

GUIDELINES FOR CONTROL OF SALMONELLA IN FEED



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AB GIDA GÜVENLİĞİ**

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Funded under the EU Aid Program for the Turkish Cypriot community (TCc), the “TCc Food Safety Project” executed under the contract 2021/423-933 “Technical assistance to improve implementation of food safety standards and disease crisis preparedness”, strives to support faster social and institutional development of the Turkish Cypriot community and higher economic growth of its agri-food chain sector. The aim is to achieve improved food safety, public health, animal health, and protection of the environment, and to mitigate the impact of potential exotic animal diseases, in particular those posing imminent threats. The project started in May 2021 and will be completed in April 2024.

For more information about the project, you can visit the project’s website, and follow its social media account and contact the project team through the following communication channels:

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1. BACKGROUND

The “TCc Food Safety Project” executed under Contract 2021/423-933 - “Technical assistance to improve implementation of food safety standards and disease crisis preparedness” strives to support a faster social and institutional development of the Turkish Cypriot community (TCc) and a higher economic growth of its agri-food chain sector.

The project aims to achieve improved food safety, public health, animal health and protection of the environment, and to mitigate the impact of an imminent threat of potential exotic animal diseases.

This document was produced within the following project activity:

Prepare guidelines for stakeholders to complement the input delivered in specific trainings, workshops, and other capacity building activities.

2. INTENDED AUDIENCE

The intended audience of these guidelines are all feed business operators.

3. AIM OF THE GUIDELINES

These guidelines have been produced to assist the feed business operators in achieving the legal requirements of the Feed Hygiene Regulation (1) for minimizing *Salmonella* contamination all along the feed supply chain, whatever the serotypes.

The guidelines are also available to the public on the project’s Online Food Safety Platform: <http://tccfoodsafetyproject.eu/>. All parties involved in the food and catering sector should find them a valuable tool in their day to day operations.

4. INTRODUCTION

Each feed business operator is responsible for the safety of the feed they place on the market, in relation to feed safety requirements laid down in the Feed Hygiene Regulation (1).

Feed in which *Salmonella* has been detected does not meet the feed safety requirements and is therefore an unsafe feed. Feed containing *Salmonella* shall not be placed on the market or fed to any food-producing animal.

If the feed business operator or the authorities determine positive *Salmonella* finding in feed, they take the necessary measures to protect against health risks.

Feed containing *Salmonella* can be subjected to an appropriate treatment method that kills the *Salmonella* present. If there is evidence that the treatment method has killed the *Salmonella*, this feed can be placed on the market and fed to food producing animals.

According to the scientific opinion of the Panel on Biological Hazards of the European Food Safety Authority (EFSA) on the microbiological risk assessment of feed for food-producing animals (2), *Salmonella* is the main source of microbial contamination of animal feed. A continuous reduction in the occurrence of *Salmonella* in animal feed helps to reduce the occurrence of these pathogens in food.

In the legislation of the European Union, **no uniform criteria for *Salmonella* in feed have yet been established**. Where pet food is produced using animal by-products, specific requirements under the Animal By-products Regulation (3) apply to the production process and placing on the market.

This Guidelines are addressed:

- to the feed business operators, in particular primary production of feed, oilseed crushing, compound feed production, storage, transport, and distribution, and, with the aim to avoid *Salmonella* contamination as much as possible and
- to the local bodies with the aim of ensuring that further spread of these pathogens along the feed and food chain is effectively prevented when detecting feed contaminated with *Salmonella*.

The objective of these Guidelines is to minimize the *Salmonella* contamination all along the feed supply chain, whatever the serotypes.

These Guidelines are consistent with the requirements of the Feed Hygiene Regulation and consider the existing voluntary Guides to good hygiene practice developed by the European feed industry for the implementation of this Regulation including as well as the Recommendation for action on the handling of feed containing *Salmonella* developed by the German feed control authorities.

In accordance with the Feed Hygiene Regulation, feed business operators must apply good manufacturing practice or good agricultural practice and, in certain cases, a HACCP system in the production, storage, transport, distribution and feeding.

The feed hygiene requirements for feed business operators are described in the Guidelines for self-check for feed producers.

5. EPIDEMIOLOGICAL ASPECTS OF SALMONELLOSIS, WITH REFERENCE TO FEED

5.1 OCCURRENCE OF SALMONELLA IN FEED

The natural habitat of bacteria of the genus *Salmonella* is the intestines of animals and humans. As a result of a *Salmonella* infection, organs of the host are also colonized with these pathogens. Thus, the detection of *Salmonella* in feeding stuffs may indicate possible direct or indirect faecal contamination or the use of materials of animal origin contaminated because of infection.

Due to a relatively high stability in the environment, *Salmonella* can survive outside the human or animal organism for weeks or even months. Under favorable environmental conditions (nutrient supply, temperature, humidity), *Salmonella* can also multiply outside the human or animal organism. *Salmonella* is particularly common in protein-rich feed (e.g., soybeans, peanut flour, flaxseed flour) detected.

5.2 NOMENCLATURE AND PATHOGENICITY OF SALMONELLA

The genus *Salmonella* belongs to the family Enterobacteriaceae. Within this genus, two species (*Salmonella bongori* and *Salmonella enterica*) are distinguished; each of them can be subdivided into serovars or subspecies and serovars. In total, more than 2500 serovars can be distinguished today within the genus *Salmonella*.

