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AN EXAMINATION OF FACTORS AFFECTING THE CLEANLINESS OF HOUSED BEEF CATTLE IN NORTHERN IRELAND

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OVERALL SUMMARY OF PROJECT

As a result of industry concerns and Government Legislation on the presentation of dirty cattle at abattoirs, a series of studies were established at the Agricultural Research Institute of Northern Ireland to examine factors affecting the cleanliness of housed beef cattle. In a major on-farm study, cattle in 164 houses on 133 farms across Northern Ireland were evaluated for dirtiness. A full description of the housing, dietary and animal factors was recorded for each of the farms and the animals given a 'dirt score'. Further controlled scientific studies were subsequently undertaken within the Institute to examine specific parameters which the on-farm study indicated to be important causal factors in the development of dirty cattle.

The results indicated that on average, cattle on slats were dirtier than those in well-bedded straw systems, but poorly managed straw-bedded units produced very dirty cattle. Cattle were cleaner where ventilation was of a high standard, and with increasing pen size and number of cattle in the pen. However, contrary to popular belief, there was no significant effect of stocking density in slatted pens on dirtiness of cattle, though increasing the proportion of solid floor in slatted pens and length of time cattle were housed resulted in dirtier cattle. Feeding high levels of concentrates, and supplements with low dry matter (DM) content (e.g. potatoes, fodder beet or brewer's grains) significantly increased animal dirt score. Cattle offered drier silages (DM content of over 30 % DM) were cleaner than those given wetter silages, while digestibility of silage did not affect dirtiness. Housing of steers and heifers in the same pen increased dirt score compared to when genders were penned separately. Clipping of cattle prior to housing was found to have little effect on animal cleanliness.

Overall, the data indicate that housing design, in particular quality of ventilation, can have a major influence on cattle cleanliness, while dietary factors influencing animal dirt score should also be taken into account when formulating rations for finishing cattle.

INTRODUCTION

Cattle presented for slaughter in Northern Ireland must meet stringent specifications for cleanliness. These requirements are largely a response to recent fatal outbreaks of food poisoning (caused by *E. coli* 0157 bacteria), which were linked to contamination of animal carcasses with faecal and other material during processing at the abattoir. Under the Fresh Meat (Hygiene and Inspection) Regulations for Northern Ireland (1997), there is now a legal obligation to ensure that animals presented for slaughter have low levels of faecal soiling.

In view of the concerns expressed by the industry, and the lack of experimental evidence on the subject, a series of studies were undertaken by the Institute to examine the factors affecting the dirtiness of housed beef cattle. This booklet summarizes the findings from these studies and considers the practical implications for the beef industry.

METHODOLOGY

Study 1 An on-farm evaluation of the factors influencing the cleanliness of housed beef cattle

A large-scale on-farm study, involving 164 cattle units on 133 farms throughout Northern Ireland, was undertaken between early December and mid-February over two consecutive winter feeding periods. The farms were selected to encompass as wide a range of housing, feeding and management regimes as possible, and representative samples of animals from each farm were assessed for dirtiness using a specially developed scale.

Housing factors measured

Cattle housing was assessed for quality of ventilation based on internal air volumes, inlet and outlet areas, number of cattle in the shed, and location of the site (exposed or sheltered). Pen size, number of cattle/pen and length of time housed were recorded on each farm and, in slatted systems, the proportion of the floor area as void or solid floor was determined.

Dietary factors measured

Details on harvesting method and number (1st, 2nd or 3rd cut) of all forages offered to animals over the housing period, as well as a description of the amount, type and method of feeding of concentrates were recorded on each farm. Representative samples of all feeds were taken for determination of chemical composition at the Institute.

