codex alimentarius commission

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

WORLD HEALTH ORGANIZATION

JOINT OFFICE: Viale delle Terme di Caracalla 00100 ROME Tel: 39 06 57051 www.codexalimentarius.net Email: codex@fao.org Facsimile: 39 06 5705 4593

Agenda Item 10 **CX/FH 05/37/10**
December 2004

JOINT FAO/WHO FOOD STANDARDS PROGRAMME

CODEX COMMITTEE ON FOOD HYGIENE

Thirty-Seventh Session
Buenos Aires, Argentina, March 14 – 19, 2005

DISCUSSION PAPER ON THE GUIDELINES FOR THE APPLICATION OF THE GENERAL PRINCIPLES OF FOOD HYGIENE TO THE RISK BASED CONTROL OF *SALMONELLA* SPP IN BROILER CHICKENS

Prepared by Sweden with the assistance of Australia, Brazil, Canada, Denmark, France, Germany, Netherlands, New Zealand, Thailand, USA, European Commission and ALA

BACKGROUND

At its 34th session in Bangkok, the Codex Committee on Food Hygiene was informed about the outcome of the FAO/WHO expert consultations on risk assessment on *Listeria* and *Salmonella*. It was noted that there was a need to develop a discussion paper on Risk Management Strategies for *Salmonella* spp. in broilers based upon the risk assessment document (FAO Food and Nutrition Paper 72). The committee agreed that a drafting group led by Sweden and with the assistance of Australia, Canada, China, Czech Republic, Denmark, France, Germany, Netherlands, New Zealand, Thailand, USA and the European Commission should develop a discussion paper to be considered at its next session. The drafting group met in Uppsala, Sweden, the 25-26th of February 2002.

At the 35th session in Orlando a draft was presented for discussion together with an alternative suggestion in the form of a risk profile from the USA. The committee decided that the drafting group, enlarged with Brazil and ALA, should elaborate the document and specifically:

- refine and prioritize possible interventions throughout the food chain with potential for risk reduction, with a view of formulating questions to risk assessors to be delt with in modelling risk;
- encourage input from experts on aspects throughout the food chain;
- risk management/risk assessment should be further developed.

The drafting group sent out a circular letter (CL 2003/25 FH) to Codex Contact Points asking for relevant input and a literature study was performed. The results of these activities were incorporated in the document.

The document was presented to the 36th session in Washington. After a discussion on the format of the document it was decided that the drafting group should revise the document according to the structure of the Recommended International Code of Practice-General Principles of Food Hygiene, with annexes as necessary, for circulation, comments and further consideration at the next session.

The previous document has been redrafted after electronic consultations in the drafting group.

In order to facilitate an understanding of the document it is recommended that it should be read in conjunction with relevant sections of The Joint FAO/WHO Expert Consultation on Risk Assessment on Microbiological Hazards in Foods (FAO Food and Nutrition Paper 72, Rome, 2000).

INTRODUCTION

The genus *Salmonella* belongs to the family *Enterobacteriaceae.* The bacterium is a facultative anaerobic, gram-negative rod. The genus consists of two species, *Salmonella enterica and Salmonella bongori.* In this document all *Salmonella* considered belong to the species *Salmonella enterica*. More than 2,400 *Salmonella* serotypes have been identified.

Salmonellosis is one of the most frequently reported foodborne diseases worldwide and also one of the most complex in its epidemiology and control. The reported incidence of salmonellosis per 100,000 people generally varies between 10 and 120 in different countries.

In most countries salmonellosis in humans is mainly a food-borne disease with foods of animal origin being most often associated with transmitting the bacteria. Climate, human and animal densities, land use, farming practices, food harvesting and processing technologies and consumer habits are some of the factors resulting in different epidemiological patterns in different parts of the world.

