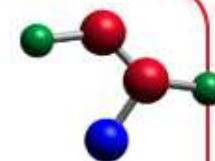


Total Mill Hygiene from intake to out loading

Microbiological risk in feed mills

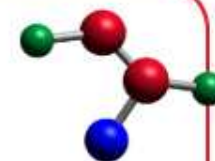
Presented by Dr. Luis Conchello, Kemin Agrifoods Europa N.V.

Presented for AFMA FORUM 2010, 2-5 March, Sun City, South Africa.



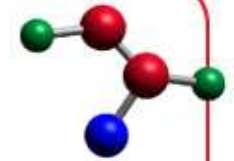
Outline of presentation

- Why Feed Hygiene
- Major Risks
- GMP & HACCP
- Microbiological Criteria
- C&D
- Strategies to Control Salmonella
- Decontamination; Standard Test Model
- Sampling
- Conclusions and Recommendations



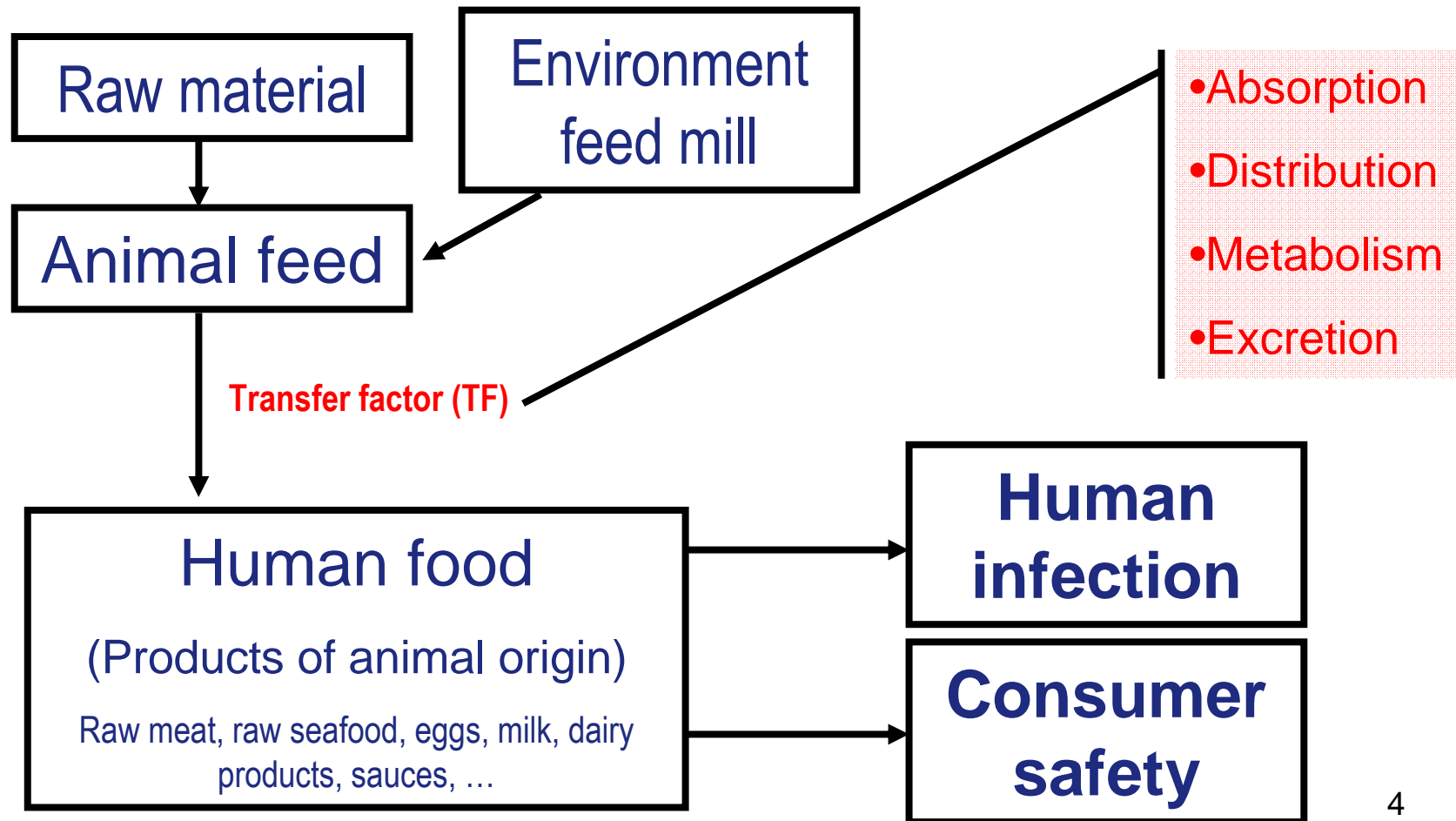
Why feed mill hygiene?

- We must produce safe feed
 - Legislation and International Trade requirements
 - Animal Health and Performance
 - feed mill hygiene has beneficial effects on the health and performance of the animals.
 - Food Safety and Consumer Safety implications



From feed safety objectives to food safety objectives

Unsafe feed = if it makes the food derived from food-producing animals unsafe for human consumption

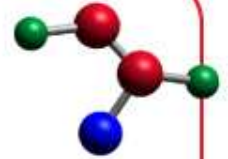




Major biological hazards and high risk materials

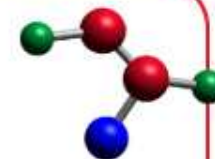
- **Salmonella spp.**, *Escherichia coli* O157: H7, *Listeria monocytogenes*, and *Clostridium sp.*
 - *S. Enteritidis* amongst serotypes isolated from eggs and broiler meat
 - *S. Typhimurium* predominates in isolates from pig meat, and is also prominent in isolates from beef and chicken.
- **Oil seed meal** and **animal derived protein** are the major risk feed materials for introducing *Salmonella*
 - Animal and fish derived protein including e.g. meat and bone meal (MBM) and fish meal as well as vegetable proteins derived of soya bean, rape seed meal and palm kernel could be regarded as high risk products.
- Several of the *Salmonella*-positive feed materials of both animal or plant origin, as well as industrial compound feed are produced in industrial processes (rendering and crushing plants and feed mills) where *Salmonella* should have been destroyed due to high temperatures employed in the production processes. This is caused by **recontamination** during cooling and further handling.

