Literature Featherpecking - Risk factors - Health

Altan, O., et al. (2005). "Heritabilities of tonic immobility and leucocytic response in sire and dam layer lines." Turkish Journal of Veterinary & Animal Sciences **29**(1): 3-8.

Fearfulness reaction was examined using tonic immobility (TI) response and differential leucocyte counts as physiological indicators of distress from sire and dam brown layer lines. The study was performed on 20 male and 131 female chickens from the sire line and 24 male and 116 female chickens from the dam line. The duration of TI, the time interval until the bird righted itself, and the number of inductions (15 s periods of restraint) necessary to attain TI were recorded. If TI could not be induced after 5 attempts, a score of 0 was recorded. After the TI test, blood samples were collected from 16 male and 45 female chickens in the sire line and 17 sires and 42 dams in the dam line and leucocyte parameters were examined. After the normality test, TI, tonic immobility per number of inductions (TI/Ind) and the heterophil:lymphocyte (H/L ratio) showed deviations from normality. After applying the Box-Cox transformation all data were analysed by a general linear model using JMP. Heritabilities and phenotypic correlations were also obtained. Significant line differences were obtained from TI reactions. There were no significant differences in the leucocytic parameters between lines, except for eosinophils. The H/L ratio was significantly higher in males than in females. Heritability estimates for the duration of TI and TI/Ind were low to moderate in the sire line, but moderate to high in the dam line. The results suggest that fearfulness could be controlled through selection.

Campo, J. L. and M. T. Prieto (2009a). "Association between plumage condition and fluctuating asymmetry and between feathers removal, heterophil-to-lymphocyte ratio and tonic immobility duration in chickens." Archiv Fur Geflugelkunde **73**(4): 250-+.

The purpose of this study was to analyze the relationship between plumage condition and fluctuating asymmetry and between removal of feathers and heterophil-to-lymphocyte ratio and tonic immobility duration of chickens. in experiment 1, cocks (n = 46; 36 wk old) from 2 Spanish breeds (Black Castellana and Red Villafranquina), and hens (n = 40; 36 wk old) from the Quail Castellana breed, having bad or good plumage condition were used. The fluctuating asymmetry of several traits (middle toe length, leg length, wing length, wattle length, and leg width) was measured in these birds. in cocks, the effect of plumage condition on the relative asymmetry of leg width and the combined asymmetry depended on the genotype, differences being significant ($P < 0.05$) in the Red Villafranquina breed. In this breed, the relative asymmetry of cocks with bad plumage condition was significantly larger. The relative asymmetry of leg width in females with poor plumage condition was significantly ($P < 0.05$) larger than that of females with good pulmage condition. In experiment 2, cocks from the Birchen Leonesa breed (n = 40; 36 wk old) in which five feathers of the hackle and five feathers of the saddle have been removed at one instance or not, were used. The heterophil-to-lymphocyte ratio and the duration of tonic immobility were measured in these birds. The effect of feathers removal was not significant, suggesting that the levels of stress and fear were similar in both groups of birds. TWO housing system (deep litter and free range) were used in this experiment, the tonic immobility duration being significantly longer ($P < 0.05$) within the group of birds housed in deep litter than within the group of free-ranged birds. Thus, plumage condition can be negatively associated with some measures of stress depending on the genotype, whereas a single event of feathers removal was not associated with these indicators of the stress and fear levels of males.

Campo, J. L., et al. (2008). "Association between vent pecking and fluctuating asymmetry, heterophil to lymphocyte ratio, and tonic immobility duration in chickens." Applied Animal Behaviour Science **113**(1-3): 87-97.

