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I BIOSECURITY

The intensification of production in poultry farming has increased the risk of epidemics occurring, the financial consequences of which can be very damaging. Pathologies such as salmonellosis or mycoplasmosis, which are endemic on certain farms, lead to lower productivity, inferior product quality or even mortality. Health and sanitisation measures can limit the introduction and propagation of vectors of micro-organisms or the micro-organisms themselves on farms. Biosecurity is a term which covers the various measures implemented. The most effective and most economic means of controlling animal health on the farm must be found, since this increases profits and results in more healthy products being consumed.

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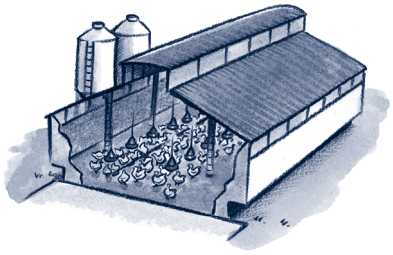
A FARM DESIGN AND FLOW CONTROL

• 1. FARM DESIGN

General points :



The geographical location of the farm, the arrangement of the buildings and the materials used in their construction must be studied carefully, since they have an impact on the hygiene and health balance on the farm.

Selecting the location of the farm

The geographical location must not be chosen at random. There are a number of common sense rules which should be applied when determining the best place to set up a farm :

- Build the farm as far away as possible from other commercial farms, so as to avoid the propagation of pathogens.
- Take into consideration the prevailing wind direction so that uniform and controllable ventilation can be provided.
- Avoid building the farm near to waterways, ponds or lakes used by water fowl. Prefer well drained zones so as to avoid any problems associated with stagnant water.
- If possible, try to build the buildings away from main roads, which may be used by lorries to transport poultry.

Design the buildings so as to limit flows as much as possible

The arrangement of the buildings within the farm must be studied with care :

- If several age groups are kept on the farm at the same time, ensure that the buildings which house them are as far away as possible from each other, so as to minimise the risks of micro-organisms spreading from one building to another.
- Each building must be fenced off so as to prevent access by pests which are excellent vectors of micro-organisms (Salmonellae, Mycoplasmas, Newcastle disease, infectious bronchitis virus). The entire farm must be enclosed by a security fence, and fitted with a gate to control everything that comes in and goes out.
- The zone immediately around the poultry houses must be kept clear of vegetation and rubbish, and should ideally be covered by concrete or a similar material.
- The general hygiene can be controlled most effectively if the building can be disinfected completely : the floor should be concreted and the walls smooth.

1 Biosecurity

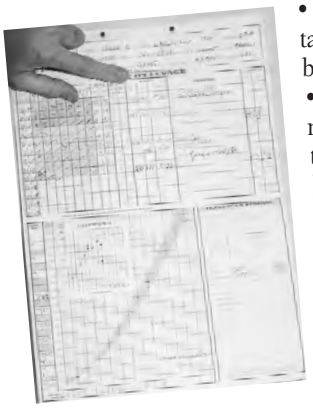
A FARM DESIGN AND FLOW CONTROL

It is essential to implement biosecurity measures at the entrance to the farm.

- Everytime something enters or leaves the farm a record should be made in a log. No visitor must be allowed to come through the gate without being checked. No lorry should be allowed onto the farm without being disinfected.
- In each building, an access room, for both entering and leaving the building, must be provided for all personnel and the farmer. This access room must act as an "air-lock", separating the clean sector from the dirty sector and must be fitted with a washbasin, hot running water if possible, bactericidal soap, disposable hand towels and a waste basket. Overalls or coats, hats and clean boots must be provided for all personnel and visitors entering the building. A foot bath, fitted with a draining system must be provided for disinfecting shoes.

The right choice of production management methods contributes to biosecurity

- The best form of poultry production is rearing flocks of birds of the same age, known as production cycle. Simply introducing new animals onto a farm is a major biosecurity risk. These animals may be sick or healthy carriers of specific pathogens, or alternatively the current flock may already be a healthy carrier of certain forms of infection to which new birds may be susceptible.
- If different age groups are reared on the farm at the same time, each group must be treated separately. Start by working with the youngest and finish with the oldest. Equally, implement measures firstly in the healthy buildings before moving on to the isolation building.
- The buildings occupied by the poultry in addition to the feed or egg storage areas must be kept free from insects and parasites and inaccessible to wild birds. If necessary, a specific flying insect control programme should be implemented.
- When a poultry house or farm is cleared of the birds, all the litter must be removed from the premises and cleaning and disinfecting work carried out. It is advisable to carry out bacteriological monitoring to determine the efficacy of the disinfecting methods.
- The feed must be stored in clean and sealed containers (silos or bags). The drinkers must be supplied with drinking water of satisfactory quality.
- Sick or dead birds must be removed from the poultry houses as quickly as possible and disposed of in accordance with the necessary precautions.



- Methods for eliminating waste and a suitable system for evacuating waste water must be provided.
- Exhaustive logbooks, used to record all mortalities, diagnoses of disease, and any treatments and vaccinations given must be kept for each of the farm's production cycles.

1 Biosecurity

A FARM DESIGN AND FLOW CONTROL

Since breeder farms are the first stage in the poultry production chain, it is particularly important that specific biosecurity rules are applied on these farms

- The animals used to repopulate a poultry house or a farm must be sourced exclusively from healthy farms and should be disease free.
- Breeder farm must be monovalent, i.e. breed a single species only. No poultry should be reared on the farm of other species (although other age groups are permitted) in buildings constructed for this purpose.
- The litter used for layers must be dry and in good condition. The litters provided for building nests must be clean and a sufficient quantity must be available.
- Eggs must be collected frequently (not less than twice a day) and placed in clean and disinfected containers. Dirty, broken or cracked eggs, as well as those showing shell defects must be placed in a separate container. They are not incubated. Clean eggs must be disinfected as soon as possible after being collected, then they are stored in a clean, dust-free room, which is used exclusively for this purpose and maintained at a temperature of 13 to 15 °C and with a relative humidity of 70 to 80%. The eggs are then transported to the hatchery in clean and disinfected trays. The vehicles used to transport them must also have been cleaned and disinfected.
- Entry to the hatchery must be via a unique access room, fitted with showers and with clothing provided by the farm. Only personnel authorised to work in the hatchery can enter the hatchery, which must be out-of-bounds to personnel employed in the other sectors of the farm and to visitors.
- The hatchery must be designed so that the eggs are moved forward progressively as they approach hatching and so that air can circulate in a single direction. The various work zones must be physically separated with, if possible, individual ventilation for each room (GOATER, 1988).