HACCP and GMP/GHP should be ensured

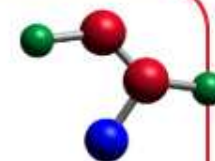


- Effective implementation of the **7 principles of HACCP** and **11 programmes of GMP**
 - **Dust control** (control introduction and from rework, aspersion) from raw materials unloading, in the production line and in the cooling air
 - **Cleaning** and disinfection programmes
 - Design the feed factory with **two zones** totally separated
- Starting control already at the **crushing plants**
 - The importance of starting the control already at the crushing and the rendering plants is emphasised in contrast to the currently often applied practice to focus only on the feed mills.
- Control of **decontamination** (Standard test model)
- Avoiding **recontamination** and preventing the microbial multiplication
 - Salmonella can be found on **equipment surfaces** in contact with the feed and in the dust particles.
 - **Dust particles** carry *Salmonella* and is important route for the spread of contamination
 - **Condensation**

HACCP and GMP/GHP should be ensured

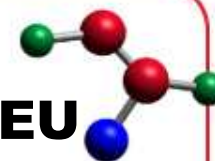


- Establishment of microbiological criteria for *Salmonella* contamination
 - Sampling of dust in filters or other equipment **in the processing line** is a good indicator for the presence of *Salmonella* in the mill. In some countries the *Salmonella* control programme for feed mill is based on scrapings from different parts of the processing line, and not on testing of feed materials or finished feed.
 - Sampling of dust in **raw materials reception** is a good indicator if *Salmonella* is present in the material and it is an introduction source for a endemic contamination in feed mill
 - Most probably feed is contaminated by *Salmonella*, which is spreading from raw material, rodents, birds or dust.



EU: Commission Regulation on microbiological criteria for Salmonella contamination in feedstuffs and feed mills

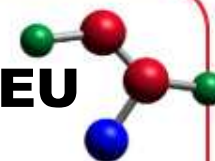
Feed or sample category	Micro-organisms	Sampling -plan		limits	Analytical reference method	Stage where the criterion apply	Action in case of unsatisfactory results
		n	c				
Raw materials for production animal feeds	<i>Salmonella</i>	10	0	Absence in 25 g	EN/ISO 6579	At any stage until the processing of the feed	Processing of the feed material using techniques effective to destroy Salmonella.
Storage and Processing Environment and Transport Equipment in contact with the feed materials and processed feed	<i>Salmonella</i>	10	0	Absence in 25 g	EN/ISO 6579	Along the compound feed production chain at a processing plant	Cleaning and disinfection of the contaminated environment and equipment. Investigation of the contamination source and improvement of the cleaning and disinfection practises. Increased monitoring raw materials and finished feed.
Finished compound feed	<i>Salmonella</i>	10 ²	0	Absence in 25 g	EN/ISO 6579	At any stage before leaving the manufacturing establishment until to the intended use	Investigation of the contamination source. Increased monitoring of the raw materials and processing environment and transport equipment. Reviewing of the Critical Control Points. Reprocessing of the feed if still at the control of the manufacturer. Informing the holdings if delivered to the holdings and if intended for certain species (e.g. species for which a target for reduction of Salmonella has been set in accordance with R. 2160/2003?). Informing the competent authority.



Hygiene standards: Examples of other limits used in EU in GMP codes for the animal feed sector

HYGIENE STANDARDS	QUALITY INTERPRETATION	Feed levels
<i>Enterobacteriaceae</i> TEC (cfu/g)	Good	< 100
	Acceptable	100 - 1000
	Questionable	1000 – 10 000
	Poor	>10 000
<i>Salmonella</i> in 25 g	Maximum	0
<i>Clostridium</i> (cfu/g)	Maximum	10

Target
Action limit



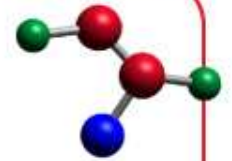
Hygiene standards: Examples of other limits used in EU in GMP codes for the animal feed sector

HYGIENE STANDARDS	QUALITY INTERPRETATION	Feed levels	
		Monogastric	Ruminants
E Coli (cfu/g)	Good	< 1	< 1
	Acceptable	1 - 10	1 - 10
	Questionable	10-100	10-100
	Poor	>100	>100
Total Mould Count TMC (cfu/g)	Good	< 1000	< 1000
	Acceptable	1000 - 5000	1000 - 10000
	Questionable	5000 – 10 000	10 000 – 50 000
	Poor	> 10 000	>50000

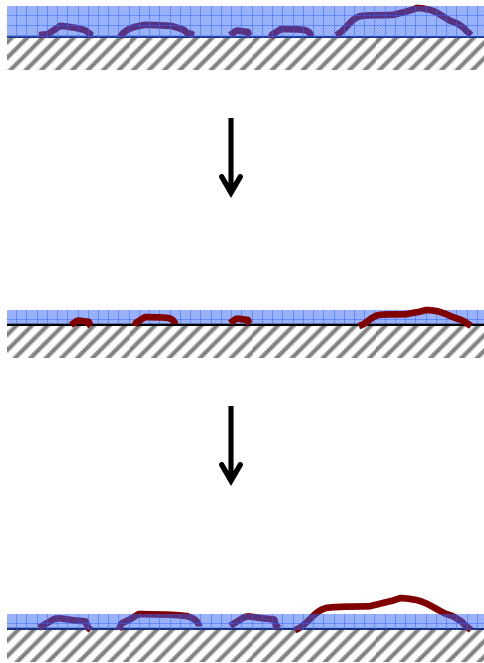
Target

Action limit

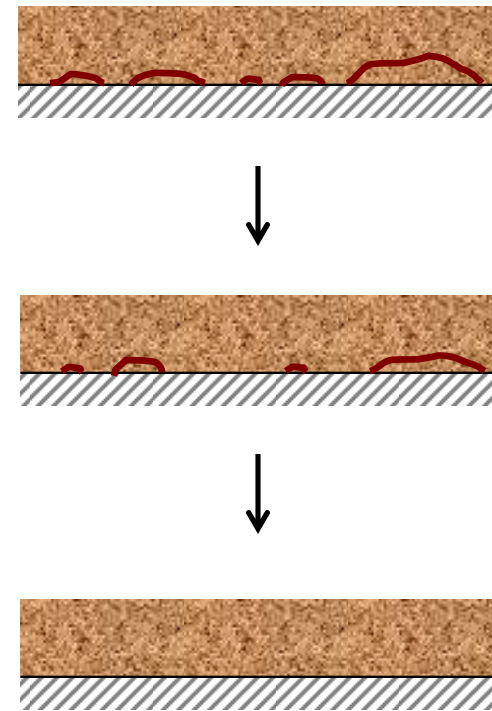
Cleaning and Disinfection – The Principle



