Aviagen™

Management Tools to Reduce Footpad Dermatitis in Broilers

By: Dr. Ingrid de Jong & Ing. Jan van Harn

Management Tools to Reduce Footpad Dermatitis in Broilers

By: Dr. Ingrid de Jong & Ing. Jan van Harn

Dr. Ingrid de Jong is the Senior Researcher in Poultry Welfare at Wageningen University (Livestock Research) in Lelystad, The Netherlands. She joined the University in 2002 as a Scientific Researcher and has served as the project leader and researcher of various projects in poultry and rabbit welfare. Recent research topics include: management to prevent mutilations in laying hens and broiler breeders; footpad lesions in broiler chickens; further development of Welfare Quality broiler welfare monitor; development of group housing systems for rabbit does. Dr. de Jong is a member of EFSA scientific panels on broiler and breeder welfare (2010) and animal-based measures in broilers (2012).

Jan van Harn, BSc, is a Poultry Nutrition Researcher and Account Manager for Broilers in the Animal Sciences Group of Wageningen University (Livestock Research) in Lelystad, The Netherlands. Since joining the Animal Science Group in 2003, he has led management trials with broilers on various subjects including, comparisons of lighting schedules and/or temperature scheme's, and the reduction of footpad dermatitis through management. He has also conducted several environmental trials to reduce ammonia and fine dust emissions from poultry housing systems.

Ingrid de Jong & Jan van Harn
Wageningen Livestock Research
Wageningen University and Research Centre
PO Box 65
8200 AB Lelystad
The Netherlands.

Summary

Footpad dermatitis (FPD) is receiving increasing attention in the broiler industry. Footpad dermatitis affects animal welfare and farmer income, and in the future it is likely to have increasing importance in terms of legislation. Wet and sticky litter is the major cause of footpad dermatitis. So, by maintaining a good litter quality, broiler producers can reduce losses and improve bird welfare. This document gives broiler producers management tools to help reduce footpad dermatitis in broilers.

This article has been written specifically for European broiler production conditions and the information given is based on research completed within Europe. The external authors of this document provide insight to the latest information on footpad dermatitis and strategies to minimise the incidence of footpad dermatitis under European conditions. The general principles discussed are felt to have global application and relevance. However, some of the information given here may differ from recommended global practices and might not be suitable for use under all circumstances. For further advice on the relevance of this information for you please consult your local Aviagen Technical Services Manager.

INTRODUCTION

Footpad dermatitis (FPD) is commonly seen in the broiler industry. In Sweden, before the welfare monitoring programme started, 32% of all broilers were considered to have mild, and 6% of all broilers severe, footpad lesions (Ekstrand et al, 1997). Before Denmark began monitoring FPD, just below 40% of all broilers were considered to have severe footpad lesions in the summer. However, the incidence of FPD in Denmark has decreased sharply since the mandatory monitoring of FPD was introduced in 2002 (see **Figure 1**). In The Netherlands, De Jong et al (2011) showed that 38.4% of broilers had severe lesions while 26.1% of broilers displayed mild lesions. The same study also showed a clear seasonal influence on the incidence of FPD. Broilers placed between June and August had lower levels of severe FPD and a lower FPD score than broilers placed in March and December. A similar seasonal pattern in FPD has been seen in Denmark and Sweden.

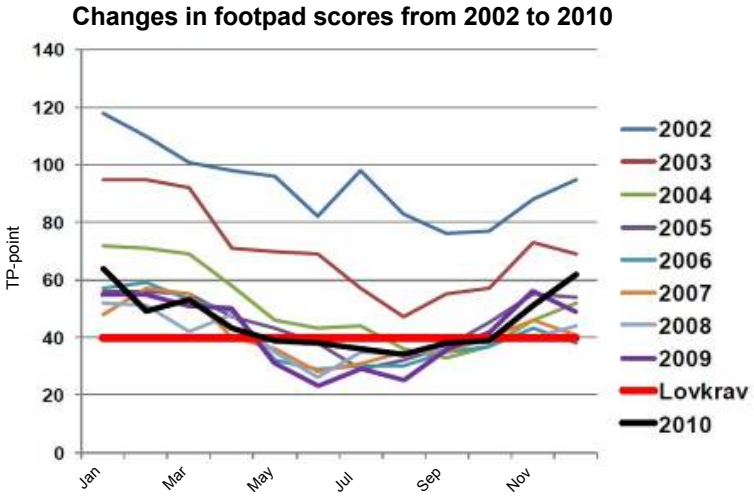


Figure 1: Variation in footpad scores in Denmark between 2002 (year monitoring programme started) and 2010. The red line ('Lovkrav') indicates the Danish footpad score limit. *Source: Petersen, VFL, Denmark, 2010.*

Broilers spend their whole life in close contact with some type of litter material and are also in regular contact with droppings which form a part of the litter surface. If litter conditions are suboptimal there is considerable risk that birds will develop contact dermatitis on their feet, hock and/or breast. FPD, also called pododermatitis, foot burn or footpad lesions, is a contact dermatitis of the plantar surface of the birds' feet. FPD starts as an erosion of the skin on the foot. This can initially appear as a dirty mark, but once the skin is broken, painful ulcers may develop (**Figure 2**). Broilers with severe lesions will experience pain and therefore, move, eat and drink less. Broilers with severe lesions also often have other types of contact dermatitis such as breast blisters or hock burns. In addition to causing pain, the lesions can be a gateway for bacteria, which can cause impaired product quality (increased downgrades and rejections at the processing plant) and secondary infections (Staphylococci spp. and E. coli). Flocks with a high incidence of FPD will have a lower growth rate, increased downgrades and reduced profitability.

Figure 2: Left: no footpad lesion; Right: severe footpad lesion.

Photo: Wageningen UR Livestock Research.

In Asia, chicken feet are a valuable product for human consumption. The increased demand from the Asian markets has made broiler feet an important export commodity for the EU broiler industry. However, only feet with no lesions can be exported. The economic and welfare significance of FPD for the broiler industry is clear.

The aim of this document is to provide information on what can be done to prevent FPD in a broiler flock by adjusting flock management.

FPD AS AN INDICATOR FOR ANIMAL WELFARE

In Europe, the welfare of broilers is receiving increasing attention. This is clearly illustrated by the European Council Broiler Directive which lays down minimum standards for the protection of chickens kept for meat production (Council Directive 2007/43/European Council, 2007). The Directive restricts maximum stocking density, but also prescribes requirements on housing conditions (e.g. light intensity and duration, air quality) and stockmanship.

Individual countries may choose to include in the Broiler Directive additional welfare measures (other than mortality) in their national legislation. FPD could be (and is increasingly likely to be) one such additional measure. In Sweden and Denmark FPD has been used as an indicator of the welfare of broiler flocks for several years now. It is expected that in the next couple of years other European countries will also choose to include FPD as an additional measure of broiler welfare in their national legislation.

MEASURING FOOTPAD DERMATITIS

A number of scoring systems have been developed to assess FPD incidence and severity within individual broiler flocks. The Swedish system (Berg, 1998) is the generally accepted FPD scoring system used within Europe. This system is a three tier scoring system.

SCORE	DESCRIPTION
0	No lesions; no or very small superficial lesions, slight discolouration on a limited area of the footpad, mild hyperkeratosis (thickening of the outer layer of the skin) or healed lesion.
1	Mild lesion; discolouration of the footpad, superficial lesions, dark papillae and hyperkeratosis.
2	Severe lesion; epidermis is affected, ulcers or scabs, signs of haemorrhages or swollen footpads.