The purpose of the present study was to analyze the relationship between incidence of vent pecking, fluctuating asymmetry, heterophil to lymphocyte ratio, and tonic immobility duration in chickens. The experiment (140 birds in three different replicates) measured the fluctuating asymmetry of several traits (middle toe length, leg length, wing length, wattle length, and leg width), the heterophil to lymphocyte ratio, and the tonic immobility duration in 20-week-old pullets of five Spanish breeds of chickens (Blue Andaluza, Quail Castellana, White-faced Spanish, Red-barred Vasca, and Birchen Leonesa), and a White Leghorn population, with and without evidence of suffering from vent pecking. The number of birds per breed was 20, 24, 12, 20, 18, and 46, respectively. There was a significant difference between vent pecked and non-vent pecked birds on the relative fluctuating asymmetry of middle toe length ($P < 0.05$), the relative fluctuating asymmetry of birds who suffered from vent pecking being larger. The combined relative fluctuating asymmetry of the five traits approached levels of statistical significance ($P = 0.08$). There was a significant difference ($P < 0.001$) in heterophil to lymphocyte ratio and tonic immobility duration between vent pecked and non-vent pecked birds, the ratio being higher and the duration being longer in the group of birds that suffered from vent pecking. Thus, vent pecked birds were more asymmetrical, stressed and fearful than non-vent pecked birds, having increased relative fluctuating asymmetry, heterophil to lymphocyte ratio and tonic immobility duration. Differences were consistent across the breeds. Results indicate that vent pecking is associated with other measures of stress e.g. fluctuating asymmetry. heterophil to lymphocyte ratio, and tonic immobility duration.

Cheng, H. W. and W. M. Muir (2007). "Mechanisms of aggression and production in chickens: genetic variations in the functions of serotonin, catecholamine, and corticosterone." Worlds Poultry Science Journal **63**(2): 233-254.

The neuroendocrine systems, such as dopamine (DA) and serotonin (5- HT) as well as corticosterone (CORT), are involved in regulating behavioural patterns and reproduction in humans and other mammals. Similar functions of neuroendocrine system may present in laying hens. To test the hypothesis, two divergent chicken lines were used in the study. Each line has distinct levels of aggressiveness and productivity at a group setting and exhibits differen susceptibility to various environmental stressors. We found that, at 21 wks of age, LGPS (Low Group Productivity and Survivability) birds had significantly higher blood concentrations of DA and epinephrine than the KGB birds (Kind Gentle Birds, also previously termed HGPS, birds with a High Group Productivity and Survivability) (P< 0.01, respectively). The blood concentration of norepinephrine was not significantly different between the lines but the ratio of epinephrine to norepinephrine was higher in LGPS birds (P< 0.01). The blood concentration of 5- HT was also significantly higher in LGPS birds compared to KGB birds (P< 0.01). In contrast, KGB birds tended to have a higher level of blood CORT (P= 0.1). The results suggest that genetic selection for productivity and survivability with domestic behaviours alters the birds' neuroendocrine homeostasis. The selection-associated plasticity of the neuroendocrine system in controlling animal aggression and productivity were discussed in the article.

Cronin, G. M., et al. (2011). A retrospective study of the impact of injurious pecking on stress response in hens, measured via egg corticosterone. Sydney, Poultry Research Foundation.

This paper describes the temporal change in egg corticosterone concentrations around a minor outbreak of injurious pecking by laying hens. The event occurred during an experiment in which we were measuring corticosterone concentrations in egg albumen at weekly intervals, as an indicator of physiological stress response. For the experiment, a total of 96 Hy-Line Brown birds were housed in two adjacent controlled environment rooms, enabling the imposition of different photoperiod treatments. Six identical 8-bird cages were used per room. Injurious pecking occurred in one of the two rooms, in two cages (situated back-to-back) containing birds aged 18-23 weeks. Affected birds were treated by swabbing the injured area(s) with Stockholm tar. Corticosterone concentrations were elevated in eggs from these cages, as well as the two abutting cages, even though those birds were neither handled nor treated with Stockholm tar. The findings suggest that the elevated corticosterone was elicited by aversive stimuli (stressors) experienced by the hens. It is also possible that disturbance caused by the stockpeople catching and treating birds in the affected cages, induced a stress response in birds in the abutting cages. In the more-distant cages in this room, and in the other room, corticosterone concentrations were not elevated.

