Literature Featherpecking - Treatment

Bestman, M., et al. (2009). "Influence of farm factors on the occurrence of feather pecking in organic reared hens and their predictability for feather pecking in the laying period." Applied Animal Behaviour Science **121**(2): 120-125.

Feather pecking is one of the most obvious welfare problems in laying hens. It is seen in all types of housing systems. Although banned in some countries, beak trimming is generally used to reduce the damage caused by this behaviour. In organic farming, where beak trimming is prohibited, the animals are being kept in a less intensive way than in conventional farming in order to improve their welfare. However, feather pecking is also seen in organic laying hens. Generally, rearing circumstances play an important role in the development of this behaviour. Therefore, rearing flocks were monitored for feather pecking and the relations between rearing factors and feather pecking at a young and at an adult age were analysed. Also the correlation between feather pecking during the rearing period and feather pecking during adult life was studied. Twenty-eight commercial flocks of rearing hens were monitored. These flocks split into 51 flocks of laying hens. Flocks were scored for signs of feather damage during rearing at the ages of 7, 12, and 16 weeks and on the laying farms at 30 weeks. On the rearing as well as the laying farm, data were collected on the housing system. Logistic regression was used to analyse our data. Feather damage was seen in 13 out of 24 (54%) of rearing flocks. Logistic regression showed that a higher number of pullets being kept per square meter in the first 4 weeks of life were associated with feather damage during the rearing period (Chi square = 8.49, df = 1, p = 0.004). Moreover, the combination of not having litter at the age of 1-4 weeks and the absence of daylight at the age of 7-17 weeks was a significant predictor of feather damage during the laying period (Chi square = 13.89, df = 4. p = 0.008). In 71% of the cases that pullets did not show feather pecking damage during rearing, they did not show feather pecking damage in the laying period either. When flocks of pullets did show feather damage, in 90% of the cases they did so during adult life. These results lead to suggestions on how to improve the rearing conditions of laying hens and increase their welfare not only during rearing but also during later life. Although the observations were done on organic farms, the results can be applied for other non-cage systems too. (C) 2009 Elsevier B.V. All rights reserved.

Daigle, C. L., et al. (2014). "Use of dynamic and rewarding environmental enrichment to alleviate feather pecking in non-cage laying hens." Applied Animal Behaviour Science **161**(0): 75-85.

Abstract Feather pecking (FP) can cause feather loss, resulting in physical injuries, which may lead to cannibalism. FP appears to be a redirection of foraging behavior, which intensifies when hens have difficulty coping with stress and fear. Dynamic environmental enrichment (EE) may allow expression of natural foraging behavior thus reducing conspecific pecking behavior and alleviating hen injury. Three treatments (plastic box: BOX; hay bale: HAY; and no enrichment: CON) were randomly applied to 30 identical floor pens (10 hens/pen; 10 pens/trt). At the pen level, hen behavior, and the number of severe FP (SFP), gentle FP (GFP), aggressive pecks (AP), and enrichment pecks (EP) were recorded from video prior to (21 wk) and after (24 wk) treatment implementation, and when hens were 27, 32, and 37 wk of age. A manual restraint test (MR) was performed immediately after behavioral observations and levels of blood serotonin (5-HT) and glucocorticoids (GC) measured. Short-term (ST) and long-term (LT) analyses identified the impact of EE over the ST (21 vs. 24 wk of age) and LT (21 vs. all other ages) at the pen level. At the pen level, HAY (3.18 ± 0.33) tended to reduce GFP compared to CON (4.10 ± 0.34) over the ST (P = 0.15) and LT (P = 0.09), but did not impact the number of SFP, or AP over the ST or LT. More EP was observed in HAY (3.56 ± 0.14) than BOX (1.61 ± 0.18) throughout the study (P < 0.0001). More HAY hens perched (P = 0.05) at 24 wk (0.28 ± 0.12) compared to 21 wk (0.19 ± 0.11), and more HAY hens (3.69 ± 0.25) performed dust bathing compared to CON (4.14 ± 0.22, P = 0.05) throughout the study. CON performed more struggles (1.13 ± 0.04, P = 0.04) and were quicker to vocalize (4.87 ± 0.07 s, P = 0.05) during MR than HAY (latency to vocalize(s): 5.16 ± 0.05; number of struggles: 0.96 ± 0.05), counter-intuitively suggesting CON were less fearful. Treatment did not affect 5-HT or GC. HAY appears to be a promising EE for mitigating GFP in non-cage laying hens. Future studies should examine the impact of EE on individual, rather than group-level responses. These results suggest that the presence of a hay bale is stimulating and may reduce GFP while encouraging hens to redirect pecking towards a dynamic and manipulable EE.

de Haas, E. N., et al. (2014). "Predicting feather damage in laying hens during the laying period. Is it the past or is it the present?" Applied Animal Behaviour Science **160**(0): 75-85.

