

A Lameness Control Strategy for Broiler Fowl

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CONTENTS

1	Executive Summary	1
2	Introduction	3
3	Commercial Background to Lameness Control	11
4	Practical Rationale for a Control Strategy for Improving Leg Health in Commercial Broiler Flocks	21
5	Protocol for Collecting Information Required to Quantify Possible Risk Factors for Lameness within a Producer Company	31
6	Summary of Possible Control Strategies	33
7	Control Strategy Training Materials	39
	Bibliography	49
	Appendices	55

EXECUTIVE SUMMARY

Leg health problems are to be found globally in the production of modern broilers. Studies in Denmark and Sweden have found high levels of leg health problems in broiler chicken flocks (Sanotra et al., 2003). These authors found levels of birds with gait scores of over 3 to be 30.1% for Ross 208 birds in Denmark, and 14.1% and 26.1% in Ross 208 and Cobb birds, respectively, in Sweden. The findings of the 2005 UK study, as well as several others, indicate that that one of the major causes of leg health problems in broiler chickens is high body weights due to fast growth rate (Kestin et al., 2001; Sanotra et al., 2003), which may be genetically determined (Kestin et al., 1992; Kestin et al., 1998; Bradshaw et al., 2002; Julian, 2005). The bird strains used in the UK and Europe are used globally. This report identifies some husbandry changes that might be used to address this problem, and proposes a control strategy that companies may wish to employ to enable improvements in both their animal welfare and economic performance. The assessment and control measures described in this report may enable poultry companies to first assess the level of lameness in their own flocks, and then use this information in combination with pathology monitoring, and collection of risk factor and control point information to make decisions on management, biosecurity, hygiene, feeding and medical treatment programmes to reduce broiler lameness. It would probably not be in the best interests of overall animal welfare if this process led to changes in the European industry to make it uncompetitive with foreign production, resulting in imported broiler meat from systems where bird welfare is poor. Nevertheless, if leg weakness does cause pain and reduce mobility, and if the proportion of birds affected overall is accurately reflected in the studies described in this report, then broiler lameness represents a significant welfare problem.

INTRODUCTION

Levels of leg disorders which lead to lameness can be high in rapidly growing broilers (Sanotra 2000). This has been highlighted as a major welfare concern (FAWC, 1992; FAWC, 1998; European Commission, 2000). However, there has been debate about the level of leg disorders in UK, European and world flocks (<<http://www.fawc.org.uk/letters/broilerlet.htm>>). Research has highlighted the importance of some specific husbandry practices in determining the expression of leg problems, but it has not always been clear how these practices interact to determine the overall level of leg disorders in particular flocks. Kestin et al. (1992) reported a study of gait abnormality in intensively reared, slaughter age broilers and found that 90% had a detectable gait abnormality and 26% were moderately to severely affected. Weeks et al. (1994) found that 80% of birds in an experiment designed to examine effects of access to range and nutrient density in feed had detectable gait abnormality at 7 weeks of age. A Danish survey of commercial birds found that 30.1% of birds had a gait score of over 2 (Sanotra, 2000). In this document, a large number of the risk factor and control strategy suggestions are based on the findings of a UK industry wide study carried out between 2002 and 2005 which found that overall, 27.3% of the 4.8 million birds surveyed had gait scores of 3 or above (University of Bristol, 2006). Throughout this report, the findings of this study are referred to as the UK 2005 survey. Leg weakness can result from metabolic, developmental (Williams et al., 2000) or infectious causes (Butterworth, 1999). In addition, developmental abnormalities can act as a focus for infection (McNamee et al., 1998) and some developmental abnormalities are exacerbated by nutritional imbalances such as choline deficiency (Ferguson et al., 1978) and the effects of including soya bean oil in the diet (Watkins et al., 1991). The principal factors affecting levels of broiler lameness are represented diagrammatically in Figure 2.1.

2.1 INFECTIOUS LEG DISORDERS

Several studies indicate that localised bacterial infections, notably Bacterial Chondronecrosis (BCN) (synonyms: Femoral Head Necrosis (FHN), Tibial Head Necrosis (THN)) and osteomyelitis, are a common cause, perhaps the most common cause, of severe lameness in broilers between 25 and 45 days-of-age (Riddell, 1984; Pattison, 1992; Thorp, 1996; McNamee and Smyth, 2000; Butterworth, 2001). BCN has been recorded as causing

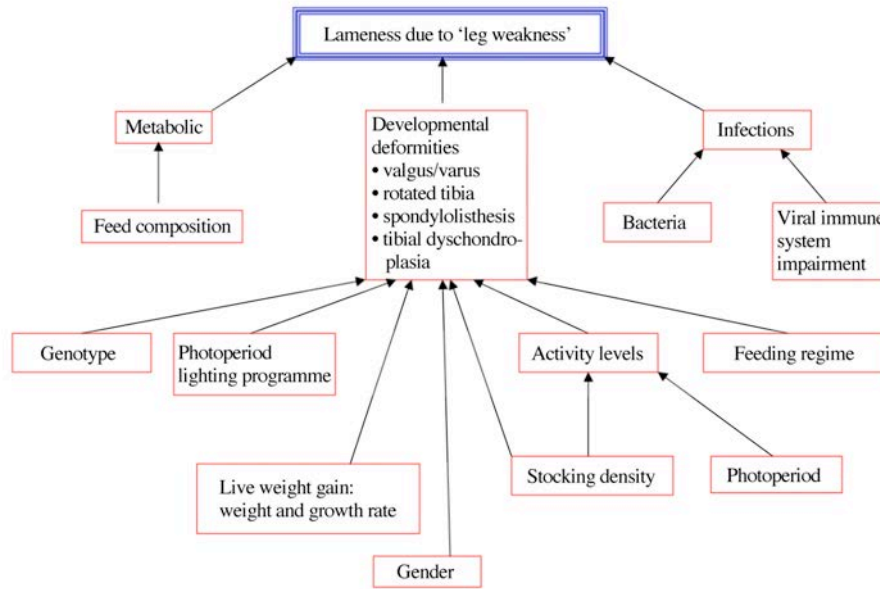


FIGURE 2.1 Broiler Lameness – Causal Associations.

0.5–0.7% of losses from total UK production through mortality and culling. The primary infectious agent causing leg disorders is *Staphylococcus aureus* (McNamee et al., 1998; Butterworth, 1999; Butterworth, 2001) although infections with *Salmonella* (Padron, 1990; Thorp, 1996) and *E. coli* (Nairn and Watson, 1972; Gomis et al., 1997; McNamee et al., 1998; Butterworth, 2001) have been recorded. Viruses and Mycoplasma spp. are not thought to cause primary lameness (Butterworth, 2001) but to impair immune function leading to increased levels of BCN (Butterworth, 1999).

Mycoplasma and Chlamydia may be associated with lameness (Butterworth, 1999). These organisms may infect existing developmental or metabolic lesions (Wyers et al., 1991). Immune system impairment by viruses has been shown to be associated with increased levels of BCN and has been demonstrated to occur due to Infectious Bursal Disease, Chicken Anaemia Virus, Marek's Disease, Laryngotracheitis virus, Reoviruses, Adenoviruses and Pox viruses (Butterworth., 1999).

In view of the requirements of the draft broiler Directive – that high levels of foot pad dermatitis measured at the processing plant may result in the enforcement of lower stocking densities in subsequent flocks, it is of interest that high levels of leg weakness have been weakly but significantly correlated with increased levels of hock burn and foot burn in two studies (Sorensen and Kestin, 1999; Su et al., 1999).

2.2 METABOLIC CONDITIONS

The metabolic conditions in intensive broiler production are primarily rickets and chondrodystrophy. Currently, lesions due to rickets of clinical severity are rare (Pattison, 1992) and little chondrodystrophy has been recognised in commercial poultry for many years (Riddell, 1992; Bradshaw et al., 2002) probably because these problems have been identified as resulting from nutritional imbalances and broiler feeds have been adapted accordingly. However, outbreaks may occur with food mixing errors and, with the increase in organic farming, in which feeding artificial supplements is prohibited, these metabolic causes of lameness may again become a problem. Rickets is caused by lack or imbalance of calcium, phosphorus and vitamin D. Chondrodystrophy is thought to result from trace element deficiencies such as zinc (Young et al., 1958), manganese (Kealy and Sullivan, 1966), choline (Jukes, 1940), vitamin E (Scott, 1953), folic acid (Danial et al., 1946), pyridoxine (Greis and Scott, 1972) and vitamin D3 (Riddell, 1992; Thorp, 1992) or interactions among trace minerals, vitamins and other food ingredients (Sauveur, 1984).

2.3 DEVELOPMENTAL LEG DISORDERS

Many of the less severe forms of leg disorders are caused by skeletal abnormalities. Many different forms of skeletal abnormality have been reported (Riddell 1992). There is strong evidence that almost all of these are a function of the combined effects of conformation, rapid growth and heavy weight-bearing, causing abnormal bone and joint remodelling (Hurwitz, 1992; Kestin, 1994; Thorp, 1996; Su et al., 1999; Kestin et al., 2001). Nutritional deficiencies are also a common cause of developmental leg disorders (Jordan, 2001).

The primary clinical manifestations of developmental leg deformity in 1992, when the last major review was undertaken, were classified as: valgus/varus deformity (VVD); rotated tibia (RT); spondylolisthesis (SL); and tibial dyschondroplasia (TD) (Riddell, 1992). It is not clear how the picture may have changed now. The primary factor associated with many of these conditions is live weight gain (Riddell, 1983; Riddell, 1992; Kestin et al., 1994; Sanotra, 2000; Kestin, 2001). Many of these conditions are more common in males than females (Haye and Simons, 1978; Riddell and Springer, 1985; Leterrier and Nys, 1992), which is interesting as males have a higher rate of growth and as overall levels of leg disorders are higher in males (Riddell and Springer, 1985; Classen and Riddell, 1989; Kestin et al., 1994; Sanotra, 2000). This has been highlighted as a major welfare concern (FAWC, 1992; FAWC, 1998; European Commission, 2000). However, there has been debate about the level of leg disorders in some flocks (<<http://www.fawc.org.uk/>

TABLE 2.1 Locomotor disorders in broilers.

