in three sectors of the commercial poultry industry. The survey highlights potential disease risk pathways in all sectors, particularly layer enterprises and especially the free range sector. Despite the environmental exposure to wild bird pathogens inherent in a free range production system, biosecurity precautions more typical of other poultry sectors are still important as part of a disease risk reduction programme. The debate over the relative importance of wild birds versus the role of commercial industry movements in the spread of H5N1 is ongoing as commentators worldwide attempt to piece together the epidemiology of the current avian influenza outbreak. What is certain is that both sources pose potential risks to managed commercial flocks, and biosecurity measures should be implemented for pathways where risk can be reduced or mitigated.

Measures that ensure water and feed do not act as a route for the entry of pathogens should be prioritised. Water has been implicated as the likely source of avian influenza virus in a number of outbreaks[2][3][4] and untreated water has been identified as an important risk factor for other avian pathogens in overseas studies[4][5]. In this survey, a risk pathway for disease entry associated with drinking water was identified in 5% of caged and 31% of free range layer enterprises (Table 6). Keeping more than one avian species should be avoided[6], vermin control strictly implemented[7][8] and measures to minimise wild bird interaction optimised (for example, strict indoor feeding, plastic curtains at entry to laying house)[4][11].

The presence of wild birds on farm was identified as a strong risk factor for Newcastle disease seropositivity on some farm types in a cross-sectional survey of the Australian poultry industry[9]. Other researchers have similarly identified wild and managed free range bird interaction as a risk for poultry disease introductions[4][10]. Keeping free range birds in bird-proof runs has been employed in Europe against the threat of H5N1 and could be implemented in New Zealand under similar circumstances. The movement of personnel and equipment has been important in outbreaks overseas of avian influenza and Newcastle disease[11][12] and should take place in a way that minimises virus entry to the farm, and dissemination between management groups[5][9][14]. This survey identified a risk pathway associated with the movement of farm personnel, and farm equipment on to farms, in 33% and 10% of layer enterprises, respectively (Table 4). Similarly, pathways for disease dissemination between management groups on a farm was present on about a third of the layer farms surveyed (Table 4). Equally important for the industry as a whole are measures that safely dispose of risk conveyors to minimise virus spread within and between farms[7][9].

Survey findings should be used for biosecurity education in conjunction with codes of practice developed as part of MAFBNZ's Biosecurity Risk Profile project[13], and as a baseline against which to assess industry endorsement and uptake[1]. Measures will be least invasive and most effective when implemented as part of a farm's normal routine. Proactive adoption of biosecurity measures by all members of the industry should be encouraged, and will be facilitated by the development of an industry code of practice.

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[1] The Poultry Industry, in co-operation with the New Zealand Agriculture Industry Training Organisation, has developed unit standards and qualifications for poultry broiler chicken farmers: National Certificate in Poultry Production with strands in Egg Production, Poultry Hatchery, and Poultry Meat Production (Levels 1-3), and a National Certificate in Poultry Management (Level 4). Access the Poultry Industry Association (www.pianz.org.nz/Training/training.php) and Agriculture ITO (www.agricultureito.ac.nz) websites for further information.

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Thomas Rawdon
Investigation and Diagnostic Centre (Wallaceville)
MAF Biosecurity New Zealand
PO Box 40 742
Ward Street
Upper Hutt
Email: Thomas.Rawdon@maf.govt.nz

Ron Thornton
Biosecurity Surveillance Group
MAF Biosecurity New Zealand
PO Box 2526
Wellington[2]

Joanna McKenzie
EpiCentre
Institute of Veterinary, Animal and Biomedical Sciences
Massey University
Private Bag 11 222
Palmerston North

Natalie Gerber
Poultry Industry Association of New Zealand
96D Carlton Gore Road
Auckland

[2] Current Address: FAO Area Coordinator, Disease Investigation Centre VI, Jl. Ray Sesetan No. 266, Denpasar Seletan 80223, Bali, Indonesia