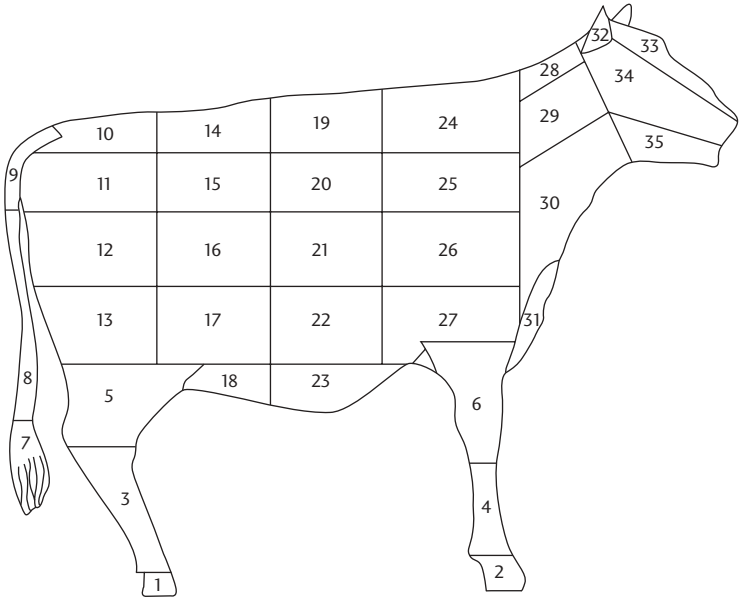
General details and management

Animal gender, parasite treatments administered and which (if any) parts of the animal had been clipped at housing were recorded for each individual holding.

Assessment of dirtiness

Cattle were evaluated for dirtiness in accordance with the dirt scoring system developed by Scott and Kelly (1989). Using this system, both sides of the animal are diagrammatically divided into 35 segments and each segment given a score between 0 (very clean) and 3 (very dirty). Thus, the overall dirt score of an individual animal can range from 0 to 210. The segmental divisions of an animal side used in the scoring system are illustrated in Figure 1.

Figure 1 The segmental divisions on each side of an animal used to assess dirt score



REVIEW OF FINDINGS

Summary data showing the range of values recorded for some of the main factors examined in the study are presented in Table 1, and highlight the wide variation in housing, animal and diet factors existing across the farms. Only 20 of the 164 units examined represented non-slatted accommodation (predominantly straw bedded systems). The effects of these factors on animal dirt score are discussed below.

Dirt scores in the present study ranged from 7.0 to 99.3 and represented very different extents of animal cleanliness. For illustrative purposes, photos of cattle across the range of dirt scores encountered are presented in Plate 1, with animals being divided into categories according to level of dirtiness.

Table 1 Summary data for the parameters measured in the study (164 units)

	Minimum	Maximum	Mean
Housing/Animal factors			
Cattle/pen	4	60	16
Pen size (m^2)	10.8	420.0	53.3
Area (m^2)/animal	1.6	25.3	3.2
Stocking density (kg/m^2)	19.4	347.4	214.2
Live weight (kg)	370	720	549
Ventilation[a]	1.0	4.0	2.5
Feeding period (days)	45	195	92
Dirt score	7.0	99.3	47.1
Silage factors			
Harvest number	1.0	3.0	1.3
pH	3.37	5.48	4.23
Dry matter (%)	15.8	37.9	22.3
Crude protein (% DM)	8.9	19.0	12.9
NH_3-N (% total nitrogen)	3.5	47.0	13.3
D-value	57.0	75.0	66.4
Intake value[b]	61.0	89.0	75.4
Concentrate factors			
Dry matter intake (kg/day)	0.36	8.67	3.20
Fresh weight intake (kg/day)	0.45	14.00	4.05
Dry matter (%)	40.6	90.0	82.8
Crude protein (% DM)	7.0	21.6	14.8
Crude fibre (% DM)	2.5	22.0	8.8
Ether extract[c] (% DM)	0.7	17.0	3.7
Ash (% DM)	1.7	11.1	6.1
MADF[d] (% DM)	3.5	30.6	12.7

[a] 1.0 = good ventilation; 4.0 = poor ventilation
[b] Predicted from Hillsborough Feeding Information System
[c] Oil content
[d] Modified acid detergent fibre

Plate 1 Examples of cattle representing various dirt score categories across the range of dirtiness encountered in the current study

Category 1 (dirt scores 0-20)

Category 2 (dirt scores 21-40)

Category 3 (dirt scores 41-60)