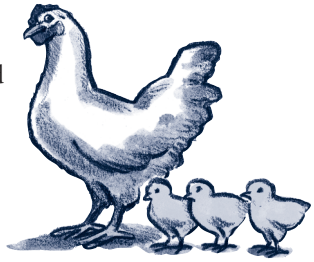


TABLE I : PROGRAMME FOR COMBATING SALMONELLAE IN HATCHERIES

STORING AND SORTING EGGS

- Wash, rinse and disinfect by spraying the rooms and the material after each batch of eggs. Disinfect by formaldehyde fumigation once a week, even when eggs are present in the storage room.

INCUBATION

- Wash, rinse, disinfect by spraying and dry the incubators, trolleys and material
- Disinfect by formaldehyde fumigation each empty incubator.
- Carry out a general fumigation of the rooms outside the incubators once a week.

TRANSFER

- Wash, rinse and disinfect by spraying the rooms and material after each transfer. Disinfect by formaldehyde fumigation once a week.

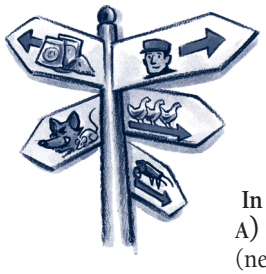
HATCHING

- Wash, disinfect by spraying and disinfect by fumigating the hatchers, each day after hatching.

SORTING THE CHICKS

- Each day, the chick sorting, packing and storage rooms must be washed, disinfected by spraying and once a week disinfected by formaldehyde fumigation. Clean material must be stored separately, away from live material (eggs, chicks) or waste.

• 2. FLOW CONTROL : PERSONS, MATERIAL, FEED, PESTS



Flow control is a fundamental aspect of biosecurity. The term flow refers to everything which enters or leaves the farm, such as delivery lorries, visitors, farm personnel, pests, poultry, feed, etc.
From a biosecurity point of view, flows of people and vehicles can be a serious risk to the farm if they are not correctly controlled.

In poultry farming, there are three main sources of contamination :

A) CONTAMINATION FROM THE SURROUNDINGS
(nearby contaminated farm, rats carrying pasteurellae or salmonellae, wild birds carrying mycoplasmosis, etc.)

B) CONTAMINATION TRANSMITTED BY VECTORS
(lorries, workers who are keeping contaminated but not clinically diseased farmyard birds at home and who may transmit the pathogenic micro-organisms to the farm, contaminated feed supplies, etc.).

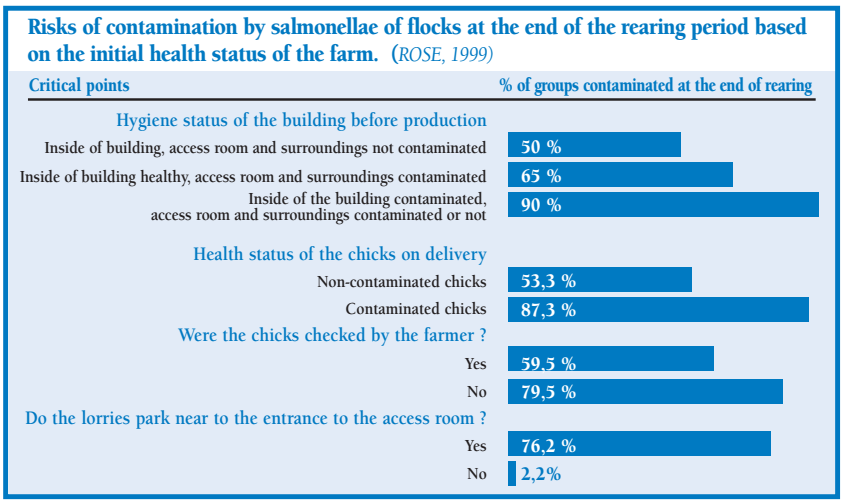
Personnel and visitors :

- The most common vector of health problems for poultry is man.
- Access to the farm must be restricted so as to prevent access by unauthorised persons and animals as well as the drivers of vehicles used to take away mortalities.
- Sales representatives, lorry drivers, technicians and all other visitors must not be allowed to enter the premises unless they have a valid reason. An access room must be provided, with special clothing supplied by the farm which must be worn before entering a building.
- Employees must not walk from one building into another without first changing their clothing in the access room provided for this purpose.

Delivery vehicles

- Lorries transporting feed are a serious risk since they can transfer contaminated dust from farm to farm.
- The lorries used to transport poultry, eggs or feed must be carefully cleaned and disinfected before being loaded. They are disinfected at the entrance to the farm.
- If it is not possible to decontaminate these lorries and their drivers at the entrance to the farm, an enclosure should be constructed in front of the silos which obliges them to stay outside the protective perimeter.
- If this is not possible, another option is to make them unload into temporary silos at the perimeter of the farm, with the feed subsequently redistributed to the various units on the farm.

Risks of contamination by salmonellae of flocks at the end of the rearing period based on the initial health status of the farm. (*ROSE, 1999*)



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C) CONTAMINATION FROM RESURGENT MICRO-ORGANISMS
(i.e. from micro-organisms which are already present on the farm). Many micro-organisms can survive, if effective cleaning and disinfecting is not practised, by employing natural survival techniques such as producing spores, or if they are protected within organic matter (faecal material, dirt, etc.) or in biofilms. Some micro-organisms can preserve their full virulence for months :

- Newcastle disease virus — 6 months
- Salmonella typhimurium — 39 weeks
- IBD virus — several months
- Coccidia — several weeks

Biofilms

Biofilms develop wherever there are wet surfaces, and have been known about for many years. More recently, they have been the subject of greater interest as the intricate details of their structure has been revealed. They are aggregates of heterogeneous bacteria, embedded in a mucous exocellular matrix which can attach firmly to surfaces using "anchors" known as “pili” or “fimbriae”. The biofilm contains bacteria from various different families and strains (FOULON, 1999).

Biofilm formation is a complex and heterogeneous phenomenon which can be thought of as a survival strategy developed by bacteria. This state gives them many advantages : for example, the bacteria embedded within the biofilm are protected from harsh external conditions (ultra violet light, adverse environments, chemical attacks, etc.). In nature, biofilms act as a reservoir of microbial species and thus play a part in maintaining the ecological equilibrium.