Compared to more detailed scoring methods, the Swedish system has the advantage of being easy to learn and thus is practical. Moreover, the Swedish system distinguishes between severe lesions that are painful and have a negative effect on the welfare of the chicken, and mild lesions, which it is generally believed are probably not painful but are a risk for reduced welfare (Ekstrand et al, 1998, Haslam et al, 2006). A modified photo guide for broiler foot health classification based on the Swedish scoring method has been developed by Wageningen UR Livestock Research and is located at the end of this document. You may also contact your local Aviagen Technical Services Manager for more information.

Footpad lesions can be assessed at the slaughterhouse (visually or using a camera) or at the broiler farm (visual assessment). Assessing FPD at the slaughterhouse has several advantages:

- Assessment takes place on clean footpads (most litter and manure is removed in the scalding tank).
- Assessment does not cause stress to the birds as it takes place after killing.
- Lighting is better in the slaughterhouse than in a commercial broiler house making assessment easier and potentially more accurate.

In Denmark and Sweden a flock footpad score (FPS) is calculated for each flock delivered to the slaughterhouse. This flock score is calculated as follows:

$$\frac{100\% \times [(0 \times \text{the total number of specimens with score 0}) + (0.5 \times \text{the total number of specimens with score 1}) + (2 \times \text{the total number of specimens with score 2})]}{\text{Total number of scored specimens}}$$

The flock FPS ranges from 0 (all specimens having no lesions) to 200 (all specimens having score 2). In Denmark, Sweden and, in the near future in The Netherlands, financial penalties are imposed when flock scores are above locally agreed acceptable levels.

CAUSES OF FOOTPAD DERMATITIS

The prevalence of FPD is strongly linked to litter quality; wet, sticky and caked litter increases the prevalence of FPD. Footpad lesions are sometimes referred to as ammonia burns but this is not completely correct. Several studies have shown that litter moisture alone can cause or induce FPD (Mayne et al, 2007; Youssef et al., 2008). The presence of ammonia or other chemical substances in the litter may play a role in the further development of FPD but does not appear to cause it directly.

FPD increases in severity as litter moisture increases. The best way to prevent FPD is to keep the litter dry and friable, especially during the brooding period when the birds appear to be more susceptible to lesion development. Litter quality is influenced by a number of factors:

- Litter management (litter material and litter depth).
- Light: distribution of light, light colour, and lighting programme.
- Water supply and water management.
- Ventilation and heating.
- Feed.
- Stocking density.
- Breed & disease may also play a role but these factors will not be discussed here.

LITTER MANAGEMENT

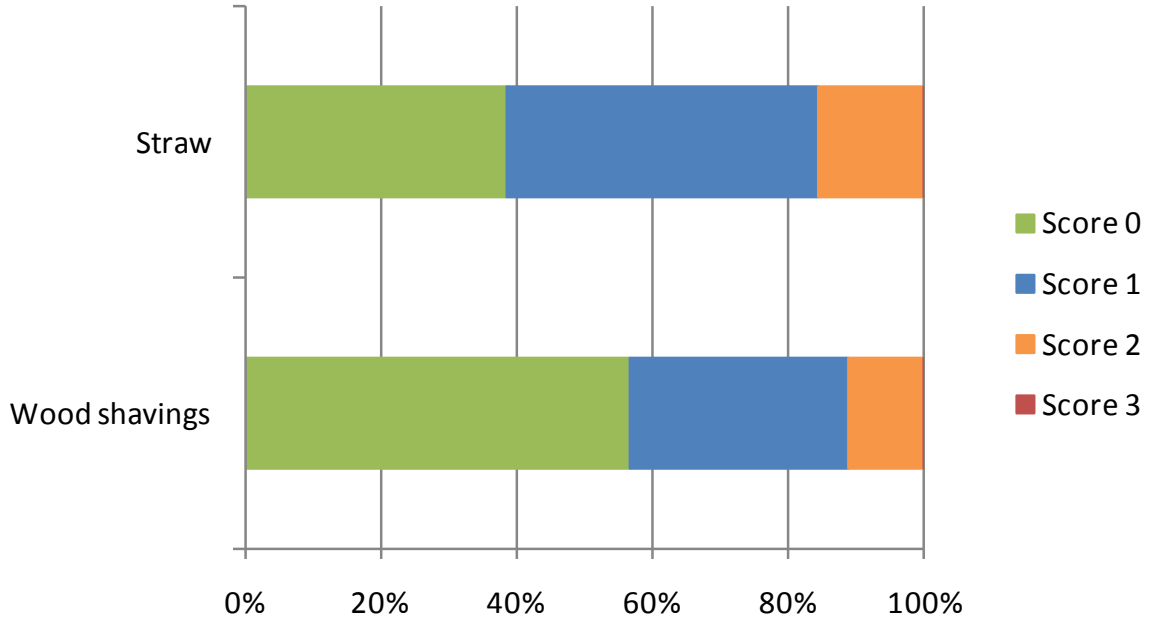
Litter Material

In Northern European countries wood shavings and chopped (to increase water absorption capacity) wheat straw are the most commonly used litter materials for broilers. But other materials such as peat, lignocellulose, rapeseed straw, and maize silage are also used.

German research found that compared with wood shavings and chopped straw the use of lignocellulose (Pelletino® Strohstreugranulat G) reduced FPD (Berk, 2009). This reduction in FPD is thought to be due to the higher water binding capacity and the faster water release of lignocellulose.

De Baere and Zoons (2004a) compared chopped wheat straw and wood shavings as litter material for broilers. Broiler performance was not found to differ between the two litter materials, but there was less FPD on wood shavings than on chopped straw (see **Figure 3**). In contrast, Van Harn et al (2009) did not find a difference in severity of FPD between the two litter materials.

Figure 3: Comparison of wood shavings and chopped wheat straw on the severity of FPD (Score 0 = no lesion; Score 1 = mild lesions; Score 2 = moderate lesions and Score 3 = severe lesions). Incidence of FPD lower and less severe on wood shavings (P<0.001). *Source: de Baere and Zoons, 2004a. Strooiselmateriaal in pluimveestallen. Pluimvee nr. 40.*



In Scandinavian countries, peat is often used as a litter material for broilers, especially during the winter months (a combination of wood shavings and peat may also be used). Comparisons of wheat straw, wood shavings and peat have demonstrated that most severe FPD occurs on (chopped) wheat straw, followed by wood shavings, with FPD being least severe on peat.

From small and large scale experiments in Denmark, the following rules of thumb can be given:

1. Wood shavings: gives a footpad score that is 20 points lower than straw.
2. Peat: gives a footpad score that is 20 – 40 points lower than straw.