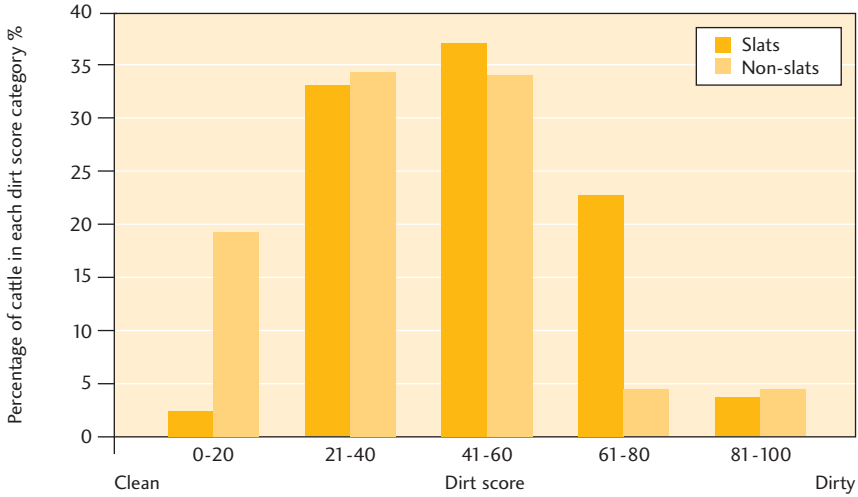
Category 4 (dirt scores 61-80)

Category 5 (dirt scores 81-100)

Effects of housing/management factors

The proportion of animals in each dirt score category for slatted and non-slatted accommodation are illustrated in Figure 2 below.

Figure 2 The proportion of cattle in the range of dirt score categories recorded in the present study



Cattle in slatted accommodation were dirtier than those housed in non-slatted accommodation, largely reflecting the much greater percentage of animals in the lowest dirt category (dirt scores 0-20) and the much smaller percentage in higher dirt categories (dirt scores 61-80) for cattle housed in non-slatted units. However, it was observed on-farm that cattle housed in a few poorly managed bedded units were very dirty.

The mean dirt scores of animals housed in accommodation with each specific category of assessed ventilation standard are presented below (Table 2). On average, across all farms, the quality of ventilation in cattle housing tended to be of relatively low quality, with some 66% of units falling into ventilation categories 1 and 2. However, overall, dirtiness was reduced as quality of ventilation in the housing environment was improved, indicating the importance of maintaining a 'fresh air' environment within beef cattle housing.

Table 2 The mean dirt scores of animals accommodated in sheds with different standards of ventilation

Ventilation#	1	2	3	4
Number of units	44	64	50	6
Dirt score	52.6	48.3	41.5	39.8

Quality of ventilation: 1 = poor; 4 = best

Cattle were dirtier as the length of time they were housed increased. Similarly, increasing the stocking density (kg live weight/m^2) in cattle housing tended to increase the dirt score of animals and, contrary to the generally accepted view, lower stocking densities on slatted floors did not produce dirtier cattle. However, increasing pen size and number of cattle in the pen produced cattle with much lower dirt scores (across all stocking densities). This observed trend with slatted systems may have reflected increased animal movement in larger pens and hence the greater foot contact may have kept the slats, and consequently cattle, cleaner. Animal live weight had no effect on dirtiness.

Increasing the proportion of solid floor in slatted housing systems resulted in dirtier cattle. However, increasing the proportion of the floor as void within the slatted area appeared to have little effect on the dirt score of animals, suggesting that this parameter is less important in the production of clean cattle from slatted housing systems than proportion of pen floor as solid.

Effects of dietary factors on dirt score

(1) Concentrates - Regardless of housing system, cattle were dirtier as the amount of concentrates fed increased. The mean dirt scores of cattle receiving various levels of concentrates (dry matter (DM) basis) are presented in Table 3. These data highlight the major difference in dirt scores recorded between animals offered low levels of concentrate supplements (e.g. mean dirt score of 41.7 for cattle receiving 0-1 kg concentrates per day), compared with those cattle receiving much higher levels of concentrates (mean dirt score of 72.4 for feed levels of 8-9 kg per day).