Clinical signs	Histopathology	Likely Cause	Contributory Factors	Diagnosis
Loss of motor and upper motor neurone responses in hind limbs.	Deformity of thoracic spine causing spinal cord compression. Infection of thoracic spine.	Spondylolisthesis. Scoliosis.	Genetic.	Histopathology.
Loss of motor function and lower motor neurone responses in hind limbs.	Demyelination of the sciatic nerve.	Infectious spondylopathy.	Infection. Staphylococci. Fungi.	Histopathology. Bacteriology Mycology.
Severely lame, difficulty in rising, wing tips may be used for support.	Disintegration of the proximal femur or tibia, confirmation by histology.	Riboflavin deficiency. Marek's disease.	Infection Staphylococci <i>E. coli</i>	Histopathology Bacteriology Virology
Severely lame. Hot swollen joints/tendons.	Synovitis/tenosynovitis. Infected hocks.	Inflammation of tendon/ligament and sheaths.	Reovirus ? Infection Staphylococci Reovirus Mycoplasma	Histology Bacteriology Virology.
Bone deformity in the absence of growth plate thickening, +/- displacement of the gastrocnemius tendon.	Valgus (lateral) or varus (medial) and/or torsional deformity, frequently of the tibiotarsus or tarsometatarsus in the absence of growth plate abnormality.	Long bone deformity.	Exercise Diet Growth rate Unknown	Measurement of torsion and angulation
Bone deformity with thickened growth plates.	Thickening of the growth plate in the proximal tibiotarsus/tarsometatarsus, accumulation of non-mineralized cartilage.	Dyschondroplasia.	Marginal Hypocalcaemia Genetic	Histology
Long bone deformity with shortening and thickening of growth plates.	Tibiotarsus and tarsometatarsus shortened with no effect on growth plate mineralization.	Chondrodystrophy.	Manganese Choline Vitamin E Biotin Folic Acid Mycoplasma?	Bone ash analysis. Histology.

Source: Thorp, 1996.

letters/broilerlet.htm>). Research has shown the importance of some specific husbandry practices in determining the expression of leg disorders but it is not always clear how these practices interacted to determine the overall level of leg disorders in particular flocks.

2.4 INFECTIOUS AND DEVELOPMENTAL INTERACTIONS

Studies comparing ad libitum and restricted-fed (45–60% of free-feeding intake) broilers have shown that the high growth rates associated with ad libitum feeding predispose broilers to some forms of leg disorder and to bacterial infections associated with lameness (McNamee et al., 1999; Corr et al., 2003). Many husbandry factors have been found to play a role in the expression of infectious and developmental leg disorders, including:

- hatchery practices (Butterworth, 2001), feeding regimen (Riddell, 1975; Haye and Simons, 1978; Poulus et al., 1978; Duff and Thorp, 1985; Edwards and Sørensen, 1987; Lilburn et al., 1989; Classen and Riddell, 1990; Robinson et al., 1992; Yu and Robinson, 1992; Kestin et al., 1999; McNamee et al., 1999; Sørensen et al., 1999; Corr et al., 2003);
- photoperiod and light intensity (Classen et al., 1991; Renden et al., 1991; Blair et al., 1993; Sørensen et al., 1999);
- bird activity and stocking density (Reece and Deaton, 1971; Riddell, 1976; Haye and Simons, 1978; Riddell, 1983; Newberry et al., 1988; Grashorn and Kutritz, 1991; Pattison, 1992; Kestin et al., 1994; Dawkins et al., 2004);
- litter quality (Nairn and Watson, 1972; Harms and Simpson, 1975; Harms et al., 1977; Greene, 1985; Hemminga and Vertommem, 1985; Martland, 1985; Bray and Lynn, 1986; McIlroy et al., 1987; Pattison, 1987; Weaver and Meijerhof, 1991; Tucker and Walker, 1992; Dobrzanski and Bialas, 1993; Sainsbury, 1993; Ekstrand et al., 1997);
- genotype (Rauw, 1998; Kestin et al., 1999).

2.5 DOES LAMENESS MATTER?

Many of the birds in the moderate to severe gait score categories (3 and 4) will not be so compromised in their ability to reach resources of food and water that they do not grow, and will be harvested for slaughter. From a production perspective, it is only the very lame birds (gait scores 5, and severe 4) that will be culled, or may not be identified by the stockman and will die. The issue of stockman identification, and of sick and lame animals is significant for a number of reasons:

1. removal of diseased animals promptly is likely to reduce the spread of any infectious disease throughout a flock;
2. diseased birds are exhibiting poor welfare through distress and pain, and should be dealt with promptly.

Recent work has demonstrated that broilers in high gait score categories, many of which will be in the acute stages of BCN, are in pain (Duncan et al., 1991; Gentle & Thorp, 1994; Thorp, 1996; Danbury et al., 1997; Pickup et al., 1997; McGeown et al., 1999; Danbury et al., 2000). Osteomyelitis in humans is recognised to be a painful and debilitating condition (Whalen et al., 1988), and chickens have been used as an experimental model of haematogenous osteomyelitis in humans (Emslie et al., 1983). It is proposed that BCN and osteomyelitis in broiler chicken should not be discounted as ‘mild’, or ‘acceptable’ impacts on the welfare of the individual broiler, but as having a potentially ‘severe’ impact on the life experience of broilers affected by these diseases.

1.6 ANIMAL WELFARE AND ECONOMIC IMPACT OF LAMENESS

The number of birds which are picked up by stockmen on farm and culled before they reach the severe lameness category (gait scores 4 or 5) is a good indicator of the ‘quality’ of stock observation, and is related to animal/stockman ratios. Some farms record ‘leg culls’ routinely as part of their daily recording of mortality. However, the decision as to whether a moribund bird is a ‘leg cull’, or simply a diseased bird that is unable to walk, is usually unclear, and so ‘leg cull’ figures from farm records cannot be used as an accurate reflection of the prevalence of lameness in a flock, or of the efficiency of stockman detection of lame birds.

If you have 100 000 birds on your farm, and 0.8% of these birds are lost through lameness related culling or do not achieve full body weight through lameness, then 0.8% of your final productivity is lost or only partially achieved – in an industry where margins per bird and per flock are very small, this can be a significant loss which, if remedied, can result in increased profit and productivity as well as a tangible increase in ‘animal welfare’ – which retailers, through the inspection bodies that carry out farm inspections for them, will be reassured to be able to report.

The problem of ‘detection’ of lameness, is one of the reasons that many producers perceive broiler lameness as having a comparatively small impact on ‘production’ through dead or culled birds. However, the ‘welfare’ impact has been shown by many studies to be potentially much greater than the ‘production’ impact. What are the components of this impact on bird welfare? FAWC (Farm Animal Welfare Council) has used the five freedoms as a ‘framework’ for assessing the impact various animal health and welfare concerns in production animal systems. In terms of the five freedoms; moderate or severe lameness is likely to affect the following.

1. Freedom from hunger & thirst. Lameness may reduce ability to access water, and to compete for feed.

2. Freedom from discomfort. Lameness is painful (Duncan et al., 1991; Gentle and Thorp, 1994; Thorp, 1996; Danbury et al., 1997; Pickup et al., 1997; McGeown et al., 1999; Danbury et al., 2000). Gait (i.e. walking motion and posture) is used to weight spare (i.e. to shift weight off an affected limb), and to reduce the impact of 'pain' (we all know this from our experience of pain and our use of the 'limp' to reduce weight bearing on an affected limb.)
3. Freedom from pain injury and disease, by prompt diagnosis and treatment. A number of studies support the hypothesis that infections, particularly pathologies linked to the presence of *S. aureus*, are a significant cause of lameness in broilers (see Section 2.1). The treatment of individual birds is not a commercial option, and so the decision to cull (a form of treatment), or to 'ignore' lame birds depends very much on the individual acceptance level set by the production company and the stockman. Prompt diagnosis relies on prompt detection, and as the pressures of time on stockmen in intensively reared houses are likely to increase with increasing commercial pressure, the risk that diseased birds are not rapidly detected and promptly dealt with may increase.
4. Freedom to express normal behaviours. Gait scoring is a means of assessing how far from 'normal' a birds walking ability is. Birds with high gait scores, which have demonstrable pathologies are not able to express normal behaviours. Some studies (Kestin et al., 1999) and the UK 2005 survey, have demonstrated that, at the present time, Ross (Aviagen) birds have a measurably lower incidence of lameness than do Cobb birds, and many companies will confirm this (verbally).
5. Freedom from fear or distress. It would be difficult to assert that lame birds are more 'fearful' than sound birds, but it is likely that lameness results in 'distress', if a dictionary definition of distress – subject to anxiety, exhaustion, affliction, vexation, is adopted.

There are potentially two concerns relating to the welfare of birds that appear to have an abnormal gait. First, an abnormal gait could indicate leg health problems that are associated with pain. Second, lameness could restrict the bird's movement so that its normal behavioural repertoire is affected – for example, leg health problems could influence the ease with which birds access feeders and drinkers.

Recent reviews have concluded that high gait scores can be associated with pain, and that the mobility of these birds may be impaired (Bradshaw et al., 2002; Julian 2005). Evidence is based on studies of the effects of analgesic drugs. Birds with gait scores of 3 negotiated an obstacle course more quickly (McGeown, 1999), or showed a significant improvement in gait score (Danbury et al., 2000) after the administration of analgesic drugs. Self-selection experiments showed that individually housed birds with gait scores 1–4 preferentially selected feed containing analgesic drugs in preference to unadulterated food, whereas birds with gait score 0 preferred unadulterated food (Danbury et al., 2000). The implication is that the birds selected the analgesic to reduce the pain associated with abnormal gait. However, although there was overall a linear relationship between gait score and analgesic feed intake, in this relatively small sample this appeared largely due to differences between the gait score 0 birds and all other gait score categories. It was also the case that the plasma concentrations of analgesic in the gait score 0 and higher gait

score group did not differ significantly, although these samples were taken at the very end of the self-selection period, when intake levels may have dropped. Further work with a larger sample size is probably required to elucidate the motivation of birds of different gait scores to self-select analgesics and, particularly, to determine whether some leg pathologies are more painful than others, even within a given gait score banding. However, the evidence that analgesic administration results in significant increases in mobility and reduced gait score is convincing, suggesting that higher gait scores are generally accompanied by pain.

High gait score also changes bird behaviour, and, in one study, influenced the ability to obtain a food reward in simple tests (Bokkers and Koene, 2004). Affected birds generally walk shorter total distances, have greater total lying time, longer mean lying periods and undertake a reduced number of visits to feeders and drinkers in a given time period, (Weeks and Kestin, 1997; Weeks et al., 1998, 2000), although total time spent eating and drinking may be the same for birds with gait scores 0 and 3 (Weeks et al., 2000).

Overall, 27.3 % of the 4.8 million birds surveyed in the 2005 UK study had gait scores of 3 or above. If this proportion of birds were a true reflection of the whole broiler population in the UK (and, by association, Europe), and if all birds affected to this degree were in some degree of pain, then it implies that the welfare of more than a quarter of birds produced currently is being compromised to some degree. It is not possible to quantify exactly to what degree, because of the nature of the perception of pain. Neither is it possible to say how important to the birds' welfare would be the changed behavioural repertoire. However, if this resulted in the sensations of thirst or hunger in severely affected birds because they found it difficult to access food and water it would obviously be of considerable concern.