Ghareeb, K., et al. (2008). "Individual differences in fear and social reinstatement behaviours in laying hens." International Journal of Poultry Science **7**(9): 843-851.

Individual differences in behavioural responses are of growing interest in behavioural studies. The present study investigated the consistency of the individual differences over time and across social (social reinstatement responses) and non social test situations (tonic immobility response). Three breeds of commercial hybrid layers (ISA Brown, Lohmann Tradition and Lohmann Silver) were reared from hatch to 37 weeks of age. Individual birds were subjected to tonic immobility test at 3, 5, 7, 10, 11, 15, 16, 20, 24, 35 and 37 weeks old and to runway test of sociality at 3, 5, 10, 16, 20 and 37 weeks old. Fearfulness did not show breed differences either in the overall means or in a certain tested age. However, ISA Brown had a higher latency to emerge to a runway than LT (16 and 20 weeks) and LS (at 37 weeks). In addition, ISA Brown hens had a higher latency to reinstate with their companion than LS (10 and 37 weeks). The individual ranks for behavioural traits of fear and sociality were consistent over time. These results indicate that fear and sociality responses are behavioural strategies used by individuals in certain test situation when repeated. Moreover, the duration of TI response was positively correlated to both sociality traits (latency to emerge and reinstate with a companion) indicating that birds had overall behavioural traits that were consistent across different contexts. This suggests that hens can be categorized into behavioural types or styles based on their test responses. The highly fearful birds (longer TI duration) had a higher latency to emerge and reinstate with their companions (reactive style) and the less fearful birds (shorter TI duration) had a lower latency to emerge and socially reinstate with their companions (proactive style). In conclusion, these individual differences are consistent over time and the behaviour of hens in one test can predict their behaviour in other test situation. Thus it could be used to assess individual hens and potentially be used in a breeding programme to select a hen with more desirable personality traits.

Gilani, A.-M., et al. (2013). "The effect of rearing environment on feather pecking in young and adult laying hens." Applied Animal Behaviour Science **148**(1–2): 54-63.

Abstract Although the rearing period has an important influence on the development of feather pecking in laying hens, few studies have quantified the risk factors operating on commercial farms during this time and identified their long-term impact. Our aim was to conduct a longitudinal study to investigate the effect of rearing environment on feather pecking in young and adult laying hens. Thirty-four flocks from 29 rearing farms were recruited and visited at the beginning, middle and end of the rearing period and once at lay (35 weeks). Twelve flocks were beak trimmed. Information on rearing environment was used to create models predicting feather pecking and plumage damage during rear and lay, using the multilevel statistical software MLwiN 2.25. Across all flocks, gentle feather pecking (GFP) was observed during 94% of the visits at both rear and lay, at 1.3 and 1.0 bouts/bird/h respectively. Severe feather pecking (SFP) was observed during 27% of the visits during rear and

during 65% of the visits at lay, with a mean rate of 0.4 pecks/bird/h during rear and 1.9 pecks/bird/h at lay, across all flocks. The mean percentage of the flock with missing feathers was 12% at 16 weeks and 49% at lay. The mean individual feather score at lay was 21 (range 6–24 (best)). The study confirmed that feather pecking and feather damage occur during the rearing period. Statistical modelling further showed that the percentage of the flock with missing feathers was significantly lower and individual feather scores significantly higher (better) at lay, in flocks where feather pecking had not started at the end of rear. The three models on the effect of rearing environment on GFP, SFP and the percentage of the flock with missing feathers during rear contained 21 significant variables. Approximately a third of those related to house climate (temperature, humidity, sound, light and dust levels), while another third related to foraging. Foraging itself appeared in all three models, confirming that good foraging is one of the major factors in reducing feather pecking. The four models on the effect of rearing environment on GFP, SFP, the percentage of the flock with missing feathers and individual feather scores at lay contained 17 significant variables and sound level was significant in three of the four. The analysis further indicated that experienced rearing staff was protective against feather pecking at both rear and lay and that feather pecking increased with an increasing number of diet changes during rear.