Table 3 The influence of level of concentrates on animal dirtiness

Concentrate DM intake (kg)	0-1	2-3	4-5	6-7	8-9
Number of units	42	82	31	7	2
Mean dirt score	41.7	44.7	54.8	65.3	72.4

While there was only a slight trend for lower dirt scores with increase in concentrate DM content, cattle given wetter concentrates (mean DM content 47.4%) (e.g. concentrates containing proportions of potatoes, fodder beet and brewer's grains) were found to be much dirtier that those given drier concentrates (mean DM content 84.7%). Feeding concentrates with high ash, fibre or oil contents also tended to increase animal dirt score.

(2) Silage - Animal dirt scores were largely unaffected by any of the silage parameters measured in this study (including crude protein (CP), ammonia nitrogen (N), pH, volatile fatty acid content, digestibility and intake factor). However, cattle given drier silages (greater than 30% DM) were significantly cleaner than those given wetter silages. The mean dirt scores of cattle offered silages within a range of categories of DM content are presented in Table 4.

Table 4 The influence of silage DM content on animal dirt score

Dry matter (%)	15-19	20-24	25-29	30-34	35-39
Number of units	38	98	20	5	2
Dirt score	47.9	47.6	50.7	30.7	23.3

Animal treatment and animal factors

Gender appeared to have little effect on dirt score, but when steers and heifers were penned together, they tended to be much dirtier than if penned separately. This observation presumably reflects increased activity between animals when held in mixed pens. Similarly, there was little difference in dirt score between cattle which had been treated for parasites (e.g. lice and worms) and un-treated animals.

Clipping of animals prior to housing, particularly the tail, flank and belly areas, improved animal cleanliness. However, regardless of body area clipped, it was noted that any improvement in animal dirt score achieved was not sufficient to eliminate the need for further clipping prior to slaughter to meet the cleanliness specifications required by law.

Study 2 An examination of the dirtiness of housed beef cattle offered different levels and types of concentrates

This study was designed to address some of the issues raised in the on-farm study in relation to the effects of level (high levels of concentrate feeding were found to increase animal dirt score) and type (concentrates high in oil and fibre contents resulted in dirtier cattle) of concentrates offered on the dirtiness of housed cattle. Three different concentrate types, designated A, B and C, and formulated to supply 15% CP in the DM were offered :

(1) Concentrate A represented a traditional ingredient mix commonly fed on farms and consisted of rolled barley, maize gluten and maize meal.

(2) Concentrate B was formulated using ingredients high in oil and fibre contents to further examine the influence of these parameters on animal cleanliness.

(3) Concentrate C contained high levels of copra meal which is recognised in the industry as having a 'drying-up' effect on animal faeces, and may therefore have beneficial effects on the production of cleaner cattle at a farm level.

The ingredient compositions of the different concentrates offered in the trial are shown in Table 5.

Table 5 The ingredient composition of the concentrates offered in the present study

Concentrate	Ingredients	Amount (kg/ton)
A (traditional mix)	Rolled barley	300
	Maize gluten	390
	Maize meal	290
	Minerals/vitamins	20
B (high oil and fibre)	Citrus pulp	600
	Distiller's dark grains	380
	Minerals/vitamins	20
C ('drying-up' properties)	Rolled barley	300
	Maize meal	260
	Copra meal	420
	Minerals/vitamins	20

Treatments and measurements

Forty-eight continental cross steers, housed on slats, were allocated to 1 of 4 treatments differing in type and/or level of concentrates offered. The concentrates were fed with low DM, poorly-fermented grass silage offered *ad libitum* for a period of 7 weeks. The treatments were:-

1) 8 kg/head/day of concentrate A plus *ad libitum* silage
2) 4 kg/head/day of concentrate A plus *ad libitum* silage
3) 4 kg/head/day of concentrate B plus *ad libitum* silage
4) 4 kg/head/day of concentrate C plus *ad libitum* silage

The chemical compositions of silage and concentrates were determined regularly throughout the study, while animal dirt scores were assessed at the beginning of, during, and at the end of the study using the system described previously.

REVIEW OF FINDINGS

Animals offered high levels of concentrates (8 kg) had considerably higher dirt scores, and showed much greater increases in dirt score over the study period, than animals offered lower levels of concentrate (4 kg) (Table 6).