Lameness pathologies, including those directly, or indirectly, influenced by infectious processes, can have a serious impact on bird welfare. However, experience from studies carried out with the support of the broiler industry in the UK, Asia, Brazil and Australasia indicate that lameness is not recognised as an important production disease because losses through mortality and culling are usually maintained at levels that are considered tolerable, although, as illustrated above, the economic costs of lameness can be quite significant.

COMMERCIAL BACKGROUND TO LAMENESS CONTROL

Almost all large scale commercial poultry farms are run on an all-in/all-out basis. This means that a ‘flock’ is often not defined as the birds within an individual house on a farm but rather all the birds in all of the houses on a farm at one time. A process known as ‘thinning’ is also common, in which birds are selected from within the flock, based on a combination of size and/or sex, for early slaughter. This process means that almost all summary measures e.g. average age, average weight, stocking density, etc, lack any form of standardisation between, and often within, companies and this adds a significant complication to making comparisons between broiler production companies, and also adds complexity to comparisons between farms which operate different systems within the same company.

From discussion with a number of poultry production companies it is concluded that the ‘number of birds placed’ is generally a reliable and consistent measure between companies. Some companies routinely supply extra chicks (usually up to 2%), to allow for mortality during transport and immediately after placement. Further, the methods for categorising and recording measures such as mortality and culls differed between companies, as do the criteria used for assessing measures such as hock burn, foot burn and breast blisters. The criteria used by different slaughterhouses to categorise rejects by poultry meat inspectors (PMI) are known to vary between slaughter houses (Haslam et al., 2005). This lack of standardisation of measures can reduce their direct usefulness to any assessment of pathologies linked to lameness.

One interesting aspect of the broiler industry is the great difference in the final product produced by broiler production companies. As an illustration of this, Figure 3.1 shows the average live weight of individual flocks for 4 different companies in the UK, plotted against their average age. The significance of this to an understanding of leg health issues, is that the real age of the birds (in days) is more important than the ‘days before slaughter’ as this figure varies greatly from company to company and from system to system. Thus, specifying ‘2 days before slaughter’ as the optimum day to visit a farm, must also account for the fact that ‘2 days before slaughter’ can vary from 28 to 56 days (see Table 3.7) These differences will be extremely important in terms of the prevalence of leg disorders found within a given flock. As discussed in the Introduction, poorer gait has been shown to be very strongly associated with older birds, heavier birds and birds with a greater rate of growth (Riddell, 1983; Kestin et al., 1994; Sanotra, 2000; Sorensen et al., 2000).

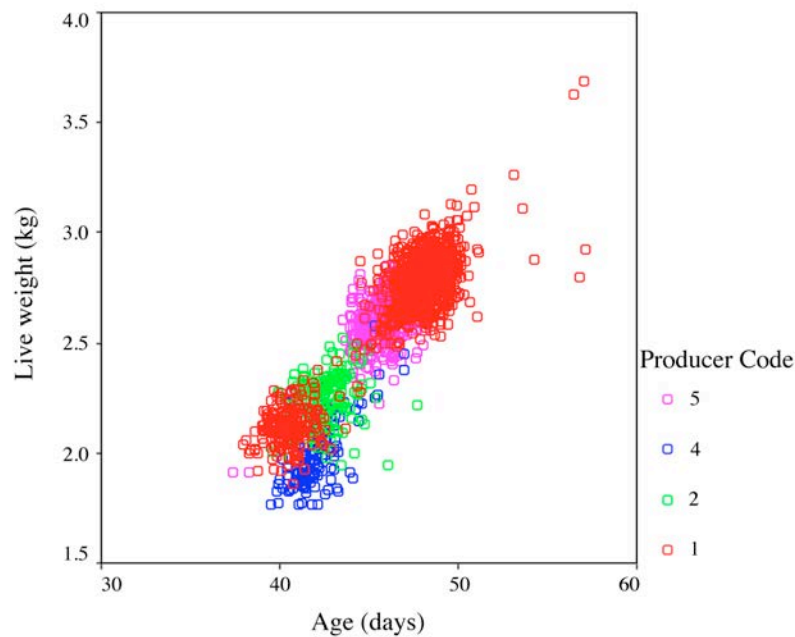


FIGURE 3.1 A plot of flock by live weight and age for 4 production companies in the UK, indicating the broad spread of age and weight at slaughter even within one country.

Broiler companies do not have comparable, centrally recorded measures of the level of leg weakness in their flocks that could be used directly in an lameness control strategy. This general problem is not peculiar to the broiler industry as it is widely reported in the statistical literature that records kept for financial and production control across farming companies are generally insufficient for cross-company comparisons to be made.

3.1 WHAT MIGHT COMMERCIAL FLOCKS EXPECT TO SEE? THE DISTRIBUTION OF GAIT SCORES

Table 3.1 shows the percentage of birds within each gait score category across a large survey carried out in the UK between 2002 and 2005. The percentages shown are calculated from the flock averages weighted by the number of birds placed. For each house, flock and company, the use of gait scoring will allow a similar distribution to be calculated (see the protocols in Chapter 7 and Table 5.1)

The figures given here can be considered to be representative of the companies in the UK 2005 survey and can be used to make comparisons across company, and as a basis for comparison with European production.

TABLE 3.1 The estimated percentage of birds in the whole UK 2005 (Anon 2006) survey within each gait score category.

Gait Score	0	1	2	3	4	5
Mean	2.2	26.6	43.5	24.3	3.1	0.2
SD	4.8	21.1	15.9	21.3	7.0	0.5
Min	.0	.0	1.6	.0	.0	.0
Max	34.7	82.7	74.6	83.7	45.9	3.2

Notes: Mean, SD, minimum and maximum for flocks are shown. The values are calculated from flock averages weighted by birds placed and include first and second visits. Total birds placed n = 4 845 962.

Source: Anon, 2006.

The UK survey indicates that prevalence of broilers with a gait score (GS) of 3 and above, at close to the time of slaughter, was 27.3%, which is in good agreement with previous estimates from the UK and Europe (Kestin et al., 1992 (26%); Sanotra, 1999 (30%).

3.2 WHAT RISK FACTORS HAVE PREVIOUS STUDIES SHOWN?

In the UK 2005 study, at the flock level, environment and management factors significantly associated with high gait score included:

- season (summer months)
- the age of the bird (older birds)
- bird genotype (lower % Ross)
- not feeding whole/cracked wheat
- shorter dark period during the day
- higher stocking density at the time of assessment
- no use of antibiotics
- intact rather than 'dusty' feed pellets

A tabulation of the data from which this summary of risk factors comes is provided in Table 3.2.

3.3 BACTERIOLOGICAL RISK FACTORS

E. caecorum and *S. aureus* have been recorded as causal agents and the 2005 UK study found them to be associated with birds with higher gait scores (Figure 3.2, Table 3.3). Additionally, *Enterococcus* and *E. coli* were weakly associated with higher gait scores,

TABLE 3.2 The parameter estimates for the UK 2005 Survey, their standard errors and significance for the model of average flock gait score in terms of manipulable husbandry factors.

Variable	Variable Type	Parameter Estimate	SE	P
Season (Sin)	Continuous	-.099	.0408	.016
Season (Cos)	Continuous	-.035	.0442	.463
Age assessed (day)	Continuous (Centred)	.048	.0049	.000
Second visit	Binary	.25	.089	.005
Percentage of flock Ross (Aviagen) sourced birds	Continuous	-.0024	.00108	.025
Dietary wheat (at week 3) (%) ^a	Continuous	-.017	.0078	.027
Average dark (hr/day)	Continuous (Centred)	-.079	.0283	.005
Stocking density (kg/m ²)	Continuous (Centred)	.013	.0057	.024
Antibiotic use on these birds?	Binary	-.17	.069	.011
Dusty/broken feed pellets	Binary	-.15	.063	.017
Constant ^b		2.52		

Notes: ^a For each risk factor – an increment in 1 unit for the variable results in an increase (positive parameter estimate) or decrease (negative parameter estimate) in average gait score for the study group. For example, and increase in 1% in dietary wheat causes a decrease in average lameness score of -0.017 (with an SE of 0.0078 and a P value of 0.027). ^b The ‘constant term’ of 2.52 is the average flock gait score for a flock visited at the average age of 39.8 days, on the average dark period of 2.9 hrs/day, at the average stocking density of 31.3 kg/m², at the first visit, with no Ross birds, no wheat in the diet, without antibiotic, on good quality feed and not corrected for the month of the year. Risk factors with negative parameter estimates reduce average gait score, whilst those which are positive, increase average gait score.

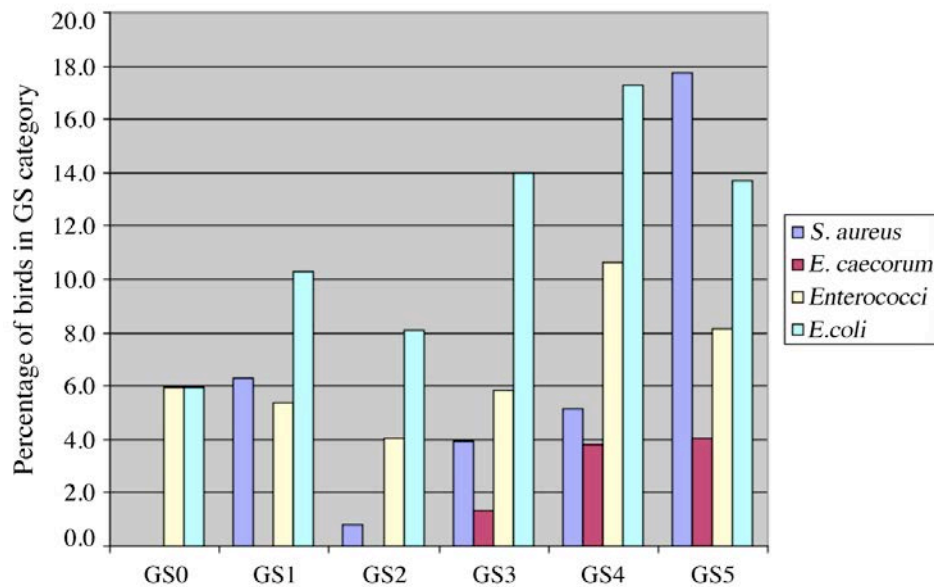
FIGURE 3.2 Percentage of birds from a sample of 1,990 birds (UK 2005 study) in each gait score category in which each of *S. aureus*, *E. caecorum*, *Enterococci* and *E. coli* were isolated.