Abstract Feather damage due to severe feather pecking (SFP) in laying hens is most severe during the laying period. However, SFP can develop at an early age and is influenced by early rearing conditions. In this study we assessed the risk factors during the rearing and laying period for feather damage at 40 weeks of age, in ISA brown and Dekalb White laying hens. Variables related to housing conditions during the rearing and laying period, and variables related to fearfulness (response to novel object, stationary person, and social isolation) and feather pecking (SFP, feather damage and feather eating) were tested to affect feather damage at 40 weeks of age. Feather damage on the neck, back and belly region was assessed on 50 hens, resulting in a total body score, and averaged per flock (based on Welfare Quality ®, 2009). First, analysis was conducted by a two-way ANOVA to assess separate factors to influence feather damage at 40 weeks of age. Hereafter, the final GLM for predicting feather damage at 40 weeks of age included only variables which had P < 0.1 in the two-way ANOVA. Risk factors during the rearing period were high levels of SFP at five weeks of age and elevated fear of humans (explained variance 29% and 5.3%, resp.). Risk factors during the laying period were a large group size (explained variance: 1%), distance to stationary person (explained variance: 16%), floor housing compared to aviary housing (1.27 ± 0.18 vs. 0.75 ± 0.07, explained variance: 21%) and a standard management compared to adjusted management such as a radio, pecking blocks, round drinkers and/or roosters (0.98 ± 0.31 vs. 0.51 ± 0.04, explained variance: 26%). Approximately 49% of the laying flocks and 60% of the rearing flocks in this study showed high SFP or severe feather damage. This high incidence emphasizes the severity of the problem and the importance of finding a solution. The results of this study may aid in providing practical solutions to this serious animal welfare problem.

Dixon, L. M., et al. (2010). "The effects of four types of enrichment on feather-pecking behaviour in laying hens housed in barren environments." Animal Welfare **19**(4): 429-435.

Severe feather pecking, a potentially stereotypic behaviour in chickens (Gallus gallus), can be reduced by providing enrichment. However, there is little comparative information available on the effectiveness of different types of enrichment. Providing forages to birds is likely to decrease feather-pecking behaviour the most, as it is generally thought that feather pecking stems from re-directed foraging motivation. Yet, other types of enrichment, such as dustbaths and novel objects, have also been shown to reduce feather pecking. In order to develop a practical and effective enrichment, these different possibilities must be examined. Using a Latin Square Design, 14-week old birds were given each of four treatments: i) forages; ii) novel objects; iii) dustbaths; or iv) no enrichment. The amount of feather-pecking behaviour and the number of pecks to the enrichments were recorded. Results showed feather pecking to be highest when no enrichment was present and lowest when the forages were present, with the other two enrichments intermediate. This was despite the fact that the numbers of pecks birds gave to the forages and dustbaths were not significantly different, suggesting that they were similarly used. Thus, we suggest here that forage enrichments are most effective at alleviating feather pecking at least in the short term and attempts should be made to develop poultry housing that allows for natural foraging behaviour. Following this, providing any kind of enrichment will increase bird welfare and is therefore still beneficial.

Drake, K. A., et al. (2010). "Influence of rearing and lay risk factors on propensity for feather damage in laying hens." British Poultry Science **51**(6): 725-733.

1. Feather pecking is one of the major problems facing the egg industry in non-cage systems and is set to become even more of an issue with the European Union ban on the keeping of laying hens in barren battery cages which comes into force in 2012 and the prospect of a ban on beak-trimming. Reducing feather pecking without resorting to beak treatment is an important goal for the poultry industry. 2. We report here a longitudinal study that included over 335 500 birds from 22 free range and organic laying farms. Accelerated failure time models and proportional hazards models were used to examine the effects of a wide range of factors (management, environment and bird) on development of substantial feather damage in lay. Particular emphasis was placed on risk factors during rear and on practices that could feasibly be changed or implemented. 3. The age at which a flock exhibits substantial feather damage could be predicted both by factors in the environment and by early symptoms in the birds themselves. Factors that were associated with earlier onset of severe feather damage included the presence of chain feeders, raised levels of carbon dioxide and ammonia, higher sound and light levels, particularly in younger birds. Increased feather damage (even very slight) in birds at 17-20 weeks of age was also highly predictive of the time of onset of severe feather damage during lay. Increased feed intake also indicated that a flock was at risk of early severe feather damage. 4. Birds that stayed on the same farm for rearing and lay showed later onset of serious feather damage than those that experienced a change in farm from rearing to lay. However, an increased number of changes between rearing and lay (feeder type, drinker type, light intensity etc) was not associated with earlier onset of serious feather damage. Further research needs to be done on the role of the transition from rearing to lay as a risk factor for FP in lay.