Salmonellae can cause symptoms from mild diarrhoea up to severe sepsis, but asymptomatic carriers are common. The principal symptoms in man are diarrhoea, abdominal pain, mild fever, chills, nausea and vomiting; prostration, anorexia, headaches and malaise may also occur. The incubation period is 5-72 hours. In general the course of disease is self-limiting and clinical recovery takes place in 2-5 days, though recovery to full strength may take an additional 1-2 weeks. Illness is usually more severe in very young and elderly people and in immuno-compromised hosts. After an infection, patients are usually bacterial carriers 1-3 months if not treated with antibiotics. Complications like reactive arthritis can occur in direct relation to the acute phase or within a few months.

High attack rates are generally observed with *Salmonella* outbreaks where the levels ingested are $\geq 10^6$ cells for healthy adults, however, a number of outbreaks involving doses of ≤ 100 cells have been documented.. Factors such as variation between bacterial strains, age and health status of the host, portal of entry and chemical nature of the food-vehicle will influence the infectious dose.

Poultry and poultry products are common food vehicles of *Salmonella* in many countries.

Most *Salmonella* serovars, with the exceptions of *Salmonella* Typhimurium and the host-adapted *Salmonella* Gallinarum and S*almonella* Pullorum, produce little clinical disease in poultry. Detection of infected flocks must therefore be based on bacteriological or serological analyses.

At the 33rd session of the CCFH, the preliminary report of the Joint FAO/WHO Expert Consultation was discussed and a number of risk management questions to be addressed by the FAO/WHO expert consultations were identified. Amongst these were questions concerning on-farm interventions. These could not, however, be evaluated by JEMRA due to lack of representative data. It was acknowledged that destruction of *Salmonella* positive flocks will influence public health outcomes, but due to the lack of specific information on how this would translate to fewer infected birds or fewer *Salmonella* cells per infected bird at the completion of processing, the magnitude of risk reduction was not estimated. It was nevertheless estimated that a reduction in the concentration of *Salmonella* cells on carcasses leaving the chill tank as well as a reduction in the prevalence of infected birds leaving processing would reduce the risk of illness per serving at least proportionally.

The expert group found the available data on the importance of various routes for introduction of *Salmonella* spp. into flocks including feed, replacement birds, vectors and hygiene to be inconclusive. It was not possible therefore to evaluate the importance of on-farm routes of introduction of *Salmonella* spp. The expert group also pointed out the need to increase the understanding of cross-contamination processes in all the different steps in the production chain.

The drafting group, considering the result of the risk assessment and realising the current gaps in data concerning the efficacy of various strategies, has decided to refrain from prioritising between specific strategies and instead list known intervention options. The group acknowledges that a combination of intervention options is the best way of achieving a reduction of contaminated products on the market. The

challenge for both member countries and industry is to find the optimal combination of options, pertinent to their specific conditions, that controls salmonellae to the greatest extent feasible.

The choice of appropriate risk management strategies for *Salmonella* spp. in broilers falls within national competence and should be discussed in the national context. Each country can select those risk management strategies that are most appropriate to its national situation. What is, at one point in time, feasible and highly effective for one country might, at the same time, be quite unrealistic and/or ineffective for another.

It is preferable, that, prior to selecting their strategies, the countries set their appropriate level of protection and the food safety objective as regards S*almonella* in broilers in order to guide the selection.

Since information about the effects of different risk management strategies is rarely available, all parties are invited and encouraged to forward such information.

SECTION I – OBJECTIVES

These guidelines provide advice to governments, the food industry, consumers and other interested parties on management options for the control of *Salmonella* spp. in broilers with a view towards protecting public health and facilitating trade. The primary objective is to minimize the incidence of human salmonellosis caused by consumption of broiler products.

SECTION II – SCOPE

These guidelines apply to the production, processing and handling of broilers and broiler products. They highlight management options that can reduce the frequency and extent of contamination of broilers and broiler products with *Salmonella* spp.