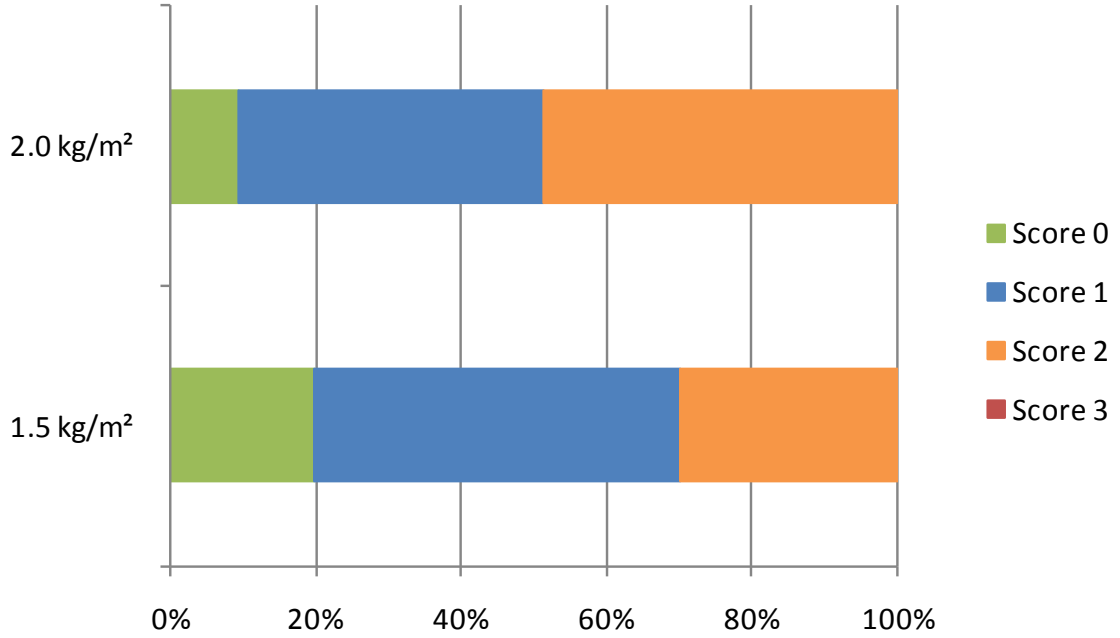
Belgian research has also shown that the use of peat as a litter material for broilers reduces the severity of FPD (De Baere, 2006).

In conclusion, to lower the risk of FPD, studies suggest that the use of peat or a mixture of peat and wood shavings (50/50) as a litter material instead of wood shavings or chopped wheat straw is preferable, especially during the winter months. If peat is not available, or is too expensive, wood shavings are better than wheat straw. The use of lignocellulose as litter material could also be considered, but field information on the use of this product is not yet available.

Bedding Amount / Litter Depth

The influence of litter material depth on FPD is not always clear. Researchers found no difference in FPD incidence between using 1.0 kg or 1.5 kg/m^2 wood shavings or chopped wheat straw. However, using more than 1.5 kg/m^2 of chopped wheat straw was found by De Baere and Zoons (2004b) to increase the severity of FPD (**Figure 4**).

Figure 4: Effect of bedding depth (chopped wheat straw: 1.5 vs. 2.0 kg/m²) on the severity of FPD (Score 0 = no lesion; Score 1 = mild lesions; Score 2 = moderate lesions and Score 3 = severe lesions). Providing more than 1.5 kg/m² of chopped wheat straw significantly increased the incidence and severity of FPD (P< 0.001). *Source: De Baere and Zoons, 2004b. Strooisel bij vleeskuikens: hoeveelheid houtkrullen en stro. Pluimvee nr. 39.*



In contrast, a study by Van Harn et al (2009) comparing the use of 1.0 and 2.0 kg/m² wood shavings and 1.25 and 2.5 kg/m² chopped wheat straw concluded that amount of litter material had no influence on broiler performance or incidence of FPD.

However, for control of FPD, using a thinner layer of litter material (0.5-1.0 kg/m²) may be beneficial - as a rough guide 1 kg/m² equates to a depth of 1 cm for wood shavings, for chopped wheat straw a depth of 1 cm will be achieved with 1.5 kg/m². Chickens are more likely to peck, scratch and turn the litter if it is not too deep; working of the litter in this way increases aeration and helps to keep the litter drier. A thin layer of litter may also be able to be kept more dry and friable by the air stream from the fans than a thick layer of litter. If a thinner layer of litter material is used, pre-warming of the floor prior to flock placement is essential. Floor temperature prior to placement should be at least 30°C. This will prevent condensation from building up on the concrete floor which will help to maintain litter quality. The litter material should not be spread out until after the target floor temperature has been reached. Spreading the litter prior to pre-warming the house means the concrete floor will warm up more slowly and the risk of condensation forming will be increased.

Note: If the floor is not well insulated or not pre-heated, it is better to use a thicker layer of bedding.

DRINKER AND WATER MANAGEMENT

The type of drinking system used has a clear influence on the prevalence of FPD. However, performance is not always optimised with drinking systems that result in a low incidence of FPD (Petersen, 2004 – **Table 1**).

Table 1: Effect of drinking system type on footpad score (FPS). *Source: Petersen, 2004 (Boksforsøg nr. 82)*

	Corti 110	Corti 65	Val	LifeLine	P-Value
Type of drinker	Drip cup	Nipple	Nipple	Cup	
Replicates n	3	3	3	3	-
Feed intake d 0-38 (g)	3684	3604	3667	3759	0.15
Water intake d 0-38 (ml)	6829 [a]	5854 [c]	6524 [b]	6714 [ab]	<0.01
Water / feed d 0-21	1.90 [a]	1.64 [c]	1.84 [b]	1.78 [d]	0.02
Water / feed d 22-38	1.83 [a]	1.62 [c]	1.75 [b]	1.79 [ab]	<0.01
Live weight d 38 (g)	2155 [ac]	2057 [b]	2105 [ab]	2200 [c]	<0.01
FCR d 0-38	1.71	1.75	1.74	1.71	0.11
Footpad score	**50** [a]	**13** [cb]	**38** [ab]	**68** [a]	0.02

**If superscripts differ P<0.05.*

It is well known that nipple drinkers reduce water spillage compared to drinking systems with drinking cups; this decreases the risk of wet litter and therefore FPD. The effect of drinking systems on the incidence of FPD has been clearly demonstrated by a field study completed in Sweden (Ekstrand, 1997). The use of nipple drinkers with drip cups (**Figure 5**) can improve things even further.

Figure 5: Nipple drinkers with drip cups reduce water spillage.

Photo: Wageningen UR

Comparison tests of drinking systems in Danish research (Jørgensen, 2011a; Jørgensen, 2011b) showed that the use of nipple drinkers with drip cups not only reduces the severity of FPD, but also improves broiler performance compared to the use of nipples without drip cups. Dutch research (Van Harn et al, 2009) supports these findings (**Table 2**).

Table 2: Effect of drip cup on performance results, dry matter content of the litter, and footpad lesions (Van Harn et al, 2009).