Due to the adaptation of different serovars to certain host, 4 epidemiological groups can be distinguished (4):

- Serovars adapted to humans, which cause the diseases of typhoid fever and paratyphoid fever (*Salmonella* Typhi and *Salmonella* Paratyphi A, B and C).
- Serovars adapted to certain animal species which cause animal-specific diseases (pronounced clinical pictures, epidemic disease courses, e.g. *Salmonella* Dublin in cattle, *Salmonella* Choleraesuis in pigs). Human infections are rare, but in individual cases serious diseases occur.
- Serovars without specific host adaptation, which predominantly cause latent infections in animals; however, clinical diseases are also possible. In humans, these can cause food poisoning. This group includes the majority of Serovars known today.
- Serovars without specific host adaptation, which cause severe disease-like to latent infections in animals. In humans, they are the main pathogens of the so-called enteritis infectiosa. *Salmonella* Typhimurium and *Salmonella* Enteritidis are the main representatives of this group.

Regarding the pathogenicity of the various *Salmonella* serovars, EFSA emphasizes in its risk assessment (2): “Although only a minority of the serotypes isolated from animal feed is found to cause clinical disorders in animals, they may all be pathogenic to humans.” In this sense, ***Salmonella* strains of each serovar are to be considered as potential zoonotic agent.**

5.3 RELEVANCE OF FEED CONTAMINATED WITH SALMONELLA

Feed contaminated with *Salmonella* can cause animals to be infected with this pathogen and thus to enter these germs into the food chain. The relative importance of the introduction of *Salmonella* into livestock via contaminated feed varies. In regions with a low prevalence status where there is no endemic infection or where it is well controlled, *Salmonella*-contaminated feed is the main source of introduction of these pathogens into livestock production. In regions with a high prevalence, the relative importance of feed may be lower compared to other sources (e.g., trade of infected animals) for *Salmonella* infection, even if it is difficult to quantify (2). For example, EFSA’s quantitative microbiological risk assessments assume that feeding *Salmonella*-free feed to breeding and fattening pigs leads to a 10–20% reduction in *Salmonella*-positive carcasses in countries with high *Salmonella* prevalence. In Member States with a low *Salmonella* prevalence, a reduction of between 60 and 70 % is expected (5).

Contaminated feed is likely to be of relevance in the introduction of hitherto lesser-known *Salmonella* serovars into the food chain. A typical example of this is the spread of *Salmonella* Agona. After the introduction of this pathogen via contaminated fishmeal into poultry flocks in the USA and various European countries at the end of the 1960s, a sharp increase in *Salmonella* Agona infections in humans was observed there. In the USA, *Salmonella* Agona is now one of the most isolated serovars from human cases. It is assumed that during the period from the introduction of this serovar over contaminated feed more than one million human cases by 2001 were caused by this pathogen (6).

In 2009/2010, a case of human-related *Salmonella* infection in Austria could be traced back to contaminated feed using molecular biological methods. In 2009/2010, one hundred and fifty confirmed human diseases caused by *Salmonella* Mbandaka occurred here, which could be attributed to the consumption of eggs and egg products contaminated with this pathogen. The laying hen populations from which these eggs originated were supplied with feed contaminated with this pathogen (7).

The scientific literature describes many other cases in which infections in humans, but also in livestock and pet animals, can be traced back to contaminated feed. A summary overview can be found e.g. at Jones (2011) (8).

6. ASSESSMENT OF FEED CONTAINING SALMONELLA

Salmonellosis in humans is primarily due to the ingestion of contaminated food, in various cases contamination of food of animal origin with these pathogens could be causally attributed to feed contaminated with *Salmonella*. Since all *Salmonella* serovars are potentially pathogenic to humans, feed in which *Salmonella* has been detected does not meet the feed safety requirements and is therefore classified as unsafe feed.

Against the background of *Salmonella* exposure, it can be assumed that feed containing *Salmonella* can affect human and animal health. This applies regardless of the concentration at which *Salmonella* occurs in feed, as these pathogens can multiply in the feed itself and small amounts of pathogens (< 1 CFU/mg) may be sufficient to trigger an infection, especially in young animals and animals with limited immune defense (2, 9). Thus, feed for food-producing animals must not contain bacteria of the genus *Salmonella*, both for reasons of protection of human health and for reasons of maintaining the health and performance of farmed animals.

Feed in which *Salmonella* has been detected may not be placed on the market or fed to food-producing animals, irrespective of which *Salmonella* serovars are involved.

These provisions for feed for food-producing animals also apply in principle to petfood. It should be noted that due to the frequent close contact between pets and their owners, transmission of *Salmonella* from infected pets to humans may be possible (fecal-oral pathogen transmission).



7. MEASURES TAKEN BY THE FEED BUSINESS OPERATORS TO AVOID SALMONELLA CONTAMINATION

7.1 GENERAL REQUIREMENTS

Each feed business operator is responsible for the safety of the feed he places on the market, in relation to feed safety objectives laid down in the Feed Hygiene Regulation.

Each feed business operator shall have and implement a quality management system that creates a common approach to minimize the *Salmonella* contamination all along the feed supply chain. This includes preventive actions, monitoring and/or verification plans and corrective action to minimise *Salmonella* contamination and re-contamination within the scope of responsibility of each feed business operator of the feed supply chain.