Hemsworth, P. H. (2009). Impact of human-animal interactions on the health, productivity and welfare of farm animals. Wageningen, Wageningen Academic Publishers.

While technical skills and knowledge are important attributes of the work performance of stockpeople, two other important but less well recognised characteristics of stockpeople are their attitude and behaviour towards farm animals. Research has shown that the attitude of the stockperson, by affecting the stockperson's behaviour, can affect animal fear and stress and in turn animal productivity, health and welfare. While fear thresholds have been reduced by domestication, fear responses to humans have not been eliminated in farm animals. Indeed there is considerable variation within farm animal species in their fear responses to humans and this variation highlights both limitations to animal productivity, health and welfare and the opportunities to reduce these limitations in the livestock industries. This chapter examines the impact of human-animal interactions on farm animals and discusses the opportunities to improve human-animal interactions to improve animal health, productivity and welfare. The chapter concludes that there is a strong case for utilizing stockperson training courses that target stockperson attitudes and behaviour.

Lambton, S. L., et al. (2015). "The risk factors affecting the development of vent pecking and cannibalism in free-range and organic laying hens." Animal Welfare. 24.

Injurious pecking remains one of the biggest animal welfare and economic challenges for free-range egg producers. This prospective epidemiological study investigated the development of vent pecking (VP) and cannibalism on 62 free-range and organic UK farms (119 flocks). Flocks were visited at 25 (± 5) and 40 (± 5) weeks of age. Rates of VP were recorded and farmers were asked whether they had observed cannibalism in their flocks. Environmental and management data were collected for each flock. Risk factors associated with these behaviours were modelled using MLwiN. VP was observed in 19.5 and 29.9% of flocks, at mean rates of 0.35 and 0.21 bouts per bird per h, at 25 and 40 weeks, respectively. Cannibalism was reported at 22.6% of visits. The odds of flocks showing VP or cannibalism increased with rate of severe feather pecking (SFP). VP was more likely to be observed in laying houses with more and/or longer pop holes and where feed was scattered on the floor. Providing more aerial perch length, or perches > 0.5 m in height, was associated with increased risk of VP. When SFP was excluded from the model, likelihood of VP was higher in flocks fed pelleted feed. All of these may provide a useful basis from which to derive management strategies to reduce the risk of VP and thus improve the welfare of laying hens. However, it is important to remember that this study does not elucidate the causal relationships between these variables, and further work is needed to understand the mechanism behind these associations.

Mahboub, H. D. H., et al. (2004). "Outdoor use, tonic immobility, heterophil/lymphocyte ratio and feather condition in free-range laying hens of different genotype." British Poultry Science **45**(6): 738-744.

Movement (frequency of changes) between inside and outside housing areas, time spent in each area, tonic immobility (TI) and differential blood cell counts were studied in relation to feather condition in laying hens of two genotypes, white (LSL) and brown (LT). From 18 weeks of age, LSL and LT were kept in 4 groups of 50 birds in a poultry house with passages to a roofed scratching room and a grassland area with a stocking density of one bird/10 m². All birds had transponders to record the movements of each hen between inside and outside areas and the time spent in each area during 24 h. Feather scoring was carried out at 6 ages from 20 to 48 weeks. At 44 weeks of age, TI reactions of 40 hens (20 from each genotype) were quantified and blood smears from 20 hens (10 from each genotype) were analysed for differential leukocyte counts. LSL hens moved more frequently to outdoor areas than LT hens (44.66 vs 28.78 least square/d). However, the proportion of time spent on grassland was greater in LT than in LSL hens, whereas time (%) spent by LT hens in the roofed scratching area was less than for LSl hens. In LT hens TI was shorter while heterophil/lymphocyte ratio and basophilia were greater than in LSL hens. Total body feather score was poorer in LSL than in LT hens. Incidence of footpad inflammation was higher in LSL than LT hens. There was a positive association between TI and footpad inflammation. The percentage of time spent on grassland and feather damage were inversely correlated. More movement between the areas, as in LSL hens, was positively associated with fearfulness, whereas long periods on grassland, as in LT hens, were associated with indicators of increased stress. The negative correlation between feather damage and time spent outside suggests that feather pecking risk decreases in birds attracted to grassland.