Jordan, D., et al. (2010). "The influence of sequential feeding on behaviour, feed intake and feather condition in laying hens." Applied Animal Behaviour Science **127**(3-4): 115-124.

Feeding of whole-wheat grains and a protein-mineral concentrate in sequence had been shown to modify behaviour in broilers and performance in laying hens. The objective of this study was to test whether sequential feeding with wheat would induce changes in laying hen's behaviour, feed intake, feather condition, and egg production. These parameters were measured on 320 non-beak-trimmed ISA Brown laying hens from 30 to 37 week of age. The birds were placed in 64 standard cages (five birds/cage) and allotted to one of four treatments. The control (C) was fed a complete conventional diet. Three treatments were fed sequentially with whole wheat (SWW), ground wheat (SGW) or ground wheat with added vitamin premix + phosphorus + 2% oil (SGWI). In sequential treatments, 50% of the ration was fed as wheat and the remaining 50% as a protein-mineral concentrate (balancer diet). All treatments received their daily ration in two distributions: 09:00(4 h after light on) and 16:00 h (5 h before light off). During weeks 30,32 and 34, hens' behaviour was recorded using scan sampling method (once per week during the light period), while focal sampling was used between the 32 and 34 weeks (2 halter each feeding, and 2 h in between). Feather condition of individual hen was scored at 30 and 37 weeks, number of eggs and feed intake were recorded weekly. Sequential feeding delayed the oviposition for almost 1 h. When fed wheat-based diet (09:00-16:00 h) SWW birds spent less time feeding and stood still longer compared to birds in other treatments. Four hours after distribution of

wheat diets, the occurrence of feather peaking was the highest in SWW and the lowest in the SGW treatment. The poorest feather condition was recorded in the SWW treatment. Total feed intake was the highest in the C treatment, while the intake of wheat diet and the ratio wheat diet intake/total feed intake was the highest in the SGWI treatment. We concluded that sequential feeding with whole wheat had detrimental effect on behaviour of laying hens probably due to long period of access to wheat used in this work. It is therefore suggested that wheat should be used either ground or presented on shorter time sequence. The time access should be reduced when whole wheat is used. (C) 2010 Elsevier B.V. All rights reserved.

Kalmendal, R. and W. Bessei (2012). "The preference for high-fiber feed in laying hens divergently selected on feather pecking." Poultry Science **91**(8): 1785-1789.
Earlier studies in laying hens have demonstrated a negative correlation between feather pecking and the dietary fiber content of the feed. However, the factors underlying this relationship are not fully understood. In the present experiment, we hypothesized that birds prone to feather pecking would prefer a diet supplemented with dietary fiber. Thus, the aim was to investigate the voluntary consumption of a wheat-soy control diet (CON) and a diet supplemented with 8% spelt hulls (FIB) on the expense of wheat in 20 individually caged hens selected for high feather pecking (HFP) behavior and 20 individually caged hens selected for low feather pecking (LFP) behavior. The proportional intake of FIB was 0.39 and significantly different from 0.50 ($P < 0.001$). As hypothesized, HFP had higher proportional intake of FIB (0.43) than LFP hens (0.36; $P < 0.05$). The HFP hens had inferior plumage condition ($P < 0.001$), higher BW ($P < 0.001$), and higher feed intake ($P < 0.01$) than LFP. The HFP hens plucked more feathers from a simple inanimate feather-pecking model, but the number of feathers being pulled out did not correlate with the proportional intake of FIB. It was concluded that the preference for feed supplemented with spelt hulls was different between hens displaying different feather-pecking behavior. The underlying reason for such a difference needs further investigation.