Feed business operators involved in the primary production of feed (including agricultural mixtures, except where additives and / or premixes are used) and / or the feeding of animals must apply good agricultural practice and a risk-based approach to microbial quality of feed.

All other feed business operators, except primary production, shall implement the good manufacturing practice and introduce the Hazard Analysis Critical Control Point (HACCP) principles.

Good agricultural practices and good manufacturing practices must be followed to achieve and maintain a high level of feed safety, including avoiding contamination of feed with *Salmonella*.

The requirements of the Feed Hygiene Regulation are described in detail in the Guidelines for self-control for feed producers.

7.2 REQUIREMENTS FOR FEED BUSINESS OPERATORS, EXCEPT PRIMARY PRODUCERS

The following applies to feed business operators, except primary producers (10):

- Implementing pre-requisite programs aimed at prevention of *Salmonella* entering the products flows as mentioned in the relevant European Guides to good practices.
- Controlling processes, especially related to prevention of growth and to reduction of *Salmonella* in the heating or disinfection steps.
- Controlling the *Salmonella* status of the premises via a monitoring program targeted at predefined areas and equipment, focusing where relevant on areas after the heating or disinfection steps, where re-contamination or growth can take place.
- Preserving processed feed from contamination during processing, collection, storage, trading, and transport, e.g. by closed systems, hygiene practices, or by separating the premises into hygienic zones as appropriate.

To achieve this, the feed business operator shall:

- Define control points in the process, based on risk assessment.
- Establish the *Salmonella* status in the feed business via a monitoring program at predefined areas/equipment. The purpose of the monitoring plan is to verify that the processes are sufficiently controlled and to check for the presence of *Salmonella*; a further serotyping can be performed.
- Set a realistic target for improvement based on the continuously updated *Salmonella* status of the feed business.
- Repeat the sampling routinely to monitor the performance against the target, the frequency of sampling to be based on the risk assessment of the process performed and the products handled in the premises.
- Regularly review the monitoring program on the basis of the findings (i.e. the *Salmonella* status), the information collected from feed chain partners and the targets for improvement.

Along the supply chain, feed business operators shall have measures in place to minimize and if possible, avoid the risk of introduction of *Salmonella* to their establishment from incoming materials. This means:

- The business operators responsible for transport shall ensure that transport is undertaken in good hygienic conditions, e.g., the transporter should have undergone a risk assessment and developed a hygiene plan.
- Ensure incoming feed is from reliable sources (e.g.: through screening / evaluation of suppliers and approval of each new supplier by the purchaser; using the results of monitoring and data on feed, when performed by the supplier, or guarantees that appropriate hygiene or guarantees that good hygiene practices/risk based procedures have been followed in the case of feed coming from/originating from on farm production).
- Monitoring the *Salmonella* status of incoming materials if the supplier neither applies adequate process control measures nor monitors final feed *Salmonella* status.

To ensure an appropriate transfer of information throughout the chain, feed business operators should strive to make available, at customer request, relevant microbiological information.

In the following, the measures to control and to minimise the contamination of feed with *Salmonella* are explained using the example of compound feed manufacturers. (10)

7.2.1 Prevention

Prerequisite programs shall be implemented to avoid contamination of the premises via sources such as rodents, birds, waste materials, personnel movements etc. The installation and equipment shall be designed in such a way as to facilitate cleaning and to avoid growth of *Salmonella*. Such good prerequisite programs are already defined in the Feed Hygiene Regulation and described in the Guideline for self-checks for feed producers.

7.2.2 Defining Control Points at Feed Compounder Level

If a Critical Control Point (CCP) is defined in a feed business, preserving processed product from contamination by separating the premises into unclean area (prior to CCP in process) and clean area (after the CCP in process).

Control points (CP) shall be defined in relation to the *Salmonella* risk. Feed business operators may identify one or several CPs. If a CCP is identified, no control point is needed before that CCP unless they are needed to secure the functionality of the CCP. Microbiological objectives may be different depending on animal species. Similarly, CPs may differ depending on the type of feed being produced; (e.g. meal vs. pellets).

Typical control points in a compound feed establishment are:

- **Analytical control at reception of incoming feed materials and premixtures:** where there is no CCP further on in the process, the *salmonella* risk management objective is to monitor *Salmonella* entering the feed mill. In some instances, incoming feed is rejected or treated before being accepted in the feed establishment or action taken to change the supplier. Analytical control of incoming feed shall focus on those at-risk. Such a control point is not easy to handle, because of the time required before analytical results are known. If there is a CCP further on in the process, analytical control at reception of incoming feed serves a screening/evaluation of suppliers and improvement purpose.
- **Heat treatment/pelleting:** at-risk feed materials or compound feeds may be subject to heat treatment that reduces/controls *Salmonella*. The control focuses on heat treatment parameters (time/temperature/moisture) or microbiologically defined objectives; in the latter case this point may serve as a CCP.
- **Chemical treatment:** this process aims at inhibiting/controlling *Salmonella*. Controls are based on records of quantities of chemical substances used. Such chemical treatment is mostly used on feed materials but may also be used for compound feed.
- If a CCP is defined, analytical control of samples of deposition of dust within processing equipment from CCP and onwards in the process (i.e. inside coolers, conveying systems, final feed silos and transport vehicles).

Analytical control of samples of final feed alone is not adequate to measure the efficiency of the CPs and CCPs within the process but serves as a verification tool.