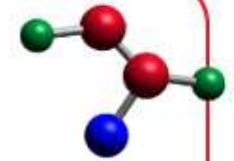
LIQUID



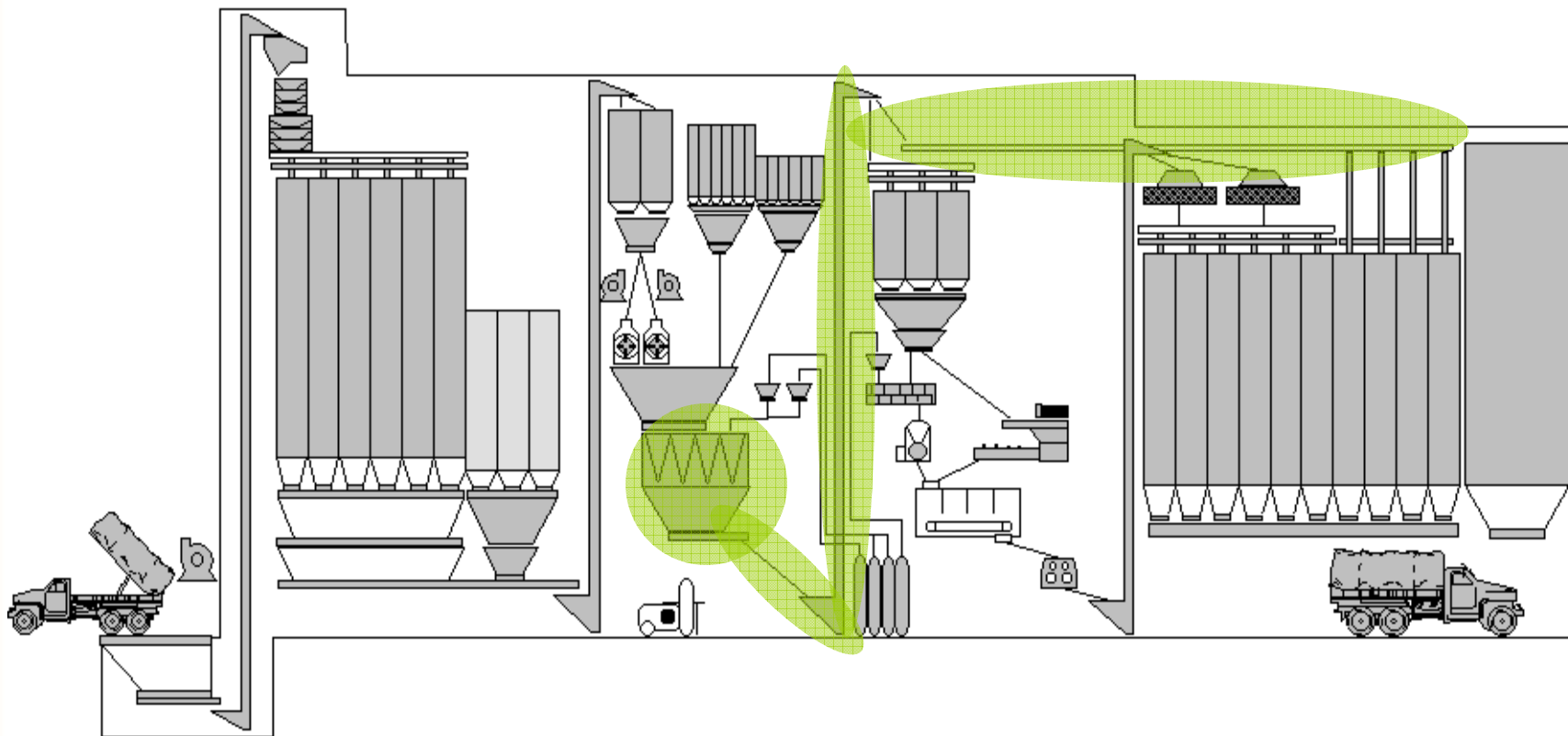
DRY



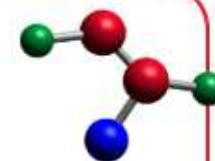
Liquids to clean by fumes. Solids to clean by direct contact on surfaces