Meyer, B., et al. (2012). "Feather ingestion affects intestinal microbiota and microbial metabolites in growing leghorn-type chickens." Poultry Science **91**(7): 1506-1513.

Feather pecking in laying hens is a serious behavioral problem that is often associated with feather eating. The intake of feathers may influence the gut microbiota and its metabolism. The aim of this study was to determine the effect of 2 different diets, with or without 5% ground feathers, on the gut microbiota and the resulting microbial fermentation products and to identify keratin-degrading bacteria in chicken digesta. One-day-old Lohmann-Selected Leghorn chicks were divided into 3 feeding groups: group A (control), B (5% ground feathers in the diet), and C, in which the control diet was fed until wk 12 and then switched to the 5% feather diet to study the effect of time of first feather ingestion. The gut microbiota was analyzed by cultivation and denaturing gradient gel electrophoresis of ileum and cecum digesta. Short-chain fatty acids, ammonia, and lactate concentrations were measured as microbial metabolites. The concentration of keratinolytic bacteria increased after feather ingestion in the ileum ($P < 0.001$) and cecum ($P = 0.033$). Bacterial species that hydrolyzed keratin were identified as Enterococcus faecium, Lactobacillus crispatus, Lactobacillus reuteri-like species (97% sequence homology), and Lactobacillus salivarius-like species (97% sequence homology). Molecular analysis of cecal DNA extracts showed that the feather diet lowered the bacterial diversity indicated by a reduced richness ($P < 0.001$) and shannon ($P = 0.012$) index. The pattern of microbial metabolites indicated some changes, especially in the cecum. This study showed that feather intake induced an adaptation of the intestinal microbiota in chickens. It remains unclear to what extent the changed metabolism of the microbiota reflects the feather intake and could have an effect on the behavior of the hens.

Meyer, B., et al. (2013). "Differences in intestinal microbial metabolites in laying hens with high and low levels of repetitive feather-pecking behavior." Physiology & Behavior **110–111**: 96-101.

Abstract Feather pecking in laying hens is a serious behavioral problem and is often associated with feather eating. There is some evidence that ingested feathers affect gut function. The aim of the present study was to explore whether differences in intestinal microbial metabolites in laying hens with high and low levels of repetitive feather-pecking behavior exist. Sixty high feather-pecking birds (H) and sixty low feather-pecking birds (L) of the White Leghorn breed were used for behavioral recordings of feather pecking. Feather pecking activity was observed for 5 weeks, after which 22 H birds with the highest and 22 L birds with the lowest feather pecking activity were chosen. The number of whole feathers and feather parts in the gizzard and intestinal microbial metabolites in the ileum and ceca of these laying hens was examined. Biogenic amines, short-chain fatty acids, ammonia and lactate were measured as microbial metabolites. A higher number of feather parts and particles were found in H than in L birds. Putrescine and cadaverine concentrations were higher in the ileum of the hens with low pecking activity ($P < 0.001$ and $P = 0.012$). In the cecum the amounts of l-lactate, d-lactate and total lactate and SCFA were higher in H birds ($P = 0.007$, $P = 0.005$, $P = 0.006$, and $P < 0.001$). Acetate, i-butyrate, i-valeriate and n-valeriate all displayed significantly higher molar ratios in the cecal contents of L birds ($P = 0.001$, $P = 0.003$, $P = 0.001$, and $P < 0.001$). Propionate and n-butyrate showed higher molar ratios in H birds ($P < 0.001$ and $P = 0.034$). Ammonia was higher in the ileum and cecum of the L birds ($P < 0.001$ and $P = 0.004$). For the first time, this study shows that birds with high and low numbers of repetitive pecking movements to the plumage of other birds differ in their intestinal microbial metabolism. Further experiments should be conducted to investigate whether these differences alter behavior in H and L feather pecking birds. The present results, however, open new avenues of research into implications of gut bacteria, their metabolites and the polyamine system on brain and behavior in laying hens.