These guidelines are supplemental to and must be used in conjunction with the *Recommended International Code of Practice – General Principles of Food Hygiene*, CAC/RCP 1 – 1969, Rev. 4, 2003**.**

SECTION III – PRIMARY PRODUCTION

Objectives:

Primary production should at each step be managed in ways that as far as possible reduce the frequency and extent of contamination of birds and eggs with *Salmonella* being sent to the next step in the primary production chain and eventually to slaughter and further processing.

The ultimate objective should be to deliver *Salmonella*-free chickens to slaughter.

Rationale:

Interventions at primary production are important tools for reducing the frequency and extent of *Salmonella*-contamination in broilers and broiler products.

Interventions at primary production to prevent, eliminate or reduce the frequency and extent of *Salmonella*-contamination can be very effective in reducing the incidence of human salmonellosis caused by consumption of contaminated broiler products.

Typically a combination of different interventions is necessary to get substantial results. Depending on the circumstances the optimal combination of interventions will vary.

Potential risk management interventions for the primary production are discussed in detail in ANNEX 1.

SECTION IV - ESTABLISHMENT: DESIGN AND FACILITIES

Objectives:

At all stages in the food chain following primary production, equipment and facilities should be designed, constructed and laid out to ensure cleanability and to prevent harbouring and cross-contamination by *Salmonella* spp.

Rationale:

Slaughter, processing and handling of *Salmonella*-contaminated broiler flocks has resulted in harbouring and cross-contamination of products originating from *Salmonella*-free flocks.

In addition to the guidance provided in Section IV of the Recommended International Code of Practice – General Principles of Food Hygiene (CAC/RCP 1 – 1969, Rev.4, 2003) the following areas are particularly important for the control of *Salmonella* spp. in establishments at different steps in the food chain.

4.1 PREMISES AND ROOMS

Whenever feasible, premises and rooms should be designed to store and handle *Salmonella*- free products separately from *Salmonella*-contaminated products. Where appropriate, cleaning areas for equipment and containers should preferably also be separate for the two categories in order to prevent cross-contamination.

4.2 EQUIPMENT

Whenever feasible separate equipment and containers should be used for *Salmonella*-contaminated and uncontaminated products. Special attention should be paid to the cleaning, disinfection and drying of the crates used for transporting chickens Cleaning and disinfection methods should be validated for efficiency. Ineffectively cleaned crates are sometimes more frequently contaminated with *Salmonella* than unwashed crates. Washed crates should be free of faeces and the disinfectant concentration should be regularly checked to ensure effectiveness. Also, crates must be free of cracks and crevices as these form excellent hiding places for bacteria. Improved hygiene management during transport of chickens can reduce the risk of *Salmonella* contamination of poultry meat.

4.3 FACILITIES

The water flow in tanks in the slaughtering process should be according to the counter-flow principle.

SECTION V – CONTROL OF OPERATION

Objectives:

Control measures should be used to

- reduce the frequency and extent of contamination in the finished product
- prevent the growth of *Salmonella* in the finished product and
- reduce the likelihood of cross- and re-contamination of products

Rationale:

Differences in hygienic practices between slaughterhouses with resulting differences in carcass contamination have been demonstrated indicating that improved hygiene management could significantly reduce the frequency and extent of *Salmonella* contamination of broilers and broiler products.

Prevention of cross-contamination and strict adherence to Good Hygienic Practices will reduce the risk of salmonellosis.

5.1 CONTROL OF THE FOOD HAZARD

Control of *Salmonella* in broiler products requires strict application of Good Hygienic Practices and the use of validated control measures appropriate for the respective stages in the food chain.

5.2 KEY ASPECTS OF HYGIENE CONTROL SYSTEMS

5.2.1 TIME AND TEMPERATURE CONTROL

Control of temperature is important all along the food chain starting with chilling at slaughter.
Chilling and/or freezing must take place without delay after slaughter in order to minimize bacterial growth. A temperature of $\leq 4^{o}$ C should be reached in all parts of the carcass in less than 4 hours. Frozen products should be kept at $\leq$ - 18^{o} C and refrigerated products below 4^{o} C.