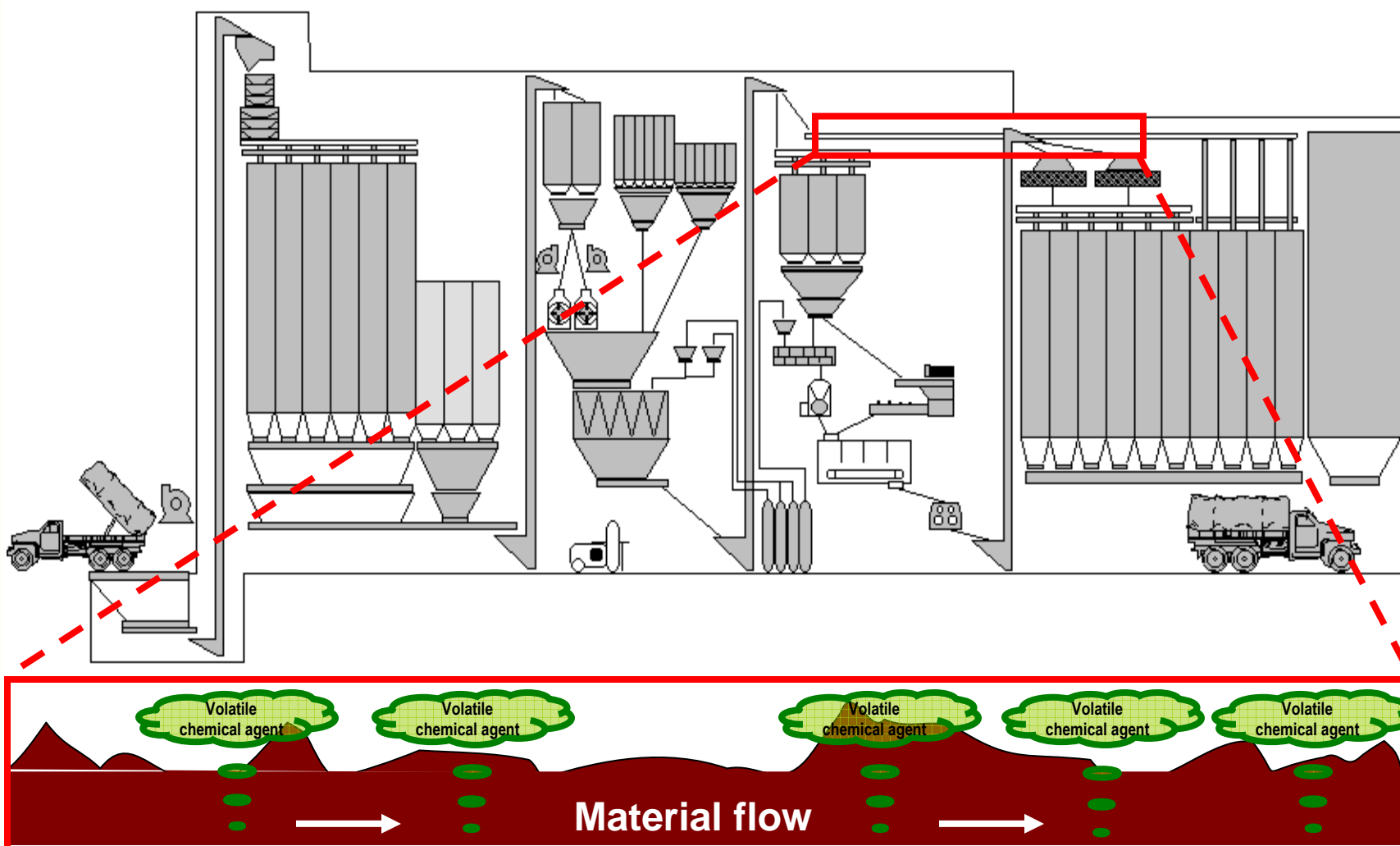
Model for C&D in places without an easy access



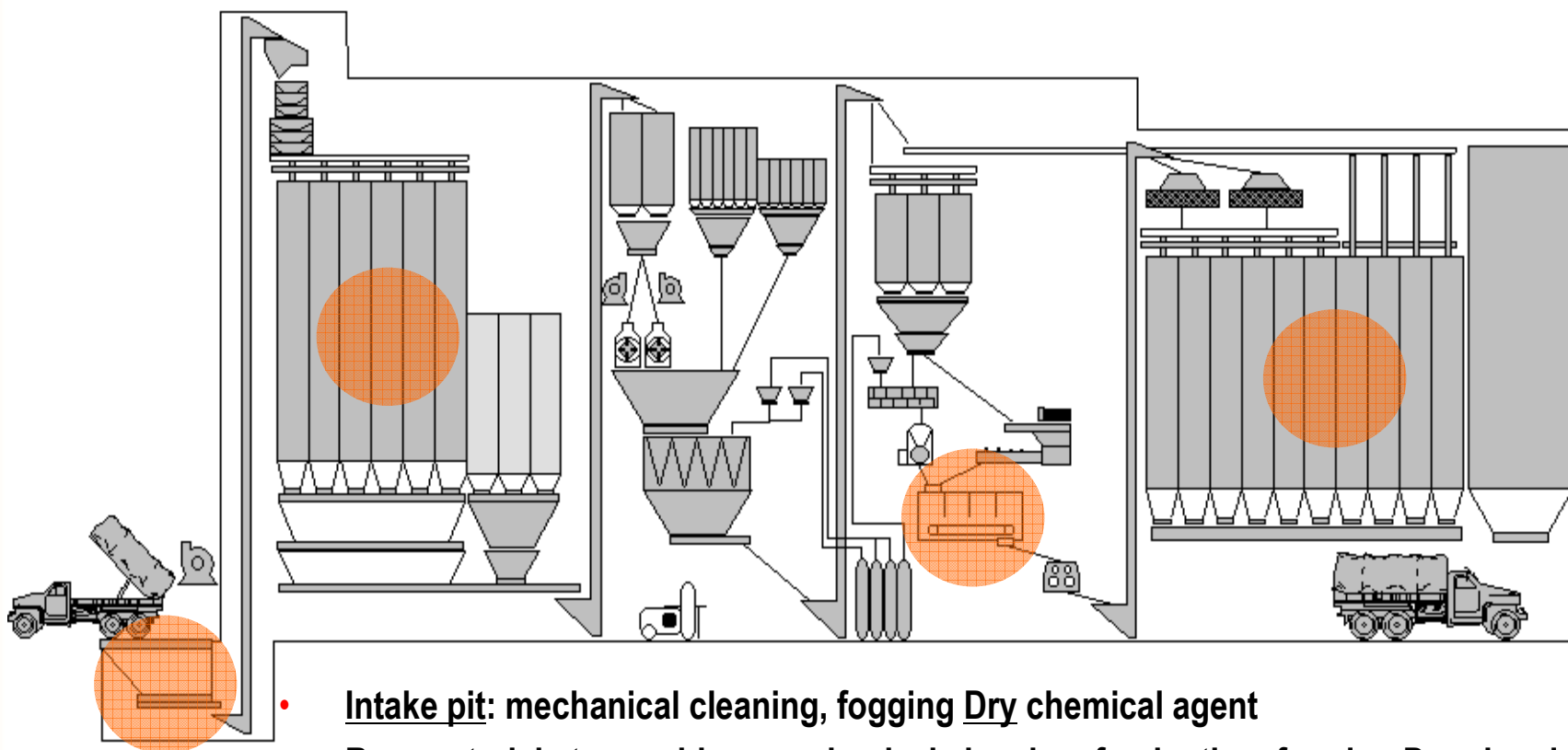
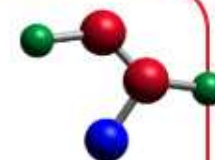
- **Non-accessible areas: treat 2-5 batches (in the mixer) of feed every day with liquid chemical agents generating fumes in the non-accessible processing line**



