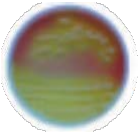


Red Meat Safety & Clean Livestock



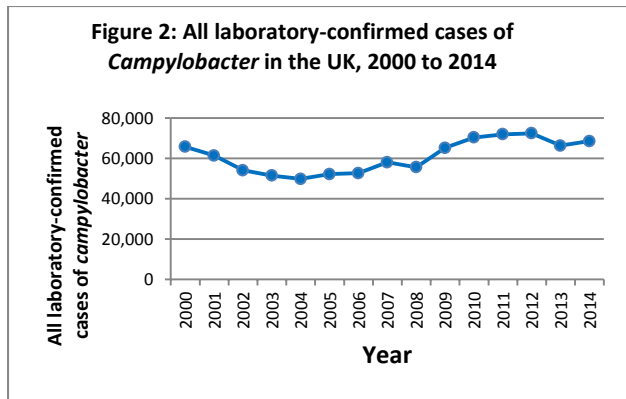
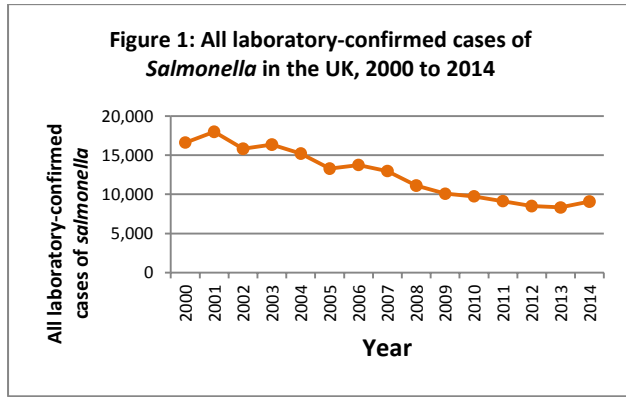
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Introduction

Over the last 15 years, there has been a general increase in the number of cases of foodborne illness, although there has been a decrease in the number of food poisoning cases due to *Salmonella*. Refer to Figure 1 and Figure 2, which illustrates the number of laboratory reports of *Salmonella* and *Campylobacter*.



Figures supplied are 'all cases', including UK acquired and those that are acquired abroad.

Figures have been provided by Public Health England, Health Protection Scotland and Public Health Agency for Northern Ireland. Data provided is also from a dynamic database, and liable to small changes. (June 2015)

The reasons for the increase include:

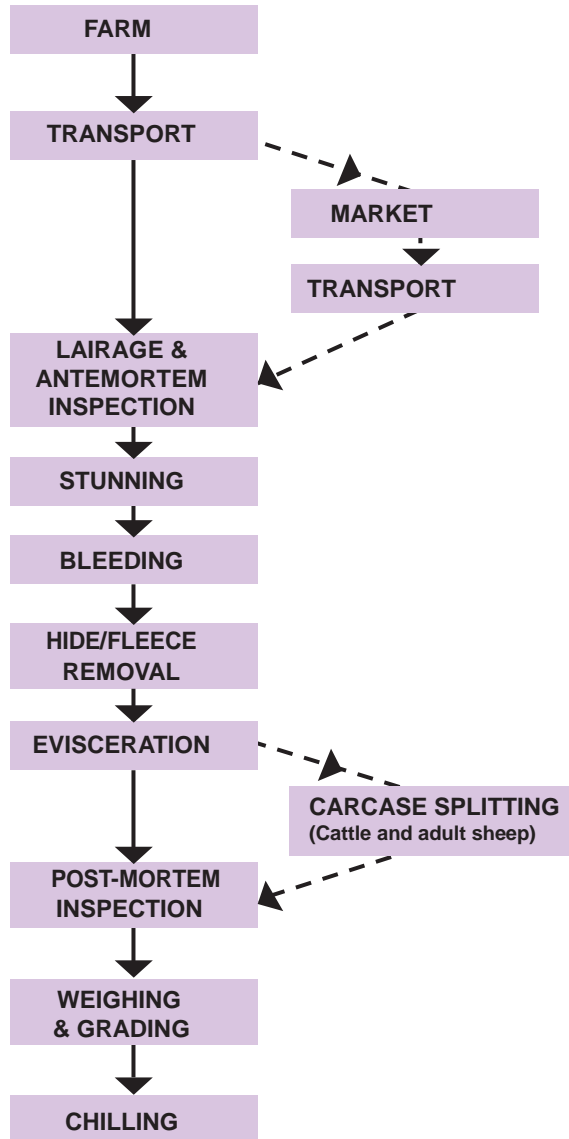
- Increased consumption of fresh, chilled or minimally processed foods rather than highly processed foods, e.g. canned foods, and reduced use of preservatives
- More dining out/take-away meals
- Alternative cooking methods
- Increased consumer awareness of food-borne illness
- Improved GP reporting and laboratory confirmation of cases