Heat treatment is another important control step for *Salmonella* in broilers and broiler products. Before consumption all broiler products should be heated up to a temperature of at least 70^{o} C in all parts. Such a heat-treatment will effectively kill *Salmonella* in the product.

5.2.2 SPECIFIC PROCESS STEPS

Steps that may contribute to reduced prevalence of *Salmonella*-contaminated products include:

- At slaughter
    - Head pulling should be carried out so that leakage from the crop is prevented.
    - Evisceration should be carried out with care to prevent damage to the viscera leading to leakage of intestinal contents.
    - Air-chilling might be preferable to water chilling due to reduced risk for cross-contamination. Where water–chilling is used this should be through use of counter-flow set up, appropriate flow rate and, possibly, use of an anti-microbial agent to prevent cross-contamination.
    - *Salmonella* positive flocks should be slaughtered at the end of the day.
    - Intensified cleaning and disinfection routines should be used after slaughtering of positive flocks.
    - Decontamination of positive carcasses (examples of decontamination methods are given in ANNEX 2) including use of water sprays to wash off contamination particularly after plucking, evisceration and just prior to immersion chilling.

- At processing
    - Consideration of channelling of meat from infected flocks to special treatment, e.g. heat treatment.
    - Controlling the physical separation of contaminated and uncontaminated batches.

- At distribution, retail sale and catering
    - Physical separation of heat-treated and raw products.

5.2.3 MICROBIOLOGICAL AND OTHER SPECIFICATIONS

Depending on the circumstances different microbiological criteria may be established for the control of *Salmonella* spp. in broiler products. These criteria may initially target *Salmonella* serotypes with most public health significance and should be based on the epidemiological situation in the region or country for which the criteria apply.

When feasible, the ultimate goal should be to establish microbiological criteria that can be linked to an established food safety objective for *Salmonella* spp. in broilers and broiler products.

At slaughter and processing sampling programmes to measure cross-contamination and changes in *Salmonella*-prevalence or concentration of indicator organisms can be helpful in pointing out when improvements in hygiene routines are needed.

5.2.4 MICROBIOLOGICAL CROSS-CONTAMINATION

Preventing cross-contamination is one of the most important measures in the control of *Salmonella* spp.

Careful cleaning and, when necessary, disinfection should take place between batches and flocks.

When the salmonella-status of a flock or a batch is known, surfaces, utensils and equipment that come in contact with the products should preferably be dedicated for use with either contaminated or uncontaminated products. At all steps the physical separation of contaminated and uncontaminated products and, when applicable, between heat-treated (or otherwise decontaminated products) and raw products is of vital importance.

SECTION VI – ESTABLISHMENT: MAINTENANCE AND SANITATION

Objectives:

To establish maintenance and cleaning systems which effectively prevent cross- and recontamination of products with *Salmonella* spp.

Rationale:

Strict adherence to effective maintenance and cleaning systems are necessary to prevent cross- and recontamination.

Generally, poultry processing does not reduce carcass contamination. It is therefore necessary that, unless methods, such as irradiation, known to eliminate contamination are used, slaughtering and processing of a contaminated flock is followed by particularly careful cleaning and disinfection of surfaces, utensils and equipment to prevent cross-contamination.

The same careful routines should, when feasible, be used at processing intervals, between shifts or at least at the end of the day.

At catering, and especially in institutional kitchens preparing food for the sick and the elderly people, careful cleaning and disinfection after handling broiler products is also advisable.

6.1 MAINTENANCE AND CLEANING

6.1.1 GENERAL

Establishments should implement an effective, scheduled maintenance programme to prevent equipment failures that could lead to the development of residence sites and contamination of products.

The maintenance programme should specify the intervals between normal replacement of equipment and the periodicity of routine inspections.

Care should be taken to prevent *Salmonella*-contamination during repair or change of equipment.

Equipment food contact surfaces should be cleaned and disinfected after maintenance work, prior to use.