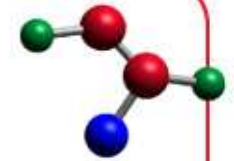
Model for C&D in places without an easy access



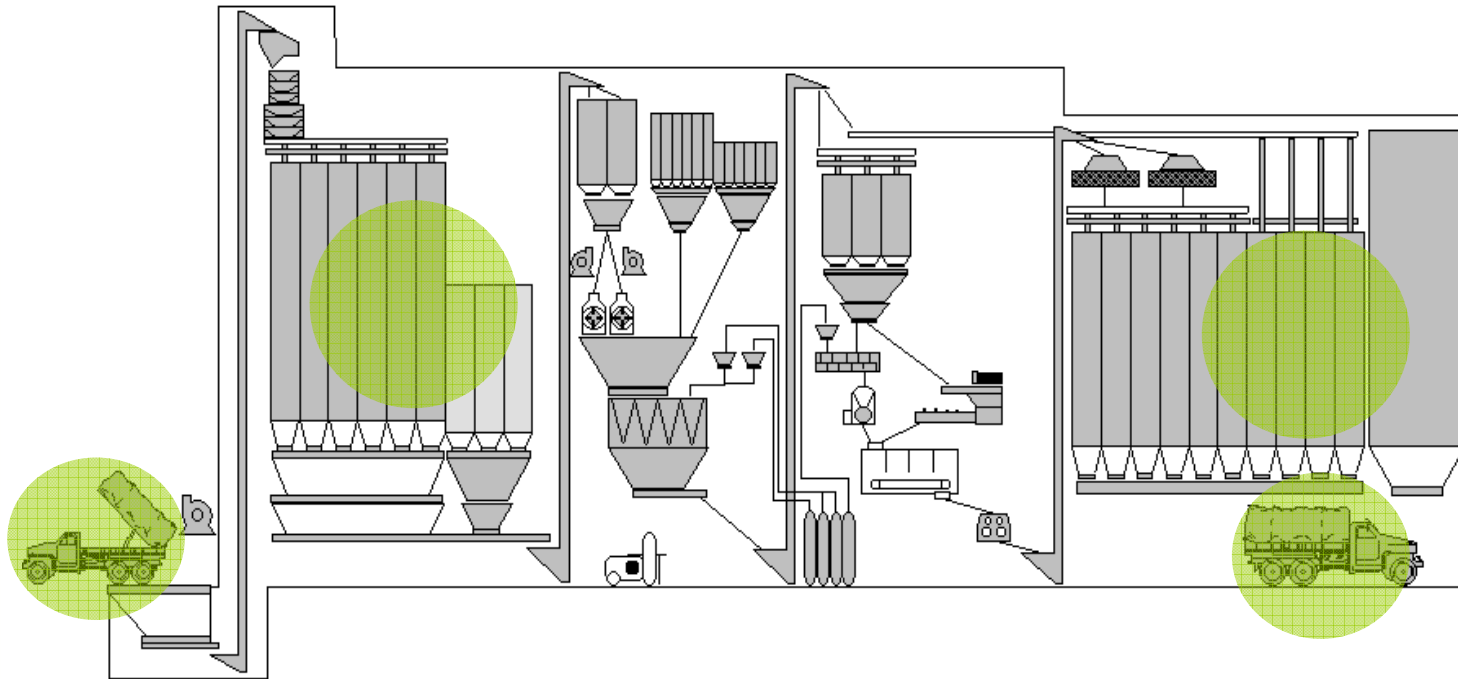
Model for C&D in accessible areas



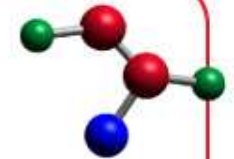
- Intake pit: mechanical cleaning, fogging Dry chemical agent
- Raw material storage bins: mechanical cleaning, fumigation, fogging Dry chemical agent
- Cooler and crumbler: mechanical cleaning, fogging Dry chemical agent
- Finished feed storage silos: mechanical cleaning, fogging Dry chemical agent