Lambton, S. L., et al. (2013). "A bespoke management package can reduce levels of injurious pecking in loose-housed laying hen flocks." Veterinary Record **172**(16): 423.
This study investigated the protective effects of an on-farm management package designed to reduce injurious pecking (IP) in loose-housed laying hens. A systematic review of scientific literature generated 46 potentially protective management strategies. Bespoke management packages were designed for treatment flocks (TF) using these management strategies. IP in 53 TFs was compared with IP in 47 control flocks (CF) where the management package was not employed. Scoring of plumage damage (PD) and observations of gentle and severe feather pecking (GFP; SFP), and vent and cannibalistic pecking (VP) were completed, and management strategy use was recorded, at 20, 30 and 40 weeks of age. Differences between treatment and CF were examined using multilevel modelling. Compared with CF, TF employed more management strategies ($P<0.001$), had lower PD ($P=0.003$) and SFP ($P=0.019$). Regardless of treatment or control flock status, the more of the 46 management strategies that were employed the lower was the PD ($P=0.004$), GFP ($P=0.021$), SFP ($P=0.043$), mortality at 40 weeks ($P=0.025$), and the likelihood of VP ($P=0.021$). Therefore, the provision of a bespoke management package was protective against the majority of forms of IP in commercial laying hen flocks.

Leeson, S. and T. Walsh (2004). "Feathering in commercial poultry - II. Factors influencing feather growth and feather loss." Worlds Poultry Science Journal **60**(1): 52-63.
In commercial production, there is often concern about the quantity and/or quality of feathering in both broilers and layers. For broilers, the concern is adequacy of protective feather cover, while in layers it is usually the necessary degree of feathering needed to optimise feed efficiency. Feather development is under the control of hormones such as thyroxine and oestrogen and indirectly by testosterone. Environmental or nutritional status that influences such hormonal output will indirectly affect feathering. In broilers, rate of feathering is influenced by genetics, since some 20 years ago there was a conscious decision to introduce slow (K) vs. fast (k) feathering as a means of sexing day-old chicks. With the relative "immaturity" of modern broilers, these genes influence feather cover well into the production cycle. In White Leghorn crosses, initial problems with apparent Leukosis susceptibility of the progeny of slow feathering dams had to be overcome by eradication of Leukosis before feather sexing could be generally introduced. Nutrition can influence rate of feathering as well as feather structure, colour and moulting. Amino acid balance and especially deficiencies of TSAA and branched chain amino acids will influence feathering in young birds. Deficiency of vitamins and certain trace minerals also induce characteristic feather abnormalities, as does the presence of dietary mycotoxins. A number of viruses, bacteria and mycoplasma can infect the feather follicle and so influence feather development. Feather pecking and feather licking are behavioural abnormalities, although these conditions can be induced by changes in environmental conditions or nutritional adequacy of the diet.

McAdie, T. M., et al. (2005). "Reduction in feather pecking and improvement of feather condition with the presentation of a string device to chickens." Applied Animal Behaviour Science **93**(1-2): 67-80.
Feather pecking remains a serious problem in commercial egg production. It has been argued that feather pecking,occurs as a result of misdirected pecking, so a possible solution would be to increase the likelihood that such pecking was targeted at another object in the environment rather than to the feathers of conspecifics. Chickens of various strains and ages will readily peck at a device consisting of strands of white string but it is not yet known if pecking at that device would substitute for pecking at conspecifics. Therefore, the effects of providing string devices on feather pecking in an experimental

situation (Experiment 1) and on feather condition under commercial conditions (Experiment 2) were examined. In Experiment 1, 300 chicks of a high-feather pecking strain of white leghorn-type layers were housed in groups of five in litter-floor pens. The 60 pens were randomly allocated to one of five treatments: devices incorporated in the chicks' pens continuously from 1 day of age till the end of the experiment at 57 days; devices presented for 4 h per day from 1 day of age; first presented from 22 days of age; first presented from 52 days of age; and finally, devices never presented. Feather pecking was virtually eliminated when the devices remained in the pens from 1 day of age or when they were presented for 4 h per day. Feather pecking was most pronounced among birds that had never received the device whereas its introduction at 22 or 52 days of age yielded intermediate results. This orderly pattern of more pecking at feathers when the device was added at later ages was significant ($p < 0.005$). In Experiment 2, 768 Lohmann LSL laying chickens were housed in rearing cages and 720 were transferred in groups of three to conventional laying cages when 16 weeks old. The birds were allocated to one of four treatments: devices present from 1 day of age; presented for 24 h every 4 weeks; continuously present from 16 weeks of age; and finally, devices never presented. At 35 weeks of age, hens with access to the device had significantly better plumage condition than those that had never received the device ($p < 0.05$). In conclusion, the addition of a simple string device to the pens of non-beak-trimmed high-feather-pecking birds decreased feather pecking behaviour (Experiment 1), and to the cages of non-beak-trimmed commercial layers significantly improved feather condition (Experiment 2). (c) 2004 Elsevier B.V. All rights reserved.