Parameter*	Drinking Nipple	Drip Cup
Body weight (g)	2047 [a]	2093 [b]
Body weight gain (g/b/d)	57.4 [a]	58.7 [b]
Mortality (%)	2.5	2.6
FCR	1.603 [b]	1.595 [a]
Feed intake (g)	3219 [a]	3276 [b]
Water intake (ml)	5814	5831
Water / feed ratio	1.81 [b]	1.78 [a]
EPEF	349 [a]	358 [b]
Dry matter litter (%)	48.7 [a]	52.8 [b]
Footpad lesions (%)		
No (Score 0)	0	4
Mild (Score 1)	4 [a]	18 [b]
Severe (Score 2)	95	78

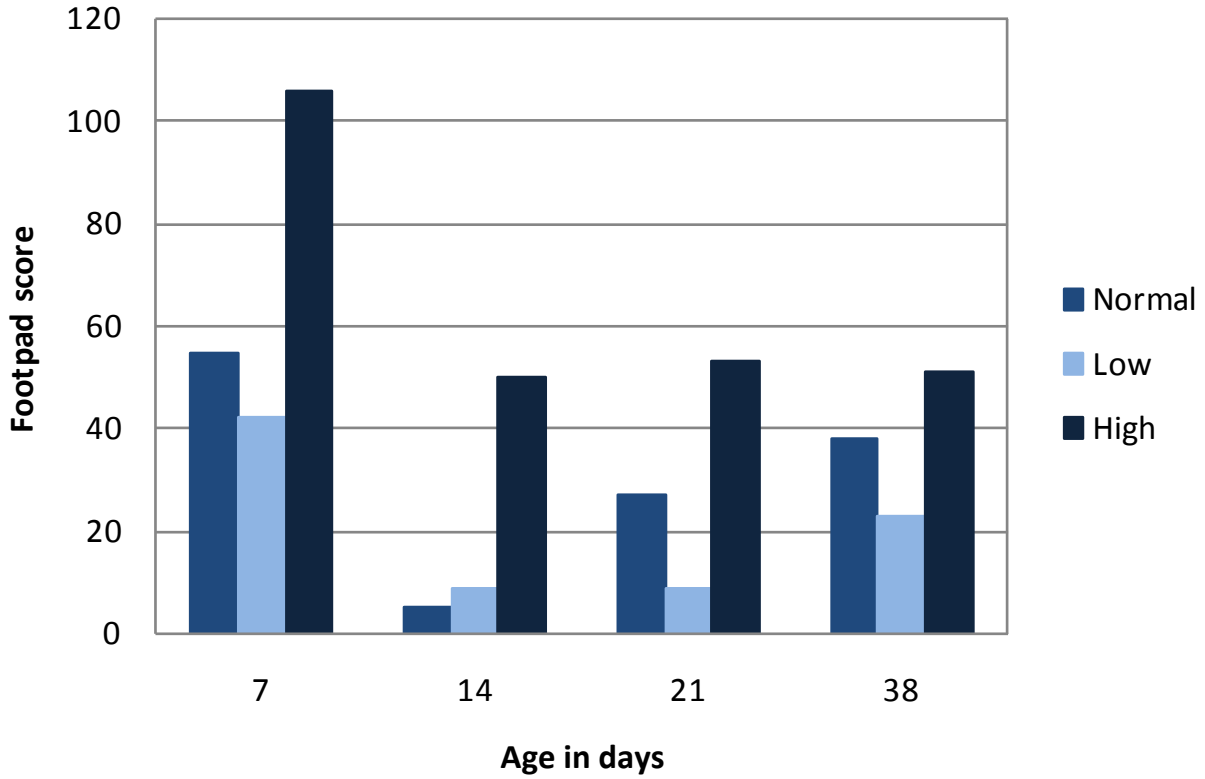
**If superscripts differ P<0.05.*

Drinking line height should be appropriate for bird height, **not** bird age. Many producers have the drinker lines too low because of concerns that the birds won't be able to find water. The drinking line is at the optimal height when the birds (when standing) have to reach, not stretch, for the nipple. Water will then flow from the nipple straight into the birds' beak. If a bird has to turn its head sideways to activate the nipple (i.e. the nipple is too low), some water will fall on to the litter resulting in wet litter and a higher risk of FPD. Older broilers, especially, will also play with the water if drinking lines hang too low. To minimise problems with wet litter, drinking line height should be adjusted daily.

It is important that the drinking system is well maintained and regularly checked for leakage. If nipples are leaking or blocked they must be replaced. Drinking systems should be flushed with fresh water and cleaned (disinfected) before each new flock. Storage tanks should be cleaned regularly and water analysed annually; an analysis for bacterial contamination and a chemical analysis (for example, for calcium salts, salinity and nitrates) should be completed. Drinking systems should also be flushed with fresh water after any product (e.g. medication or vitamins) is run through the line. These practices will avoid the build up of contaminants or blockages in the system. It is good practice to replace the entire drinking system every 5 - 7 years. New drinking lines must be flushed before first use to remove any debris that may still be present in the line (debris in the line will increase the risk of leakage).

Water pressure must meet the guidelines set out by the drinker system manufacturer. If water pressure is too low, birds will not be able to consume enough water, and bird welfare, feed intake and growth will be affected. If water pressure is too high, water leakage will occur, leading to wet litter and an increased risk of FPD (**Figure 6**).

Figure 6: Effect of water pressure on footpad score (*Source: Petersen, 2003 (Boksforsøg nr. 75)*). Normal water pressure was 10, 17 and 20 cm of water column, low water pressure was 8, 12 and 15 cm of water column, and high water pressure was 20, 25 and 30 cm of water column at 0-14, 14-28 and 28-38 days, respectively. Water yield was 19, 49 and 59 ml/min for normal water pressure, 18, 39 and 52 ml/min for low water pressure and 76, 80 and 85 ml/min for high water pressure at 0-14, 14-28 and 28-38 days of age, respectively.



As young broilers are more susceptible to FPD, achieving the correct water pressure during the first two weeks after placement is especially important. At this time, water pressure, and therefore flow, should be low. Thereafter, water pressure can be adjusted rapidly. Lowering water pressure may help to reduce the severity of FPD by reducing litter moisture content (Van Harn et al, 2009). However, any reduction in water pressure must be managed with extreme care, if water pressure becomes too low, broiler performance and welfare will be negatively affected.

Optimal water supply is important for the birds to grow well and for bird welfare. Broilers should have unlimited access to clean, fresh, good quality drinking water at all times. However, when water intake is naturally low, for example during the dark period when birds are inactive, control of water supply may help to reduce unnecessary water leakage. Any such control of water must be managed with care; there must be no restriction in the amount of water needed for birds to grow, and a balance must be found between growth, welfare and potential FPD risk.

Water should have a low bacterial count and be free from E. coli and Pseudomonas spp. The presence of any of these organisms in the water will challenge the gut and increase the risk of enteritis, a common consequence of which is wet litter. Regular disinfection and flushing or cleaning of the drinking system will prevent the build-up of biofilms (which can both contaminate and block the drinking system). Recent studies in The Netherlands (Van Harn and De Jong, 2012a) found evidence that the use of an acidified water additive (which removes and prevents the build up of biofilm) may help to reduce the severity of FPD. However, acidifying water was also found to result in a lower growth rate. Similar results were found when water restriction (**Table 3**) was implemented.

Table 3: Effect of acidifying drinking water and water restriction on performance results, dry matter content of the litter, and footpad lesions (Van Harn and De Jong, 2012a).

Parameter*	Control	Acidified Water	Water Intake Controlled to the Same Level as Acidified Water Intake
Body weight (g)	2106 [b]	1961 [a]	1974 [a]
Body weight gain (g/b/d)	58.9 [b]	54.8 [a]	55.2 [a]
Mortality (%)	1.7	2.0	2.3
FCR	1.584	1.597	1.592
Feed intake (g)	3269 [b]	3063 [a]	3074 [a]
Water intake (ml)	5964 [b]	5327 [a]	5242 [a]
Water / feed ratio	1.82 [b]	1.74 [a]	1.71 [a]
EPEF	366 [b]	336 [a]	339 [a]
Dry matter litter (%)	60.7 [a]	65.6 [b]	65.2 [b]
Footpad lesions (%)			
No (Score 0)	5.5	35.0	38.5
Mild (Score 1)	28.0 [a]	50.5 [b]	47.5 [b]
Severe (Score 2)	66.5	14.5	14.0

*If superscripts differ P<0.05.