Where appropriate, tools used for maintenance of equipment should be designated for use in either raw or finished products areas.

Maintenance personnel should have a basic training in food hygiene and should respect the hygiene requirements of the establishment. Special attention should be paid to movements between areas of different hygienic status in the establishment.

Due to the design and layout of the slaughter- lines in modern broiler slaughterhouses microbiological contamination of the equipment by the broilers is inevitable. Cleaning and disinfection routines must be adapted accordingly and to the prevailing conditions in each establishment.

6.1.2 CLEANING PROCEDURES AND METHODS

Salmonella bacteria are not known to be particularly resistant against disinfectants or to have an extraordinary capacity to attach to surfaces.

Studies have shown that *Salmonella* bacteria can survive for many years under dry conditions. Where applicable, cleaning programmes must therefore also include dry environments where routines for dry cleaning should be implemented.

Equipment used for cleaning must be maintained in good condition and should be regularly cleaned and, when necessary, disinfected to prevent cross-contamination. When applicable, cleaning equipment should be designated either for use in raw or finished product areas.

6.2 CLEANING PROGRAMMES

Cleaning and disinfection programmes should first be validated for effectiveness before implementation and then be regularly monitored and verified after implementation. Daily inspections should take place before the start of operations and in case of unsatisfactory results, cleaning and disinfection should be repeated before operations are allowed to commence.

6.3 MONITORING EFFECTIVENESS

Verifying the effectiveness of control measures or a food safety control system with microbiological sampling of the environment and food contact surfaces should be done on a regular, scheduled basis and in case of suspicions or evidence that the measures or the system is ineffective or incorrectly applied.

The analytical parameters used for verifying effectiveness should not always be restricted to general hygienic indicators like total aerobic counts and total *Enterobacteriaceae* but should preferably also include *Salmonella* spp. with regular intervals.

SECTION VII – ESTABLISHMENT: PERSONAL HYGIENE

Objectives:

To prevent employees from contaminating products or causing cross-contamination by incorrect behaviour and actions.

Rationale:

People can serve as both the vehicle and source for direct or indirect transfer of salmonellae.

7.1 HEALTH STATUS

People known or suspected to be carrying *Salmonella* bacteria should not be allowed to work in direct contact with unpackaged products or in places where they may contaminate food contact surfaces, utensils or equipment.

When clinically or epidemiologically indicated, medical examination of personnel should be carried out. Attention should be paid to the fact that people carrying *Salmonella* bacteria quite often show no clinical

symptoms. Hence frequent, at least yearly, medical examination, including sampling for *Salmonella,* of people working in the primary production and of slaughterhouse staff may be justified.

7.2 PERSONAL CLEANLINESS

Personal hygiene is of utmost importance to prevent people from contaminating food and food surfaces. With respect to *Salmonella* it is especially important that people wash their hands carefully after using the toilet and at the start of food handling activities. In addition employees handling unpackaged products should wear clean working clothes free from visible contamination at the start of each working day.

7.3 VISITORS

In principle, visitors should be kept to a minimum. Movement of visitors through the establishment should start at the clean areas (end of production line) and proceed in the opposite direction of the production line, ending at the live animal reception area.

SECTION VIII – TRANSPORTATION

Objectives:

Transportation should be carried out in such a way that products are not contaminated and the concentration of salmonellae is not allowed to increase.

Rationale:

Food must be properly protected during transportation to prevent contamination.

Salmonella spp. can multiply in broilers and broiler products if the temperature is above 8-10^{o} C.

8.1 GENERAL

Salmonella spp. multiply rapidly in broiler products given the right circumstances. Control of temperature throughout the cold chain is necessary to prevent an increase of *Salmonella* in the products.

8.2 REQUIREMENTS

Vehicles, containers, crates and other equipment used for transportation must be designed and constructed so that contamination of broilers and broiler products with *Salmonella* can be prevented. They should at all times be kept in a hygienic condition appropriate for the intended use. Special attention should be paid to the separation of contaminated and not contaminated products as well as raw products from finished products.