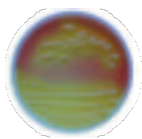
The numbers of laboratory confirmed cases in Figure 1 are thought to be an under-estimate of the real incidence of foodborne illness. The vast majority of people do not seek medical advice and then only a relatively small percentage provide samples for laboratory analysis. In the second study carried out by the Infectious Intestinal Disease Study Group for England in 2009, the estimated real incidence of *Salmonella* and *Campylobacter* were approximately 4.7 and 9.3 times, respectively, the number of laboratory confirmed cases.

Red meat and meat products have been implicated in many cases of foodborne illness. Pathogenic micro-organisms, i.e. those that cause human disease, are found in the digestive tract of healthy cattle and sheep. These micro-organisms are excreted in the faeces and can be found on the hides and fleeces of the live animal. Bacteria contamination of the fleece/hide can then be transferred onto previously sterile meat surfaces during slaughter and dressing. Visible cleanliness of the live animal has been shown to be directly related to carcass hygiene and, hence, can be used as one of a number of control points for improving the safety of red meat.



Production chain for cattle & sheep





Factors affecting microbial contamination in red meat production

Various aspects of the red meat production chain can affect the visible dirtiness and microbial load on the outside of the live animal and the dressed carcass. Spread can occur by direct contact with contaminated animals or environmental surfaces, indirect transfer of contamination, e.g. via hands or knives of slaughtermen, or via environmental vectors such as dust or aerosols. Other factors, including stress at any stage of the chain, can lead to increased incidence of defaecation and hence greater opportunity for contamination.

On farm

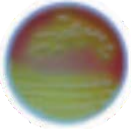
Increasing fibre length increases the degree to which the hide/fleece of livestock becomes dirty.

Finishing diets with low dry matter content, such as young, lush grass, silage (particularly acidic silage) and roots result in large quantities of wet faeces. Conversely, small amounts of dry faeces are produced from appropriately designed intensive cereal-based diets. Diet changes, if carried out too rapidly, can cause scouring, as can high levels of salt, nitrogen from fertiliser and minerals. Grass finished animals are relatively clean, but wet summers and heavy, poorly drained soil can produce wet muddy livestock.

Building design can influence cleanliness of livestock finished in housing. Poor ventilation, inadequate drainage, and construction defects, such as leaking roofs and guttering, or floors with pot-holes, can result in dirtier animals. Inappropriate siting and design of feeders and drinkers can also lead to build up of contamination in these areas of the house.

Straw bedding levels, frequency of bedding change and stocking density are vital. The latter is important also in houses with slatted floors as it will limit the quantity of faeces produced, whilst ensuring that as much as possible is trodden through the slats.

Good animal health is important in the control of meat safety. Diseases such as pneumonia, coccidiosis and salmonellosis may result in animals becoming susceptible to further infection. Also, infection with endoparasites can cause scouring and, hence, should be prevented by appropriate husbandry and treatment. Infestation with ectoparasites can cause damage to hides and pelts and affect leather quality.