TABLE 3.3 Bacteriological risk factors in the UK survey.

Variable	Variable Type	Parameter Estimate	SE	P
<i>S. aureus</i>	Binary	.42	.120	.000
<i>E. caecorum</i>	Binary	.74	.199	.000
<i>Enterococcus</i>	Binary	.39	.106	.000
<i>E. coli</i>	Binary	.24	.080	.003

this study did not establish causality. The inclusion of whole/cracked wheat in the diet appeared to be protective against infection by the four bacteria associated with leg weakness.

In the UK 2005 study, from 1,990 birds bacteriologically sampled the presence of *S. aureus*, *E. caecorum*, *Enterococcus* and *E. coli* were found to be associated with an increase in gait score of 0.42, 0.74, 0.39 and 0.24, respectively (Table 3.3).

3.4 SKELETAL PATHOLOGIES

Post mortem inspections of birds can be used to determine the pathologies which are present at the bird, the farm and flock level, and can be used by the company in the assessment of risk factors to reduce the incidence of lameness. The gait score (i.e. a measure of the impact on the pathology or disease condition on the ability of the birds to walk) of the individually identified birds is used as a response variable.

- Please see Chapter 7 for photographic scales for recording limb pathologies.
- The presence of pus, synovitis, tenosynovitis or ruptured gastrocnemius in a bird's leg were associated with an average increase in gait score of 0.39, 0.21, 0.41 and 0.78, respectively.

3.5 BIRD WEIGHT

A number of variables measured on the birds are direct measures of size, and are proportional to weight:

- tibial length;
- femur length;

- three measures of hock diameter can be used to calculate ‘hock width variability’ (HWV) (see Chapter 7, resources, Figure 7.23).

Bird weights at slaughter ranged from 0.7 kg to 4.78 in the recent UK study. For many people, including broiler production staff, it is commonly assumed that birds are ‘lame because they are heavy’. This oversimplification proves to be incorrect:

- The relationship between bird weight (adjusted for size) and gait score is shown in Figure 3.3.
- The curve shown in Figure 3.3 shows that, at slaughter, once the size of a bird had been taken into account, the lighter a bird was than average the higher (worse) was the gait score, whilst those birds heavier than average had slightly lowered gait scores.

3.6 HUSBANDRY FACTORS ASSOCIATING BACTERIAL INFECTION WITH LAMENESS

Infection is a possible primary cause of lameness in a significant number of birds but likely to be of less overall significance than skeletal (non infectious effects). However the sum of skeletal (greater) and infectious pathologies caused by bacteria (lesser) create the complex overall picture of lameness.

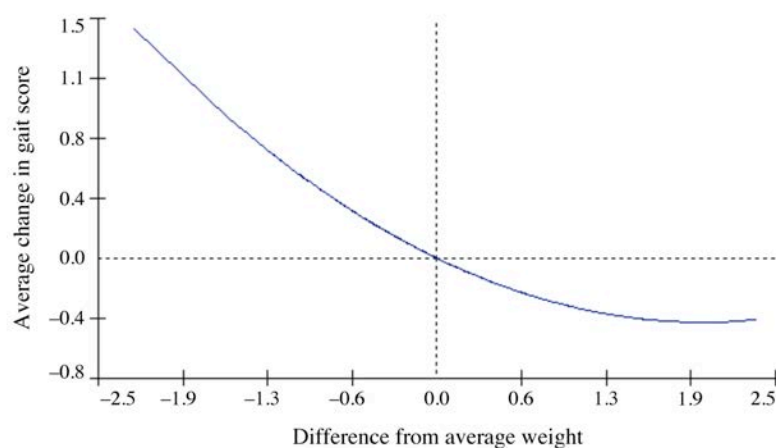


FIGURE 3.3 The average change in gait score with deviation from the average bird weight (at slaughter).

Risk factors for bacteriological pathologies associated with lameness:

- the UK 2005 study indicated a seasonal trend for the occurrence of *E. coli* and/or *Enterococci*, and, as with the other two bacteria, the highest probability of occurrence was in June and the lowest in December (Table 3.4);
- the inclusion of wheat in the diet also appeared to be protective against infection from *E. caecorum*, *S. aureus*, *E. coli* and *Enterococci*;
- birds that were more heavily soiled were more likely to have *E. coli* and/or *Enterococci* isolated from the two leg joints;
- there is some evidence that smaller flocks, as measured by the number of birds placed, have a higher prevalence of *E. coli* and/or *Enterococci* associated with lameness than larger flocks.
- seasonal effects: the mean, minimum and maximum of the predictor variables for season in the UK 2005 survey are shown in Table 3.5 – when all other variables are held constant, there was a seasonal pattern to average flock gait score with the lowest (best) gait scores occurring in March and the highest (worst) in September.

It has been reported previously that feeding wheat improves gut microflora and is protective against pathogens (Bjerrum et al., 2005), the presence of feed dust is likely to aid the survival and transmission of bacteria, the seasonal pattern of infection is in line with that reported for campylobacter (Meldrum et al., 2005) and the probability of infection is likely to increase throughout the lifetime of a flock.

TABLE 3.4 The effects of some husbandry factors on lameness.

Variable	Variable Type	Parameter Estimate	SE	P	OR
Constant		-.91	.484	.060	.402
Season (Sin)	Continuous	-.021	.1430	.883	
Season (Cos)	Continuous	-.49	.154	.002	
Soiling	Continuous	.29	.119	.015	1.335
Dietary wheat % (wk 3)	Continuous	-.06	.022	.010	.944
Birds placed (000s) ^a	Continuous	-.03	.013	.022	.971

Notes: odds ratios, parameter estimates, their standard errors and significance from model of the presence of *E. coli* and/or *Enterococci* from the UK 2005 survey; a for each risk factor – an increment in 1 unit for the variable results in an increase (positive parameter estimate) or decrease (negative parameter estimate) in average gait score for the study group. For example, an increase in 1,000 birds placed causes a decrease in average lameness score of -0.03 (with an SE of 0.013 and a P value of 0.022); risk factors with negative parameter estimates reduce average gait score, whilst those which are positive, increase average gait score.

TABLE 3.5 Mean, minimum and maximum values of variables used in the model for the UK 2005 for the presence of bacterial isolates in terms of the husbandry factors soiling, dietary wheat, age assessed and the number of birds placed.

Variable	Mean	Min	Max
Soiling	2.2	1	4
Dietary wheat % (wk 3)	9.2	0	30
Age assessed (day)	39.9	28	56
Birds placed (000's)	23.6	8.2	44.0

The association between soiling and infection may be causal, with a dirtier environment supporting the bacteria and their transmission to the bird, but may also be the result of an artefact – dirtier feathering leading to increased sample contamination. An increased isolation of *E. coli* and *Enterococci* from smaller units may suggest that it can be worth investigating whether hygiene is, on average, less well controlled on smaller farms.

3.7 BIRD GENDER AND GENOTYPE

- Male birds, in the UK 2005 Study, had an average gait score 0.22 higher than female birds at a given weight and size.
- On average, as the percentage of Ross birds in a flock was increased by 1%, gait score was decreased by 0.0024.

3.8 BIRD HYGIENE

- Feather soiling can be assessed on a subjective scale from 0 to 3, soiled (clean 0, mild 1, moderate 2, severe 3). Every increment in the soiling scale was associated with a 0.35 increase in gait score.

3.9 SKELETAL MEASURES

Please see the figures in Chapter 7 for example images and scoring schemes for skeletal measures.

- The tibiotarsal curvature score (TTCS) ranged from 0 to 3, with 3 the most curved. Every increase in the TTCS was associated with an increase in gait score of 0.30 (Table 3.6).

TABLE 3.6 The parameter estimates, their standard error and significance for the model of bird gait score in terms of intrinsic bird factors.

Variable	Variable Type	Parameter Estimate	SE	P
Constant		1.75	.179	.000
Bird Weight (kg)	Continuous (centred)	-.41	.069	.000
Bird Weight squared	Continuous (centred)	.10	.034	.003
Size (principal component)	Continuous (centred)	.22	.063	.001
Male	Binary	.36	.071	.000
Ross %	Continuous (0–100)	-.0024	.00082	.004
Soiling	Ordinal (0–3)	.35	.047	.000
Tibiotarsal curve (TTCS)	Ordinal (0–3)	.30	.042	.000
Pus ^a	Binary	.39	.129	.003
Synovitis	Binary	.21	.061	.001
Tenosynovitis	Binary	.41	.102	.000
Ruptured gastrocnemius	Binary	.78	.216	.000
Hock burn	Ordinal (0–3)	.27	.046	.000
Tibial dyschondroplasia	Ordinal (0–3)	.073	.0378	.054

Notes: ^a for each risk factor, an increment in 1 unit for the variable results in an increase (positive parameter estimate) or decrease (negative parameter estimate) in average gait score for the study group – for example, the detection of pus (presence vs absence) increased average lameness score by 0.39 (with an SE of 0.129 and a P value of 0.003); risk factors with negative parameter estimates reduce average gait score, whilst those which are positive, increase average gait score.

3.10 HOCK BURN

In the UK 2005 survey, each increment in hock burn score was associated with an increase in gait score of 0.27.

The degree of tibial dyschondroplasia (TD) was assessed on a scale of 0 to 3 (0 none, 1 mild, 2 medium, 3 severe). Each increment in TD was associated with an average deterioration in gait score of 0.073.

The presence of *Enterococcus* or *E. coli* in joints may not necessarily have a direct effect of gait score but may be indicative of a weaker bird with poorer gait and a lowered immunity. Hock burn may be both causal and associative – it may contribute to lameness but could equally, wholly or in part, be caused by more time spent sitting on the litter.

3.11 HUSBANDRY FACTORS ASSOCIATED WITH POOR GAIT (AT THE LEVEL OF THE FLOCK)

Husbandry factors play a significant role in the development of lameness, and may be causal factors for poor gait, which can be manipulated by the industry to reduce gait score within a flock.

The husbandry factors in the UK 2005 survey significantly associated with changes in average flock gait score were (Table 3.7):

- the age at which the birds were assessed was important in determining gait score, with every extra day across the range of 28 to 56 days leading to an increase in score of 0.048;
- the percentage of Ross (Aviagen) birds in a flock – for every percentage increase in Ross birds in the flock, between 0% and 100%, there was a 0.0024 decrease in gait score;
- the amount of dietary wheat fed in week 3 – for every percentage increase in dietary wheat fed in week 3, from 0% to 30%, there was a 0.017% decrease in flock gait score;
- the average dark period per day – for every 1 hour increase in the daily dark period, from 0 to 8.5 hours, there was a 0.079 decrease in flock gait score;
- the stocking density (at assessment) – for every 1 kg/m² increase in stocking density, from 15.9 to 44.8 kg/m², there was a 0.013 increase in flock gait score;
- whether the birds had received antibiotic – in flocks that had received antibiotics, the mean gait score was reduced by 0.17.
- the quality of the feed as subjectively assessed on the day of the visit – if feed was judged to be of poor quality (dusty/broken) by the assessor, the flock gait score was on average 0.15 lower.