Farm premises, and particularly the pipework, are not spared from the biofilm phenomenon. If no regular and effective cleaning/disinfection protocols are followed, biofilms will result in recurrent pathologies occurring on the farm.
Numerous studies have shown that the resistance of biofilms to disinfectants is much greater than that of isolated bacteria, consequently disinfection is less effective and the classical tests to measure disinfectant activity cannot be applied. Moreover, the techniques used to measure the efficacy of the cleaning/disinfection operations (e.g. sampling the surface using contact dishes) are also called into question.
Biofilms can only be dealt with effectively by applying suitable sanitary cleaning and disinfection measures, which must respect the basic rules of biosecurity.

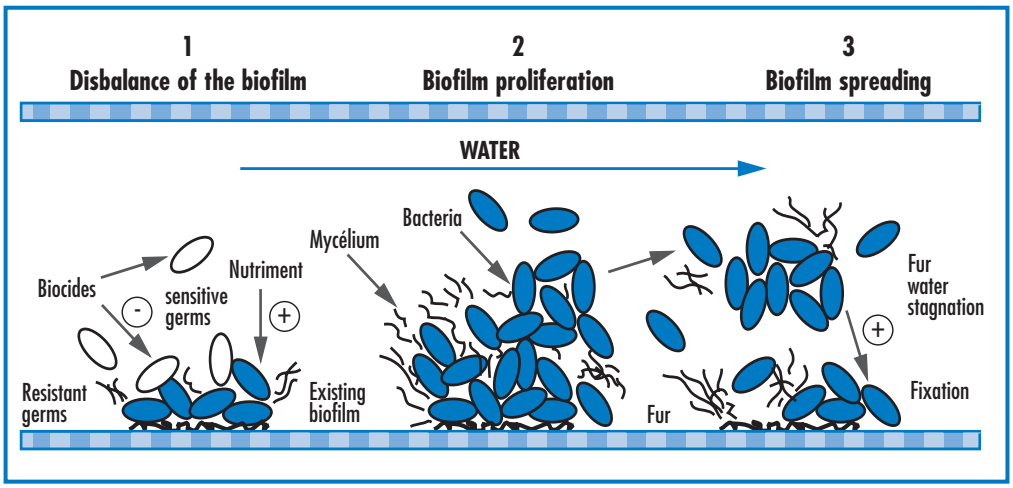

Figure 1 : Illustration of micro-organic proliferation in the pipework on a farm

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B DECONTAMINATION

• 1. DISINFECTING AND SANITARY PERIOD BETWEEN PRODUCTION CYCLES

Disinfecting the poultry house and the associated premises once the batch of birds has been removed is essential, not only to prevent health problems but also to ensure good zootechnical performance and the quality of the poultry products.

Disinfecting covers the various operations conducted with the aim of destroying the micro-organisms present in the external environment. Its objective is to protect the animals against two types of microbial attack :

1 gram of poultry house dust contains 200 000 to 800 000 colibacilli

1 gram of poultry litter contains 7.9 billion colibacilli

- ***Specific infectious diseases*** (viral, bacterial, fungal) which cause health problems. Insufficient immunity in young animals or a no vaccine cover, and the stress associated with grouping animals are all factors which promote the development of these diseases.
- ***The ambient microbial flora,*** the importance of which has been revealed by the advent of intensification (concentration, rapid rotation, confinement). The effect of this microbial flora is usually expressed as a drop in yield (egg production, growth rates, etc.) and in product quality. It is independent of the apparent state of health of the animals.

The disinfection programme conducted once the birds are cleared from the building must comprise two series of operations :

1. ELIMINATING THE SOURCES AND RESERVOIRS OF MICRO-ORGANISMS :
   - Cleaning, insect control and anti-rodent measures..
2. DECONTAMINATION, WHICH INVOLVES :
   - An initial application of disinfectant after cleaning
   - Leaving the premises empty between production cycles
   - It is highly advisable to carry out a second disinfection by fumigation or spraying just before the next batch of chicks arrives.

1.1 Eliminating the sources and reservoirs of micro-organisms

• CLEANING

ONLY PERFECTLY CLEAN SURFACES AND MATERIAL CAN BE DISINFECTED.

As soon as the animals are cleared, the litter and all removable material must be taken out. The litter is piled in the centre of the building, desinsectised and then transported, covered, to the storage zone which must be as far as possible from the farm buildings. The cleaning of the outside of the buildings must not be forgotten (roofs, outside walls, drains and service areas)

Then the inside of the buildings can be cleaned, an operation which comprises two stages :

Soaking, which softens old, dried soiling in preparation for water-blasting. Matter must be left to soak for at least 20 minutes on average to be effective.

Water-blasting all the surfaces using high-pressure cleaning equipment eliminates soiling and other organic waste, which are major reservoirs of contaminants.

An alternative is to use hot, pressurised water or steam.

For all these operations, the quality of the water used is of paramount importance and must be checked.

A correctly-performed cleaning operation eliminates 70 to 90 % of microbes and is an important factor in the subsequent effectiveness of the disinfectant.

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INSECT CONTROL PROGRAMME

The aim of this operation is to destroy external parasites, especially red mites and insects such as mealworms. Red mites, an haematophagic acarian, cause production drops as high as 30 % in laying hens. They can also form an important reservoir of salmonellae. Mealworms degrade insulation material and can act as vectors of numerous viral diseases (Marek's disease, infectious bursal disease, Newcastle disease) and bacterial diseases (salmonellosis, colibacillosis).
Insecticides and acaricides can be applied by spraying, by thermonebulisation and by fumigation. They are not mixed with disinfectants (unless recommended by the manufacturer). They are used during the sanitary period between production cycles; if a massive infestation breaks out, treatment can be given during the rearing period, so long as care is taken to avoid spraying the animals.
Avoid, wherever possible, introducing material from another farm : cardboard boxes or containers of eggs which may be contaminated.

Finally, to prevent the rapid multiplication of mealworms, the corpses of birds must be collected as often as possible, and damp or mouldy feed should be disposed of. Do not store dung in the immediate vicinity of the buildings and once the birds have left the building, remove very carefully the litter, liquid manure and all organic debris which may contain eggs or larvae.