Transport

Various aspects of transport may result in an increase either in the level of defaecation, or in the cross-contamination from animal to animal or from the environment.

The climate on the days before, or at, loading can influence contamination levels. Cross contamination is more likely to occur between wet animals.

The vehicle noise, vibration and motion can induce stress and can lead to an increase in the frequency of defaecation. Appropriate ventilation within the vehicle is important to ensure animal comfort, particularly on very hot or very cold days. Longer journey times increase the exposure of the livestock to these stresses, as well as increasing the period of time without water and/or feed, potentially leading to hunger and thirst. For these reasons, Council Regulation 1/2005² requires livestock vehicles to be used for long journeys (over 12 hours) to be approved, for which they need to comply with design, construction and maintenance conditions. The transporter also needs relevant authorisations and must ensure that water and feed can be made available to the animals. All maximum journey times are inclusive of the time to load and unload the animals.

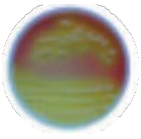
At the end of the journey, unloading into the foreign environment of a livestock market or an abattoir lairage has the added stress of the presence of large numbers of unfamiliar animals.

In order to reduce the risk of cross-contamination between successive batches of transported animals, and to limit within batch contamination, a number of measures should be taken:

- Vehicles must be cleaned and disinfected between loads to prevent the survival of bacteria and disease according to the Transport of Animals (Cleansing and Disinfection) (England) Order 2003³ together with any additional cleansing and disinfection requirements of licences under Disease Control (Interim Measures) (England) Order.
- Vehicles should be well ventilated
- Straw bedding should be provided
- Animals should be dry at loading and kept dry at unloading
- Animals should be protected from adverse weather conditions during loading
- Correct overall stocking rates should be observed
- Appropriate group sizes of uniform animals should be used

² Council Regulation (EC) No 1/2005

³ Transport of Animals & Poultry (Cleansing and Disinfection) Order (N.I.) 2007, The Transport of Animals (Cleansing and Disinfection) (Wales) Order No. 3 2003, The Transport of Animals (Cleansing and Disinfection) (Scotland) Regulations 2005



Markets

On arrival at a market, all animals are moved through a system of pens or races to a crush where identification tags are checked and sale numbers allocated. Faecal contamination may be spread through successive batches by contact with soiled environmental surfaces of these common pathways. During the sale, animals again pass along common routes, through a weigh crush to a crowded sale ring. Defaecation may occur which can be spread to subsequent sale-lots of animals.

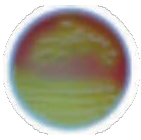
After sale, animals bought by a particular buyer are moved to holding pens where they may be mixed with animals from many different sources prior to transport. This may lead to agitated, mock sexual or aggressive behaviour patterns which result in spread of contamination through increased contact between animals. Bulls are normally penned individually before and after sale to avoid such physical contact.

Abattoir

Lairage design and construction can affect faecal contamination. Slatted or mesh floors allow faeces to fall through thus reducing the amount available to contaminate the underside and legs of animals. Faeces can accumulate on solid concrete floors, though clean bedding can absorb faeces, effectively sequestering it from contact with the hide or fleece. Solid pen walls and raceways have larger surface areas with which livestock may come into contact. Metal rails may, however, be less easy to clean and disinfect.

Time in lairage allows animals to recover from the stress of transport. Longer lairage durations may reduce overall microbial load on the outside of livestock by the cleaning and drying action of clean bedding, or the drying effect of air currents from below through non-solid floors. However, increasing time in lairage offers greater opportunity for animal to animal contact or exposure to contaminated environmental surfaces, dust or aerosols. This may lead to a greater proportion of animals becoming contaminated with pathogens.

After slaughter, external contamination can become airborne in dust or aerosols and, if air currents are in a particular direction, they can be spread towards the finished carcase at end of the slaughter hall.



In order to kill a stunned animal, it is necessary to bleed it to stop its circulation and, hence, the pumping action of the heart. Circulation only continues for a short period of time once the major blood vessels in the chest/neck of the animal are severed. Any pathogens on the coat around the incision area which are transferred to the bloodstream can be pumped to the internal tissues and may represent a human health risk.