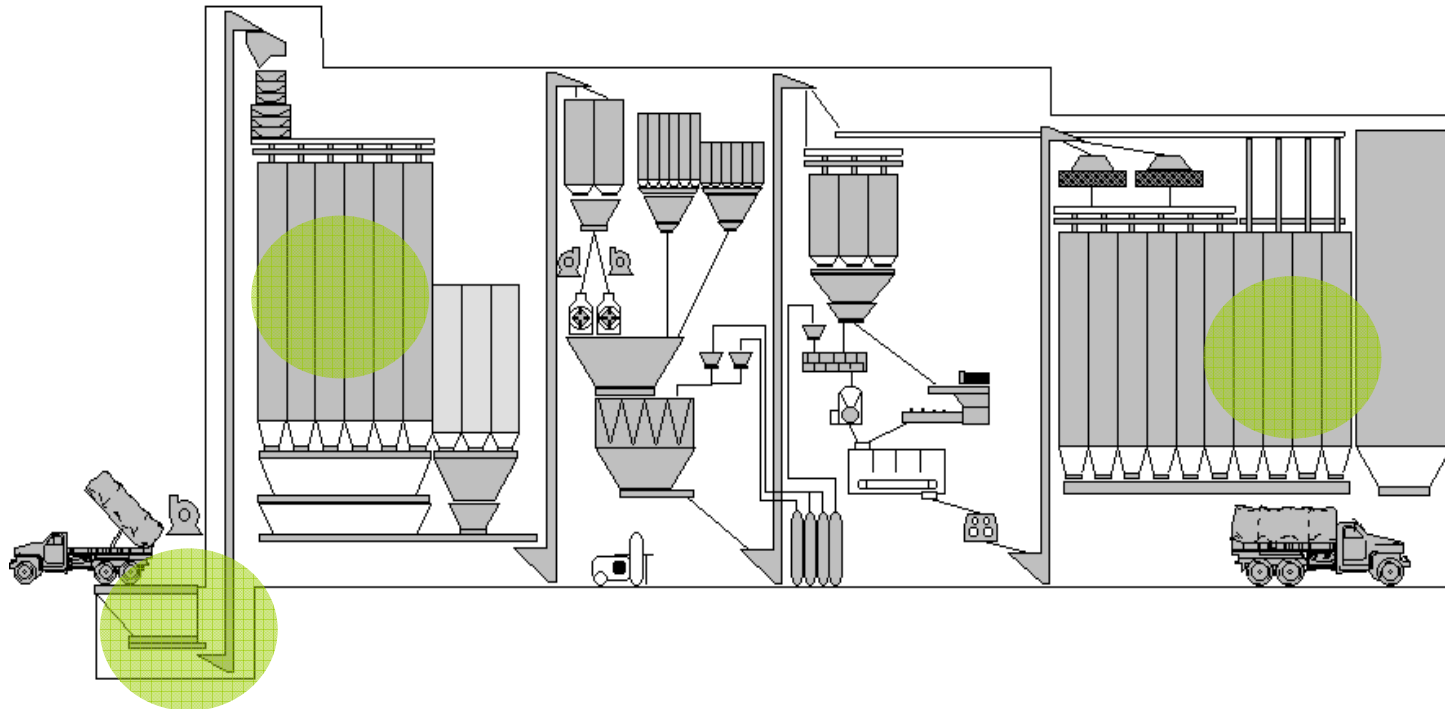
Strategies to control **Salmonella** in the feed chain



- **Trucks:** Cleaning and disinfection by **fogging Dry chemical agent** between each batch as part of the transport Guide
- Controlling **vermin** contamination and avoiding access of wild birds (8% faeces contaminated) during transport and storage. Survival more than one year in surfaces.

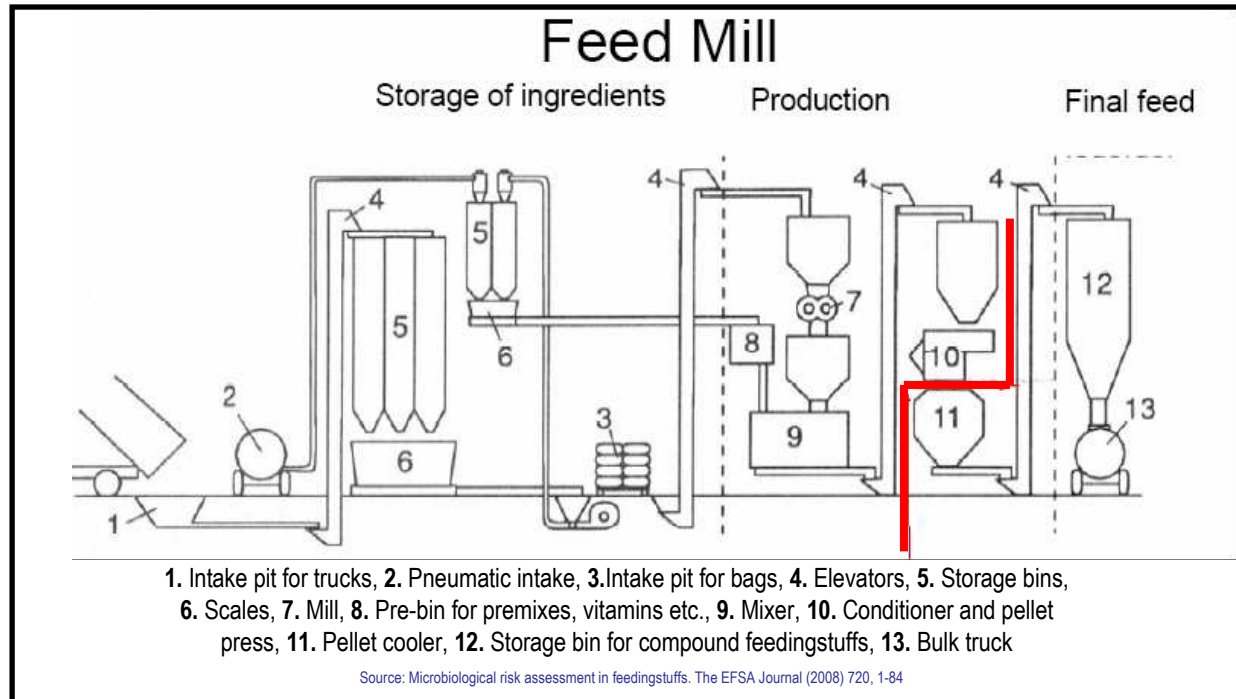
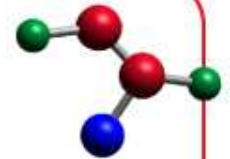