LIGHTING AND DISTRIBUTION OF LIGHT

Light Duration

The European Council Broiler Directive stipulates the following guidelines regarding light intensity and duration:

- Within 7 days from the time when the chickens are placed in the building and until 3 days prior to the foreseen time of slaughter, lighting must follow a 24-hour rhythm and include periods of darkness lasting at least 6 hours in total, with at least one uninterrupted period of darkness of at least 4 hours, excluding dimming periods.
- All buildings must have lighting with an intensity of at least 20 lux during the lighting periods, measured at bird eye level and illuminating at least 80 % of the useable area. A temporary reduction in the lighting level may be allowed when necessary following veterinary advice.

Studies in The Netherlands and Belgium have found evidence that intermittent light schedules may be beneficial for reducing the occurrence of FPD (De Baere, 2008; Van Harn, 2009). During the light period, birds are more active and scratch more which keeps the litter more friable. An intermittent light schedule has also been shown to improve feed conversion ratio (FCR). This all leads to dryer and more friable litter, and a potential decrease in FPD (**Table 4**).

Table 4: Day/night versus intermittent light: effect of light scheme on performance results, dry matter content of the litter, and footpad lesions (Van Harn, 2009).

Parameter*	18L:6D[1]	Intermittent[2]
Body weight (g)	2029 [a]	2061 [b]
Body weight gain (g/b/d)	58.5 [a]	59.4 [b]
Mortality (%)	3.5	3.7
FCR	1.572	1.566
Feed intake (g)	3125 [(a)]	3164 [(b)]
Water intake (ml)	5243	5233
Water / feed ratio	1.68 [b]	1.65 [a]
EPEF	359 [a]	366 [b]
Dry matter litter (%)	58.6 [a]	61.2 [b]
Footpad lesions (%)		
No (Score 0)	50.7	61.4
Mild (Score 1)	42.3 [a]	35.8 [b]
Severe (Score 2)	7.0	2.8

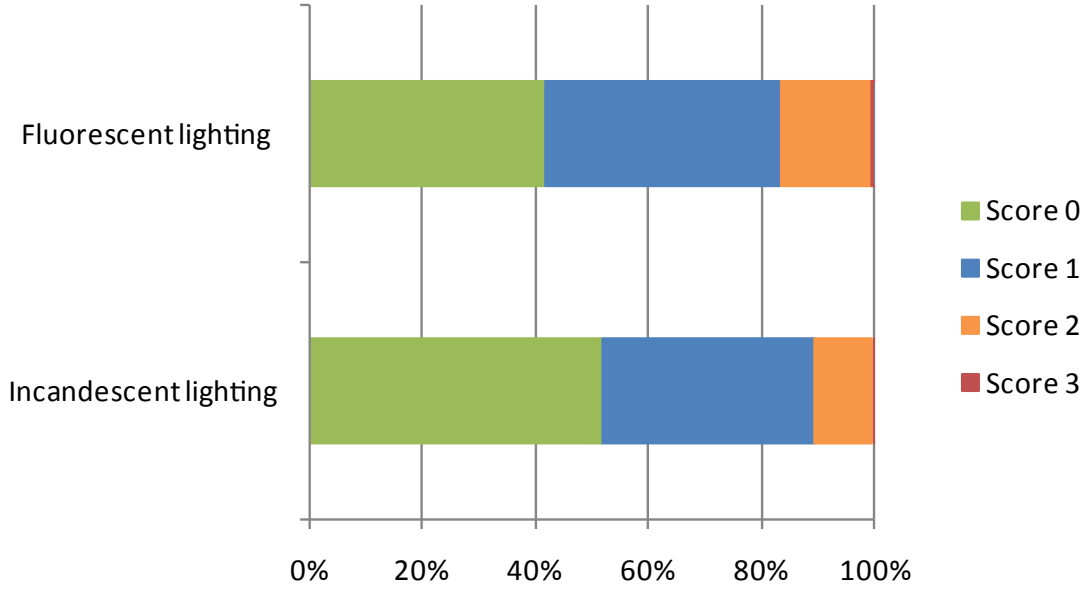
[1]18L:6D; [2]4L:4D:3L:1D:3L:1D:3L:1D:3L:1D
*If superscripts differ P<0.05.

Light Distribution
To maintain good litter quality an even distribution of light throughout the broiler house is crucial. Broilers prefer to rest in areas with a low light intensity. If light intensity in the house is uniform, the distribution of the birds in the house, and therefore the litter quality, will be more uniform. If it is not possible to achieve uniform light distribution, placing tape or a metal plate with small holes underneath the lamp will help to improve uniformity of light distribution. Light distribution is better with incandescent lights (light bulbs) than with fluorescent lighting. Vertical mounting of fluorescent lighting will also improve light distribution.

The use of dimmable fluorescent lighting has been shown to decrease the friability of the litter particularly when the fluorescent lights are positioned near to the floor (less than 2.5 m). This can lead to behavioural changes, probably due to the lights flickering when dimmed, which results in litter depth under the lights being reduced. If droppings are passed onto minimal amounts of litter it will quickly become capped. If litter levels do become depleted under the lights, the litter should be moved back or replaced as soon as possible.

Light Colour and Light Intensity
There is little information available about the effect of light colour on the severity of FPD. However, studies in Belgium (De Baere and Zoons, 2004c) have found evidence that the use of light bulbs (incandescent lighting) instead of TL (fluorescent lighting) decreases the severity of footpad lesions in broiler flocks (**Figure 7**). Any potential benefit must be balanced against the increased energy use of light bulbs compared to TL and sodium light. Research in The Netherlands in which TL light was compared with sodium high pressure light and green/blue PL lighting indicated that light colour has a limited influence on FPD (Rodenburg et al, 2004), although there was a tendency for FPD to be lower with green/blue light. The European Council Broiler Directive requires a minimum light intensity of 20 lux at birds' eye level during the entire growing period. It is questionable whether the European Council Broiler Directive prescribed light intensity of 20 lux can be achieved with green/blue light.

Figure 7: Effect of lighting system (fluorescent vs. incandescent - light intensity 20 lux) on the severity of FPD (Score 0 = no lesion; Score 1 = mild lesions; Score 2 = moderate lesions and Score 3 = severe lesions). Incandescent lighting reduces the incidence and severity of FPD (P = 0.01). *Source: de Baere and Zoons, 2004c. Lichtsterkte en lichtkleur bij vleeskuikens. Pluimvee nr. 38.*



Research completed in The Netherlands and Belgium before the European Council Broiler Directive was implemented (at a time when many broilers were kept at light intensities lower than 20 lux) indicated that the use of light intensities below 20 lux was not beneficial to FPD (De Baere and Zoons, 2004c; Van Harn, 2009).