Removal of the hide or fleece is the principal mechanism by which contamination from the outside of an animal is transferred to the exposed muscle surfaces. This can occur in a number of ways:

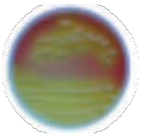
- Via knives during initial incisions through the skin
- Via hands, arms and tools of slaughtermen during separation of the skin from the underlying musculature
- By direct contact between contaminated fleece/hair and muscles
- Via dust or aerosols created by the action of mechanical fleece/hide pullers
- Aerosols from uncontrolled drainage of water onto the floor and the use of high pressure hoses in the slaughterhall

In modern 'inverted' sheep dressing lines, the initial incisions through the fleece are made at the neck and front legs. Following separation of the skin from the underlying musculature at the brisket, shoulder and flanks, the fleece is pulled off the rear end of the carcass, 'like a sock', in a downwards direction. This effectively isolates the most contaminated, perianal fleece, thus reducing spread of contamination to the hind quarters.

Contamination with gastrointestinal pathogens can also occur during evisceration. Care should be taken to avoid puncture of the viscera, and leakage from the oesophagus and anus prevented by tying or clamping the alimentary canal at either end.

Spray washing prior to carcass inspection has been shown to spread faecal contamination to other areas of the carcass.

Trimming of visibly contaminated areas should only be carried out by plant operatives, under FSA supervision. Since much of the microbiological contamination on dressed carcasses will be non-visible, trimming cannot be wholly effective in eliminating faecal pathogens.



Bacterial pathogens

Some of the most important pathogens associated with raw meat and meat products are listed below along with their properties, sources and human disease characteristics. Data regarding numbers of laboratory confirmed cases in the UK have been taken from Public Health England, Health Protection Scotland and Public Health Agency for NI figures.

Campylobacter spp.

Morphology and growth characteristics;

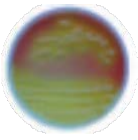
- Gram negative vibroid or spiral shaped
- Minimum growth temp. 32°C, (optimum 42-43°C)
- Microaerophilic (optimum 5% oxygen)
- Minimum pH 4.9 (optimum 6.5-7.5)

Reservoir and sources of infection;

- Gastrointestinal tract of birds (particularly poultry) and animals
- Contaminated water
- Unpasteurised milk

Disease in humans;

- Incubation period 1-11 days (usually 2-5 days)
- 68,471 laboratory confirmed cases in 2014
- Diarrhoea
- Fever
- Abdominal pain
- Complications - reactive arthritis
Guillain-Barré Syndrome
(acute neuro-muscular paralysis)
- May be fatal



Salmonella spp.

Morphology and growth characteristics;

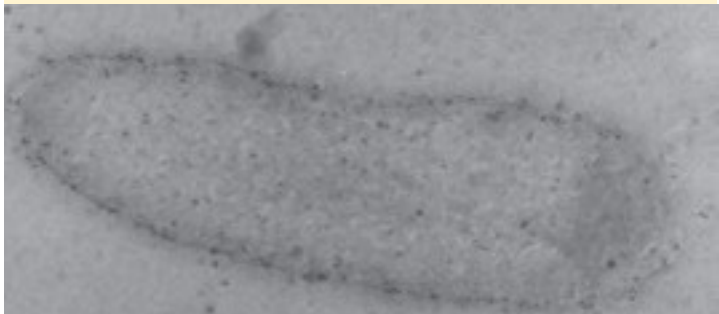
- Gram negative rods
- Growth temp. 5-46°C, (optimum 35-43°C)
- Facultative anaerobes
- pH 4.1-9.5 (optimum 7.0-7.5)
- Some strains resistant to multiple antibiotics

Reservoir and sources of infection;

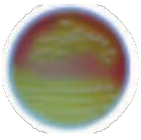
- Gastrointestinal tract of birds (particularly poultry), reptiles, wild and farmed animals (including pigs, sheep and cattle)
- Red and white meat
- Milk and dairy products
- Raw eggs
- Raw vegetables