TABLE 3.7 Mean, minimum and maximum values of predictor variables in the model of average flock gait score in terms of husbandry factors.

Variable	Mean	Min	Max
Age assessed (day)	39.8	28	56
Ross (Aviagen) sourced birds %	85.6	0	100
Dietary wheat % (by wk 3)	9.2	0	30
Average dark (hr/day)	2.9	0	8.5
Stocking density (kg/m ²)	31.3	15.9	44.8

PRACTICAL RATIONALE FOR A CONTROL STRATEGY FOR IMPROVING LEG HEALTH IN COMMERCIAL BROILER FLOCKS

It is clear that there is no single ‘fix’ or set of recommendations that will result in a reduction in lameness in all farms, in all systems and in all countries. The clinical and commercial finding is that individual broiler sheds, and individual crops of birds, can suffer fluctuating levels of lameness. Many poultry keepers (and their veterinarians) find the ‘fluctuating’ and unpredictable nature of broiler lameness frustrating and non-rewarding to ‘treat’. The occurrence of lameness is not predictable, and hence not susceptible to ‘cure’ by, for example, routine use of antibiotics at a particular point in the growth cycle. For these reasons, many experienced people in the poultry industry consider lameness a ‘disease’ that is an inevitable periodic irritant.

However, there are some risk factors and control strategies that are consistently linked with improved leg health.

To achieve an impact on lameness, the company could identify and target a number of objectives.

4.1 KEY OBJECTIVES TO ACHIEVE A REDUCTION IN LAMENESS

Objective 1

Determine the range of variation in broiler leg health that occurs in different commercial production units by using trained personnel to gait score birds in houses across the company and determine the range of variation in parameters (mortality, growth rate, hock burn, footpad, post-mortem reject data etc.; see Chapter 5 for the protocol for additional information collection) that may relate to broiler leg health in different commercial production units.

Objective 2

By this means, within each company it may be possible to detect:

1. poor farms with respect to leg health – those that perform predominately in the upper quartile for indices of leg health;
2. good farms with respect to leg health – those that perform predominately in the lower quartile for indices of leg health;
3. environmental and managemental risk factors for both poor and good farms – by identifying which risk factors appear to be linked to lameness within the company it becomes more likely that it can be identified what it is that farms with low levels of leg health problems are able to do, and how they are able to achieve these levels.

Objective 3

To carry out veterinary (or trained technician) inspections of flocks within the company, to estimate the incidence of specific pathologies and leg disorders, to gather additional information and flock data for analysis (Chapter 5), and to evaluate the welfare of the birds within the flock.

Objective 4

To use the information gathered in Objectives 1–3 to provide recommendations to breeder units and hatcheries, and to individual farms and groups of farms within the company that may be used to improve broiler leg health within the company under commercial conditions.

Each broiler company may carry out the following steps to achieve Objectives 1–4 (please see Chapter 7 for photographic and video resources to assist in making the following measures).

1. Find out the prevalence and severity of leg disorders in the flocks within the company. Include in this an assessment of the economic impact of small birds, moribund birds and culled birds resulting from lameness. In general, significant improvements in profitability can be made if lameness is tackled within a company, as well as an improvement in overall bird welfare. Inspection bodies in some countries are now beginning to focus on leg health issues as a marker for company welfare performance.
2. Make comparisons between ‘good’ and ‘poor’ farms (with respect to lameness) within the company to help identify management, house environment, feeding, medication, stockmanship and genotype factors that differ between these farms.
3. Investigate the use of water in different farms – farms with increased water use per bird (in equal weather conditions) may have systematic problems with leaking

- drinkers. Small amounts of water leaked chronically into the litter can severely damage the management of litter and impact on leg health.
4. Carry out an investigation of the bacteriological pathologies linked with lameness and identify whether these bacteria can originate in the hatchery, the transportation or by lapses in farm biosecurity.
 5. Carry out an analysis of the skeletal components of lameness. These are most likely to be linked with nutrition and genotype – and differences between flocks and farms on different diets, or with different mixes of Ross/Cobb/other genotype birds may reveal (within the company) which of these factors has an effect on the incidence of overall lameness of birds – and the economic and welfare performance which results from this.

To carry out the steps above the company will require trained assessors.

4.2 PROTOCOL FOR THE TRAINING OF ASSESSORS

To ensure standardisation of assessment and data collection a formal training course is proposed. This is in line with the outline objectives of the WelfareQuality® for training of assessors in on farm assessment techniques.

The standardised course will comprise:

- training on post-mortem protocols;
- completion of on-farm assessment forms;
- sample collection techniques;
- assessment of bird gait.

Assessment of leg health through gait scoring will be achieved by:

- training in gait scoring will be by means of on-farm visits and video training sessions;
- the inspectors will require to be assessed during the training course until they develop a uniform scoring;
- assessors will also be sent, at approximately 6 and 12 months, a tape containing video sequences of the range of gait scores;
- the scoring of the tapes will be monitored to ensure that the assessors remain in agreement.

4.3 ON-FARM ASSESSMENT

It is suggested that on-farm assessment consists of three main stages.

1. Completion of a farm questionnaire or standard inspection report with the assistance of a representative of the farm, which provides a description of the farm, house and flock. (This is likely to be a part of the bigger on farm assessment activity to be generated by the protocols in the WelfareQuality® project – i.e. broiler leg health assessment is likely to be a part of a bigger farm inspection protocol.)
2. Assessment of the gait score of 250 birds, selected at random, within one house following the protocol described in Chapter 7, Figures 7.5–7.7.
3. Post mortem examination of ten (10) birds selected preferentially from high gait score individuals within the flock. This part of the assessment is to determine the main pathological causes of lameness for the company and the farm as a specific risk assessment to enable farms and companies to understand the causes of lameness within their own business and to carry out a risk assessment and HACCP to assist in controlling lameness within their own business. (This is not the intended protocol for the Welfare Quality® inspection.)

The on-farm recording system that has been used in related studies consisted of over 130 questions, which included:

1. broiler breeder information including genotype/strain, broiler breeder history and age;
2. hatchery information including hatchery, distance/time transported and hatchery vaccination programme for chicks;
3. general information including number and weight of chicks placed, sex, time of year, age at assessment and slaughter;
4. specific husbandry practices including stocking density and thinning practice, brooding conditions, nutritional profile (detailed), vitamin/mineral levels, litter substrate, feeder and drinker design/type, lighting programme, age of house, construction details, target ventilation profile, diseases and medication history, coccidiostats used, vaccination programme and water source;
5. performance information including growth profile from weekly weighings, weekly mortality pattern, weekly leg cull pattern, other culls weekly pattern;
6. processing plant information including scratches, breast blisters, hock burn levels, foot burn levels, Local National Meat Hygiene Service reports, weight at slaughter;
7. background information about the management including: stock person ratios, age of stock persons and training/qualifications;
8. background information about the site/company including size of houses, number of birds on site and biosecurity measures.

4.4 BACKGROUND TO GAIT SCORING

To allow some ‘measure’ of the severity of lameness, and hence to allow improved understanding of the effects of lameness on a flock basis, a number of studies have given subjective severity ‘scores’ to lameness in commercial birds.

Nestor (1984) describes a rating system for turkeys in which 16 week old male experimental birds were given subjective scores of from ‘1 to 5’, with 1 indicating that the bird had legs without any lateral deviation and no difficulty in walking, and 5 representing birds whose legs exhibited extreme lateral deviation or had extreme difficulty in walking, or both. Ratings 2, 3 and 4 represented intermediate values between these two extremes.

Emmerson et al. (1991) used the scheme described by Nestor (1984) to compare walking ability of different strains of turkeys. Reiter and Bessei (1997) used videotracking of reflective points on marked birds to compare vertical and horizontal movements in sound and lame broilers and in layers. However, no further categorisation was attempted, the method being described as a tool contributing to quantitative description of gait abnormalities.

Kestin et al. (1992) described a subjective scoring system based on a scale of 0 to 5, with precise description of the gait and walking criteria to be met by birds within scores. Gait scoring, as described, is usually carried out by two people, one herding the birds with a light stick, and the other recording observations. Kestin et al. (1994) describe the use of this method for gait analysis of commercial birds, and obtained a high repeatability for scoring of the same birds twice on the same day.

Recent American studies (Mench, 2002, personal comment) have started to refine the existing gait scoring method, but repeatability measures are, as yet, unpublished.

Whilst accepting the subjective nature of any gait scoring scheme, the advantages of such a system are:

1. non-invasive methods, such as gait scoring, have the least influence on ‘normal’ walking behaviour of the birds;
2. the birds may be assessed alive. Some previous categorisations have relied on measurement of bone and joint angles after dissection (Riddell, 1976; Riddell and Classen, 1992);
3. large numbers of birds may be gait scored in situ, i.e. in the poultry house;
4. if practical welfare steps based on lameness are to be considered on farm, a critical level may be set by the stockman, i.e. gait scores 4 and 5, and birds reaching this level may be destroyed on farm;
5. no complex machinery or imaging system is required.

4.5 PROTOCOL FOR GAIT SCORING ON FARM

A recognised method for assessing the walking ability of the birds was developed by Kestin et al. (1992) and this forms the basis for the assessments. Birds are given a score from 0 to 5, with 5 being the poorest gait. The following written descriptions of gait score can be taken as a guide to the broad description of the behaviour of animals in the different gait score categories; however, training using video footage, and on farm assessment of the performance of the assessor is considered to be more robust, giving assurance as to the uniformity, repeatability and validity of the assessor performance.

Birds can be assessed in vivo in the broiler house for degree of disability (Kestin et al., 1992) and given a gait score. Birds demonstrating specified gait scores can then be selected and humanely killed, weighed and scored for valgus and varus and feather soiling. One leg can be dissected aseptically, the other not. Both legs can be scored for the presence and severity of foot lesions, hock burn, synovitis, tenosynovitis, ruptured gastrocnemius (and other) tendons, visible osteomyelitis and pus in the joints. Bacteriology swabs can be taken from the femoral head and the proximal tibia of the aseptic leg, which should be crushed aseptically after removal (McNamee and Smyth, 2000; Butterworth, 2001). Culture and classification of bacteria from the swabs should be undertaken by the company laboratory or a laboratory operating to good laboratory standards using established UKAS accredited protocols.