ENVIRONMENT

Ventilation and Temperature Control

The aim of ventilation is to supply birds with fresh air and to remove excess heat, and (importantly for FPD) moisture, harmful gasses, such as ammonia and carbon dioxide, dust, and airborne organisms from the house. In practice, ventilation is a compromise between maintaining the in-house temperature and supplying sufficient fresh air to the birds. It is important that sufficient ventilation is provided from placement. Young broilers are more susceptible to the development of FPD, therefore it is recommended to circulate the air in the house using internal circulation fans during the first couple of days after placement, while applying appropriate minimum ventilation. To save on energy costs, particularly during winter, broiler producers often minimise ventilation rate. However, reducing ventilation rates too much, even during periods of cold weather, will increase the relative humidity (RH) in the house, which will increase the risk of wet litter and footpad lesions. It is important that some minimum level of ventilation is given at all times.

As broilers grow, environmental temperature within the house must be reduced. Recent research from Wageningen UR, found evidence that a more rapid decline temperature schedule (**Table 5**) may increase the severity of FPD (**Table 6**).

Table 5: Temperature schedules used to determine the effect of rate of temperature reduction on FPD. Both temperature schedules tested are higher than Aviagen's current published recommendations (see Ross Broiler Management Manual for further details).

Age (days)	Control (rapid decline) Temperature Scheme	Slower Decline Temperature Scheme
-5	--	25
-4	--	25
-3	--	30
-2	28	30
-1	30	33
0	33	33
1	33	33
7	28	30
14	25	28
21	22	25
28	21	22
35	20	20
42	19	19

Table 6: Effect of temperature scheme (**Table 5**) on performance results, dry matter content, and footpad lesions (Van Harn and de Jong, 2012b).

Parameter*	Control Temperature Decline	Slow Temperature Decline
Body weight (g)	2108	2108
Body weight gain (g/b/d)	59.0	59.0
Mortality (%)	3.6 [(b)]	3.0 [(a)]
FCR	1.566 [b]	1.536 [a]
Feed intake (g)	3236 [b]	3171 [a]
Water intake (ml)	5678	5687
Water / feed ratio	1.75 [a]	1.79 [b]
EPEF	364 [a]	373 [b]
Dry matter litter (%)	65.5 [a]	67.0 [b]
Footpad lesions (%)		
No (Score 0)	69.1	86.2
Mild (Score 1)	23.5 [a]	11.2 [b]
Severe (Score 2)	7.4	2.6

*If superscripts differ P<0.05.

The type of heat source used can also affect the occurrence of footpad lesions. Since the start of the footpad monitoring programme in Denmark, the number of broiler houses with open combustion heating has decreased rapidly. Today, almost all houses are equipped with central heating systems (Peterson, personal communication). Houses with central heating systems tend to have better quality litter than those with open combustion heating systems, like air heaters, because central heating systems produce less moisture. The use of heaters, which blow hot air over the litter floor, may also result in drier litter, and thus potentially lead to fewer footpad lesions.

Spray (evaporative) cooling systems can have a negative impact on litter quality if not properly managed. If the water droplets being sprayed from the system are too large they will not be evaporated before touching the floor. As a result, the litter will become wet and the risk of FPD will be increased. Evaporative cooling systems must be well maintained.

Under floor heating may also be beneficial for FPD (Van Harn and Ellen, 2009) because control of floor temperature and, therefore, moisture content of the litter is easier.

Relative Humidity

It is essential to control relative humidity (RH) in the broiler house. If RH becomes too high (>70%), litter quality will be reduced (as the litter becomes wet, sticky and caked) and the risk of FPD will be increased. However, it is also important that the RH is not too low (less than 50%), which is often the case during the first couple of days after placement. If RH is too low, litter material can become dry and brittle and may puncture the skin of the footpad which can be the start of the development of FPD. Furthermore, there is a greater risk of dehydration and uneven growth when the RH is too low. Ideally, RH should be maintained between 60-70% for the first 3 days after placement and should not fall below 50% in the first week. Broiler producers who use peat as a litter material don't have problems achieving an RH of 50-60%, but producers who use, for example, (chopped) wheat straw or wood shavings as a litter material may find it more difficult to achieve desired RH levels. If the house is fitted with a (evaporation) spray cooling system, then this can be used to increase RH where it is too low. As the broilers age, the RH will increase, but it is important that RH is controlled so that it does not exceed 70%. If RH does rise above 70%, the ventilation rate should be adjusted and extra heating can be given if necessary to help control RH levels.

FEED

Broiler producers don't have much influence on the feed formulation of the delivered feed. However, feed formulation can have a significant impact on the occurrence of FPD. It is well known that the following nutritional factors can influence litter quality:

- Minerals
- Crude protein (CP) level and quality
- Digestibility of raw materials
- Fat quality
- Feed form

Excess levels of sodium and potassium in the feed (above the levels recommended in the Ross Broiler Nutrition Specifications) may affect water uptake and lead to wet litter problems. Sodium and potassium levels in broiler rations should be balanced to supply adequate levels for broiler performance without encouraging excessive water intake. Some feed ingredients, like soy and tapioca, have high potassium levels which, if not accounted for in feed formulation, may lead to an increased water intake and poor litter quality.

High levels of CP (above the levels recommended in the Ross Broiler Nutrition Specifications) are also known to have a negative effect on litter quality. High CP levels lead to high levels of uric acid being formed in the liver and excreted by the kidneys. This stimulates water uptake, causing wet droppings and thus increasing the risk of FPD. Feeding diets which are unbalanced in CP will have the same impact. Formulating diets on the basis of digestible amino acids will ensure that the nutrient content of the feed matches the needs of the birds and reduces the risk of wet litter.

The CP requirement of the broiler decreases with age. This means that by the end of each feeding phase there is usually a surplus of CP (current feeding programmes for broilers do not exactly match the reductions in CP requirement with age). Reducing CP levels on a daily basis by adding whole wheat to the diet can help to better match CP supply to requirements. Van Harn and Veldkamp (2005) showed that whole wheat feeding resulted in a better litter quality and less severe FPD. However, growth rate and FCR was also decreased compared to the control (**Table 8**).

Table 8: Results of daily adjusting the CP content of the ration using whole wheat as a diluent (van Harn and Veldkamp, 2005). The CP intake of the whole wheat fed broilers was 13% lower compared to the control group.

	Control	Reduced CP
Body weight (g)	2325 [b]	2248 [a]
Body weight gain (g/b/d)	57.1 [b]	55.1 a
Mortality (%)	5.2	5.6
FCR	1.74 [a]	1.86 [b]
FCR 2300 g	1.73 [a]	1.88 [b]
Feed intake (g)	3962 a	4102 [b]
Water intake (ml)	6728 [b]	6324 [a]
Water / feed ratio	1.70 [b]	1.54 [a]

Dry matter litter (%)	69.8	74.1
N-content litter (g/kg)	40.6 [b]	39.2 [a]
Footpad lesions (%)		
No	26.5 [b]	70.0 [a]
Minor	24.0	15.5
Moderate	43.5 [a]	14.5 [b]
Severe	6.0 [a]	0.0 [b]

*If superscripts differ P<0.05.

Highly digestible (unsaturated) fats will promote enteric health in the broiler. The use of poor quality fats often causes greasy or sticky litter which will lead to FPD problems.

The use of raw materials that have a low digestibility or are particularly high in fibre should be avoided as these will have a negative effect upon gut integrity, excreta of the broilers, and litter quality. The use of non-starch polysaccharide (NSP) enzymes in wheat-based diets is an important tool for improving gut health and controlling litter quality. These enzymes reduce gut viscosity and will lead to drier litter.