Merrill, R. J. N. and C. J. Nicol (2005). "The effects of novel floorings on dustbathing, pecking and scratching behaviour of caged hens." Animal Welfare **14**(3): 179-186.
From the year 2012, conventional battery cages for laying hens will be banned under the European Union Council Directive 1999/74/EC Enriched cages, which include a perch, a nest area, and a pecking and scratching area will not be banned, and have certain advantages over other systems of egg production. Previous studies have shown that even when a pecking and scratching area is provided, most dustbathing occurs on the wire floor as sham dustbathing. This study investigated whether novel cage floor types could stimulate full expression of dustbathing behaviour, similar to that seen on loose litter. One hundred and forty four hens were housed in pairs in non-commercial enriched cages that differed only in that they contained one of four randomly allocated floor types. Floor types were conventional wire ('wire), wood shavings (litter), conventional wire wrapped with garden twine (string) and perforated rubber matting (rubber). Birds on litter or rubber performed fewer bouts of dustbathing than those on wire and string. However, bouts on litter were longer than those on the three other floor types. Overall, birds on litter or string showed a greater total duration of dustbathing than those on rubber, and birds on litter had a richer repertoire of dustbathing elements. Birds on litter performed significantly more pecking and scratching than those on string or rubber, which did not differ from those on wire. Birds on rubber and litter had poorer foot and feather condition than those on wire or string. Altering the cage floor produced minor changes in behaviour, and further novel floor types should be evaluated.

Miller, K. A. and J. A. Mench (2006). "Differential effects of 4 types of environmental enrichment on aggressive pecking, feather pecking, feather loss, food wastage and productivity in Japanese quail." British Poultry Science **47**(6): 646-658.
1. We examined the effects of 4 types of environmental enrichment (foraging opportunities, structural complexity, sensory stimulation/novelty, and social companionship) on aggressive and feather pecking, feather condition, food wastage, body weight, feed conversion, and egg production in adult Japanese quail. Sex differences were examined where possible. 2. GLM analysis was used to evaluate the effects of enrichment and housing, while test-retest reliability and the stability of measures over 18 d were assessed using partial correlation. 3. Foraging enrichment reduced food wastage. 4. Body weight, feed conversion, and egg production were not affected by enrichment. Rates of aggressive and feather pecking were also not significantly affected, but these behaviours were observed very infrequently in this study. 5. Socially-housed birds had poorer feather condition, lower body weight and less efficient feed conversion than singly-housed birds. Social housing did not affect food wastage. 6. There were no sex differences in feather pecking, feather condition, food wastage, or feed conversion. 7. All measures except feather pecking were reliable over 24 h, but only feather condition and body weight were stable over 18 d. The instability of the behavioural measures over time suggests that enrichment effects may vary with age.

NICOL, C. J., et al. (2013). "The prevention and control of feather pecking: application to commercial systems." World's poultry science journal **69**(04): 775-788.
Studies on the prevalence of feather pecking in different commercial laying hen systems and its welfare and economic impacts are reviewed in the following paper. Current methods for controlling feather pecking include beak-trimming and alterations to light regimes, but these methods have significant disadvantages from the perspective of bird welfare. A substantial body of research has now identified risk factors for feather pecking during both the rearing and laying periods. It is argued that these findings can be translated into optimised management practices that can prevent and control feather pecking whilst simultaneously conferring welfare benefits. The genetic basis of feather pecking is considered, and studies that suggest group selection techniques could produce birds with a reduced tendency to feather peck in commercial flocks are highlighted.
Petek, M. and J. L. McKinstry (2010). "Reducing the prevalence and severity of injurious pecking in laying hens without beak trimming." Veteriner Fakultesi Dergisi, Uludag Universitesi **29**(1): 61-68.

Injurious pecking is a general term used to describe feather pecking, vent pecking, cannibalism and toe-pecking in laying hens. The severity of injurious pecking varies enormously, ranging from limited feather removal to cannibalism and death. Alternative housing systems for laying hens such as barn, free-range and aviary systems show much higher incidences of injurious pecking than with those birds housed in conventional caged system. From a welfare perspective injurious pecking can cause pain, stress, injuries, increased susceptibility to diseases, fear and death. Any major outbreak of injurious feather pecking can result in serious economic loss for the industry through decrease in egg production and feed efficiency. At present the egg industry uses both beak trimming of the birds and dim lighting methods to help reduce injurious pecking. However, both of these are being criticised from a welfare point of view. In fact a general ban on beak trimming already exists in some European Union countries, with other countries considering a ban by 2011. Moreover, The EU ban on conventional laying cages (2012), when combined with a ban on beak-trimming, will increase the risk of injurious feather pecking and cannibalism. It is therefore important for future to consider other ways of controlling injurious pecking. Injurious pecking is a multi-factorial problem, which can be caused by environmental, genetic or nutritional factors and can be largely prevented by the use of a combination of environmental and husbandry management programs. This paper is intended to give a general overview of the potential risk factors and possible control measures associated with injurious pecking in laying hens, and in particular those flocks housed in non-cage systems.