For gait scoring, birds should be selected at random within the house by reference to a randomised location identifier. Birds are selected from four locations, in groups of up to 80 birds, by corralling at each location using a hinged catching pen. Each bird is individually encouraged to walk out of the pen and is scored as it does so (see Chapter 7, Figures 7.5–7.7).

Note: In the future, it is the clear intention of the WelfareQuality® project to establish training programmes so that assessors/inspectors who perform farm inspections operate in a uniform and reliable way – and the material presented here (in deliverable and subtask 3.4.5.1 D3.28.1) represents a first step in this direction – for this reason, it is likely that any gait scoring protocol proposed by WelfareQuality® may develop and evolve with time.

A programme of training in the techniques described has been used in the UK, Asia, South America and Australasi. Commercially the training can be provided by <<http://www.awtraining.com>> and has been carried out for a large number of poultry companies who have recognised that good welfare practice can also make good economic sense.

4.6 GAIT SCORE CATEGORIES

Brief written descriptions of the characteristics of birds in different gait score categories are provided below. These should be used in conjunction with the video and photographic reference material to be found in Chapter 7 (7.1 video resource, 7.2 photographic resource).

Gait score 0

‘The bird walked normally with no detectable abnormality; it was dextrous and agile. Typically, the foot was picked up and put down smoothly and each foot was brought under the bird’s centre of gravity as it walked (rather than the bird swaying). Often the toes were partially furled while the foot was in the air. The bird should have been capable of balancing on one leg and walking backwards easily if necessary. It should also have been in full command of where it was going, and been able to deviate its course easily to avoid other birds.’

Gait score 1

‘The bird had a slight defect, which was difficult to define precisely but would have precluded its use for breeding if gait had been the sole selection criteria at the standard of a pedigree breeder. For example, the bird may have taken unduly large strides, which, although the observer may not have recognised the exact cause, produced an uneven gait.’

Gait score 2

‘The bird had a definite and identifiable defect in its gait, but the lesion did not hinder it from moving or competing for resources. For example, it may have been sufficiently lame on one leg to produce a rolling gait that did not seriously compromise its manoeuvrability, acceleration or speed.’

Gait score 3

‘The bird had an obvious gait defect, which affected its ability to move about. For example, the defect could take the form of a limp, jerky or unsteady strut, or severe splaying of one leg as it moved. The bird often preferred to squat when not coerced to move, and its manoeuvrability, acceleration and speed were affected.’

Gait score 4

‘The bird had a severe gait defect. It was still capable of walking, but only when driven or strongly motivated. Otherwise it squatted down at the first available opportunity. Its acceleration, manoeuvrability and speed were all severely affected.’

Gait score 5

‘The bird was incapable of sustained walking on its feet. Although it may have been able to stand, locomotion could only be achieved with the assistance of the wings or by crawling on the shanks.’

In the gait score area 2, 3 and 4 there is sometimes difficulty in differentiating readily between these scores. The schematic in Figure 4.1 has been found to be useful in differentiating between scores during training.

4.7 GAIT SCORE TRAINING RESOURCES

Please view the training videos associated with this report (6.0).

Reference video examples of gait scores 0 to 5.

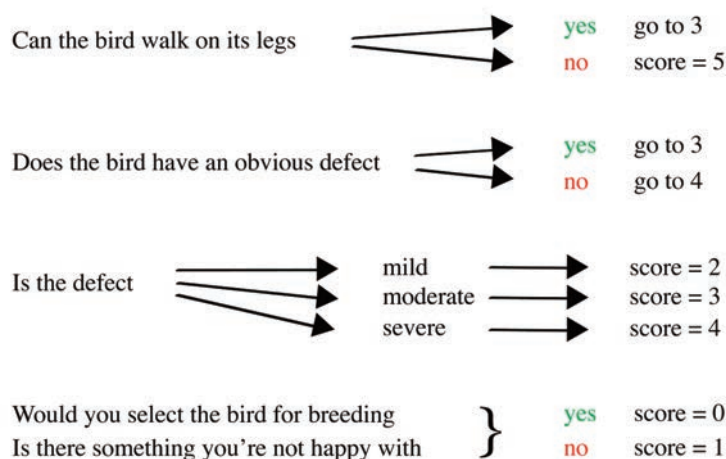


FIGURE 4.1 Schematic ‘decision support’ flow chart to help decide gait score of birds.

Notes: scores: 0 normal, dextrous and agile; 1 slight abnormality, but difficult to define; 2 definite and identifiable abnormality; 3 obvious abnormality, affects ability to move; 4 Severe abnormality, only takes a few steps; 5 incapable of walking.

1. First set of 'standardised' clips of birds of characteristic gait score for assessment purposes.
2. Second set of 'standardised' clips of birds of characteristic gait score for assessment purposes.

The training videos require a recording sheet, to be found in Appendix 2.

WelfareQuality® aims to implement programmes for training and developing assessors and inspection personnel in areas of on-farm and commercial inspection, and the implementation of control strategies for conditions such as broiler lameness. Until this programme has been developed and in the interim period, training in the techniques of gait scoring, and lameness impact assessment, in a uniform and repeatable fashion, can be achieved through an accredited course provided by, for example <<http://www.awtraining.com>>.

PROTOCOL FOR COLLECTING INFORMATION REQUIRED TO QUANTIFY POSSIBLE RISK FACTORS FOR LAMENESS WITHIN A PRODUCER COMPANY

Figure 5.1 shows the suggested order of data collection events in the company to enable improved understanding of the risk factors within the company, and to adopt control strategies for lameness.

Random selection of birds. For all farm visits, made close to slaughter age, 250 birds approximately will be caught using a catching pen at random locations generated by computer – it is not critical to score ‘exactly’ 250 birds, as averages and group statistics are always used.



Gait scoring. For each bird caught, the gait score will be recorded. The flock average gait score can be calculated by multiplying the number of birds in each gait score category, then dividing the total by the total number of birds scored – as shown in Table 5.1.



Flock records. Records of weekly bird mortality, culls and weight will be recorded.



Production and environment data. Standard production data can be obtained for the producer and for each flock, including feed conversion efficiency, average growth rate, weight at kill and MHS reject data, genotype of birds used, age of breeder stock, egg holding time before setting, egg cleanliness, early enteric disease, viral disease challenge, bacterial loading, bacterial ‘type’, use of antibiotics in early stages of growth, feed restriction programmes (if used), changes in feed quality, drinker type, feeder type, exercise levels, bird size variation within the house, litter quality, litter material (straw, wood shavings, paper), house age, floor type (concrete, earth).



Plant data. Contact dermatitis levels, foot pad dermatitis, hock burn, breast burn, meat hygiene or local veterinary service data including dead-on-arrival number at the slaughter plant.

FIGURE 5.1 Suggested order of data collection events.

TABLE 5.1 Example of calculation of flock average gait score (FAGS).

Gait score category (A)	Number of birds scored in this category (B)	% of total (C)	A x B (D)
0	10	4	0
1	25	10	25
2	137	55	274
3	60	25	180
4	11	4	44
5	5	2	25
Total	248	100	548
Flock average = Total of D/Total of B = 548/248			2.21

Notes: FAGS can be used as a single measure to compare lameness on individual farms, flocks and within companies.

SUMMARY OF POSSIBLE CONTROL STRATEGIES

A pragmatic question is: what do the ‘good’ flocks do (or have) that the ‘poor’ flocks don’t have? Retrospective analysis of the data collected by farms and companies (McNamee et al., 2000) has been used to examine the gross changes that may occur between crops, such as alterations in the feed composition, of the source of the chicks (breeder flock) and of recorded disease challenges. Small variations in, for example, litter quality and house humidity are often not recorded, and subtle changes such as the effects of an early disease challenge – for example, an episode of enteritis – are often not easy to quantify or record. The causes of lameness are multifactorial and are complex because they alter over time.

However, it is apparent from the analyses of the husbandry factors associated with poor gait that an over-riding and controllable cause of poor gait appears to be high growth rate (a measure that is a useful summary of weight and age). If growth rate is calculated as the average weight of birds at assessment divided by the age at assessment, this tends to be strongly positively correlated with the average gait score for a flock ($R = 0.6$, $P < 0.001$).

This is already widely appreciated by the industry in many parts of the world, who use a highly restricted diet to slow the growth of broiler breeders to maturity to ensure that they are less susceptible to developmental and reproductive disorders linked with high weight.

The studies and commercial work described in this report allow a group of control measures to be suggested. If the company can use the steps outlined in Chapters 4–6 and the video and photographic resources in Chapter 7, they are more able to be provided with the information required to identify which of the following control strategies are relevant and applicable to their own business.

Growth Rate

To reduce growth rate and to slaughter a younger and lighter bird. Reduced growth rates might be achieved through dietary and dark period manipulation, but such strategies may have other welfare implications. Leg disorders in broiler chickens are a global problem. It is important that in addressing this, the EU broiler industry is not compromised to an extent that would encourage imports of broilers from sources where the welfare of the birds would be outside local observation and regulation, and where welfare may be compromised and less well regulated than within the EU.

Age at Slaughter

In the short term, slaughtering birds at younger ages would significantly improve leg health in the European broiler industry. Practical problems: this would require an increase in bird numbers to meet demand. Currently the size (weight) of birds at slaughter is determined by the retail customer.

Whole Cereals

Feeding whole or cracked wheat in the diet. Whole grain and cracked wheat is incorporated into the diet for the purposes of slowing growth, to stimulate the crop and gizzard and to encourage a healthy gut micro flora. The use of a mash instead of a pellet slows feed intake; it is used with laying hens to slow their rate of food intake so that the risk of feather pecking is reduced.

Feed Type

Feeding less easily consumed forms of feed (dusty pellet) could improve leg health indirectly by slowing growth rate. Studies suggest that ad libitum feeding, and consequent fast growth, predispose broilers to bacterial infections. It is possible that reducing growth rate could reduce the incidence of infection.