The benefit to broiler performance in terms of live-weight gain and FCR from feeding a good quality crumb and pellet is well documented. A feed that is of poor physical form with high levels of dust not only leads to problems with broiler performance but could also lead to an increased ratio of water to feed intake, which in turn could lead to poor litter conditions and ultimately increase the risk of FPD. Fine meal diets will also increase the risk of FPD, because of the higher water intake and a faster passage of the meal through the digestive tract.

Some feed additives may help to reduce the occurrence of FPD in broilers. Clay mineral binders, zinc and biotin are examples of such additives. The addition of clay minerals such as bentonites and zeolites into the diet may improve the gut health since they have a water binding capacity which will result in drier droppings, a better litter quality, and thus decrease the risk of FPD developing. Zinc plays an important role in cell regeneration and is involved in protecting the skin. Zinc deficiency will increase the risk of FPD. Biotin improves the formation and development of the upper skin and trials have shown that deficiencies can result in FPD (Shepherd, E.M. and B. D. Fairchild, 2010). Therefore it is important to ensure that dietary levels of zinc (min. 100 mg/kg) and biotin (between 0.1 and 0.2 mg/kg) are adequate and that deficiency is avoided. Deficiency of B vitamins should also be avoided for similar reasons.

If intestinal problems (e.g. dysbacteriosis) and wet litter problems occur, diluting the diet by feeding extra whole wheat may be beneficial.

STOCKING DENSITY

Litter management is harder at higher stocking densities. High stocking densities can lead to poorer air quality (e.g. high ammonia, carbon dioxide concentrations) and a higher RH in the broiler house, especially when the ventilation capacity is insufficient. It also increases the “faecal load” on the litter. This all increases the risk of FPD. However, these negative effects of a high stocking density can be compensated for by improvements in housing and management (e.g. insulation, ventilation, feeder and drinking space). So, it’s important to match housing and management to the stocking density in the house.

Research in Belgium and The Netherlands has shown that less severe FPD occurs at a stocking density of 13 birds/m^2 compared to 20 birds/m^2 (De Baere, 2009; Van Harn, personal communication). However, in the range between 18 – 24 birds per m^2 (which are standard stocking densities in Northern Europe) the effect of stocking density on FPD is limited.

SUMMARY OF FACTORS THAT MAY BE HELPFUL IN REDUCING THE INCIDENCE OF FPD IN BROILERS

FPD is a common and wide spread problem and is receiving more attention from the broiler industry. Not only does FPD affect animal welfare and farmer income, but in future it will also become important in terms of legislation. Wet and sticky litter is the major cause of FPD and by maintaining good litter quality, broiler producers can reduce losses and improve bird welfare. The following advice can help broiler producers to maintain a good litter quality and thus prevent FPD.

Preparation of the Broiler House

- Clean, disinfect and dry out the house properly prior to each placement.
- Check and repair all house equipment (e.g. ventilation system, air inlets, heating system).
- Warm up the floor to 30°C before litter is placed. Keep the house warm between flocks.
- Check the drinking water system for leakages, repair / replace leaking nipples or cups and replace any missing drip cups.
- Flush the water pipes just before chickens are placed.

Litter Material and Litter Management

- Using peat results in fewer footpad lesions than wood shavings, and using wood shavings results in fewer footpad lesions than chopped straw.
- If wheat straw is used it is better to chop the straw (cutting length 2 - 4 cm). This will increase the water absorption capacity.
- A mixture of peat and wood shavings or peat and chopped straw as a litter material is better than using wood shavings or chopped straw alone with respect to the incidence and severity of FPD.
- Trial results suggest that lignocellulose results in less FPD than wood shavings and chopped straw but there are no field data to back this up.
- For control of FPD a thin layer of litter material (0.5 - 1.0 kg /m^2) may be beneficial, provided floor temperatures are correct.
- When a thin layer of litter material is used, pre-warming of the floor to at least 30°C is necessary.
- Do not spread out the litter material until the floor has reached the target temperature of 30°C.
- Remove wet litter and replace it with clean, dry, fresh litter.
- Stimulate scratching behaviour by loosening up the litter and loosen up any litter that becomes caked.
- Take away feed paper used during brooding. Paper should be removed by approximately 3 days of age, ideally before it disintegrates.

Water Supply and Water Management

- Maintain and check drinking systems regularly. Replace leaking or blocked nipples and missing cups.
- Replace the entire drinking system every 5 - 7 years.
- Provide water of good quality only.
- Flush and sanitise drinking lines regularly to reduce drinker leakage by preventing the build up of contaminants and biofilms.
- Flush the water pipes prior to chicks being placed and then regularly during the first two weeks of life.
- FPD is lower with nipple systems compared to drinking cups; the use of drip cups underneath a drinking nipple will minimise water leakage into the litter and reduce FPD.
- Avoid having a water pressure that is too high, especially during the first two weeks after placement.
- Make sure that the drinking line is level to ensure that water delivery is equal along the entire length of the line.
- Adjust the drinking line daily for bird height. A drinking line that is too low will lead to wet litter.
- Acidifying water may help to reduce the severity of FPD but can also impact broiler growth.
- Controlling water supply during periods when water intake is naturally low will help to minimise unnecessary water leakage, but care must be taken not to restrict the amount of water needed for growth.

Light Distribution, Light Colour and Light Programme

- The use of an intermittent light schedule may be beneficial for reducing the severity of FPD.
- FPD is lower but energy costs are higher with incandescent compared with fluorescent light.
- Light must be uniformly distributed throughout the house. Vertical hanging TL armatures (fluorescent tubes) generally give a better light distribution compared with TL armatures on the ceiling.
- Light intensities of lower than 20 lux have no benefit to FPD.
- There is limited influence of light colour on FPD. Green/blue light seems to result in less FPD, although it is not clear if the European Council Broiler Directive prescribed light intensity can be achieved with this lighting system.

Ventilation and Heating

- The use of central heating systems is preferred over the use of combustion heaters because they produce less moisture.
- Heat distribution must be uniform throughout the house and the heating system must be the correct size for the house.
- Under floor heating provides better control of floor temperature, which may help to reduce the incidence of FPD.
- Using a temperature profile with a more gradual decline in temperature may reduce the incidence of FPD.
- Provide minimum ventilation from day one of the flock.
- It can be helpful to circulate the air in the house during the first couple of days after placement.
- Monitoring / controlling the RH in the house is important. The RH should be between 50 - 70%. If RH is above 70%, extra ventilation and sometimes heating is necessary.
- If the house is fitted with a (spray) cooling system it must be in good working order. Large droplet size or blockages in the spray nozzles will increase the risk of wet litter and FPD.

Feed

- If feed manufacturers use only good digestible raw materials, formulate their diets on the basis of digestible amino acids, and avoid high sodium and potassium levels in the diets, the risk of FPD will be decreased.
- Make sure zinc, biotin and B vitamin levels in the feed are sufficient.
- Adding clay minerals into the diet can have a beneficial effect on litter quality and FPD.
- Daily adjustment of dietary CP (dynamic feeding) by adding whole wheat can be an effective way to reduce FPD.
- If intestinal problems and wet litter problems occur, a broiler producer can dilute the diet by feeding extra whole wheat.