CONTROLLING RODENTS

Rodents can carry pasteurella and salmonella.
The control of rodents is carried out mainly during the period of disinfection between two production cycles, and is then maintained each month by placing anti-coagulant type bait in specific poisoning sites. To be as effective as possible, it is important to combat the rodents in a methodical manner.

TABLE II : Programme of rodent control

INSPECTION
• Inspect the outside of the buildings in order to detect any sites which might provide rodents with water, food or shelter.
IDENTIFICATION
• Identify the species present by finding out about the characteristic behaviour to look out for, and by examining their tracks, droppings, etc.
SANITISATION MEASURES
• Outside: The area around the buildings must be kept clean. Any vegetation around the building must be destroyed (in a zone up to 3 metres from the building). Place all feed and waste in sealed containers that are regularly cleaned. External debris (used material, flooring, etc.) must be disposed of since rodents can use them to make nests. List all the water sources, since water is an essential element of a rodent's environment. • Inside : Prevent the rodents from entering the buildings. Block up all holes in outside walls, fit doors which close automatically if the doors are used often. Check for gaps under roofs, at the top of the building, in the air conditioning system, etc.
BAIT
• For rats, place the bait in holes in the ground with the exits unobstructed ; for mice, place the bait along walls and where the signs of infestation are visible. Place the bait sites every 10 metres around the perimeter of the buildings. Always ensure that there is sufficient bait.

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DISINFECTING (FORD, MEROZ, SAMBERG, 1995)

Following on from effective cleaning of all the material and premises, **disinfecting is an essential stage** prior to the sanitary period between production cycles. **To be effective, the disinfecting must be carried out** :

- on material and installations which are in good condition, and which have been thoroughly cleaned not more than 24 hours previously. Damp conditions encourage the multiplication of micro-organisms. These young micro-organisms will not yet have acquired a resistant form, and consequently the disinfectants will act better on the target structures.
- with water of known quality.
- using an approved disinfectant.
- by not mixing products unless recommended by the manufacturer (e.g. : detergent + disinfectant ; disinfectant + insecticide).

This is because, with some detergents, the product must be rinsed off before disinfecting. It all depends on the persistence of the product, on whether its residues are toxic for the animals and on whether the material to which it is applied can resist its corrosive action.
Most disinfectants are more effective if they are diluted using warm or hot water. In general, a product will act twice as quickly if its temperature is increased by 10°C.

SANITARY PERIOD BETWEEN PRODUCTION CYCLES

Leaving the premises empty only becomes an effective method once the first disinfection stage has been performed. It prolongs the action of the disinfectant and especially enables the floor and the building to dry out.
A poultry house that is not dry is a poultry house at risk:

- Whilst there is humidity, the microbial flora cannot be reduced to a minimum and the parasitic elements are infestive. Drying helps to reduce the microbial flora and parasitic infestation.
- Damp floors and walls, especially at ground level, are harmful to young birds since they cause stress due to chilling.

THE KEYS TO SUCCESSFUL DISINFECTING
(DROUIN ; 1988)

Rapidly	**: As early as possible after the poultry are cleared**
Effectively	**: Use a good quality, approved disinfectant**
Methodically	**: Follow an extensive programme**
Totally	**: Buildings**
	: Material
	: Silos
	: Stores
	: Area around the building
	: Water circuits
	: Vectors (insects, rodents)
Logically	**: Check the water quality, rear a single flock, employ sanitary barriers**

The minimum sanitary period must reflect the time needed to dry out the poultry house completely, i.e. 15 days on average. This period should be extended in cold and wet times of the year. The sanitary period can be reduced by heating the building.

It is very important : to remove all dust, to clean not only the poultry house but also the areas in front of the entrances, to clean and disinfect the water circuits, to desinsectise, to check the draining around the poultry house and to check that the building has dried thoroughly during the sanitary period.

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SECOND-STAGE DISINFECTING

This is not conducted systematically, but does provide an important protective effect against salmonella and others.

CONTROLLING DISINFECTING EFFICACY USING A BACTERIOLOGICAL METHOD

Very useful information can be found out by investigating and isolating micro-organisms after decontamination using approved methods. Such techniques are particularly useful in the fight against salmonellosis.

1.2 The main bactericidal, virucidal and fungicidal disinfectants

CHEMICAL DISINFECTANTS

PHENOLS AND CRESOLS
Phenols are virucidal and bactericidal mainly on Gram+ bacteria. They are often combined with halogens. The biphenols are antifungal and offer a prolonged residual action, even in the presence of organic substances. Phenols are generally applied as a solution containing 1 to 3 % active ingredient.
Cresols are virucidal and bactericidal against Gram+ and Gram- bacteria. They are marketed in preparations containing 30% active product, combined with saponifying agents (15%). They can be used to disinfect earth floors. Their main drawback is their smell, which means that they cannot be used near to zones used to store eggs or animal feed. **They are rarely used.**

QUATERNARY AMMONIA
These products are virucidal and bactericidal (Gram+ and Gram-). The preparations contain 15 to 18% active ingredient. They must not be mixed with ionic detergents which cancel out their bactericidal and virucidal activity. They are used in combinations with other products.

THE ALDEHYDES : formaldehydes, glutaraldehydes, glyoxal
Formaldehydes have been used widely in gaseous form for fumigation and they are excellent disinfectants, notably for hatcheries (at a temperature of 20°C and with a relative humidity of about 65%). However, they are both corrosive and more worryingly carcinogenic. If used, the precautions inherent to their toxicity must be respected, and they may soon be banned, notably in the United States.
Glutaraldehydes are often combined with phenols and quaternary ammonia in commercial preparations.

IODINE COMPOUNDS
The commercially-available preparations contain iodine compounds (20%) combined with phosphoric acid (15%). They are virucidal, bactericidal and have a significant residual effect. When used at the correct concentration they are effective in hatcheries, on smooth surfaces and for equipment. Their use is limited due to their cost, due to the fact that they stain and that they can also be corrosive. **The iodophors retain a certain efficacy at low temperature and can thus be used in foot bathes, especially since they offer the advantage of losing their colour when they are no longer active (enabling their efficacy to be checked visually)**. However, they are only moderately effective in the presence of organic matter and attack and colour the rubber of boots.

CHLORINATED COMPOUNDS
The most concentrated preparations contain 70% chlorine. Although their spectrum of activity is fairly broad, they are inactivated by organic matter, the sun and the high pH values. They are added to drinking water to destroy pathogens.