Table 6 Effects of concentrate type and level of feeding on animal dirt scores

Concentrate	A	A	B	C
Feed level (kg/day)	8	4	4	4
Animal dirt scores				
Initial	24.1	23.9	23.8	23.8
Mid-study	53.1	37.9	36.9	39.0
Final	51.3	41.0	41.6	41.4
Increase	27.2	17.1	17.8	17.6

However, there were no differences in dirt scores at the end of the study, or the increase in dirt scores over the duration of the study, between animals offered the different concentrate types (A, B or C) at similar levels of intake. It is suggested that the absence of any effect of concentrate type in the present study might reflect the moderate level of feeding at which the comparisons were made, or the very poor quality of the silage offered. This may have masked any potential differences between concentrate types.

High levels of concentrate feeding increased animal dirt score

Study 3 An examination of the dirtiness of housed beef cattle offered a range of grass silages

As a follow-on from results obtained in the on-farm study, a further trial evaluated the effect of offering grass silages differing in DM, date of harvest, quality of fermentation, protein and fibre contents, and digestibility (D-value) on the dirtiness of beef cattle housed in slatted accommodation. Seven different grass silages were compared in the study.

Treatments

Seventy-seven continental cross steers were used in the trial which lasted for seven weeks. All silages were offered *ad libitum* and supplemented with concentrates sufficient to achieve an equal level of energy intake across all treatments. Concentrate composition varied between treatments in order to maintain an overall dietary CP content of 15% of the DM.

Measurements

Silage and concentrate intakes were recorded daily and samples analysed for chemical composition. All animals were dirt scored at regular intervals during the study.

REVIEW OF FINDINGS

The harvest number and chemical compositions of the silages used in the current study are presented in Table 7. There was a wide range in silage qualities evaluated, with harvest dates ranging from early June to late September representing first, second and third harvests. Similarly, D-values ranged from 58% (silage 6) to 68% (silage 1) and DM contents from 17.4% (silage 4) to 41.4% (silage 2). Indicators of fermentation quality such as ammonia-N (% of total N) varied from a low of 7.6% (silage 5) to a maximum value of 36.3% (silage 6). Silage crude protein contents ranged from 9.3% to 18.3% while fibre contents across the different silages ranged from 32.1% to 40.7%.

Table 7 Details of grass silages offered in the present study (% volatile corrected oven dry matter unless otherwise stated)

Silage	Date cut	Dry matter (%)	D-value	Crude protein	Fibre[1]	Ammonia-N (% total N)	Summary details
1	6th July	25.9	68	13.2	34.1	8.5	High D, 2nd harvest
2	8th July	41.4	65	12.7	34.3	8.9	High DM, 2nd harvest
3	4th June	17.7	64	11.1	40.3	11.7	Late 1st harvest, Low DM
4	28th Sept.	17.4	63	15.6	32.1	8.8	3rd harvest, Low DM
5	10th June	27.2	62	9.3	39.6	7.6	Late 1st harvest, High DM
6	12th Aug.	18.0	58	18.3	40.7	36.3	Poorly fermented, 3rd harvest
7	11th Aug.	23.3	63	12.9	35.3	13.1	Well fermented, 3rd harvest

[1] Modified acid detergent fibre

The influence of silage type on the dirt score of cattle at several stages throughout the study is presented in Table 8.

Table 8 Dirt scores of animals offered silages of different qualities

Silage	1	2	3	4	5	6	7
Dirt scores							
Initial	21.0	21.5	21.0	21.1	21.3	21.2	21.6
Mid-trial	54.7	45.4	50.9	69.9	42.0	64.3	67.7
Final	56.4	67.4	67.1	82.0	49.7	68.1	71.4

The results show that type of silage offered had a major effect on the dirtiness of animals, with differences in dirt scores between cattle becoming more extreme as time on the study increased. The results of this study were in line with those recorded in the on-farm study, indicating that cattle fed low DM silages were dirtier than those fed well-fermented, first cut silages.

For example, cattle offered silage 3 (17.7% DM) were much dirtier (mean dirt score 67.1) than those offered silage 5 (27.2% DM) with mean dirt score of 49.7, despite the similar harvest dates and chemical compositions of the two silages. Similarly, it is likely that the much higher dirt score of animals offered silage 4 (82.0) compared to that of animals offered silage 5 (49.7) also reflects the difference in DM contents between the two silages (17.4 vs 27.2% for silages 4 and 5 respectively), and/or the difference in harvest number (third vs first cut).