7.2.3 Monitoring / Verification

A monitoring plan for *Salmonella* shall be established by feed producers, for incoming materials focusing on those of higher risk.

A *Salmonella* monitoring plan shall be established to identify possible contamination during the process and help understanding the reason for contamination in the process. This monitoring plan is based on risk assessment and is redefined when needed based on results of previous monitoring plans or process changes.

Whenever a control point (CP) is defined, the monitoring plan shall focus on it. Sampling at subsequent points in the process will verify the effectiveness of the CP. The monitoring plan should focus on the processing equipment and if applicable, the environment.

The *Salmonella* monitoring results will be used to verify whether the HACCP plan, including all process control points, pre-requisite programs and corrective actions taken are effective in controlling *Salmonella*.

FOCUS OF A MONITORING PLAN FOR SALMONELLA IN A FEED ESTABLISHMENT

Incoming Feed	If there is no control step further on in the process, feed materials, premixture and additive deliveries – the frequency should be based on high, medium, or low risk – composite samples are acceptable by incoming feed type. Consider whether the data are already available from the supplier.
Buildings	Samples from ledges, walls, and floors – either dust or swab samples – samples from dust units and vacuum cleaners may be included.
Plant and Equipment	Loading equipment, elevators, conveyors, dust filters, intake and loading areas in stores – either dust or swab samples. Intake, grinding, weighing, hand addition, mixing, pelleting, cooling, conveying, and packing areas in manufacturing plants as appropriate to process type and risk – either dust, feed, or swab samples.
Storage Areas	Storage bay walls and floors – dust or swab samples. Storage bin tops (inside and outside) and out loading areas – dust or swab samples.
Finished Feed	Finished feed by feed or process type – composite samples are acceptable – frequency based on high, medium, and low risk.
Vehicles	Sheets, covers, internal bodies, rear door or hatch and blower units of bulk vehicles – dust or swab samples; Buckets and vehicle bodies of loading shovels – dust or swab samples.

Any findings of *Salmonella* should be further investigated, particularly if the same serovar is repeatedly found in cooler areas, pellet shakers or dust aspiration.

7.2.4 Corrective Actions

The action to be taken following the determination of *Salmonella* will depend on the circumstances of the detection and the existence of CP/CCPs in the process.

CORRECTIVE ACTION TO BE TAKEN FOLLOWING THE DETERMINATION OF SALMONELLA

Incoming Material	<p>If reception is a control point, the following actions shall be considered:</p> <ul style="list-style-type: none">▸ Restricted use if there is no CCP further on in the process; or▸ Decontamination of feed materials;▸ Handling in agreement with the supplier (where appropriate). <p>Otherwise</p> <ul style="list-style-type: none">▸ Clean and flush intake, routes and storage;▸ Vehicle cleaning (whether own vehicles or third party);▸ Consider additional cleaning of plant and equipment; and▸ Review of test frequency and test results on incoming feed.
Processing Equipment	<p>If a control point is identified in the manufacturing process, the following actions shall be considered:</p> <ul style="list-style-type: none">▸ Review of parameters of the decontamination process (heat treatment); and▸ Consider additional cleaning of plant and equipment after the CP/CCP;▸ Consider additional training or changes in process or procedures. <p>Otherwise</p> <ul style="list-style-type: none">▸ Cleaning of plant and equipment;▸ Controls of rodents in case of repeated contamination that cannot be related to incoming feed.▸
Finished Products	<ul style="list-style-type: none">▸ Carry out traceability to identify the source of contamination; Review processing conditions and relevant pre-requisite programs;▸ Review previous monitoring results;▸ Additional cleaning of storage and vehicles (where appropriate);▸ Additional cleaning of plant and equipment;▸ Review of test frequency and test result on finished feed;▸ Introduction of corrective and preventive actions;▸ Information of the customer if relevant;▸ Handling in agreement with the customer (where appropriate);▸ Consider additional training or changes in process or procedures.

7.3 REQUIREMENTS FOR PRIMARY PRODUCERS OF FEED

The following applies to primary producers/farmers (10).

7.3.1 Prevention Measures

MEASURES FOR PREVENTION FOR SALMONELLA ON FARM LEVEL

PREMISES, EQUIPMENT, MACHINERY, AND PERSONNEL

- Farmers shall pay attention to the immediate surroundings of the buildings and control the potential “external” sources of contamination. Buildings and facilities should be regularly inspected.
- The premises shall be designed in such manner to reduce the risk of vermin and wild birds gaining entry.
- Farmers are also advised to pay attention to pest control.
- Facilities and premises used for producing, loading unloading and/or storing feed shall be separate from areas used to house animals or store their waste or store any other potential contaminants. In case the separation between these different premises/buildings proves unpractical, “physical” separation of activities shall at least be ensured.
- Storage areas, equipment and machinery should be regularly cleaned (and if necessary disinfected).
- For that purpose, premises, equipment, and machinery in contact with feed should be maintained in dry condition whenever possible and kept clean from manure.
- The farmer or the contractor performing the cleaning shall be trained and have adequate equipment and material for cleaning and disinfection.
- Measures to prevent possible contamination from workers/ in contact with animals and feed shall be in place (e.g. adequate access to washing facilities for personnel to sanitize their hands, footwear and if necessary clothing before entering the premises, regular cleaning of cloakroom and toilet facilities clear policies on smoking and drinking on site etc.). Where appropriate, this should also include training measures on safety practices and adequate information on major risks of contamination.