Strategies to control **Salmonella** in the feed chain



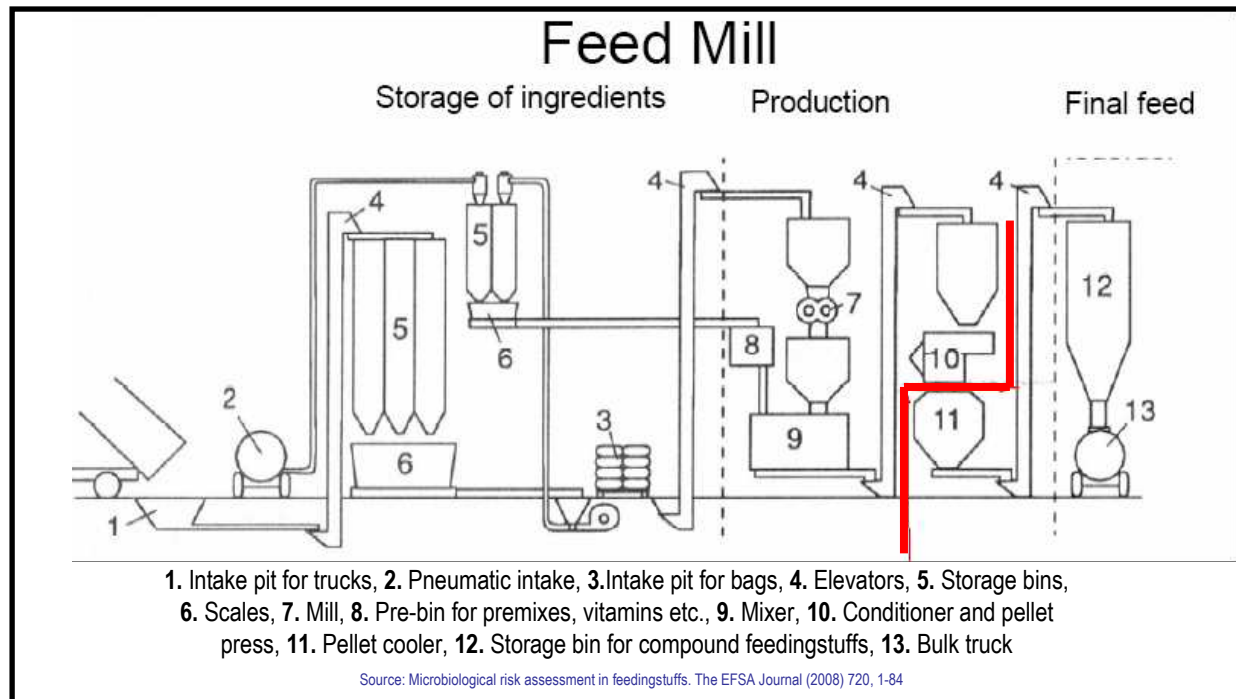
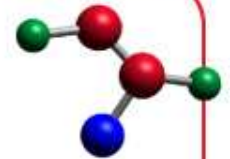
- **Intake pits:**
 - Easily attract vermin and wild birds
 - Unloading ingredients in the intake pit creates large amounts of dust
- **Silos:**
 - Ventilated silos reduce the condensation risk

Strategies to control **Salmonella** in the feed chain



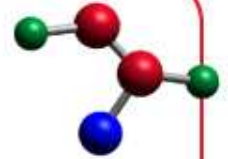
- **Design of the feed mill:**
 - Physically separate all possible contacts between ingredients and compound feedingstuffs. Segregation of the pre-heat treatment from the post-heat treatment areas.

Strategies to control **Salmonella** in the feed chain



- **Cooling process: Is the most likely place for re-contamination**
 - Condensation will occur if the temperature difference is more than **5°C** between the pelleted feed and the environment.
 - Preventing re-contamination: microbes in the cooling system pose the biggest risk of contamination, as contamination takes place after the pelleting. Pelleted feed is exposed to a risk of continuous contamination

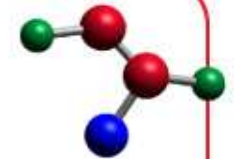
Reducing Salmonella contamination during the processing → **Decontamination**



• **Heat Treatment**

- The effectiveness is considerably influenced by the available water levels and quality of the steam used. Under **low moisture** content, the heat resistance increases
- Temperature, **time and pressure** should be appropriate.
- **Heat can damage** vitamins and other nutrients and produce protein and aminoacids degradation, and adverse effects on the integrity of the pellets
- Cost
- Has **no residual effect**, so feed can be readily re-contaminated after treatment.
- Decontaminated feed may theoretically be **more susceptible to contamination** by pathogens than its original ingredients because of the reduction in indigenous flora, including potentially protective elements such as yeasts.
- **Condensation** associated with warm treated feed may be a seasonal problem, with greatest problems when there is a wide fluctuation between day-time and night-time temperatures.

Reducing *Salmonella* contamination during the processing → **Decontamination**

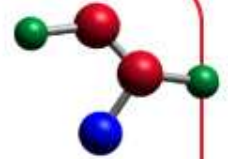


• **Chemical Treatment**

– **Acids:**

- The Antibacterial feed additives should be stable to the point of consumption but either metabolised or not absorbed so there are no residues in meat, milk or eggs from animals consuming the treated feed.
- It can provide some **residual protection** against recontamination
- Reduction of *Salmonella* in feed after acid treatment may take **several days** to achieve its full effect. **ABC** affects the efficacy.
- **Cost, corrosiveness, safety of workers, and palatability** are issues to take into account
- Intensive **high-level acid** treatment may therefore be more suitable for **treatment of batches of highly contaminated ingredients** prior to mixing. This approach also provides a lower level treatment which may be beneficial for the compound feedingstuffs which incorporates the treated ingredient.
- Achieving the **most effective blend** is most important and variations in formulations, as well as challenge, may explain the variable results obtained in different trials

Reducing Salmonella contamination during the processing → **Decontamination**



- **Chemical Treatment**

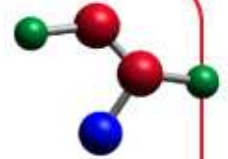
- **Formaldehyde:**

- Superior decontamination of feed by formaldehyde compared with acid products
 - Some commercial products contain a **blend of formaldehyde**, propionic acid and other dispersing agents. This combination has been shown to achieve greater decontamination of feed
 - **This blend** produce a synergistic combination allowing lower levels of formaldehyde and acids to be used which minimises fuming, operator hazard, corrosiveness and toxicity.
 - Such product may however be useful to limit contamination of feeding systems and has been used at higher levels on a grain or feed to **decontaminate the interior of inaccessible equipment**
 - It also offer protection against recontamination.
 - It can also be used for decontamination of feeds for animals such as commercial layers where heat-treated or pelleted feed may be undesirable.