SECTION IX – PRODUCT INFORMATION AND CONSUMER AWARENESS

Objectives:

When possible, products should be clearly labelled to allow industry to identify and separate *Salmonella*-contaminated products from uncontaminated products and, when necessary, to recall products.

Consumers need to be informed about the risk that raw broiler products may be *Salmonella*-contaminated. Consumers also need to be informed about the correct storage and handling of broiler products to prevent cross-contamination and how to cook the products to effectively eliminate *Salmonella*.

Rationale:

Insufficient separation of contaminated and uncontaminated broilers and broiler products can lead to cross-contamination. Informing consumers of the correct storage, handling and cooking of raw broiler

products can reduce the incidence of *Salmonella*-infections in humans.

9.1 LOT IDENTIFICATION

Marking of batches or lots enables identification of products and traceability so that when products are found to be contaminated the source of the contamination can more easily be identified and dealt with and information can be relayed to other consumers who may have purchased the same product.

9.2 LABELLING

Countries or industry may, consider including information on safe handling practices on the label.

9.3 CONSUMER EDUCATION

Complimentary to education in general food hygiene the consumer should also be educated in the proper handling and storage of broiler products to prevent cross-contamination of other products that will not undergo further heat-treatment before consumption. Consumers must also be informed about the importance of proper heat-treatment of broiler products.

ANNEX I: RISK MANAGEMENT STRATEGIES IN THE PRIMARY PRODUCTION OF BROILERS

Interventions in the primary production of broilers can effectively reduce *Salmonellae* in broilers and broiler products.

Due to lack of quantitative data on the efficacy of various strategies it is impossible to prioritise between different strategies. A combination of risk management interventions is no doubt beneficent in achieving substantial reductions in the frequency and extent of *Salmonella*-contaminated birds sent to slaughter.

Each country must select those risk management interventions that are most appropriate to the existing conditions and objectives.

Countries should also decide whether interventions should be targeted against all *Salmonella*-serotypes or against certain serotypes with most significance to public health.

To be successful, applications of specific risk management interventions must be based, in part, on Good Agricultural Practices (GAP) and Good Hygienic Practises (GHP).

Breeder production

It is crucial to keep the breeder production flocks free from *Salmonella* since an infected flock will spread the infection to a large number of broiler flocks.

The efficient control of *Salmonella* spp. in all parent flocks reduces the prevalence at the broiler production stage.

Salmonella-positive flocks should be excluded from the breeding chain. The flocks should preferably be destroyed or sent to slaughter and decontamination. The eggs should be destined for production of egg products where the elimination of salmonellae is achieved.

General management principles for breeder production:

- Buildings and facilities should be designed to prevent other animals from entering. Rodents, birds and insects have been shown to be a reservoir for salmonellae at primary production facilities. Pest control programmes should be in place. The outdoor environment should be such that other animals are discouraged from approaching the buildings.
- The interior surfaces in the buildings should be easy to clean and disinfect.
- Visitors to the facilities should be kept at a minimum.
- Feed and drinking water should be free from *Salmonella.* Feed production control and feed heat treatment are essential in preventing *Salmonella*-infections on farms. Serovars found in the feed-mills can often be found in the birds during rearing and/or slaughter. The risk for *Salmonella*- contamination is increased when the birds are given feed meal instead of pellets.
- Hygienic zones should be established with detailed routines and hygienic instructions for employees and visitors, handling of equipment etc.
- The houses including all equipment should be cleaned and disinfected between flocks and dry-out time should be respected before new flocks are introduced. The difficulties with cleaning and disinfection to get rid of *Salmonella* bacteria in broiler houses should be recognized. Ineffective procedures may aggravate the problem.
- An all in – all out strategy should be used.