PRODUCTION AND STORAGE OF FEED

Several precautionary measures are to be taken to maintain feed products under required storage conditions:

- Storage areas for dry feed shall enable goods to be maintained in a clean, dry, and orderly condition. For that purpose, storage areas and stores clamps must have sufficient drainage.
- Effective measures must be in place to control the possible contamination arising from livestock activities.

In particular, farmers must ensure that livestock buildings do not drain onto the production or storage facilities or onto their access. Removal of waste water must be kept away from feed storage and feed storage areas and precautionary measures should be taken when spreading manure to avoid the contamination of surface waters.

If the areas used for production, loading, or unloading of feed cannot be kept separate from the facilities dedicated to livestock activities, the buildings used to house animals or store their waste must have been thoroughly cleaned to remove all organic material and dried prior to storing feed.



INCOMING FEED MATERIALS

The supplier is legally responsible for ensuring the safety of the feed that is delivered to the farmer. The farmer shall also seek for guarantees that appropriate measures are taken by the supplier to minimize the risks of contamination:

- Firstly, farmers must only purchase feed from registered or approved suppliers.
- On delivery, farmers should also check that the feed or feed ingredients delivered conform to order and that the relevant paperwork is correct. Visual indicators (e.g., split bags and mould) may provide information on potential contamination. This should be immediately reported to the supplier who will determine a course of action with the farmer.
- If the farmers believe that the feed delivered does not satisfy appropriate feed safety criteria, they should ask for additional information data from their supplier (e.g., results of monitoring and controls on *Salmonella* at process or product level which may have been performed).
- In the absence of sufficient guarantees from their supplier, the farmers would still have the option to refuse the product. If they do accept the product, the farmers shall then carry out appropriate sampling tests to check the *salmonella* status of incoming product.
- Farmers must retain the delivery notes so that traceability of all feed can be demonstrated.

FEEDING ANIMALS

- Feeding and bedding areas should be cleaned from contaminants.
- Livestock shall have access to clean water suitable for animal consumption. For that purpose, it is required to observe application rates and minimum distance requirements when using slurry or manure near source of water.
- After spreading manure, sufficient period needs to be respected before grazing.

7.3.2 Monitoring/Verification Measures

Sampling/monitoring measures are to be considered in the light of relevant legal texts on the control of *Salmonella*.

In addition to 'official' samples taken as part of national monitoring programs, farmers should also consider taking additional samples to check the status of the feed that is distributed to animals (feed produced and purchased feed), in the following cases:

- When own compound feed is produced, farmers should take and retain representative samples of both the dry feed ingredients and the finished feed whenever the batches of ingredients or formulations are changed. These samples should be stored under conditions that prevent abnormal change in the composition of the sample or adulteration and should be labeled to clearly show the type of feed and the date they were taken.
- When purchasing feed, the farmers are expected to take suitable random sampling measures in the absence of guarantees from their supplier for the safety of the product supplied.

The farmer should also ensure that record-keeping systems are in place in the farm.

Farmers should keep records on:

- The names and addresses of the suppliers of all raw materials, additives, premixtures or compound feed.
- All information on *Salmonella* control applied by the supplier and any microbial monitoring results received from the supplier in case the farmer requests additional information from him.
- Details of where feed were stored.
- Detailed feed formulation of all mixes made on the farm, along with the date each formulation was used and ended.
- Records providing details of the feed that was produced and when.
- The batch number if one exists.
- Any complementary feed or mineral feed used, how much was used, in which feed it was incorporated and when it was used.
- The use of pesticides and biocides, including name of product, date purchased, date used, and on which surfaces of which equipment/facility.
- The use of plant protection products (herbicides, fungicides, and pesticides) on all growing or stored crops (including grass and forage crops) used for animal feed.
- The use of genetically modified seeds, including the variety and amount of any genetically modified seeds bought and planted for feed crops.
- Any occurrence of pests or diseases that may affect the safety of primary products.
- The results of any testing carried out on samples taken from primary products or other samples taken for diagnostic purposes that have importance for feed safety.
- Any additional documentation that demonstrates that specific hazards have been addressed.

7.3.3 Corrective Actions

Good traceability controls are essential to identify potential sources of contamination. If a source of contamination has been identified during operation, specific decontamination measures must be taken.

If feed contamination is confirmed in purchased feed, farmers should make appropriate arrangements with the supplier.

If contamination is found in home-made feed, farmers should try to identify the source of the contamination and clean up the storage, handling, and mixing areas.

Detection / isolations of *Salmonella* should be reported to the responsible local bodies.

8. MEASURES IN CASE OF SALMONELLA CONTAMINATION

8.1 MEASURES TAKEN BY THE LOCAL BODIES

If the local body becomes aware of a positive *Salmonella* result (e.g., result of an 'official' sample test, notification of the results of the feed business operator's own control or RASFF reports) it must take appropriate measures.

If feed containing *Salmonella* has already been placed on the market, the local body takes measures:

- to prevent feed that has not yet reached the user from being placed on the market by other market participants or
- to ensure that contaminated feed is withdrawn by traders.

A feed ban should be issued for feed containing *Salmonella* that has not been placed on the market and is intended for direct feeding.

If feed containing *Salmonella* is to be subjected to a suitable treatment process, the local bodies may order a provisional seizure of the feed until this has been carried out.