OTHERS
Organometals such as dibutyl can be combined with other disinfectants such as fungicides.

One of the main factors involved in selecting a disinfectant is its activity : bactericidal, virucidal and fungicidal. They are not systematically approved for all of these properties.

PHYSICAL AGENTS

Physical disinfectants (flame, superheated pressurised steam) can only be used on metal equipment and small surface areas.

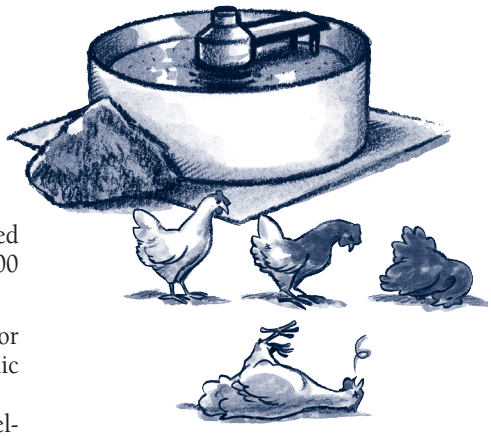
Pressurised steam is excellent for clearing away solid waste. The water should contain a chemical disinfectant that is not destroyed by high temperatures. However, this is an expensive method, which is hard work for the operator and can corrode certain metals. It is reserved for the disinfection of limited surface areas such as concrete-floored premises used for experiments.

Disinfecting by flaming is useful for metal equipment.

DISINFECTING EARTH FLOORS

The use of the following is recommended :
- Caustic soda, at a concentration of 1% (500 litres per 1000 m²) or in flakes.
- Lime, which helps the ground to dry and makes it easier to remove the litter when the flock has left the premises

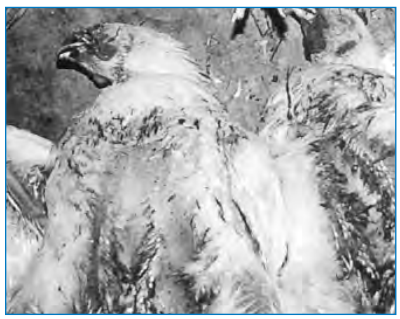
NB : **For the disinfection of parasitic elements** (primarily coccidial oocysts), *the main chemical disinfectants are :*
- Methyl bromide
- Ammonia
- Carbon disulphide



• 2. MANAGING WASTE

Do not leave the litter near to the building. If the farm is affected by a disease, burn the litter. The litter must be burnt at least 300 metres from dwellings or other farms.

The carcasses of birds must be collected at least twice a day, or even more frequently if the mortality is high due to an epidemic on the farm.
The carcasses must be incinerated at least 300 metres from dwellings or farms.
Incineration in a ditch using petrol or quick lime is the preferred method. First produce a layer of quick lime, on top of which should be placed the layer of carcasses, whose skin should previously have been gashed, followed by a second layer of quick lime. Water is then poured into the ditch, which is filled in with earth 24 hours later.
Disinfecting material and vehicles used to transport and handle carcasses.
If a necropsy is performed, it must be conducted away from the building, ideally in premises constructed for this purpose.



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C CONTROLLING THE SANITARY QUALITY OF THE WATER AND FEED

• 1. WATER

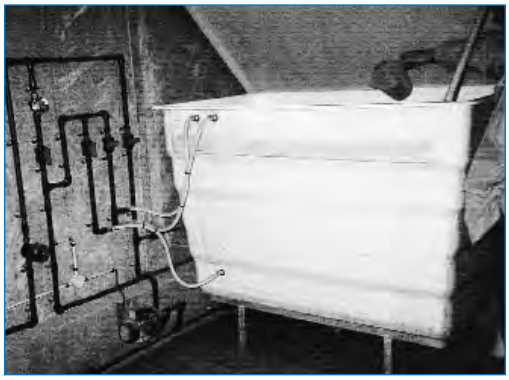
The quality of the drinking water is very important, not only because its composition can have an impact on the zootechnical performances in terms of growth and the end quality of the product, but also because it can act as a vector for pathogenic micro-organisms, or even host a pollutant whose consequences can be dramatic. Water is also used as a vehicle for the distribution of medicinal products and for vaccination, and thus poor water quality will have adverse consequences for the farm(VIENOT, 1999).

BETWEEN 2 PRODUCTION CYCLES : SERVICING THE DISTRIBUTION SYSTEM

The quality of the water distributed is dependent both on its initial quality, and on the cleanliness of the distribution system.
Keeping the water distribution system clean ensures that the following are prevented from appearing and developing over time : limescale, rust, algae and soiling. When disinfectants are used in a dirty system, they may be inactivated by the high levels of organic and inorganic matter. In such cases, the water becomes an ideal environment for the development of micro-organisms.
To keep the system clean, the water lines must be rinsed during the sanitary period between production cycles using high-pressure water. Then, water mixed with a cleaning solution is maintained in the circuits for a few hours.
Organic soiling is acidic and should be cleaned using an alkaline disinfectant. Mineral soiling (e.g. limescale) is alkaline and should therefore be eliminated using an acidic detergent (i.e. its pH is less than 7). In practice, during the sanitary period between production cycles, an alkaline disinfectant is used followed by an acidic disinfectant to remove the "limescale" from the system. The lines can then be rinsed with clean water. All the water distribution equipment must be properly cleaned and disinfected.

PROPERTIES OF THE CLEANING WATER

The “hardness” of the water is measured in ppm of calcium content. Water is considered as hard above 200 ppm (4 mg of calcium/litre).



When a too hard water is daily used on the farm, the results are :

- Deterioration of various items of equipment (particularly rubber and metal equipment)
- The deposit of limescale on the internal wall of the pipework, and particularly in the tubing inside high pressure pumps which can explode.
- A reduction in the disinfecting power of numerous commercially-available disinfectants.

On the contrary, water that is too soft (e.g. rainwater) becomes acidic and can corrode pipework. Moreover, it loses its ability to rinse effectively.
To avoid all these problems in the long term, the ideal compromise in farming is to use water at between 100 and 300 ppm.