Biosecurity and Bacterial Exposure

Bacterial infections are associated with high gait scores. The use of antibiotics improves leg health, although this may not be a satisfactory solution in the context of current concerns about selection for multi-resistant bacteria. The identification of alternatives to antibiotics would be desirable; for example, water hygiene (drinker design, cleaning and maintenance), air quality and bacterial load, viral infections, vaccination programs, Mycoplasma infection, clean-out standards and litter quality. In the UK 2005 study, the presence of *E. caecorum* was found to be severely disabling as this was associated with an increase in gait score of over 0.7, whilst the presence of synovitis (usually of bacterial origin) was associated with an increase of 0.21 in gait score. Work by McNamee et al. (1999) and Corr et al. (2003), using feed restriction to reduce growth rate, has shown that higher growth rates predispose birds to bacterial infection. The UK 2005 survey showed that bacteria are most likely to be isolated in June, and during the warmest months, and least likely to be isolated in December, and during the coldest months. Studies have indicated a protective effect of feeding whole or cracked wheat on bacterial causes of lameness. The presence of poor quality, dusty feed can be associated with an increased risk of *E. caecorum* and *S. aureus*, and the older a flock, the higher the risk of isolating either bacteria (UK 2005 survey). There appears to be a higher prevalence of *Enterococcus* and *E. coli* in smaller flocks, suggesting perhaps that biosecurity may be better on larger farms (bigger flocks).

Litter Condition

The degree of soiling is unlikely to cause direct changes in gait score, but is likely to be an indicator for the amount of time that birds are sitting (rather than standing) on the litter as a result of poor gait. Steps to improve litter quality (drinker leak control, attention to enteritis and conditions causing loose faeces, control of atmospheric humidity through ventilation and temperature control) all lead to improved living conditions for the birds and may directly and indirectly improve leg health.

Genotype

Selection of birds for good leg health from existing genotypes, and possible trials of new bird genotypes by broiler breeding companies, could result in reduced levels of leg health problems in the medium to long term. Genotype is known to be a factor in determining leg weakness (Rauw, 1998; Kestin et al., 1999) and for tibial dyschondroplasia (Sauveur and Mongin, 1978; Wonge-Valle et al., 1993; Havenstein et al., 1994a). Genotype also affects walking ability (Kestin et al., 1999; Kestin et al., 2001). The results of the UK 2005 survey indicate that, when all other variables are held constant, a flock of Ross (Aviagen) birds would have an average gait score 0.24 lower than that of a Cobb flock.

Incentive Schemes

The use of incentive schemes, for which growers receive a premium for demonstrating improved leg health, if designed, implemented and marketed effectively to the consumer, would improve bird leg health in Europe.

Gender

Overall levels of leg weakness are higher in males (Riddell and Springer, 1985; Classen and Riddell, 1989; Kestin et al., 1994; Sanotra, 2000; Sorensen et al., 2000) and are positively correlated with live weight gain (Riddell, 1983; Kestin et al., 1994; Sanotra, 2000). At a given size and weight, in the 2005 UK survey, male birds were on average 0.36 of a score poorer in gait than female birds. This male effect is generally recognised and may be due to differences in conformation and growth rate.

Feed Restriction

Reducing feed quantity or nutrient density of feed during the first two weeks of life has been found to significantly reduce levels of developmental skeletal disorders, including: tibial dyschondroplasia (Riddell, 1975; Poulus et al., 1978; Edwards and Sorensen, 1987; Lilburn et al., 1989), valgus-varus disorders and rotated tibia (Haye and Simons, 1978; Duff and Thorp, 1985; Robinson et al., 1992) and lameness (Duff and Thorp, 1985b;

Classen and Riddell, 1990; Yu and Robinson, 1992; Kestin et al., 1999; Sorensen and Kestin, 1999). There is some evidence that the age at which feed restriction commences determines the extent of improvement in walking ability and that 'meal time feeding', i.e. feeding the overall daily ration in a number of discrete meals, has the greater effect (Su et al., 1999). The practical problems of feeding meals in systems designed for ad lib feeding are recognised, but a number of companies have found that, for them, feeding meals has not only reduced lameness but also resulted in improved feed efficiency and profit returns (personal communication).

Photoperiod and Light Intensity

Step-up lighting programmes are those in which, following the brooding period, photoperiod is shortened to 6 or 8 hours and then gradually increased; it may be increased, at approximately 21 days, to 23 hours. There is considerable evidence that these programmes result in improved bird welfare, in a number of areas, in comparison to traditional 23-hour photoperiod lighting programmes. The degree of improvement depends on the period in which the regime is in place in relation to the age of the birds (Renden et al., 1991; Blair et al., 1993). The incidence of leg abnormalities and associated lameness has been shown to be reduced by step-up programmes (Classen and Riddell, 1989; Moller et al., 1999), which appears to be an effect beyond that produced by feed restriction alone (Classen et al., 1991). In some studies, a reduced level of leg weakness and deformity has resulted from reduced unbroken light periods in the first two weeks of life (Gordon, 1994) but extension of an eight-hour scotoperiod (cyclic lighting regime) programme, to 38 days rather than 26 days, was found to improve walking ability of broilers compared to controls. Although Prayitno et al. (1997) have shown that provision of bright red light during the first 16 days of rearing reduces gait abnormality and Newberry et al. (1988) have shown that high light intensity (180 lux) reduces the incidence of leg abnormality, there is insufficient evidence to establish a causal relationship for light frequency alteration and higher intensity, and further work is required in this area. It should be noted that in some countries, the use of open sided houses means that birds are reared at very high light levels provided by sunlight – and that in these systems the problems associated with high light levels sometimes seen in northern European production in fully enclosed houses are not encountered.

Bird Activity Levels and Stocking Density

An increase in bird activity levels has been shown to reduce levels of valgus/varus deformity (VVD) (Reece and Deaton, 1971; Riddell, 1976, 1983; Haye and Simons, 1978; Newberry et al., 1988) and SL (Riddell and Howell, 1972; Riddell, 1975). Bird activity levels, during the light period, have been shown to increase when birds are reared in lighting programmes with shorter photoperiods, including intermittent lighting programmes (Haye and Simons, 1978; Hester et al., 1985; Newberry et al., 1985; Ketelaars et al., 1986; Classen and Riddell, 1989). Activity levels have also been found to decrease with increasing stocking density (Lewis and Hurnik, 1990; Bessei and Reiter, 1992; Hester,

1994; Bauchernauer et al., 1996) and standing:lying ratio has been found to be lower at 27kg/m² than at 35kg/m² (Martrencher et al., 1997). Pattison (1992) has stated that stocking density is the main husbandry factor that increases the level of mortality resulting from leg disorders and (Kestin et al., 1994) found increasing severity of leg disorders with increased stocking density of over 12.2 birds per m². An increase in the incidence of leg problems has been reported in birds stocked at 30 kg/m² in comparison to those stocked at 34 kg/m² (Hall, 2001) and a substantial reduction in the prevalence of leg weakness was found in birds with 833cm² per bird as compared to those with 355cm² per bird (Sorensen et al., 2000). These studies were carried out under commercial conditions. Grashorn and Kutritz (1991) also recorded increased leg deformities with increases in stocking density and recommended a maximum stocking density of 35kg per m². In agreement with these studies, in the UK 2005 study, an association was found between increased stocking density and an increase in the average gait score of a flock.

Use of Antibiotics

If a flock has received antibiotics, in the UK study, the average gait score was 0.17 lower. It is possible that this is due to antibiotic protection from infectious causes of leg weakness. However, as stated above in 5.5, although the use of antibiotics improves leg health, although this may not be a satisfactory solution in the context of current concerns about selection for multi-resistant bacteria. The identification of alternatives to antibiotics would be desirable for example: water hygiene (drinker design, cleaning and maintenance), air quality and bacterial load, viral infections, vaccination programs, Mycoplasma infection, clean-out standards and litter quality.

CONTROL STRATEGY TRAINING MATERIALS

7.1 VIDEO ASSESSMENT RESOURCES

TABLE 7.1 Control strategy video training material.

Materials	File/Folder Name
A Reference training videos of bird of known gait score	Gait Score 1 Varispeed PRGM.sor
	Gait Score 2 Varispeed PRGM.sor
	Gait Score Gold Standard PRGM.sor
B First sequence of clips of birds of known gait score for training	Gait score Exam 01 PRGM.sor
C Second sequence of clips of birds of known gait score for training	Gait score Exam 02 PRGM.sor

7.2 PHOTOGRAPHIC REFERENCE MATERIAL



Notes: Storage and fumigation of eggs can be significant critical control area to ensure reduced risk of transmission of pathogens from the breeder farm, through the hatchery, to the production unit.

FIGURE 7.1 Egg handling and storage.



Notes: To ensure that the hatchery is not a chronic source of bacterial pathogens, routine swabbing to determine cleaning effectiveness is common in hatcheries.

FIGURE 7.2 Hatchery hygiene.



Notes: In the hatchery, during the 'hatch', fluff and shell debris falls down through the hatching trays increasing the risk of cross contamination of, particularly, bacterial infection between chicks. Steps to ensure hygiene at hatching may be a significant control point for lameness later at the farm.

FIGURE 7.3 Hatcher hygiene.



Notes: Chick handling in manual or mechanical systems can lead to significant risks of cross contamination (bacterial & viral) between chicks. Steps for CIP (cleaning in place) and routine swabbing of surfaces are control points which may result in reduced risk of bacterial pathologies.

FIGURE 7.4 Handling of chicks.



FIGURE 7.5 Penning of birds.

Notes: Penning of approximately 60 birds in an area of the house.

- Birds should not be herded into the pen.
- The pen should be placed quietly around a group of birds with minimal disturbance.
- If birds show any signs of distress or overheating, they should be released and a new group penned.



FIGURE 7.6 Gait scoring.

Notes:

- One person can quietly move individual birds out of the pen using a cane (about 1 m in length).
- The birds should not be hurried, pushed or lifted.
- Each bird is gait scored as it leaves the pen.



FIGURE 7.7 Recording.

Notes:

- Create a simple tabulation of the numbers of birds scored in each gait score category.
- It is recommended that 250 birds (approximately) are scored to give a significant sample size.



Notes: For birds that have been individually gait scored and are to be sampled for bacterial infection and skeletal pathologies, it is suggested that numbered cable ties are used on the leg. These are less likely to be lost, and keep their numbering better than spray marking the plumage of birds.

FIGURE 7.8 Marking birds.



Notes: Sterile guarded swabs should be used and should be kept on a clean tray or cloth to prevent contamination with feather dust and faeces.

FIGURE 7.9 Swabbing.



Notes: For samples taken on farm (it is best to take them either on farm, or very soon after in a laboratory, to avoid isolation of contaminant bacteria, which develop in the bird after death) sterile gloves and instruments should be used.

FIGURE 7.10 Pathological sampling.



FIGURE 7.11 Aseptic technique.

Notes: A gas torch can be used to re-sterilise instruments as they are used.
A clean cloth or drape is useful for covering the table surface.
Instruments, cloths, drapes and other equipment should be autoclaved.



FIGURE 7.12 Spinal lesions.

Notes: Some birds will be suffering lameness as a result of spinal lesions that will not be readily visible. If these lesions are suspected, it is possible to 'split the spine' using a knife to examine the area of the spine shown – lesions will appear as abscesses/discoaloured areas and compression of the spinal cord and canal may be apparent.