If the local body determines that feed contaminated with *Salmonella* has been delivered to other livestock farms, other local bodies responsible for monitoring the animals concerned may also have to be informed.

After feed containing *Salmonella* has been subjected to a suitable treatment process that kills the pathogens present, the feed may be placed on the market again or fed to food-producing animals.

8.2 MEASURES TAKEN BY THE FEED BUSINESS OPERATORS

As soon as a *Salmonella* contamination of feed has been detected, the responsible feed business operator must take the necessary measures to protect consumers. The measures should be controlled by the local body. These include in particular:

8.2.1 Notification, Withdraw and Recall

When feed business operators are aware (e.g., results of self-checks) or have a reason to believe (e.g., information that feed materials contaminated with *Salmonella* have been processed) that a feed imported, manufactured, processed, or sold by them is contaminated with *Salmonella* and therefore does not meet the requirements for feed safety, they must:

- initiate proceedings without delay to withdraw the relevant feed from the market, and
- inform the local body of the measures he already has taken and cooperate closely with the local body.

If the feed is withdrawn, the feed business operator takes precautions to prevent cross-contamination with *Salmonella*.

If feed business operators use PCR methods for the detection of *Salmonella* as part of self-checks, a positive PCR result is considered a reason to believe that the feed may not meet the feed safety requirements. FBOs are obliged to:

- to notify the local body immediately, and
- to inform the local body of the measures it has taken to avoid a risk from the use of such feed.

8.2.2 Cleaning and Disinfection Measures

If necessary, production, storage and transport facilities that have come into contact with feed containing *Salmonella* must be disinfected in order to prevent cross-contamination with *Salmonella*.

Thorough cleaning beforehand is a basic requirement for successful disinfection. Cleaning methods must be used that do not aerosolize contaminated material. Automated dry cleaning with the aid of vacuum cleaners largely fulfills this requirement.

After cleaning, disinfection must be carried out taking into account the concentration and exposure time of the respective preparation. It is recommended that feed business operators use preparations with bactericidal properties that are approved as disinfectants for the food sector.

For the disinfection of feeding systems in animal stables, the disinfectants for animal husbandry can also be used. Before resuming production, all disinfected surfaces must be completely dried.

8.2.3 Investigations Into The Cause of The Salmonella Contamination

The feed business operators should identify entry routes or recontamination processes for *Salmonella* in their establishment. On this basis, the feed business operators should adapt his HACCP concepts or their internal procedures and documents in order to prevent future *Salmonella* contamination.

Farmers should adapt their practices and documents to ensure compliance with the good agriculture practice and the good feeding practice.

For example, the following measures should be considered:

- Consideration of *Salmonella* in the hazard analysis within the framework of the HACCP concept.
- Procedures for dealing with *Salmonella* contamination.
- Pest control programs considering the risk of introduction of *Salmonella*.
- Cleaning and disinfection plans.
- *Salmonella* monitoring program, which takes into account both the process and the product hygiene (e.g., procedures for checking *salmonella*-reducing or -killing procedures; regular inspection of the incoming feed materials, initial checks of the produced feed; if necessary, testing of environmental samples in the form of dust and/or swab samples; modification of the number of samples as part of the *Salmonella* monitoring in produced feed or environmental samples).
- Procedures for the definition of batches for better identification and separation of contaminated feed.

- Methods of sampling and testing of retention samples.
- Handling of dusts from filters, residues from extraction devices, or residues from pellet presses in the process of feed production.
- Consideration of possible environmental contamination.

9. TREATMENT OPTIONS FOR FEED CONTAINING SALMONELLA

The aim of the treatment of feed containing *Salmonella* is **the complete inactivation of the *Salmonella*** contained in or on the feed in order to prevent these pathogens from entering the food chain and to maintain the health and performance of the animals.

In practice, chemical processes (**application of antimicrobial substances**) as well as physical processes (in particular **thermal or hydrothermal as well as thermal-mechanical processes**, in the case of pet food, the use of ionizing radiation in individual cases) are used for the treatment of feed containing *Salmonella*.

The pathogen-killing effect of treatment methods is also influenced by the properties of the relevant feed (including composition, water content, and pH value). Furthermore, different *Salmonella* serovars can vary significantly in their heat and pH tolerance. Therefore, the success of a pathogen-killing treatment must be demonstrated in an appropriate form. This can be done, among others, by appropriate sampling and testing or by providing evidence of the effectiveness of the treatment process.

If it was subsequently determined that compound feed was produced with feed materials containing *Salmonella* and pathogen-killing methods were used during the production process, the effectiveness of the process must be demonstrated (e.g., proof of compliance with the required process parameters).

If pathogen-reducing methods were used during the production process, the samples of the compound feed produced may also be used to prove the success of the treatment regarding the pathogen-killing effect. It must be ensured that the sampling and testing enable the effectiveness of the method to be assessed.

9.1 TREATMENT METHODS WITH PATHOGEN-KILLING EFFECT

9.1.1 Pelletizing In Combination with Long-Term Conditioning

If pelleting takes place in combination with long-term conditioning (conditioning process parameters: temperature $>85^{\circ}\text{C}$, exposure times > 4 min), based on the current state of knowledge, it can be assumed that existing *Salmonella* are safely inactivated. To prove the success of the treatment, compliance with the above - mentioned requirements for the conditioning process parameters must be demonstrated.