QUALITY OF THE WATER : STANDARDS REQUIRED FOR FARMING			
pH	6.5<pH<8.5	Nitrates	<50 mg/litre
Hardness (calcium content)	100 to 300 ppm	Iron	<0.2 mg/litre

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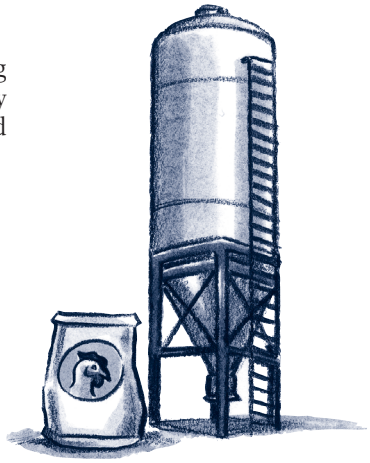
DURING FARMING

To ensure that the water supply is healthy, then during rearing acidifiers should be added regularly which are not harmful to the animals. A number of disinfectants may be added to the distribution system, notably citric acid, ammonia and chlorine. Water disinfection programmes, used routinely, bring down the levels of micro-organisms, inhibit the growth of algae and reduce the deposits of certain minerals. They can also potentialise the efficacy of certain medicinal products (e.g. citric acid improves the ability of tetracyclines to dissolve). The analysis of water samples taken from different parts of the circuit makes it possible to assess the efficacy of the prevention programme followed.

• 2. FEED

The feed can be an important source of contamination in poultry farming (e.g. salmonellosis, mycotoxicosis, colibacillosis). Pathogenic elements may be present initially in one of the ingredients, they may also be introduced when the feed is mixed, during its delivery or during storage.



CONTAMINATION VIA THE INGREDIENTS

Particular care should be taken to monitor any ingredients that contain proteins of animal origin, such as fish meal as well as any ingredients which have been transported in containers in the presence of high-risk products. The specific quality of the ingredients and the absence of pathogenic micro-organisms in these ingredients are key elements. The feed can act as a reservoir for Salmonellae, Clostridia as well as viruses such as Newcastle disease virus. It may also act as a vector for mycoplasmosis, pasteurellosis, or infectious coryza which can be transmitted via the feed, from one farm to another. In some cases, it may even be the bag that contains the feed which is the vector.
Samples of ingredients must be analysed regularly to confirm that no Salmonellae or Clostridia are present. It is also advisable to check for the presence of mycotoxins in maize and wheat. These mycotoxins cause immunosuppression, which promotes the development of bacterial, viral or parasitic infections (SANDRE, 1999).

STORING THE INGREDIENTS AND PREPARING THE FEED

The feed stored in bulk or in bags must be separated into batches so as to simplify the identification and stock management of the “all in – all out” rotation programme. The separation of the ingredients into batches must form part of a comprehensive quality control and analysis programme designed to optimise feed quality. Accurate feed formulation is a prerequisite to attaining optimal performance.
Suitable management of the storage of the ingredients prevents products at low risk (e.g. soya) from being

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contaminated by ingredients at high risk (such as fish meal, for example).
Silos, storage areas and transport equipment must be provided so as to prevent ingredients being contaminated by condensation or water leaks. Storage zones and their surrounding area must be kept clean and inaccessible to rodents and wild birds which are vectors of disease. A programme of rodent and insect control will reduce the accidental risks of feed contamination.

TRANSPORTING AND DELIVERING THE FEED

The vehicles which transport the feed must be decontaminated at a station set up for this purpose before returning to the feed storage area, so as to prevent crossed infections. Before proceeding to the loading point, the inside of the driver's cabin and the inside of the compartment which will contain the feed must be inspected to ensure that everything is clean and dry.
On breeder farms, the feed delivery zone must be located near to the enclosure so that the lorries do not need to enter the farm.
All drivers who enter the storage zone must wear hygiene equipment provided by the farm and must not enter the poultry houses.

MYCOTOXINS

Mycotoxins are toxic substances produced by fungi and are found in all types of cereals (wheat, maize, rice, rye, etc.). Although there are several types, the most serious is aflatoxin B1.
Once the toxins have been manufactured they remain stable. Commercially-available preparations, that are added to the feed (premixes), counter fungal growth, the secretion of toxins and in some cases can inactivate the toxins.
Mycotoxins affect the animals' immune response system and thus increase their susceptibility to other diseases. Their ingestion in acute or chronic contexts causes considerable economic losses, notably with a significant loss of performance with no obvious clinical signs.
The best way to avoid fungal growth and contamination by mycotoxins is to ensure that the raw materials are rapidly dried on arrival, and are stored under appropriate conditions. An air vent should be fitted in the silos, the silos should be emptied regularly and completely, any crusts should be removed, the humidity should be kept low, anti-mould fumigations applied and the entire distribution circuit should be cleaned.
It is also strongly advisable, when purchasing raw materials, to check that they are free from mycotoxins.

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D CONTROLLING THE HEALTH QUALITY OF THE ANIMALS

• 1. CHICK QUALITY

The term "chick quality" covers all the variables which may relate directly with the ability of the chick to generate a profit.
The health quality of the chick is one component of chick quality. Controlling this form of quality involves ensuring that the chick is not carrying some infections : Salmonella, mycoplasmosis, colibacillosis etc.

INTRODUCING NEW MICRO-ORGANISMS
The chick may be a carrier of certain micro-organisms, and be incubating the disease (e.g. : laryngotracheitis), however, it may also be a chronic subclinical carrier (e.g. infectious coryza, chlamydiosis). In both cases, an epidemic may break out if the chicken is brought into contact with other animals that are susceptible to the pathogen.

Amplifier of recurrent (resident) or newly-introduced micro-organisms.
The farm may be contaminated chronically by certain micro-organisms, against which the animals are resistant. If the immune status of the chicks arriving on the farm is insufficient, or if they are particularly sensitive, then this can trigger the disease.

To prevent these various risks, then, wherever possible, an “all in – all out” strategy should be adopted. Moreover, birds of different ages should never be mixed, and homogeneous groups should be introduced rather than groups from different sources. Group heterogeneity facilitates the introduction and circulation of pathogens within a population.

Care should also be taken to ensure the health quality of the chick by conducting systematic laboratory analyses :
Sampling from a lorry of chicks, ducklings or young turkeys, and from the bottom of the boxes (at least 5). The aim is to obtain a picture, as representative as possible, of the health status of the flock on arrival.