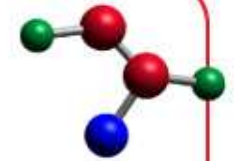
- **Others**

- Irradiation, High Pressure, Microwave Energy
 - Unlikely to be adopted for industrial feed production in the foreseeable future

Reducing Salmonella contamination during the processing → **Decontamination**

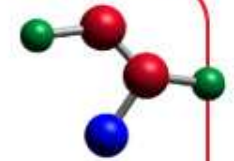


- Chemical Treatment.
 - Control of decontamination (Standard test model)
 - Verify the effectiveness of chemical treatment
 - 5 samples (100g each) before the chemical treatment, and after standard mixing time.
 - 5 samples (100g each) from the same batch after applying the chemical treatment and after standard mixing time
 - The treatment will be effective if the reduction in term of Log cycles (3) or the contamination level of the second group (50 ufc/g of indicator of harmful microbes - Enterobacteriaceae-) are reached.



Sampling

- Confidence in the results of testing will depend on the number of samples units tested.
- The more samples, the higher is the probability of finding *Salmonella*
- If *Salmonella* is found in one sample, the **whole batch** is contaminated
- Many sampling plans define the number of samples that needs to be collected to produce a result that can be regarded as valid at the 95 or 99% confidence limit.
- Samples should not be exposed to adversities such as extremes of temperature or sunlight. Ideally samples should be refrigerated.
- **Reserve** samples to be taken



Sampling

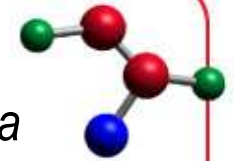
- **Indicators of contamination** in the throughput of the mill
 - **Dust** from intake auger pits, pooled dust from ingredient bins, dust and cleanings from coolers, dust from crumblers and pellet shakers, pooled dust from finished product bins, dust from out loading gantry.
 - Contamination of **feed ingredients** during production, storage, transport and processing by *Salmonella* serotypes originating from the faeces of wild or domestic animals, contaminated water or processing equipment is common.
 - **Finished product**

Testing at key sampling points along the compound feed production chain

Testing Dust



- The probability of finding *Salmonella* in dust is 10-50 times higher than of finding it in raw material of feed.
 - A dust sample always represents a larger batch of feed.
 1. Dust from unloading pit for feed materials
 - Dust escaping from the elevator which removes feed materials from the pit or dust from multiple areas within the pit area
 2. Dust from within ingredient bins
 3. Dust in the aspiration system or its collection bins
 4. Dust emanating from the coolers.
 5. Dust within finished product bins or from bagging area
-
- Testing at one week intervals has been found appropriate.
 - If samples are tested positive for *Salmonella*, corrective actions should be taken.
 - cleaning and disinfection, increased monitoring, stop of production and stop for delivery of compound feedingstuffs.
 - It is especially important if *Salmonella* is found in the top of pellets cooler and in top bin of compound feedingstuffs.

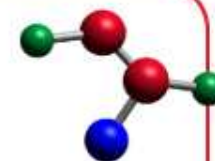


Testing of incoming raw material

- The actions to be taken if lots of ingredients are found positive for *Salmonella* will depend on the specific process that follows, and the specific HACCP programme but may include i.e. rejection, decontamination, and contact to producer.

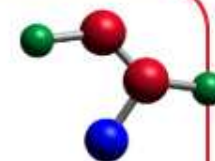
Testing of compound feed

- Daily samples could be taken as near the point of despatch from the premises as possible for each product category (1 sample for *Salmonella* analysis per 50-200 tonnes of feed depending on product category) . Samples could i.e. be bulked by category into aggregates and i.e. 50 g samples could be tested at specific intervals i.e. weekly. The samples should be taken in a way that they are representative of the batch, ideally using an automated in-line sampling device.
- Test feeds at farmer's level should be implemented as well.
- If samples are tested positive then corrective actions should be taken including i.e. (i) Investigation of the particular sections of the plant through which the product was manufactured paying particular attention to those Critical Control Points at which *Salmonella* contamination is most likely to occur, (ii) Investigation of raw material records appropriate to the compound feedingstuffs sample, (iii) Application of an effective treatment regime for feed produced (iv) Increased intensity of sampling and testing of production.



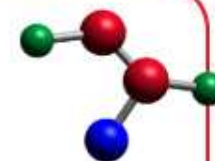
Conclusions and Recommendations (1)

- Transmission of *Salmonella* from animal feed to animals consuming the feed, and to food products derived from the animals has been shown
- Recontamination during cooling and further handling (transport and storage) is an important issue.
- Although heat treatment is generally recognised as the most effective decontamination method, in some circumstances (e.g. pelleted feed for layers) this may not be appropriate. In such cases, chemical treatment of feed may offer an alternative means of protection.
- Treatment of feed ingredients or compound feed with blends of organic acids, or with formaldehyde products at suitable concentrations, can be effective in reducing contamination by *Salmonella* and other organisms.
- Chemical treatment has a residual protective effect in feed, which helps reduce recontamination. Also, the use of chemical treatments helps reduce contamination of milling and feeding equipment and the general environment (C&D).



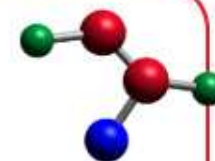
Conclusions and Recommendations (2)

- Establishment of microbiological criteria for *Salmonella* contamination along the feed chain is appropriate and suggested.
- A feed safety criteria based only on testing of the end product would not be an effective way to ensure absence of *Salmonella* contamination. Establishment of one or more process hygiene criteria at critical stages of the feed production chain, including at the end product stage, is more efficient.
- The importance of starting the control already at the crushing and the rendering plants is emphasised.
- The currently applied sampling procedures can only reliably identify highly contaminated lots of feed materials and compound feed.
- Culture according to procedure ISO 6579 is the standard method for isolation of *Salmonella* in feed. Alternative methods are used but not validated for detection in feed. Any alternative method should be equally validated for use in feed. Laboratories should be accredited.



Conclusions and Recommendations (3)

- *Salmonella* incidence in feeds in South Africa is high
- *Salmonella* comes to feed in the South African feed mills mainly from raw materials, feed mill dust and by recontamination .
- Combination of heat treatment and antimicrobial products can maximise kill-off of *Salmonella* in feed and prevent re-contamination in the South African scenario.



Final Recommendation

- Effective implementation of **HACCP** principles, and **GMP/GHP** procedures along the feed chain should be ensured. This requires proper control of **recontamination** (including dust control and condensation), as well as determination of the effective **decontamination** treatments at the individual plants, together with a **prevention of entry** into feed mill.