However, within a harvest, silage quality appeared to have little influence on animal dirtiness as evidenced by the similar dirt scores of cattle offered silage 6 and silage 7 (68.1 and 71.4 respectively), despite the very different fermentation characteristics (ammonia-N concentrations of 36.3% and 13.1% total N for silages 6 and 7 respectively).

High DM, first cut silages produce cleaner cattle

SUMMARY AND IMPLICATIONS FOR THE INDUSTRY

The presentation of clean cattle at the abattoir is becoming increasingly important due to the imposition of strict hygiene regulations. Producers should be encouraged to adopt practices promoting cleaner cattle.

Housing/management factors influencing dirtiness

- On average, cattle on slats were dirtier than those housed in well-bedded straw systems. However, cattle in poorly managed straw-bedded units were very dirty.
- Considering the limited availability and high cost of straw in Northern Ireland (there is only sufficient straw to bed 20% of the cattle here), there is little incentive or opportunity at present for producers to move to straw bedded systems for the purpose of improving animal cleanliness.
- Overall, increasing pen size and number of cattle in pens reduces dirt score (irrespective of stocking density), while increasing the stocking density in slatted pens will not produce cleaner animals.
- Slatted pens should have a minimal proportion of solid floor.
- Housing animals in well-ventilated accommodation is a key factor for reducing the dirtiness of cattle over the winter period.
- Steers and heifers should be penned separately over winter, as mixing of sexes was found to promote dirtier cattle.
- Treatments for parasite control for finishing beef cattle have minimal effect on the dirt score of animals.
- Clipping of cattle prior to housing has only a small effect on overall dirt score and is unlikely to eliminate the need for further clipping at the point of slaughter.

Dietary factors

- Feeding high levels of concentrates promotes dirtier cattle.
- Low DM supplements such as potatoes, fodder beet and brewer's grains, should be avoided in the finishing period for animal cleanliness purposes.
- Offering well-fermented, high DM (> 30%), first cut silage improves cattle cleanliness.

A full scientific report detailing the experimental tests and statistical analysis carried out in the present studies is available from AgriSearch.

ACKNOWLEDGEMENTS

The co-operation of the individual farmers involved in the study is acknowledged and gratefully appreciated.

DISCLAIMER

The Northern Ireland Agricultural Research and Development Council (AgriSearch) has provided funding for this project but has not conducted the research. AgriSearch shall not in any event be liable for loss, damage or injury however suffered directly or indirectly in relation to the report or the research on which it is based.

AGRISEARCH BOOKLETS

1 SHEEP
The Effects of Genetics of Lowland Cross-Bred Ewes and Terminal Sires on Lamb Output and Carcass Quality
Objective: Cross-bred ewes compared in terms of food consumption, prolificacy, lamb conformation.

2 DAIRY
A Comparison of Four Grassland-Based Systems of Milk Production for Winter Calving High Genetic Merit Dairy Cows
Objective: Cost effective methods of feeding high GM cows.

3 DAIRY
Dairy Herd Fertility - Examination of Effects of Increasing Genetic Merit and other Herd Factors on Reproductive Performance
Objective: Establishing on-farm management routines to improve reproductive performance.

4 SHEEP
Developing Low Cost 'Natural-Care' Systems of Sheep Production
Objective: Comparing outdoor/indoor lambing systems in terms of performance and costs, considering shelter and feed strategies.

5 BEEF
An Examination of Factors affecting the Cleanliness of Housed Beef Cattle
Objective: Effects of dietary and housing factors on dirtiness of cattle.

6 BEEF
The Effects of Housing System on Performance, Behaviour and Welfare of Beef Cattle
Objective: To evaluate the welfare, behaviour and performance of beef cattle accommodation on a range of floor types over winter.

7 DAIRY
Developing Improved Heifer Rearing Systems
Objective: Considerations of calving weight and nutrition to improve performance of dairy herd replacements.

For further information or to request a copy of the full scientific report detailing the experimental tests and statistical analysis contact:

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