Ramadan, S. G. A. and E. v. Borell (2008). "Role of loose feathers on the development of feather pecking in laying hens." British Poultry Science **49**(3): 250-256.

The effect of the presence of loose feathers (on the floor) on the behaviour and plumage condition of laying hens (Lohmann Silver, LS) was studied during the rearing and laying periods. From one day old, 60 birds in each of 4 straw-bedded pens (<i>n</i>=240 in total) with 6.5 birds/m² were either kept under conventional rearing and management conditions (CT: control group with feathers on the floor; <i>n</i>=120) or in pens from which the feathers were collected from the floor 4 times/week (FR: feathers removed; <i>n</i>=120). Fifty birds from each of these 4 groups (<i>n</i>=200 in total) were randomly selected at the age of 16 weeks and allocated to 4 identical pens in a poultry layer house (PH; with perches and 1/3 slatted floor) with access to an outside area (winter garden, WG) at a stocking density of 6 birds/m² in both PH and WG. Observations on feather pecking and other behaviours (feeding, drinking, preening, standing, sitting, foraging, moving and dust bathing) were carried out at 8 ages: 6, 10, 15 (rearing period), 20, 25, 30, 35 and 40 weeks (laying period). Feather scoring was carried out at 15, 32 and 39 weeks of age. There were no differences in feather pecking rates, forms (gentle, severe and aggressive pecks) as well as in the plumage condition between groups at the end of the rearing period. Birds in the FR group exhibited lower rates and less severe feather pecking during the laying period. Accordingly, birds in the control group had worse feather condition at 32 and 39 weeks of age. Feather pecking rates within groups were, in general, greater in the afternoon compared to the morning periods. Birds in the control group were more active in walking. Wings, rump, tail and back were the main targets for feather pecking. The majority of feather pecking occurred on the floor (66%) followed by feeding area (26%), perches (4%) and slats (4%). Our results suggest that loose feathers on the floor may play an important role in the development and severity of feather pecking behaviour in laying hens and support the hypothesis (McKeegan and Savory, 1999) that feather pecking can be viewed as redirected foraging behaviour.

Riber, A. B. and B. Forkman (2007). "A note on the behaviour of the chicken that receives feather pecks." Applied Animal Behaviour Science **108**(3-4): 337-341.

Basic knowledge of feather pecking on the individual level is still limited. The aim of this study was to investigate whether active and inactive individuals preferentially attract feather pecking. Female layer hen chicks were housed in six pens with each 15 chicks. Each occurrence of gentle and severe feather-pecking bout was recorded continuously in all pens for 30 min/pen/week when the chickens were 0-23 weeks of age. For each feather-pecking bout, the behaviour (active/inactive, dustbathing/non-dustbathing) of the recipient bird immediately before being feather pecked was recorded. Inactive individuals were more likely to become the targets of both gentle (when pecks directed to dustbathing chickens were excluded) and severe feather pecks (both when including and excluding feather pecks directed to dustbathing chickens) than active individuals. This knowledge may be used to reduce feather pecking by providing distinct resting areas such that mixing of active and inactive chickens is avoided.

Rodenburg, T. B. and P. Koene (2007). "The impact of group size on damaging behaviours, aggression, fear and stress in farm animals. (Special issue: Too many, too few: the effects of group size and density in captive animals.)." Applied Animal Behaviour Science **103**(3/4): 205-214.

The aim of this review is to discuss the impact of group size on damaging behaviours, aggression, fear and stress in farm animals and to identify housing- and management options that can help to reduce problems caused by suboptimal group sizes. Increasing group size was found to increase the risk of damaging behaviour, such as feather pecking in laying hens and vulva biting in sows. Aggression does not appear to be a problem in large groups, because dominance relationships in these groups are not based on individual recognition, but based on other signals such as body size, avoiding costly fights. There is evidence for increased fear and stress levels in large groups compared with small groups, but fearfulness is also strongly affected by type of housing. To minimise problems in large groups, is seems helpful to offer separate functional areas and to provide cover, reducing disturbance between animals. To minimise the risk of damaging behaviour, such as feather pecking in laying hens and tail

biting in pigs, stimulating foraging, exploration and manipulation behaviour by providing sufficient substrate (straw, wood shavings and sand) offers perspective. Rearing the animals in a system which allows the development of all these behaviours is very important. Other solutions can be found in optimising the diet and offering extra foraging opportunities. Furthermore, genetic selection against damaging behaviour seems promising. In conclusion, group size mainly has an effect on damaging behaviour and fear and stress in pigs and poultry. The effect on aggressive behaviour is limited. To reduce damaging behaviour, fear and stress, it is important to provide a complex environment with ample behavioural opportunities and separate functional areas.