The following are thus important :
- Selecting which animals to sample
- Ensuring that there is no contamination during transport
- The delay between sampling and analysis

Respecting these various precautions ensures the accuracy of the initial information, and limits the impact of any modifications.
The elements taken into consideration in the analysis are as follows :
1. Clinical examination : omphalitis, dehydration, malformations…
2. Necropsy
3. Bacteriological examination
   Investigation of *E.Coli* (typable or not) (liver, yolk)
   Investigation of *Salmonellae* from animal samples (liver, yolk, intestines) and from the bottom of the box.
   Investigation of *Staphylococcus aureus* (yolk).
4. Mycological examination :
   Investigation of *Aspergillus fumigatus* (lungs)
5. Serology for mycoplasmas.

The results must be interpreted with the help of the laboratory or the farm technician so as to distinguish between flocks that need to be specially

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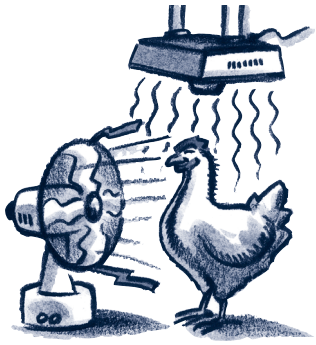
monitored and flocks that should be treated preventively. It is important to remember that the presence of a micro-organism does not automatically mean that it will be followed by a disease.
Note : these analyses also provide the opportunity to assay the levels of maternal antibodies against IBD, in order to determine the vaccination date for the chicks.

VACCINATING BREEDERS
Vaccinating breeders limits the vertical transmission of pathogens (e.g. : *encephalomyelitis*) which could otherwise degrade chick viability. It also enables the mothers to pass on protection via maternal antibodies, which will protect the chicks for a certain time. Vaccinating breeders thus enhances the chick's own passive immunity *(e.g. : against IBD and infectious anaemia)*.

• 2. MANAGING THE ATMOSPHERE



The atmosphere of the building is characterised by its :
- temperature
- humidity
- speed of the air and its circulation
- gas content (ammonia, oxygen, carbon dioxide)
- dust content
- microbial load

In intensive rearing, these various parameters rarely act in isolation ; it is the negative combination of a number of them which creates an imbalance.

Controlling the atmosphere involves finding the best compromise, by taking into consideration :
- The external climatic conditions at the present time
- The characteristics of the building's population (age, density, species, etc.)
- Energy costs (ventilation or heating)

A poorly-controlled atmosphere results in :
- Damp litter
- Temperature fluctuations
- Thermal stress
- Excesses of ammonia and humidity
- Insufficient air renewal rates

Negative combinations of the various atmospheric parameters rapidly create imbalances which can have serious consequences on various organs of the body.

COLD AND HUMID AIR :	The kidneys of young chicks are not protected. The result is irreversible kidney lesions.
DAMP AND COLD LITTER :	Since the birds' abdomen is in contact with the litter, this can cause diarrhoea.
DUST, AMMONIA, CARBON DIOXIDE :	Chronic respiratory disease

TEMPERATURE
This factor has the greatest impact on the animals' living conditions and on their performance.
Young animals : the body temperature regulation mechanisms of chicks are not very effective during the first few days of life. The surface area in contact with the air is proportionally very high. The buildings should be warmed up 48 hours before the arrival of a new flock.
At start-up and until adult feathering is achieved : : avoid temperature variations of more than 5°C over a period of 24 hours. Avoid very high temperatures, especially at the end of the production.

1 Biosecurity

D CONTROLLING THE HEALTH QUALITY OF THE ANIMALS

DRAUGHTS OF AIR

The temperature actually felt by the animals is dependent on :
the ambient temperature, the air speed and the animals' age.
Sudden changes in air circulation or severe draughts can cause anomalies to appear on the farm, notably :

- Diarrhoea, right from the first few weeks.
- Dirty feathers
- Feed conversion ratios that are regularly too high.

TEMPERATURE OF THE WALLS

The temperature of the walls and of the litter must be as close as possible to the ambient temperature.
In winter, cold walls (caused by poor insulation) cause: diarrhoea, caked litter or broad distributions of animals and heterogeneous flock.

AIR HUMIDITY

The effects of humidity vary depending on the air temperature. If the humidity is high when the ambient temperature is above 30 °C then growth is retarded since the animal cannot cool down. In general, if the humidity is very high, then the litter quality will be poor.

LITTER

On a farm, litter which is in poor condition indicates that other parameters are being incorrectly controlled.

AMMONIA

Ammonia has an irritating, corrosive and toxic effect on the respiratory system. The consequences of high levels of ammonium are : impaired immune defence systems, a drop in feed consumption, growth retardation.
Four factors are involved in the production of ammonia : droppings, humidity, heat and fermentation.
To limit the production of ammonia, it is important to :

- Ensure that the flooring is clean and of sufficient quantity
- Provide good ventilation : temperature, humidity
- Ensure that the quality of the litter is good (ground straw, wood shavings)
- Maintain the litter: Superphosphate : 300 to 500 kg /1000 m^2.

DUST

Dust provides a medium for microbial organisms.
In a dry atmosphere, when the animals are actively moving about or when the ventilation causes air turbulence, large quantities of fine dust are produced from the litter and droppings. They penetrate deeply into the respiratory system and may cause chronic respiratory disease.

VENTILATING THE BUILDING

Since the start of the 1980's, increasing numbers of poultry houses have been equipped with systems that

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maintain the temperature on a permanent basis by regulating the opening and closing of vents and air inlets. In general, performance levels in poultry farms have been significantly improved through the use of accurate and reliable automation equipment.
Fans have been used for many years. Their aims are to :

- Mix the air during cold periods,
- Improve the condition of the litter by drying it,
- Create flow of air around the animals during hot periods.

Note : open buildings have also been constructed with fans located in the middle which provide correct ventilation.

Consequences of poor ventilation

Insufficient ventilation

- Condensation : degradation of the litters
- Release of ammonia : unsatisfactory feed conversion rate, condemnation of carcasses.
- Higher body temperatures due to insufficient air speeds: unsatisfactory feed conversion rate if there is a serious lack of ventilation: Weight loss or even mortality in extreme cases.

Excessive ventilation

- Air speed too high: lowered body temperature.
- Temperature differences (greater than 6°C) : unsatisfactory feed conversion rate.