Stocking Density

- Stocking densities must be in line with local legislation, but for FPD, lower stocking densities will be beneficial.
- Match housing and management to the stocking density in the house. If housing and management are not matched, an increase in stocking density will result in an increase in FPD.

LITERATURE FOR FURTHER READING

Ross Broiler Management Manual. 2009.

Baere, de Kris en Johan Zoons, 2004a. Strooiselmateriaal in pluimveestallen. Pluimvee nr. 40.

Baere, de Kris en Johan Zoons, 2004b. Strooisel bij vleeskuikens: hoeveelheid houtkrullen en stro. Pluimvee nr. 39.

Baere, de Kris en Johan Zoons, 2004c. Lichtsterkte en lichtkleur bij vleeskuikens. Pluimvee nr. 38.

Baere, de Kris, 2006. Gebruik van turfstrooisel en voeders met een lager eiwitgehalte bij vleeskuikens. Pluimvee nr. 43.

Baere, de Kris, 2008. Lichtschema's bij vleeskuikens. Pluimvee nr. 46.

Baere, de Kris, 2009. Bezetting bij vleeskuikens: hoe omgaan met de bezettingsnorm uit de EU-richtlijn? Pluimvee nr. 53.

Berg, C. (1998). Foot-pad dermatitis in broilers and turkeys. Doctoral diss. Dept. of Animal Environment and Health, SLU. Acta Universitatis Agriculturae Sueciae, Sweden.

Berk, J., 2009. Effect of litter type on prevalence and severity of pododermatitis in male broilers. Berl Munch Tierarztl Wochenschr., 122: 257-263.

Council Directive 2007/43/European Council 2007. Council Directive 2007/42/European Council of 28 June 2007 laying down minimum rules for the protection of chickens kept for meat production. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:182:0019:0028:EN:PDF

Ekstrand, C., Algers, B. and Svedberg, S. (1997) Rearing conditions and foot-pad dermatitis in Swedish broiler chickens. Preventive Veterinary Medicine, 31: 167–174.

Ekstrand, C. and Carpenter, T. E. (1998). Spatial aspects of foot-pad dermatitis in Swedish broilers. Acta Veterinaria Scandinavica 39: 273-280.

Harn, van J., 2009. Invulling lichteisen EU-welzijnsrichtlijn voor vleeskuikens – vier lichtschema's vergeleken. ASG-Rapport 172.

Harn, J. van, H.H. Ellen, 2009. Gebruik van vloerverwarming bij vleeskuikens. ASG Rapport 171.

Harn, van Jan en Ingrid de Jong, 2012a. Zuur is zoet voor zolen (2). Pluimveehouderij 42/7. 1 juni 2012. P. 30-31.

Harn, van Jan en Ingrid de Jong, 2012b. Goede maar dure warmte. Pluimveehouderij 42/3. 2 maart 2012. P. 26-27.

Harn, van J., I.C. de Jong en T. Veldkamp, 2009. Effect strooiselmateriaal, strooiselhoeveelheid, opvangschoteltje en waterdruk op resultaten vleeskuikens. ASG Rapport 220.

Harn, J. van; Veldkamp, T., 2005. Dynamisch voeren belooft veel goed, maar... er valt nog wat te sleutelen! De Pluimveehouderij 35 (8). - p. 14 - 15.

Haslam, S. M., Brown, S. N., Wilkins, L. J., Kestin, S. C., Warriss, P. D. and Nicol, C. J., 2006. Preliminary study to examine the utility of using foot burn or hock burn to assess aspects of housing conditions for broiler chicken. British Poultry Science 47: 13-18.

Jong, I.C. de; Harn, J. van; Gunnink, H.; Hindle, V.A.; Lourens, A. (2011). Ernst en voorkomen van voetzoollaesies bij reguliere vleeskuikens in Nederland. Wageningen UR Livestock Research, Rapport 513.

Jørgensen, Marlene, 2011a. Afprøvning af drikkenipler – del 1. Boksforsøg nr. 118.

Jørgensen, Marlene, 2011b. Afprøvning af drikkenipler – del 2. Boksforsøg nr. 119.

Jørgensen, Marlene, 2011c. Afprøvning af drikkenipler – del 3. Boksforsøg nr. 120.

Mayne, R.K., Else, R.W. and P.M Hocking, 2007. High litter moisture alone is sufficient to cause footpad dermatitis in growing turkeys. British Poultry Sience Volume 48, Number 5, pp. 538-545.

Petersen, Jette Søholm, 2003. Sammenhæng mellem vandtryk og trædepudekvalitet. Boksforsøg nr. 75.

Petersen, 2004. Sammenligning af drikkeventilerne Corti Stempel, Val, Corti Kugle og LifeLine. Boksforsøg nr. 82.

Rodenburg, T.B., J. van Harn, J.H. van Middelkoop, 2004. Effect van gekleurde verlichting op technische resultaten en welzijn van vleeskuikens. PraktijkRapport Pluimvee 10.

Shepherd, E.M. and B. D. Fairchild, 2010. Footpad dermatitis in poultry (Invited review). Poultry Science 89 :2043–2051.

Youssef, I.M.I., C. Westfahl, A. Beineke and J.Kamphues, 2008. Experimental studies in turkeys on effects of litter quality and feeding on development and intensity of footpad dermatitis. 12th Congress of the European Society of Veterinary and Comparative Nutrition, 25-27.09.08, Vienna, Austria, 138.

A Photo Guide to Broiler Foot Health Classification

Class 0 - no lesion

No lesions or very small and superficial lesions, slight discolouration on a limited area, mild hyperkeratosis, old scars.

Only the footpad should be evaluated.

Class 1 - mild lesion

Substantial discolouration of the footpad, superficial lesion, dark papillae.

Only the footpad should be evaluated.

Class 3 - severe lesion

Ulcers or scabs of significant size, signs of haemorrhages or severely swollen footpad.

Only the footpad should be evaluated.

LIVESTOCK RESEARCH
WAGENINGEN UR

PRODUCTSCHAP Pluimvee & Eieren

Ministerie van Economische Zaken, Landbouw en Innovatie

www.livestockresearch.wur.nl

This photo guide should only be used after (or in conjunction with) appropriate training.

A Photo Guide to Broiler Foot Health Classification

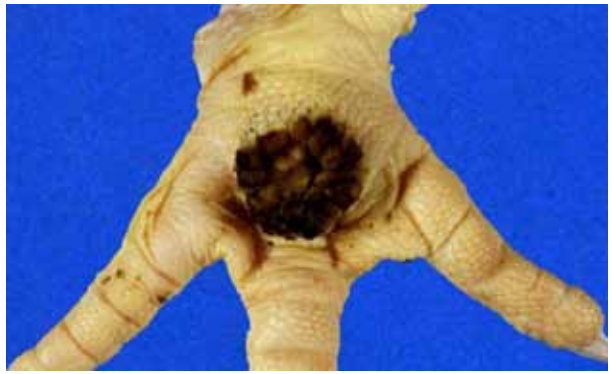
Class 0 – smooth, no lesion

Class 0 – small discolouration

Class 0 – almost healed lesion, scar

Class 1 – superficial lesion, discolouration

Class 1 – dark papillae, no ulceration



Class 1 – substantial discolouration

Class 2 – dark papillae and ulcer

Class 2 – ulcer covered by crust

Class 2 – abcess/bumble foot swollen

NOTES

info@aviagen.com

www.aviagen.com

0912-AVN-34