Rodenburg, T. B., et al. (2005a). "Can short-term frustration facilitate feather pecking in laying hens?" Applied Animal Behaviour Science **91**(1-2): 85-101.

Feather pecking is a major problem in laying hens. Frustration, i.e. the omission of expected reward, may play a role in the development of feather pecking. In two experiments, we studied if feather pecking could be facilitated by short-term frustration in birds with a high feather pecking phenotype and victims of feather pecking (experiment 1), and in birds with a high or low feather pecking genotype (experiment 2). Furthermore, the motivation to peck a key for a food reward was assessed in birds with a high or low feather pecking genotype in experiment 3, as birds that have a stronger motivation may also react stronger to the omission of a reward. We trained birds to peck a key for a food reward in an automated Skinnerbox and tested them in control and frustration sessions. During frustration, the feeder was covered with Perspex. Frustration did not facilitate feather pecking in either experiment. In experiment 1, birds with a high feather pecking phenotype did show more gentle feather pecking and aggressive pecking than victims of feather pecking during some of the control sessions. Furthermore, victims of feather pecking vocalised more than birds with a high feather pecking phenotype. In experiment 2, birds with a high feather pecking genotype scratched more than birds with a low feather pecking genotype, indicating differences in motivation for foraging or dust-bathing behaviour, which shows a relation to feather pecking. Birds with a low feather pecking genotype also had a stronger motivation to peck at a key for a food reward than birds with a high feather pecking genotype. No evidence was found that feather pecking could be facilitated by short-term frustration in a Skinnerbox. However, differences in reaction to frustration and in motivation to peck a key for a food reward in birds with a high or low feather pecking phenotype or genotype indicate that frustration may still play a role in the development of feather pecking. (c) 2004 Elsevier B.V. All rights reserved.

Rodenburg, T. B., et al. (2004c). "Reaction to frustration in high and low feather pecking lines of laying hens from commercial or semi-natural rearing conditions." Behavioural Processes **65**(2): 179-188.

The effect of rearing conditions on feather pecking and reaction to frustration was studied in two lines of laying hens. From commercial rearing conditions (large group, no mother hen), seven birds from a high feather pecking line (HC birds) and eight birds from a low feather pecking line (LC birds) were used. From semi-natural rearing conditions (small group, mother hen present) seven birds from the high feather pecking line (HN birds) were used. Feather pecking behaviour of HC, LC, and HN groups was recorded for 30 min. After that, each bird was food deprived and trained to peck a key for a food reward in a Skinnerbox. After training, each bird was subjected to a frustration session in a Skinnerbox, where the feeder was covered with Perspex. Three HC birds showed severe feather pecking, compared with one HN bird and zero LC birds. Differences in reaction to frustration were found between birds from different lines, but not in birds from different rearing conditions. LC birds tended to put their head in the feeder more frequently than HC birds over all sessions. Although limited, this study indicates that rearing conditions influence feather pecking, but not reaction to frustration. (C) 2003 Elsevier B.V. All rights reserved.

RODENBURG, T. B., et al. (2013). "The prevention and control of feather pecking in laying hens: identifying the underlying principles." World's poultry science journal **69**(02): 361-374.

Feather pecking (FP) in laying hens remains an important economic and welfare issue. This paper reviews the literature on causes of FP in laying hens. With the ban on conventional cages in the EU from 2012 and the expected future ban on beak trimming in many European countries, addressing this welfare issue has become more pressing than ever. The aim of this review paper is to provide a detailed overview of underlying principles of FP. FP is affected by many different factors and any approach to prevent or reduce FP in commercial flocks should acknowledge that fact and use a multifactorial approach to address this issue. Two forms of FP can be distinguished: gentle FP and severe FP. Severe FP causes the most welfare issues in commercial flocks. Severe FP is clearly related to feeding and foraging behaviour and its development seems to be enhanced in conditions where birds have difficulty in coping with environmental stressors. Stimulating feeding and foraging behaviour by providing high-fibre diets and suitable litter from an early age onwards, and controlling fear and stress levels through genetic selection, reducing maternal stress and improving the stockmanship skills of the farmer, together offer the best prospect for preventing or controlling FP.

