

Food safety control in the poultry industry

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involve cross-contamination. Penetration of eggs and survival within the egg is generally poor (Sahin *et al.*, 2003a).

5.4.4 Persistent farm contamination

A major source of *Salmonella* infection in poultry is contamination of the farm environment, particularly that remaining inside houses and on equipment after cleaning and disinfection (Rose *et al.*, 1999, 2000). This situation is common with less invasive serovars, particularly those originating from feed (Limawongpranee *et al.*, 1999), which may become environmentally adapted. Invasive serovars, especially *S. Typhimurium*, are less likely to persist on farms or in hatcheries and feedmills (Chriél *et al.*, 1999), and infected breeding flocks or other animal sources are more important. *Salmonella* originating from the flock may also persist outside poultry houses in anterooms or in dust and litter from the house. Wildlife with access to such materials may then become infected (Davies *et al.*, 2001). In the USA, routine cleaning and disinfection of broiler houses is not carried out after every crop but, despite this, it is not inevitable that new birds placed in a contaminated house will become infected. Poor cleaning and, in particular, insufficient disinfection may increase the risk of infection by distributing the organisms and leaving a damp environment.

The presence of breeding colonies of mice within poultry houses is a major factor that contributes to the chances of infection (Henzler and Opitz, 1992; Garber *et al.*, 2003; Liebana *et al.*, 2003). This is not a common problem in modern broiler or breeder/layer rearing houses, as there is little harbourage of, or easy access to, feed. In broiler-breeder farms, on the other hand, there may be considerable harbourage in mini-pits and easy access to feed in slave hoppers. There is a similar risk in barn or free-range egg production, but it is in cage houses that mice are particularly persistent, because they can breed in droppings pits or house insulation and readily gain access to feeders, without interference from the birds.

Persistence of *S. Enteritidis* and, to a lesser extent, other serovars on laying farms is a considerable problem, because of multi-age sites. Unlike breeding, rearing and broiler farms, these farms are occupied continuously, so there is always a source of feed, contaminated dust and other materials, as well as operatives that may rapidly infect newly-housed flocks. The risk is greatest when houses are linked by common egg belts and dung belts/channels (Davies and Breslin, 2003a). Typically, normal cleaning and disinfection of caged-layer houses and pest control are insufficient to eliminate *Salmonella*, and much reliance is placed on vaccination against *S. Enteritidis* to suppress infection (Berghold *et al.*, 2003; Davies and Breslin, 2003b). In Denmark, prolonged heating of cage houses, using steam containing formaldehyde, has been used successfully to eliminate infection on problem farms (Gradel *et al.*, 2004).

Persistence of contamination inside conventional broiler houses is not thought to be a major problem with *Campylobacter*, but farms with non-waterproof electrical fittings or roof-mounted extractor fans that are not easily cleaned can be at increased risk, suggesting that there may be some persistence