Specific management strategies for breeder production:

- Ensure that incoming birds (future breeders) are *Salmonella*-free. This may require quarantine and sampling newly arrived birds (e.g. faecal or blood samples, lining of the box used for delivering the chicks, dead chicks).
- Positive animals should not enter the breeding stock.
- Test birds during rearing and production according to specific sampling schemes.
- Exclude *Salmonella*-positive flocks from the breeding chain. The flocks should preferably be sent for slaughter, until the infection has been successfully eradicated.
- Vaccines for specific serotypes (for example *S*. Enteritidis and *S*. Typhi-murium) are available. *Salmonella* live vaccines may interfere with bacteriological testing whereas killed vaccines may interfere with serological testing. The use of vaccination depends on the epidemiological situation. Vaccines have very little chance of eradicating *Salmonella* from an infected flock, but may decrease the infectious burden.
- Competitive exclusion. A mixture of normal intestinal flora [from SPF birds] may be given either as spray at the hatchery or in the transport crates or added to the drinking water to the day-old chicks. Competitive exclusion has been shown to effectively reduce the risk of *Salmonella* infection.
- Use of pre-biotics, pro-biotics or organic acids as feed supplements. Reduced colonization of the intestine by *Salmonella* in chickens has been demonstrated when feed has been supplemented with carbohydrate pre-biotics. Pro-biotics, mostly *Lactobacillus* species, have also been shown to reduce cecal colonization in broiler chickens. A substantially reduced susceptibility for *S.* Enteritidis colonisation in broilers fed fermented liquid feed containing high numbers of lactic acid bacteria and an increased concentration of lactic and acetic acid (pH approx. 4) has been reported. Addition of organic acids to feed has been shown to reduce the horizontal transmission of *Salmonella* species.
- Cleaning and disinfecting of houses before new birds are introduced. Where a flock is found to be *Salmonella*-positive the houses should be meticulously cleaned and disinfected before new birds are introduced. Sampling from various locations and equipment in the houses should verify that no *Salmonella* infection persists. Persisting *Salmonella* contamination of the house before introducing day-old chicks has been shown to be a significant risk factor.
- Due to questionable effect and the risk of resistant *Salmonella* strains the use of antibiotics[1] is not recommended, neither for prevention nor cleaning the flock of *Salmonella*. Some antibiotics may prolong the carrier –state in poultry and some may increase the numbers of salmonellae being shed. Several antibiotics have been reported to increase the incidence of *Salmonella* colonization.

Hatchery

The important role of the hatchery in the control of *Salmonella* spp. in broilers is well acknowledged and interventions at this stage can be very effective.

General management principles for hatcheries:

- Buildings and facilities should be designed to prevent other animals from entering.
- The interior surfaces of the buildings should be easy to clean and disinfect.
- The equipment used must be easy to clean and disinfect and should be cleaned and disinfected between each batch.
- Hygienic instructions (e.g. protective clothing and footwear) for the personnel should be in place.

[1] Antibiotics in this report refers to substances used or foreseen to be used for human medical or veterinary purposes

- The design of the hatchery and layout of rooms should reflect the principle of clean-dirty separation such that all activities beyond the point of transfer from the setters to the hatchers are considered dirty. Product and personnel should not be allowed to move freely from the dirty side into the clean side.

Specific management strategies for hatcheries:

- Purchase of eggs only from flocks tested *Salmonella*-free.
- If the above is not feasible then separate handling in time and location of eggs from *Salmonella*-infected flocks and *Salmonella*-free flocks should be used. Special cleaning and disinfection routines should be used after hatching of eggs from *Salmonella*-infected flocks.
- Sampling programmes should include testing dead chicks, chicken fluff, meconium and shells.
- Positive batches are sent for destruction or the chickens are kept separate from *Salmonella*-free flocks further along the food-chain. Trace back of the infection to the breeding flock of origin will allow measures to prevent further infection to be taken.
- Transportation of day-old chickens should be done in clean, disinfected and dry boxes and in clean and disinfected vehicles.