Mielenz, N., et al. (2010). "Analysis of ordered categorical data with threshold models exemplified by plumage damage scores from laying hens differing in their genotype and rearing environment." Poultry Science **89**(11): 2521-2534.

Plumage damage scores (PDS) were assessed in laying hens of 2 genotypes (Lohmann Tradition and Lohmann Silver) at the 45th and 70th weeks of age, with scores ranging from zero (no damage) to 6 (completely denuded). This ordinally scaled categorical characteristic was recorded from different body regions of 365 hens that had experienced different housing environments (2 enrichment levels) during their rearing and laying periods. The so-called threshold model is an option for analyzing repeated ordered categorical data from individual animals. This model represents a generalized linear mixed model if the linear predictor additionally includes the animal as a random effect. This paper is intended to fill the gap between the theoretical aspects of generalized linear mixed models and their practical application in animal science. A cumulative probit model was adapted for analyzing plumage damage. The variation among birds was considered as a random effect for the analysis of cumulative probabilities. The numerical implementation of the methodology was done based on the NLMIXED procedure of the SAS statistical program. A threshold model with inhomogeneous residual variances for the latent variable was used because less plumage damages were observed up to the 45th week of age compared to the 70th week of age. Differences in PDS were evident between genotypes, age, and enrichment levels during housing periods. However, neither of the 2 enriched environments proved consistent superiority or inferiority across all traits. Major plumage damage (PDS larger than or equal to 5) was observed for the breast region in 56.6% of all birds with the Lohmann Tradition genotype and in 34.4% with the Lohmann Silver genotype when we look at the mean over all treatments. The most severe plumage damage was observed at the 70th week of age for the traits breast and housing environment without additional enrichment.

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.

Mul, M. and C. M. Koenraadt (2009). "Preventing introduction and spread of Dermanyssus gallinae in poultry facilities using the HACCP method." Experimental and Applied Acarology **48**(1-2): 167-181.

MUL, M., et al. (2009). "Control methods for Dermanyssus gallinae in systems for laying hens: results of an international seminar." World's poultry science journal **65**(04): 589-600.

Parmentier, H. K., et al. (2009). "Does enhancement of specific immune responses predispose laying hens for feather pecking?" Poultry Science **88**(3): 536-542.

To mimic airborne immune challenges, layer hens were intratracheally and concurrently challenged with various doses of the protein antigen human serum albumin (HuSA) and the pathogen-associated molecular pattern lipopolysaccharide (LPS) at 7 and 13 wk of age. All groups received 1 similar dose of HuSA plus LPS at 11 mo of age. Evaluation of plumage and body condition at 12 mo of age revealed that birds that had undergone intratracheal immunization with a high dosage of HuSA, irrespective of the concurrent dose of LPS, had significantly more feather damage but less wounds to the vent region, as opposed to birds not receiving HuSA. On the other hand, a high dosage of LPS was related to comb damage. These results suggest that stimulation of specific (humoral) immune responses (to HuSA) rather than innate responses (to LPS) at a young age may predispose layers for feather pecking (FP) behavior at later ages. Involvement of immune mechanisms in FP or vent damage may differ. Predisposal for FP behavior by specific immunity can have consequences for health and vaccine management.

Prieto, M. T., et al. (2008). "Association between vent pecking and fluctuating asymmetry in hens." Itea-Informacion Tecnica Economica Agraria **104**(2): 180-185.

