

Overview of measures against *Salmonella* at the poultry primary production level

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Aim

This document provides a systematic overview of prevention and control measures against *Salmonella* in broiler and layer farms. The overview is structured: the measures are grouped according to the different processes at the farm level that may cause a risk of introduction and/or on-farm spread of *Salmonella*, and according to certain properties of the farm that may influence the risk level (risk factors).

Introduction and transmission risks

The risk of *Salmonella* in farm animals can be split up into two parts, namely introduction into a farm, and within-farm transmission:

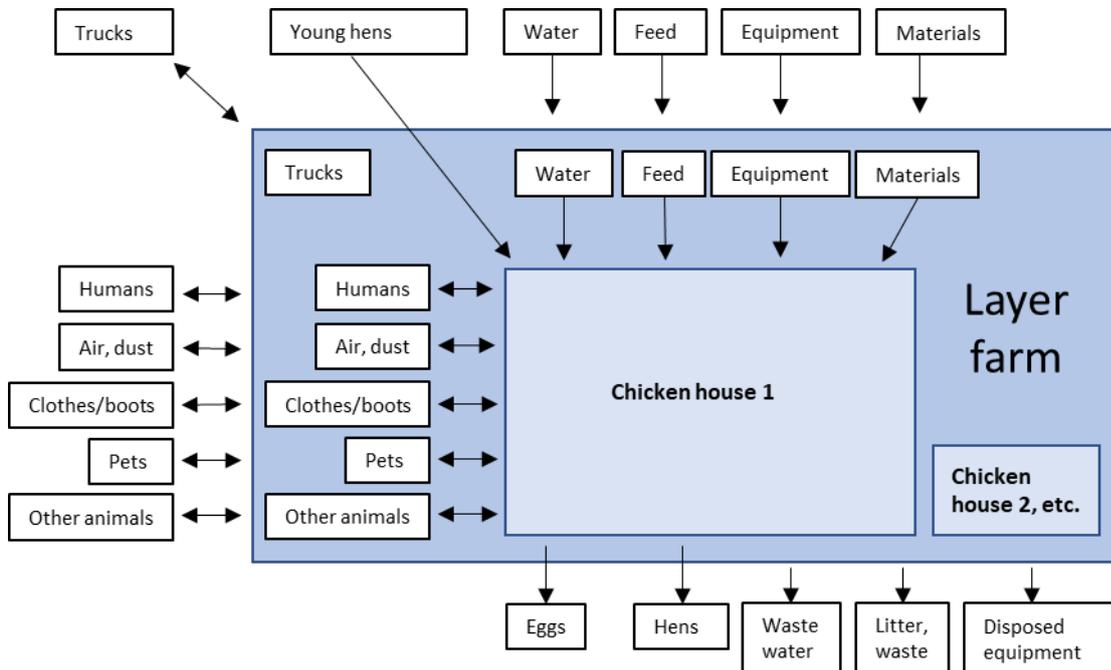
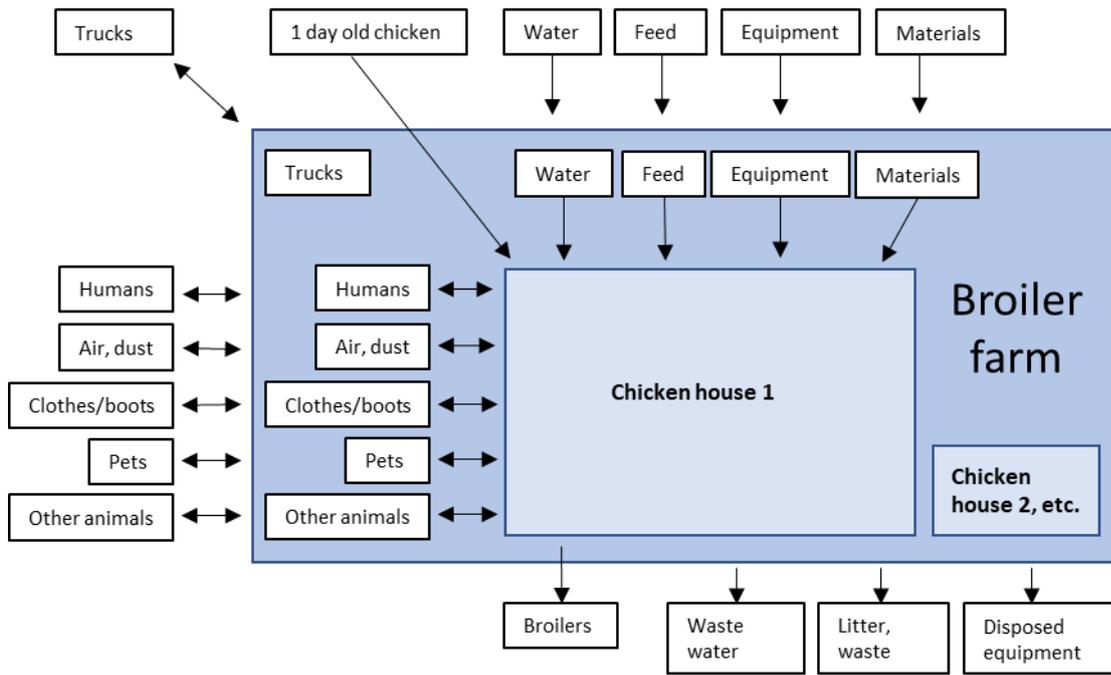
- *Introduction into a farm* can be caused by:
 - Introduction from the outside environment (including animals, humans)
 - Between-farm transmission (spread from farm to farm)
- *Within-farm transmission* can be split up into:
 - Transmission/spread between chickens in the same house
 - Between-house transmission on the same farm