Disease in humans;

- Incubation period 12-72 hours (usually within 24 hours)
- 9,074 laboratory confirmed cases in 2014 (all *Salmonellas*)
- Many serotypes cause human disease (majority are caused by *S.typhimurium* & *S.enteritidis*)
- Abdominal pain
- Diarrhoea
- Vomiting
- Fever and chills
- Complications - reactive arthritis
- septicaemia and peritonitis
- Excretion of the bacteria may occur for several weeks after recovery
- Mortality about 0.1% of cases



Transmission electron micrograph showing *Salmonella typhimurium* at a magnification of x 45,000.



Verotoxin producing Escherichia coli O157

Morphology and growth characteristics;

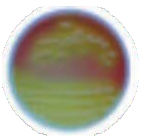
- Gram negative rods
- Growth temp. 7-46°C, (optimum 35-40°C)
- Aerobes/anaerobes
- Minimum pH 4.4

Reservoir and sources of infection;

- Gastrointestinal tract of ruminants
- Beef, beef products and lamb
- Contaminated milk & vegetables

Disease in humans;

- Incubation period 1-6 days
- Very low infective dose (<100 cells)
- 1,201 laboratory confirmed cases in 2014
- Diarrhoea
- Vomiting
- Complications - Haemorrhagic colitis
 - Haemolytic Uraemic Syndromes (HUS)
(~10% of HUS cases fatal)
 - Thrombotic Thrombocytopenic Purpura (TTP)
- Mortality about 0.7% of cases



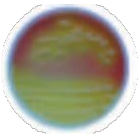
Clostridium perfringens

Morphology and growth characteristics;

- Gram positive rods
- Spore forming
- Growth temp. 12-50°C, (optimum 43-47°C)
- Anaerobic
- Minimum pH 5.5 to 9.0

Reservoir and sources of infection;

- Gastrointestinal tract of food animals
- Soil and dust
- Contaminated cooked meat and poultry dishes subject to inadequate temperature control after cooking and during storage (spores can revert to vegetative cells and multiply)



Disease in humans;

- Incubation period 8-24 hours (usually 12-18 hours)
- Enterotoxin produced after ingestion not in food
- Diarrhoea
- Abdominal pain
- May be fatal

Listeria monocytogenes

Morphology and growth characteristics;

- Gram positive rods
- Growth temp. -0.4-45°C, (optimum 30-37°C)
- Aerobic/Anaerobic
- pH 4.3 -9.4

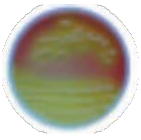
Reservoir and sources of infection;

- Ubiquitous in the environment
- Animals and man
- Damp environments in food factories (wet floors, drains ventilation/chiller systems)
- Majority of cases food borne (post-process cross-contamination of meat or dairy products, raw vegetables)
- Mother to foetus infection

Disease in humans;

- Incubation period variable (3-70 days)
- 188 laboratory confirmed cases in 2014
- Influenza-like illness or meningitis in pregnant woman
- Spontaneous abortion or premature birth
- Immunocompromised individuals and elderly also at risk
- Mortality up to 30% of cases

Other microorganisms which may cause foodborne or waterborne illness include *Staphylococcus aureus*, *Yersinia enterocolitica*, *Bacillus cereus* and the protozoa *Cryptosporidium* spp.



Animals cleanliness and carcase microbiology

In a study of sheep from five visible cleanliness score categories⁴ of the former MHS Clean Livestock Policy⁵ (CLP) (see Appendix 1), slaughtered and dressed on an inverted dressing line, mean log₁₀ Total Viable Counts at both shoulder and abdomen carcase swab sampling sites increased with increasing dirtiness of the animals from which they were derived (Figure 2). In general, the percentage of sites on the dressed carcase that were positive for Enterobacteriaceae, indicators of faecal contamination, also increased with increasing Score category (Table 1).