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TABLE III : Summary of hygiene and decontamination measures

PRELIMINARY SAFETY RECOMMENDATIONS

RELATING TO HANDLERS

- Wear a mask and gloves when carrying out any operation involving chemical products, even if this precaution is not stipulated by the manufacturer : no chemical product used in disinfection is totally harmless and without risk
- Read the safety data sheets for all the products used. These must mention the risks relating to the use of each product, the procedures to follow in the event of an accident (ingestion, spray, etc.) and, if applicable, the name of the antidote

RELATING TO NON-FARM PERSONNEL

- In all cases, and particularly in relation to rat poison, ensure that children cannot access the treated zones or to the product storage zones.

ONCE THE ANIMALS HAVE LEFT

1ST INSECT CONTROL MEASURE

- Immediately after removing the birds (not more than 1 hour after).
- Up to a wall height of 1 metre, including the stores

EMPTY THE FEEDING AND WATERING CIRCUITS

- Empty the feed supply line and the silos.
- Empty the water circuit, pipework and tanks.

DISMANTLING THE EQUIPMENT

- Remove everything that can be dismantled, not forgetting storage areas

PROTECTING OF MOTORS / ELECTRICAL COMPONENTS

- Remove any dust carefully
- Cover electric or lubricated components to protect them from water and dust.

REMOVING THE DUST FROM SURFACES

- Ceilings, walls, wire meshing, material that cannot be dismantled

REMOVING THE LITTER

- Do not keep near to the building
- If the farm is affected by a disease, burn the litter. The litter should be burnt at least 300 metres from dwellings or other farms.

SCRAPING THE FLOOR

- Scrape off the top layer of earth
- Remove all the build up of organic matter

CLEANING – DISINFECTING THE SURROUNDING AREA AND PREMISES (BUILDINGS, SILOS, STORES, ETC.)

- Check the condition of the gutters, peripheral ditches, etc.
- Disinfect the hard-packaged earth:
  spread lime (10 kg/100 m^2) or iron sulphate (2.5 kg/100 m^2)

DESCALING THE WATER CIRCUIT

- Circulate an appropriate product through the pipework, let it act for 4 to 5 hours, then rinse out and drain off.

DISINFECTING THE WATER CIRCUIT

- Circulate an appropriate product in the pipework, let it to act then rinse out
- Ensure that the tank it protected (covered) so that it cannot be contaminated during subsequent operations

WATER-BLASTING - DISINFECTION

MATERIAL

WASHING AREA

- Set up a concrete-floored washing area

SOAKING

- For 30 minutes, as a minimum, to several hours if the soiling persists

RINSING

- With clean water

DISINFECTION BY SOAKING

- For 30 minutes

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BUILDING

SOAKING THE SURFACES WITH CLEAN WATER

- Building : walls, ceilings, nest boxes (if they cannot be removed)
- Surrounding areas, stores, silos.

CLEANING - PREPARING FOR DISINFECTING

- Foam gun or spraying
- Start with the top and finish with the floor, without forgetting access doors, skylights, ventilators, gates, etc.
- Leave to act for 30 minutes if using a foam gun
- Leave to act for 1 hour after spraying

BLASTING WITH A HIGH-PRESSURE CLEANER

- Start with the top and finish with the floor
- Collect the drain-off water in a concrete or covered pit

FIRST RUBBING WITH DRAG-SWABS

- Evaluation of the initial level of contamination prior to disinfection

INITIAL DISINFECTION

- Corners and recesses : flame with a blow lamp
- Walls and ceilings
  - Low-pressure spraying (35 bar)
  - From top to bottom, starting with the ceiling
  - Pay special attention to corners, recesses and gaps
  - Collect the drain-off water in a concrete or covered pit so that the action of the disinfectant can be applied to the water used for washing
- Packed earth floor : spread quick lime (300 to 500 g/m^2)
- Silos : Use fungicidal and bactericidal smoke-producing candles, respect the manufacturer's recommendation in terms of the number of candles / silo

SECOND RUBBING WITH DRAG-SWABS

- Checking the disinfection. If the test indicates the presence of pathogenic micro-organisms, the cleaning and disinfecting operations must be repeated

SERVICING THE BUILDING, IF NECESSARY

- Treat any wooden elements with appropriate products (e.g. carbonyl) : roofs, perches, etc.
- Fill and repair cracks, gaps, etc.

ELIMINATING RATS

- Set up sanitary barriers
- If possible, identify locations frequented by rats: stores, peripheries of the building, etc.
- Do not touch the bait with your fingers
- Conceal the bait
- Renew often, and change their location.

SANITARY

SANITARY PERIOD BETWEEN PRODUCTION CYCLES

- Duration : minimum of two weeks : the building must be completely dry.
- Leave the building completely open
- Decontaminate the surrounding area and pathways (lime or iron sulphate)
- Remove any weeds and hoe or dig over the area surrounding the building

BEFORE THE ARRIVAL OF THE NEXT FLOCK

PAINT THE SURFACES WITH QUICK LIME

- Walls, doors, windows
- Ground : apply a layer of dead lime paste, 0.5 cm thick
- Apply lime paint + caustic soda : 2 kg of dead lime, 10 g of Teepol, 100 g of caustic soda in flakes for every 10 litres of water

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SPREADING THE LITTER

APPLY A DESINSECTISATION PRODUCT TO KILL OFF BOTH LARVAE AND ADULT INSECTS

- Spray onto the floor and walls...

INSTALLING THE MATERIAL

FINAL DISINFECTION OF THE ATMOSPHERE BY THERMONEBULISATION

- By thermonebulisation, before the arrival of the animals
- The building should be hermetically sealed during this operation
- Air thoroughly before the arrival of the animals

SANITARY BARRIERS REQUIRED DURING THE REARING PERIOD

FENCING AROUND THE FARM

- Controlled entrance/exit for visitors and all vehicles

FOOT BATH ROTATING SCRUBBERS (ROTOLUVE)

- All personnel must walk through the foot bath, it must be impossible to avoid, both when entering and leaving the building
- Renewal : depending on the product used and the amount of pollution introduced.

BOOTS, OVERSHOES, COATS FOR VISITORS

- Brush down before entering the foot bath
- Provide disposable, single-use overshoes
- These items must be specific to each building

DESTROYING THE CARCASSES OF ANIMALS

- Apply the health precaution measures, where applicable, otherwise,
- Perform the operation at least 300 metres from dwellings and farms
- Incinerate in a ditch using petrol or quick lime (one layer of lime / layer of corpses with gashed skin / second layer of quick lime / pour in water / fill in the ditch 24 hours later).
- Disinfect the material and vehicles used to transport and handle the corpses.