Both introduction into a farm and between-house transmission on a farm can occur through chickens and through fomites (humans, materials, other animals, etc. that can transfer the bacteria), as schematically shown below (see 'Pathway schemes').

In this document we only list measures that (might) have an effect on the farm-level (primary production phase). This study did not involve other phases of the poultry chain. The measures that we mention in this document were suggested by different organizations (see reference list). No single measure used alone will achieve effective *Salmonella* control (OIE). The magnitude of the effect of each specific measure is not known.

This document does not have the intention to provide complete checklists for bio-security. More explanation of measures and/or detailed checklists to optimize biosecurity are provided by quality control organizations/programs.

Pathway schemes



- introduction risk
- ↔ - outside blue area: introduction and/or possible between-farm transmission risk
- ↔ - inside blue area (the farm): within-farm transmission risk

Risk factors

There are certain factors that may influence the magnitude of the introduction and/or transmission risks:

- Animal related factors, amongst others:
 - race/breed
 - age
 - immune status
 - gut flora
- Management related factors, amongst others:
 - feed type/diet (heat-treated or not, pelleted or not, acidified or not, etc)
 - use of microbiota, pre/pro-biotics
 - use of antibiotics
 - use of vaccination against *Salmonella* (see also the list of measures)
 - use of (fast) diagnostics for *Salmonella* during growing/laying period
 - facilities/stables (husbandry system, indoor/outdoor, space per animal, cage type, etc)
 - method for introducing moult
 - culling of the flock when infected with a certain *Salmonella* strain

These risk factors can be influenced by certain measures; and some them such as use of vaccination can be considered measures themselves.

Systematics of measures

Measures for *Salmonella* prevention and control can be systematically listed by connecting to the risks and risk factors that were described above as follows:

- Measures directed at preventing/reducing introductions into the farm:
 - Aimed at keeping everything that goes into the farm free of *Salmonella*
 - Taking into account that *Salmonella* can be present in the environment of the farm, and that some things go into the farm continuously (air, insects) and/or unnoticed (rodents)
- Measures directed at preventing/reducing within-farm transmission:
 - Trying to optimize animal related factors
 - Trying to optimize management related factors

Overview of measures

Measures to prevent introduction:

- Sourcing new chickens introduced on the farm from *Salmonella*-free flocks/farms
- Treating feed to make it *Salmonella*-free (heat treatment or bacteriostatic/bactericide treatments (organic acids))
- Offering shower and changing room facilities for workers and visitors
- Showering before going in
- Wearing clothes and boots that are not used outside
- Limiting the entry of non-essential visitors
- Rodent control
- Insect control
- Disposing of poultry litter/feces and of other potentially contaminated farm waste in a safe manner (to prevent transmission to other farms)
- Not allowing pets in the chicken house
- Keeping negative pressure in sewage system
- Other bio-security measures