Figure 2

Animals cleanliness and carcase microbiology

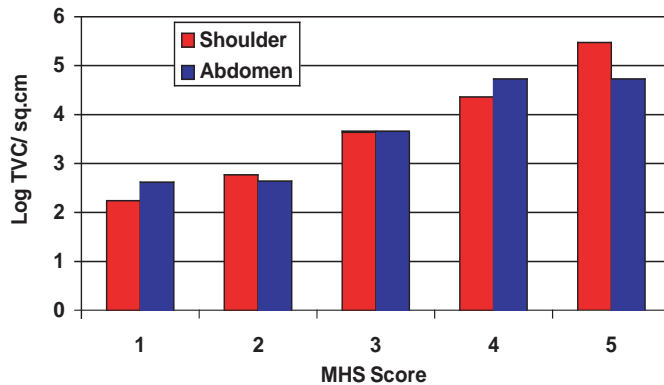


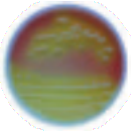
Table 1: % carcase swab sites positive for Enterobacteriaceae

CLP score	Shoulder	Abdomen
1	35	30
2	20	5
3	50	55
4	85	70
5	100	100

Source: Hadley, Holder & Hinton (1997)

⁴ CLP was also used in N.I.

⁵ The Meat Hygiene Service was set up in 1995 and was responsible for the enforcement of meat hygiene and related legislation. The Service was merged with the Food Standards Agency in 2010.



Food safety & HACCP

Historically, the microbiological safety of food products has been assessed by the analysis of a small sample of each batch of the finished product. This approach to testing has a number of disadvantages:

- Retrospective indication only of inadequate control of safety
- Destructive
- Cannot take account of batch variation or uneven distribution of micro-organisms in food
- Time-consuming and expensive
- Process control only involves a limited number of staff

In a Hazard Analysis Critical Control Point (HACCP) system, all potential hazards to food safety at each stage of the production chain are identified. A Critical Control Point (CCP) is a point, step or procedure where control must be applied to prevent, eliminate or reduce a food hazard to an acceptable level. To assure food safety, each CCP is monitored to check that it is within critical limits.

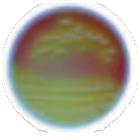
If limits are in danger of being broken, corrective action must be taken. This systematic approach, if properly implemented should ensure the safe production of food.

The seven principles of a HACCP system are:

- Conduct a hazard analysis and develop production flow chart
- Identify the CCP's
- Establish critical limits i.e. set target levels which must be met to ensure the CCP is under control
- Establish a system to monitor control of the CCP
- Establish corrective actions to be taken when monitoring indicates that a CCP is not under control
- Establish procedures for verification to confirm that the HACCP system is working correctly
- Establish documentation/records for all procedures

Microbiological testing of carcasses should be used to help confirm that the procedures are working. HACCP procedures have the following advantages:

- Proactive in identifying hazards before they occur
- Maximise product safety
- Non-destructive
- Provides evidence of due diligence
- Cost effective
- Food safety assurance involves all production staff



Clean livestock policy & its enforcement

In response to the recommendations of the Pennington Report (1996) after the outbreak of E.coli O157 in Lanarkshire and the Pennington Report (2009) following the outbreak of E.coli O157 in Wales attributed both outbreaks to cross-contamination between raw and cooked meat, the Government encouraged industry to adopt a HACCP- based approach to meat production. The MHS introduced the CLP which assessed the cleanliness of animals presented for slaughter to assist in the achievement of safe levels of dressed carcase hygiene.

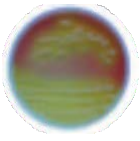
In the assurance of raw red meat safety, CCP's are points in the production chain where control can limit the microbiological hazards to a safe level. The acceptance of animals for slaughter is generally regarded as a CCP. Either way, slaughterhouse operators must ensure that animals are clean as this is a legislative requirement.

The written description for each category of the MHS classification of cleanliness, and illustrative photographs for cattle and sheep are contained in Appendix 1.