9.1.2 Pressure Conditioning (Expanding/Extruding)

During expansion/extrusion, the compound feed in pressure vessels is exposed to high pressures at high water vapour addition (thermal-mechanical treatment). Process temperatures of $> 110^{\circ}\text{C}$ are reached over several seconds and a pressure of > 25 bar builds up. When leaving the expander / extruder, the pressure suddenly drops on that of the environment, which leads to a destruction of the cell membranes in vegetative bacterial cells. Thus, a safe inactivation of existing *Salmonella* can also be assumed in these procedures (7; 11). To prove the success of the treatment, compliance with the above - mentioned requirements for the conditioning process parameters must be demonstrated.

If the process parameters listed above are not adhered to during pelleting in combination with long-term conditioning or during pressure conditioning, a reliable kill of *Salmonella* cannot be assumed. The success of the treatment must therefore be proven, as with treatment methods with a pathogen-reducing effect.

It should be noted that after successful thermal or hydrothermal hygienization, the feed can be contaminated again at any time. In particular, cooling processes that follow the toasting process in the production of extraction meals or the pelletizing process of compound feed require special attention. If the cooling device is not correctly dimensioned/constructed, condensation water can form in the thermally treated feed. If, for example, *Salmonella* is introduced into the cooling process via ventilation, it can multiply massively in areas with condensation and thus lead to permanent contamination of the production plant and the feed produced in it.

9.2 TREATMENT METHODS WITH PATHOGEN-REDUCING EFFECT

9.2.1 Pelletizing In Combination with Short-Term Conditioning

Pelletizing in connection with short-term conditioning (conventional pelleting) usually only leads to an effective increase in temperature on the surface of the pellets, so that a reduction, but not always a reliable killing of *Salmonella*, can be assumed. If this method is used for the treatment of feed containing *Salmonella*, the success of the treatment shall be demonstrated. This can be done by sampling and subsequent microbiological testing. Sampling and testing must enable the effectiveness of the method to be assessed.

9.2.2 Use of Antimicrobial Substances

In practice, mainly organic acids (e.g., propionic, formic, or lactic acid) or salts of organic acids as well as combinations of these products are used. The effect of the antimicrobial active substances depends on many factors; in particular the concentration of the active substance used, the exposure time, the type of treated feed and the level of *Salmonella* concentration play a decisive role.

In the scientific literature and in various product descriptions it is pointed out that significant reductions of *Salmonella* contamination in feed can be achieved using **antimicrobial substances**. It should be noted, however, that a significant reduction in *Salmonella* is not to be equated with a complete inactivation of these pathogens. Therefore, when using antimicrobials, the following must be considered:

- Compliance with the manufacturer's information on the concentration and exposure time of the product concerned to inactivate *Salmonella* present in feed.
- The success of the treatment must be proven. This can be done by sampling and subsequent microbiological testing. Sampling and testing must enable the effectiveness of the method to be assessed.
- In principle, when using organic acids, it can be assumed that a significant reduction in the *Salmonella* concentration requires mixing rates of >1%, in the case of more heavily contaminated raw materials, even 2-3%, as well as several days of exposure time (7, 12, and 13).

Since the effect of antimicrobial substances can persist over a longer period of time after their admixture, a certain protection against recontamination is given.

There is some information on the treatment requirements which is also prescribed in the EFSA - Opinion 2008 (2).

The use of chemical substances for reduction of *Salmonella* in feed depends on the legal Regulations. The practice in the EU is as follows:

- In the Regulation (EU) No 528/2012 on the market and use of biocidal products (14) the former product group 'products for disinfection of food and feed' was deleted. Therefore, no disinfectants may be used to disinfect feed in the EU.
- The use of feed additives authorized in the category 'technological additives' and in the functional groups 'preservatives' or 'hygiene condition enhancers' in accordance with Regulation (EC) No 1831/2003 on additives for use in animal nutrition (15) is permitted to reduce *Salmonella* in feed. Organic acids such as propionic acid, formic acid, lactic acid, etc. and their salts, but also mixed preparations are suitable for reduction of *Salmonella* in feed. Powdered preparations, are less effective and segregate themselves easily, but are less corrosive. Liquid preparations are easier to mix and are more effective but have the disadvantage of being extremely corrosive to the system.
- The renewal of the authorization of formaldehyde, which was formerly used as a very effective means of reducing *Salmonella*, as a feed additive, belonging to the category 'technological additives' and to the functional groups 'preservatives' and 'hygiene condition enhancers', was denied (16).