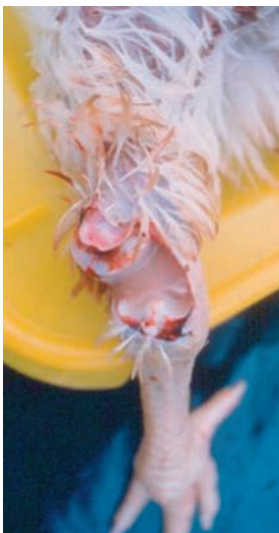


FIGURE 7.13 Hock inflammation.

Notes: Pus in the hock may be visible after dissection – if pus is detected, this is a significant pathology – and culture of the pus may indicate which organism is responsible.



FIGURE 7.14 Tenosynovitis.

Notes: Inflammation of the tendon sheaths of the lower leg may be apparent in the living bird (the bird may show evidence of discomfort if the lower leg is 'squeezed') and may also be visible as blood/pus or an increase in fluid in the tendon sheaths.



FIGURE 7.15 Ruptured gastrocnemius tendon.

Notes: In heavy birds (particularly males and breeder birds), the major tendon running along the back of the lower leg may partially rupture – this leads to haemorrhage, bruising and discolouration – which heals slowly and causes pronounced lameness.



FIGURE 7.16 Synovitis.

Notes:

- The synovia (the joint capsule) can become infected and show thickening, blood, pus or an increase in joint fluid.
- A scoring scale 0 to 3 (0 none, 1 mild, 2 medium, 3 severe) is shown.



FIGURE 7.17 Bacterial chondronecrosis (bone abscesses and necrosis).

Notes:

- Abscesses within the bone may be seen.
- It is more common for the infection to be at a microscopic level, which causes local bone death (necrosis) rather than discrete abscesses. These lesions are linked with lameness.
- The full technique for sampling can be found described in McNamee et al. (1998).

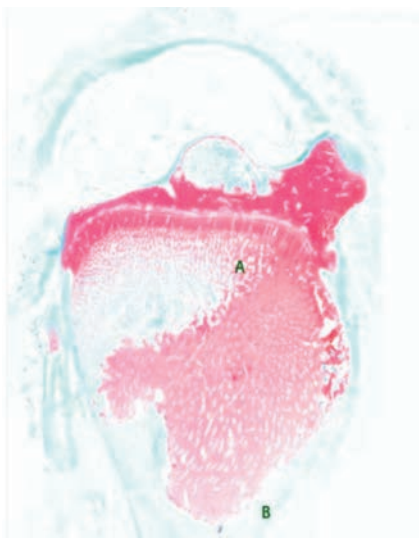


FIGURE 7.18 Tibial dyschondroplasia (TD).

Notes:

- Significantly sized TD lesions may be seen, particularly in birds reared to greater ages.
- These should be recorded.
- However, as a primary cause of lameness, TD does not appear to be as significant a cause as might be expected by the apparent size of the lesions – particularly in birds at slaughter age. These lesions can progress to cause lameness in birds kept to greater ages.

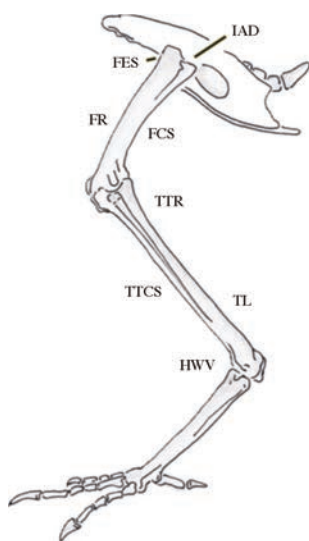


FIGURE 7.19 Skeletal sampling points.

Notes: Previous studies have involved sampling at a number of points. Practical measures include:

- IAD – distance between the acetabula (pelvic part of the hip joint);
- FES – Femoral epiphyseal score – (see below);
- FCS – Femoral curvature score – (see below);
- HWV – Hock width variability.

Femoral Epiphysis Score
(end on view)

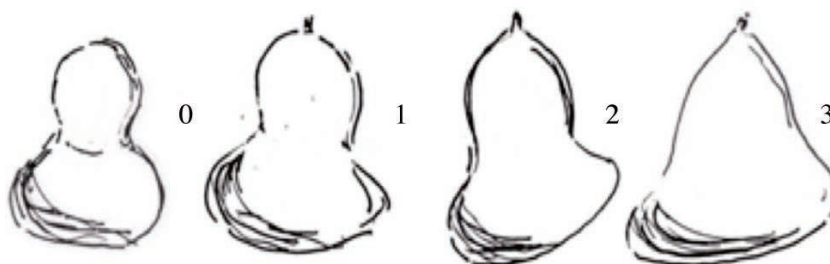
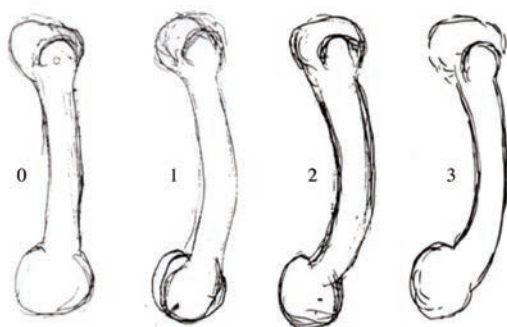


FIGURE 7.20 Femoral epiphysis (head) score.

Notes: 0 – ball very spherical with a clear ‘neck’; 1 – neck merging with ‘ball’; 2 – ball semi ‘pointed’ with poor neck; 3 – no visible neck, ball pointed.



Notes: 0 – almost straight; 1 – mild curvature;
2 – moderate curvature; 3 – severe curvature.

FIGURE 7.21 Femoral curvature score.

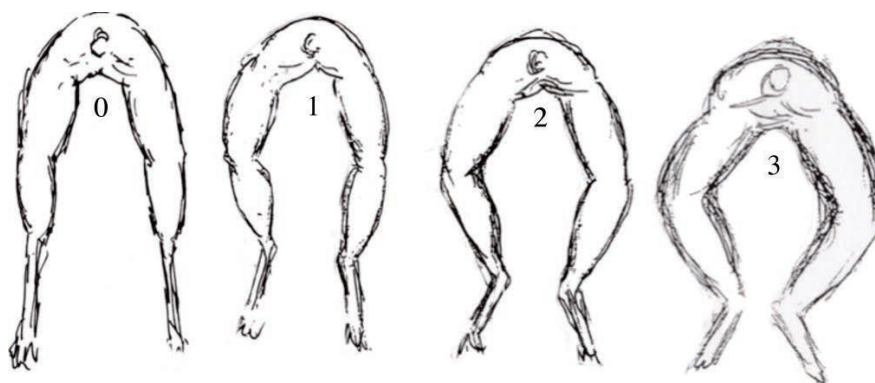


Figure 7.22 Tibio/tarsal angulation.

Notes: View from behind the bird holding the bird with a hand under the breast area: 0 – legs hang ‘straight’ when bird held up; 1 – mild curvature of legs; 2 – moderate curvature; 3 – severe – frog leg curvature.



Notes: Measure a, b and c with a calliper (mm).

A measure of hock inflammation (HWV) can be calculated:

$$\text{HWV} = (a+c)/b$$

The greater the figure, the greater the swelling at b in relation to a and c.

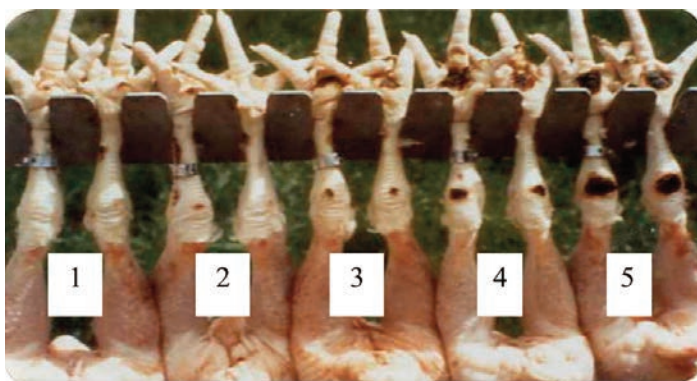
FIGURE 7.23 Hock width measure.



Notes: Pododermatitis is a direct cause of lameness and linked with litter quality, litter humidity, diet and genotype. Each company can create a scoring scheme based on samples taken from the slaughter line – and use this for farm to farm comparison of performance in foot health.

Score: 0 – none; 1 – very mild; 2 – mild; 3 – moderate; 4 – severe; 5 – very severe.

FIGURE 7.24 Pododermatitis.



1 No lesion.

2 Very small and superficial lesions: slight discolouration on a limited area, mild hyperkeratosis.

3 Mild lesion: discolouration of the foot pad, superficial lesion, superficial dermatitis.

4 Moderately severe lesion: ulcers or scabs.

5 Very severe lesion: ulcers or scabs, signs of haemorrhages or deep dermatitis.

FIGURE 7.25 Hockburn score scale.

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APPENDICES

A1 PATHOLOGY RECORDING SHEET

	Farm/Bird Name				
	Hock burn	None	Mild	Moderate	Severe
	Pododermatitis	None	Mild	Moderate	Severe
	Crop	Empty	Half full	Full	Distended
	Feather soiling	Clean	Soiled	Dirty	V Dirty
	Tibial/Tarsal Angulation Score	0 L / R	1 L / R	2 L / R	3 L / R
	Bird sex	Weight (g)			

Aseptic preparation			Anatomical location
Left	Pus		
	Synovitis		
Right	Tenosynovitis		
	Ruptured Gastroc		
Swabs collected	Proximal Femur		
	Proximal Tibia		
	Hock		

'Dirty' abdominal/thoracic dissection		None	Mild	Moderate	Severe
	Ascites				
	Jaundice				
	Emaciation				
	Dehydration				
	Air sacculitis				
	Septicaemia				
	Rickets				
	Bursa (comment)				

			Anatomical location
'Dirty' preparation	Pus		
	Synovitis		
	Tenosynovitis		
	Ruptured Gastroc		
Bone samples	Femur		
	Tibia		
	Other		

Comments arising from dissection	
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			Comment
Tentative diagnosis of cause of lameness	Metabolic		
	Skeletal		
	Microbiological		
	'Moribund'		

A2 GAIT SCORE TRAINING RECORDING SHEET

Assessor Name			Date	Score Sheet Number	
Video Clip Number/Score					
1	7	13	19	25	31
2	8	14	20	26	32
3	9	15	21	27	33
4	10	16	22	28	34
5	11	17	23	29	35
6	12	18	24	30	36



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