It is everyone's responsibility throughout the meat supply chain to ensure that only clean animals are presented for slaughter. The Official Veterinarian (OV) or Meat Hygiene Inspector (MHI) has legislative powers to prohibit the entry of any animal into the slaughterhall, if in doing so would compromise hygienic dressing operations. This Guidance was written for use by MHS officials in support of its clean livestock policy; however the advice in it remains good practice for FBOs.

Each animal should be assessed against the cleanliness scoring scale. Animals in categories 1 & 2 are considered safe for slaughter with no further precautions. Animals allocated a score of 3 should be rejected for normal slaughter and can be dealt with in a number of ways:

- Retained in lairage on clean bedding to clean/dry
- Clipped to remove contaminated areas of wool/hair
- Killed in the lairage and carcase disposed
- Slaughtered with a reduction in line speed to allow special care to be taken
- In England and Wales the Disease Control Orders prohibit anyone sending animals to an abattoir unless they are to be slaughtered without undue delay



Animals scored 4 or 5 should be rejected for slaughter and re-presented once they are clean, unless killed in the lairage and the carcase disposed. MHS records showed that there were seasonal trends, with the highest percentages of initial rejections from September/October to December, relating to climate and housing of animals.

Management/production systems to produce clean livestock

Diet & animal health

The following dietary issues should be considered with respect to animal cleanliness:

- High dry matter diets produce cleaner animals than low dry matter diets
- Diet change to reduce the moisture content of the faeces should be done gradually to prevent scouring
- Mineral/salt intake should be controlled

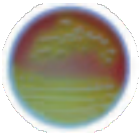
Good standards of general animal health should be maintained by:

- Adhering to an animal health plan for the farm with effective veterinary regimes to reduce infection with pathogens
- Appropriate husbandry and therapy to prevent endoparasite and ectoparasite infestation

Housing

Housing should have:

- Good ventilation
- Adequate straw bedding changed as frequently as necessary
- Large wood chips can be considered as an alternative material to straw bedding
- Appropriate stocking densities (particularly on slatted floors)
- Well designed feeding/drinking arrangements to prevent concentration of dung in these areas, and faecal contamination of feed/water



Immediately prior to transport

Though preventing animals becoming visibly contaminated is preferable, the following can be used to clean up animals:

- Bringing livestock indoors onto clean dry bedding
- Withdrawal of feed prior to transport to decrease gut-fill and reduce overall faecal contamination
- Clipping to remove gross contamination from the underside i.e. brisket and abdomen, legs, rump and tail (timed to prevent recontamination closer to the skin)

Economic implications of compliance and non-compliance

The cost to the farmer of presenting animals for slaughter in an unacceptable condition, i.e. CLP categories 3-5, might include:

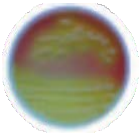
- Reduced live animal price at market
- Reduced carcase value due to excess trimming or rejected for human consumption
- Penalty for line speed reduction
- Charge for additional lairage time or clipping in lairage
- Animal rejected at ante-mortem inspection and destroyed

These additional costs are borne usually by the farmer. Information earlier in this document describes the many opportunities for livestock to become visibly dirty or microbiologically contaminated between leaving the farm, and arriving for ante-mortem inspection. Personnel at every stage along the integrated red meat production chain should have a responsibility to ensure livestock are presented for slaughter in an acceptable condition.

In addition, there are other, more general economic implications of presenting dirty livestock for slaughter:

- Costs of health care for foodborne illness cases
- Lost national productivity
- Cost of poor industry/product image
- Cost to the leather industry of dirty hides/fleeces
- Effluent treatment and waste disposal costs
- Deleterious effects on the environment

In comparison, the production costs associated with ensuring that animals are clean (e.g. fall within CLP categories 1 & 2 and thus comply with the CLP) are relatively minor. These include feeding



appropriate dietary components, effective animal health pharmaceutical or veterinary input, time to house animals immediately prior to transport, additional clean bedding and time and equipment for clipping.