Measures to reduce within-farm transmission (if the flock is infected):

- Monitoring and sampling
- Use of organic acids
- Storing feed in clean, closed containers (to prevent access by wild birds and rodents)
- Avoiding recontamination of feed
- Culling
- Not reusing litter
- Cleaning and disinfection (buildings, surfaces, fans, cooling pads and equipment) and checking result before new chickens arrive
- Changing clothes/boots for each specific chicken house
- Vector control: rodents, wild birds, insects
- Not allowing pets in the chicken house
- Other bio-security measures

Measures to optimize animal related factors:

- Only introducing chickens that are in good health
- Use of breed with (a level of) genetic resistance against *Salmonella*
- Vaccination against *Salmonella* (laying hens)
- Improving gut health/gut microbiota by:
 - Competitive exclusion in one-day old chickens
 - Use of organic acids
 - Use of probiotics, prebiotics, phytobiotics
- Use of bacteriophages
- Avoiding stress among chickens as much as possible

Measures to optimize management related factors:

- All-in/all-out management
- Controlling temperature and humidity according to known best practice
- Keeping a lower density of chickens in order to decrease infection rates between broilers
- Keeping air clean (control of incoming air/ventilation, use of filter)

The use of antibiotics is not recommended for *Salmonella* control (see OIE Terrestrial Health Code). They can cause resistance against *Salmonella*, and can affect the resistance of the animal against colonization.

Explanations on the risk schemes

Broiler farm

Going in, staying in:

These materials, supplies, etc. are introduced into the farm/chicken houses and do not leave the farm/chicken house until at least the end of the growing period.

Factor in scheme	Explanation	Farm/ chicken house*
1 day old chickens	Growing until they go to slaughter	House
Water	Drinking water for the broilers; water for cleaning, etc.	Both
Feed	Feed for the broilers	Both
Equipment and fencing	All small and large non-biological materials and equipment, including shovels, wheelbarrows, buckets, tools, office furniture, office tools	Both
Materials	Bedding material (shavings, straw, other)	Both
Chemicals (not in scheme)	Medicines, antibiotics, chemicals for cleaning/disinfection Not considered a risk for introduction of <i>Salmonella</i> (therefore not in scheme)	Both

* 'Farm': The factor is introduced onto the farm premises, but normally not into the chicken houses.

'House': The factor is introduced into the house(s), but not onto the wider farm premises. 'Both': The factor is (generally) introduced both onto the premises and into the house(s).

Going in and out:

These materials, supplies, etc. might be introduced into the farm/chicken house (and also going out) more than once or even daily or continuously during the growing period. Therefore it is also possible that they move between the chicken houses within a farm.

Factor in scheme	Explanation	Farm/ chicken house
Humans	- Farmer and family - Animal care takers, personnel - Regular visitors (veterinarian, feed expert, broiler catchers, etc.) - Occasional visitors (for example: electricians, plumbers, construction workers, carpenters)	Both
Clothes/boots	Clothing material, boots (cleaned or not cleaned in between visits)	Both
Pets	Dogs, cats	Farm (and potentially also in chicken house)
Other animals	All other animals (not kept as pet or farm animal), including birds, insects, rodents, etc.	Both
Air, dust	Everything that can easily enter the farm/chicken house from the outside environment, by wind/ventilation or opening doors, such as air, dust, pollen, etc.	Both
Equipment	All small and large non-biological materials and equipment (see above) that is used sometimes inside the farm, and sometimes outside the farm (for example equipment/tools from external builders, repair people, etc.)	Both
Trucks	Trucks with truck driver (for example feed supply, litter supply, etc).	Farm

Going out:

These materials leave the farm during and/or after the growing period (or after some years of being within the farm), and will not be going in anymore.