Broiler production

In the broiler production the same general management principles apply as for breeder production.

Specific management strategies for broiler production:

- Meticulous cleaning and disinfection routines following a contaminated flock. *Salmonella*-contamination of the house when day-old chicks are introduced is a significant risk factor
- Sampling to verify that no infection persists in the building and equipment before a new flock is introduced.
- Introduction of *Salmonella*-free day-old chickens. *Salmonella*-contamination of day-old chickens is a main risk factor for *Salmonella*-contamination of the flock.
- Competitive exclusion. (see breeder production)
- Use of prebiotics, probiotics or organic acids as feed-supplements. (see breeder production)
- Special attention to preventing litter-beetle infestation.
- Vaccination is not very effective at this stage. Should preferably be used at earlier stages in the production chain.
- The use of antibiotics is not recommended due to questionable effect and the risk of resistant *Salmonella* strains. (see breeder production)
- Sampling the flock before transportation to slaughter. This sampling should take place as late as possible during production while ensuring that the results are available before transportation. This will allow precautionary measures at slaughter and further down the chain (logistic slaughter and channelling) to be taken. Samples can be taken from dead birds, cloacal swabs, faeces or the litter-bed. Serological analysis can also be used, but the number of serotypes that can be detected will be limited.
- If thinning is used the number of “cuts” from a flock should be minimized. An all in –all out policy is recommended.
- Destruction of positive flocks or special slaughter and special treatment of the meat from positive flocks.
- Withholding of feed from the birds before transport to slaughter in order to decrease the risk for intestinal rupture during slaughter is widely applied. This practise may, apart from being controversial in terms of humane treatment of animals, be counter-productive since feed

withdrawal has been shown to markedly increase the incidence of *Salmonella* in the crop. The crop may serve as a major source of *Salmonella*- contamination in the slaughterhouse. However, lactic acid administered in the drinking water during pre-slaughter feed withdrawal can significantly reduce *Salmonella*-contamination in the crop.

- Yeast treatment may reduce *Salmonella* and *Campylobacter* populations associated with broiler chickens subjected to transport stress.
- Treatment that will kill *Salmonella* in manure from contaminated flocks.

Transport

General management principles for transport to the slaughter-house:

- Clean, disinfected and dry crates should be used for transporting chickens. Commonly used methods for washing and disinfecting crates are inefficient and washed crates are sometimes more frequently contaminated with Salmonella than unwashed crates. Improved hygiene management during transport of broilers can reduce the risk of Salmonella contamination of poultry meat.
- Vehicles should be cleaned thoroughly between transporting different flocks and, when necessary, disinfected.
- People involved in collecting chickens for transportation should follow basic hygiene rules.

Special management strategies for transport to the slaughter-house:

- The use of so-called broiler harvesters should be limited to uninfected flocks. If not, they should be carefully cleaned and disinfected between flocks.

ANNEX 2: DECONTAMINATION OF BROILER CARCASSES

Decontamination should be used as part of an overall strategy for *Salmonella* control throughout the whole production chain. Decontamination should not be used as the primary pathogen reduction measure or as a substitute for appropriate control measures at the production level or at the slaughterhouse.

As with any control measure before a decontamination compound or decontamination technique is used its efficacy and safety should be validated.

Organic acids, tri-phosphates, chlorine, chlorine dioxide are the chemical compounds that are usually used. Chlorine dioxide, acidified sodium chlorite and trisodium phosphate are effective against spoilage and pathogenic bacteria present on poultry carcasses in terms of reducing the pathogen load albeit not eliminating it. Chemical decontamination typically results in a reduction in salmonellae of $1 – 2$ [10]logs.

Decontamination with irradiation or ionisation is effective, however, public resistance against these methods has hindered its application in many countries even though scientific experts agree on the safety of these techniques.

The combined use of an inside – outside bird washers and an acidified sodium chlorite spray system has been shown to reduce the microbial load on chicken carcasses. The same has been reported for using electrolysed oxidizing water.