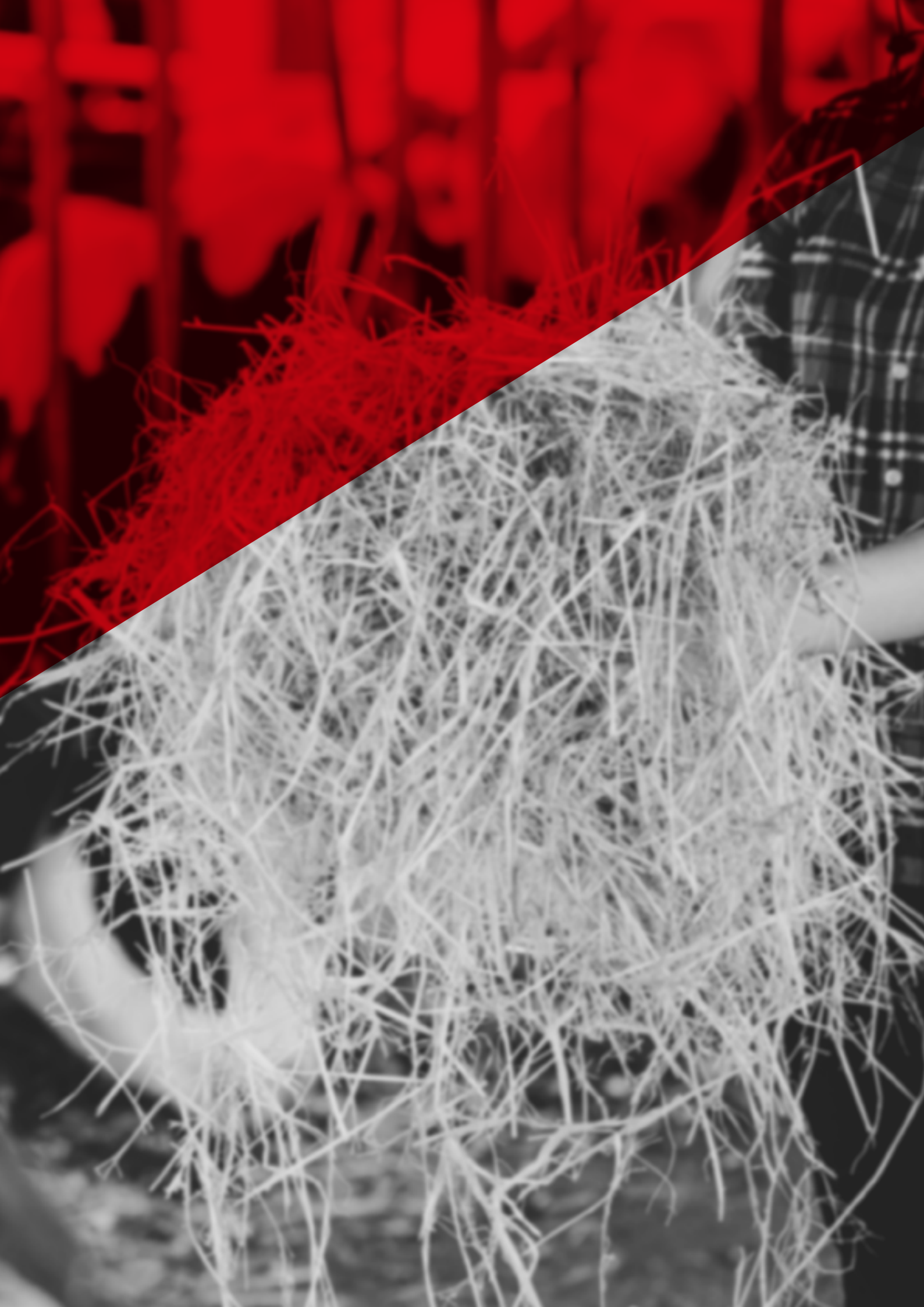
It is therefore up to the feed business operator to decide on the measures to be applied in his business, bearing in mind that the available measures should be adapted to the specific conditions.

9.2.3 Use of Ionizing Radiation

There are currently no specific regulations in the European Union for irradiation of feed. The irradiation of feed is therefore permitted if, after this treatment, the feed meets the requirements of the feed safety. In the absence of standard procedures for the treatment of feed containing *Salmonella*, the feed business operator must demonstrate to the local body that the method used is suitable for safely killing *Salmonella*.

9.3 DESTRUCTION OF FEED

If the contaminated feed cannot be treated or if this is not considered by the feed business operator, e.g., for economic reasons, the feed may have to be disposed of safely. The feed business operator must provide evidence of the safe disposal.



10. SAMPLING AND TESTING

10.1 SAMPLING

Salmonella is distributed non-uniformly throughout the feed. When taking samples, the quantitative requirements for individual samples for testing components or substances that may be non-uniformly distributed in the feed are to be applied. Therefore, the appropriate sampling method of the Regulation on Sampling and Analysis (17) should be used.

Since *Salmonella* can occur not only in feed but also in the environment (e.g., dusts), special precautions must be taken when taking samples. Contamination of the sample with *Salmonella* during sampling and sample transport must be avoided (false positive results). Therefore, specific procedures for microbiological or sterile sampling should be used.

10.2 SAMPLE TESTING

'Official' samples for *Salmonella* should be tested in accredited laboratories based on the method EN/ISO 6579:2002 (18).

The sample is used for pre-enrichment (reactivation) of *Salmonella* spp. incubated in buffered peptone water. This is followed by selective enrichment of the *Salmonella* in two different selective nutrient solutions and cultivation on two different solid selective nutrient media. Colonies suspected of *Salmonella* can be checked serologically, biochemically and by testing with O-1-bacteriophages to determine whether they belong to the *Salmonella* genus.

11. OTHER ISSUES

There are no official statistics/data available regarding general information about microbiological load of *Salmonella* in feed (log CFU/g and feed factory surface areas (log CFU/cm²) or levels of *Salmonella* most concentrated in feed factories. The last EFSA - Opinion on *Salmonella* in feed provides an overview about the prevalence of *Salmonella* in feed (2).

Microbial load is very variable and depends on the specific conditions (type of feed, processing, storage, region etc.). A *Salmonella* - monitoring would therefore have to be carried out in order to get an overview of the situation in the respective country.



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