Factor in scheme	Explanation	Farm/ chicken house
Broilers	Dead broilers during the growing period. Live broilers going to slaughter.	Not applicable
Waste water	Water used for cleaning, etc.	Not applicable
Litter, waste	Feed rests, medicine rests, fecal material, bedding material, feathers, etc.	Not applicable
Used equipment	Equipment that is no longer used and therefore being disposed	Not applicable

Layer farm

Going in, staying in:

Factor in scheme	Explanation	Farm/ chicken house*
Young hens	Young hens reared for laying	House
Water	Drinking water for the hens; water for cleaning, etc.	Both
Feed	Feed for the hens	Both
Equipment and fencing	All small and large non-biological materials and equipment, including shovels, wheelbarrows, buckets, tools, office furniture, office tools	Both
Materials	Bedding material (shavings, straw, egg cartons, other)	Both
Chemicals (Not in scheme)	Medicines, antibiotics, chemicals for cleaning/disinfection Not considered a risk for introduction of <i>Salmonella</i> (therefore not in scheme)	Both

Going in and out (this is identical to the case of the broiler farm):

Factor in scheme	Explanation	Farm/ chicken house
Humans	- Farmer and family - Animal care takers, personnel - Regular visitors (veterinarian, feed expert, broiler catchers, etc.) - Occasional visitors (for example: electricians, plumbers, construction workers, carpenters)	Both
Clothes/boots	Clothing material, boots (cleaned or not cleaned in between visits)	Both
Pets	Dogs, cats	Farm (and potentially also in chicken house)
Other animals	All other animals (not kept as pet or farm animal), including birds, insects, rodents, etc.	Both

Air, dust	Everything that can easily enter the farm/chicken house from the outside environment, by wind/ventilation or opening doors, such as air, dust, pollen, etc.	Both
Equipment	All small and large non-biological materials and equipment (see above) that is used sometimes inside the farm, and sometimes outside the farm (for example equipment/tools from external builders, repair people, etc.)	Both
Trucks	Trucks with truck driver (for example feed supply, litter supply, etc.)	Farm

Going out:

Factor in figure	Explanation	Farm/ chicken house
Eggs	Eggs produced by the hens	Not applicable
Hens	Dead hens during the laying period. Live hens after the laying period (when new hens are set up).	Not applicable
Waste water	Water used for cleaning, etc.	Not applicable
Litter, waste	Feed rests, medicine rests, fecal material, bedding material, feathers, broken eggs, etc.	Not applicable
Used equipment	Equipment that is no longer used and therefore being disposed	Not applicable

Literature and other sources used

OIE Terrestrial Health Code:

https://www.oie.int/fileadmin/Home/eng/Health_standards/tahc/current/chapitre_prevent_salmonella.pdf

EFSA Scientific Opinion on Salmonella control in poultry flocks and its public health impact

<https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2019.5596> (2019)

Poultry World:

<https://www.poultryworld.net/Special-Focus/Salmonella-special/Salmonella-control-A-global-perspective/>

The Poultry Site:

<https://www.thepoultrysite.com/articles/strategies-to-control-salmonella-in-poultry>

GD Animal Health (In Dutch): <https://www.gddiergezondheid.nl/salmonellose-pluimvee>

AVINED, IKB Kip certification scheme:

<https://www.avined.nl/themas/kwaliteitsregelingen/ikbkip/ikb-kip-in-english>

Checklists can be downloaded from: <https://www.avined.nl/themas/kwaliteitsregelingen/ikbkip/ikb-kip-in-english/ikb-kip-certification-scheme>

Fris, C. , van den Bos, J., 2007. A retrospective case-control-study of risk factors associated with *Salmonella enterica* subsp. *enterica* serovar Enteritidis infections on Dutch broiler breeder farms. Avian Pathology 24:2, 255-272, DOI: 10.1080/03079459508419067.

Ricke, S.C., Dunkley, C.S., Durant, J.A., 2013. A review on development of novel strategies for controlling *Salmonella* Enteritidis colonization in laying hens: Fiber-based molt-diets. Poultry Science 92, 502-525.

C. ter Veen, J. Wiegel, H. Bataille, 2016. S. Java: Aanpak van hardnekkig probleem (In Dutch). Pluimvee 61, April 2016, 6-7. <https://edepot.wur.nl/394197>

The diagrams on page 2 were inspired by the MSc thesis of Mohamed Said Abdulle (Wageningen University, 2019), supervised by M. Mul and M.C.M. de Jong.