Steenfeldt, S., et al. (2007). "Effect of feeding silages or carrots as supplements to laying hens on production performance, nutrient digestibility, gut structure, gut microflora and feather pecking behaviour." British Poultry Science **48**(4): 454-468.

1. An experiment was carried out to examine the suitability of using maize silage, barley-pea silage and carrots as foraging materials for egg-laying hens. Production performance, nutrient digestibility, gastrointestinal characteristics, including the composition of the intestinal microflora as well as feather pecking behaviour were the outcome variables. 2. The protein content of the foraging material (g/kg

DM) was on average 69 g in carrots, 94 g in maize silage and 125 g in barley - pea silage. The starch content was highest in the maize silage (312 g/kg DM), and the content of non-starch polysaccharides (NSP) varied from 196 to 390 g/kg, being lowest in carrots. Sugars were just traceable in the silages, whereas carrots contained on average 496 g/kg DM. 3. Egg production was highest in hens fed either carrots or maize silage, whereas hens fed barley - pea silage produced less (219 vs. 208). Although the consumption of foraging material was high (33, 35 and 48% of the total feed intake on 'as fed' basis for maize silage, barley - pea silage and carrots, respectively) only a minor effect on nitrogen corrected apparent metabolisable energy (AME(n)) and apparent digestibility was seen. At 53 weeks of age, hens fed maize silage had AMEn and apparent digestibility values close to the control group (12.61 and 12.82, respectively), whereas access to barley - pea silage and carrots resulted in slightly lower values (12.36 and 12.42, respectively). Mortality was reduced dramatically in the three groups given supplements (0.5 to 2.5%) compared to the control group (15.2%). 4. Hens receiving silage had greater relative gizzard weights than the control or carrot-fed groups. At 53 weeks of age, the gizzard-content pH of hens receiving silage was about 0.7 to 0.9 units lower than that of the control or carrot-fed hens. Hens fed both types of silage had higher concentrations of lactic acid (15.6 vs. 3.2 mu moles/g) and acetic acid (3.6 vs. 6.1 mu moles/g) in the gizzard contents than the other two groups. The dietary supplements had a minor effect on the composition of the intestinal microflora of the hens. 5. Access to all three types of supplements decreased damaging pecking in general (to feathers as well as skin/cloaca), reduced severe feather pecking behaviour and improved the quality of the plumage at 54 weeks of age. 6. In conclusion, access to different types of foraging material such as silages and carrots improved animal welfare.

Thiele, H. H. and R. Pottguter (2008). "Management recommendations for laying hens in deep litter, perchery and free range systems." Lohmann Information **43**(1): 53-63. http://www.lohmann-information.com/content/l_i_43_artikel6.pdf

Uitdehaag, K. A., et al. (2009). "Mixed housing of different genetic lines of laying hens negatively affects feather pecking and fear related behaviour." Applied Animal Behaviour Science **116**(1): 58-66.
Adult laying hens from Rhode Island Red (RIR) origin both express lower levels of feather pecking and lower fear responses towards a novel object than laying hens from White Leghorn (WL) origin. The present study investigated whether mixed housing of RIR and WL laying hens would affect their behaviour in both an open field (at 17-18 weeks of age) and manual restraint test (at 24 weeks of age) and their feather damage due to severe feather pecking. In experiment A. 'pure' groups contained birds from one line only throughout the rearing and laying period. 'Mixed' groups contained an equal number of RIR and WL birds. Pure and mixed groups contained four birds, which were housed in battery cages. It was found that RIR birds were more active in the open field and manual restraint test than WL birds, although RIR birds from mixed groups became less active in the open field test than RIR birds from pure groups. This would indicate that RIR birds were less fearful than WL birds, but that they became more fearful in presence of these WL birds. In experiment B, RIR and WL birds were only housed together during the laying period, in varying ratios. It was found that WL birds from mixed groups had more feather damage due to severe feather pecking than WL birds from pure groups, whereas no effect of mixing was found in RIR birds. RIR birds from mixed groups therefore appeared to have developed relatively high levels of feather pecking, targeted at WL birds. This would indicate that, together with results from experiment A, fearful RIR birds from mixed groups were at higher risk to develop feather pecking than less fearful RIR birds from pure groups. This study clearly demonstrates that social factors have a strong influence on the development of feather pecking and related behavioural characteristics. (C) 2008 Elsevier B.V. All rights reserved.