References and further reading

Clean Beef Cattle for Slaughter - a guide for producers - Clean Sheep for Slaughter - a guide for farmers

HSE Agricultural Information Sheet No. 35

Hadley, P.J., Holder, J.S. & Hinton, M.H. (1997) Effects of fleece soiling and skinning method on the microbiology of sheep carcasses. *Veterinary Record* **140**, 570-574

Stewart, C.S. & Flint, H.J. (Eds) (1999) *Escherichia coli* O157 in farm animals. CAB International. Oxon

Wray, C. (Ed) (2000) *Salmonella* in domestic animals. CAB International. Oxon

Pearson, A.M. & Dutson, T.R. (Eds) (1995) HACCP in meat, poultry and fish processing. Blackie, London

Waites, W.M. & Arbutnot, J.P. (Eds) (1991) Foodborne Illness. Edward Arnold, London

Varnum, A.H. & Evans, M.G. (1991) Foodborne pathogens. Wolfe Publishing, London.

Useful websites

Food Standards Agency for Environment, Food and Rural Affairs	www.food.gov.uk Department www.defra.gov.uk
Department of Agriculture Development	www.dardni.gov.uk and Rural
National Assembly for Wales	www.wales.gov.uk
ADAS	www.adas.co.uk
Public Health England	www.gov.uk/government/ organisations/public-health- england

The information in this booklet is intended as guidance and is not a complete statement of the law.

Appendix 1: Cleanliness classification of livestock

(Source: Meat Hygiene Service, 1997)

Category 1 – Clean and dry



Cattle in this category will be accepted for slaughter without any special treatment.

Dry
Clean with regard to dung/dirt
Very minor amounts of loosely adherent straw/bedding



Sheep in this category will be accepted for slaughter without any special treatment.

Dry
Clean with regard to dirt/dung
Very minor amounts of loosely adherent straw/bedding

Category 2 - Slightly dirty



Cattle in this category will be accepted for slaughter without any special treatment.

Dry/damp
Light contamination with dirt/dung
Small amounts of loosely adherent straw/bedding



Sheep in this category will be accepted for slaughter without any special treatment.

Dry/damp
Light contamination with dirt/dung
Small amounts of loosely adherent straw/bedding

Category 3 - Dirty



Cattle in this category will be rejected for slaughter except in circumstances which are exceptional, e.g. animal welfare grounds, disease control reasons.

Dry/damp
Significant contamination with dirt/dung
And/or significant amounts of loosely adherent straw/bedding



Sheep in this category will be rejected for slaughter except in circumstances which are exceptional, e.g. animal welfare grounds, disease control reasons.

Dry/damp
Significant contamination with dirt/dung
And/or significant amounts of loosely adherent straw/bedding

Category 4 - Very dirty



Cattle in this category will be rejected for slaughter except in circumstances which are exceptional, e.g. animal welfare grounds, disease control reasons.

**Dry/damp
Heavily contaminated with dirt/dung
Heavily clogged (clegged)
and/or significant amounts
of adherent bedding**



Sheep in this category will be rejected for slaughter except in circumstances which are exceptional, e.g. animal welfare grounds, disease control reasons.

**Dry/damp
Heavily contaminated with dirt/dung
Heavily clogged (clegged)
and/or significant amounts
of adherent bedding**

Category 5 - Filthy and wet



Cattle in this category will be rejected for slaughter

Very wet
Very heavily contaminated with dirt/dung and/or
Very heavily clagged (clegged) and/or a lot of bedding adherent to the coat



Sheep in this category will be rejected for slaughter

Very wet
Very heavily contaminated with dirt/dung and/or
Very heavily clagged (clegged) and/or a lot of bedding adherent to the coat

Note: Contamination of the following critical areas is particularly likely to result in rejection for slaughter of the animal: brisket, abdomen (underside), flank, ribcage (lower areas and underside), hind legs (posterior surface of the hock), fore legs (anterior surface of the knee), neck and rectal area.

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