The purpose of the present study was to analyze the relationship between incidence of vent pecking, fluctuating asymmetry in chickens. The experiment (140 birds in three different replicates) measured the fluctuating asymmetry of several traits (middle toe length, leg length, wing length, wattle length, and leg width) in 20-week-old pullets of five Spanish breeds of chickens (Blue Andaluza, Quail Castellana, White-faced Spanish, Red-barred Vasca, and Birchen Leonesa), and a White Leghorn population, with and without evidence of suffering from vent pecking. The number of birds per breed was 20, 24, 12, 20, 18, and 46, respectively. There was a significant difference between vent pecked and non-vent pecked birds on the relative fluctuating asymmetry of middle toe length ($P<0.05$), the relative fluctuating asymmetry of birds who suffered from vent pecking being larger. The combined relative fluctuating asymmetry of the five traits approached levels of statistical significance ($P=0.08$). Thus, vent pecked birds were more asymmetrical than non-vent pecked birds, having increased relative fluctuating asymmetry. Differences were consistent across the breeds. Results indicate that vent pecking is associated with measures of stress like fluctuating asymmetry.

Rodenburg, T. B., et al. (2010b). "Fearfulness and feather damage in laying hens divergently selected for high and low feather pecking." Applied Animal Behaviour Science **128**(1/4): 91-96.

Feather pecking (FP) remains a major welfare and economic problem in laying hens. FP has been found to be related to other behavioural characteristics, such as fearfulness. There are indications that fearful birds are more likely to develop FP. Furthermore, FP can lead to increased fearfulness in the victims. To investigate further the relationship between FP and fearfulness, feather damage and behavioural fear responses were recorded in three White Leghorn lines of laying hens: a line selected for high FP (HFP line), a line selected for low FP (LFP line) and an unselected control line (10th generation of selection). We used 64 birds per line housed in 16 four-bird cages (cage was the experimental unit). At 25 weeks of age, birds were subjected to a tonic immobility (TI) test and a combined human approach (HA) and novel object (NO) test, and plumage condition was recorded. Line differences in fear responses between the HFP and LFP lines were not found, neither in the TI-test, nor in the HA or NO test. As expected, birds from the HFP line had considerably more feather damage than birds from the LFP line and birds from the unselected control line were intermediate. Cages that withdrew from the NO 30 s after placement had more feather damage on the back compared with cages that did not show a withdrawal response. These results suggest that although relationships were found between feather damage and fear response at cage level, lines divergently selected on feather

pecking behaviour do not differ in their fear responses. Divergent selection on feather pecking may have altered pecking motivation rather than fearfulness.

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.

Sedlackova, M., et al. (2004). "Feather pecking in laying hens: Environmental and endogenous factors." Acta Veterinaria Brno **73**(4): 521-531.

Feather pecking, pecking directed to and damaging the feathers of other birds, is a behavioural disorder occurring in laying hens and other poultry species and breeds. Feather pecking is both a welfare and economic problem. Pulling out feathers causes pain, a higher risk of injuries and can trigger an outbreak of cannibalism. Extensive loss of feather cover is accompanied by increased heat loss that results in increased food consumption. The 1999 EU Directive laying down minimum standards for the protection of laying hens approved banning of conventional battery cages from 2012. Thus in the next few years major changes to the housing of laying hens in Europe will occur. Therefore there is an urgent need to develop feasible alternative housing systems-An increased risk of feather pecking is a main obstruction to the wide adoption of alternative housing systems, such as free range, aviaries or percheries. There is a continuous effort of many research teams in Europe and elsewhere to expand our knowledge of this behavioural disturbance and maximize the chances to solve the problem. In this review we have attempted to summarise the present status of knowledge about feather pecking. Hypotheses on causation (redirected ground pecking or dustbathing), environmental factors (feeding, lighting, housing. group size, density) and endogenous factors (sex. age. genetic factors, physiological control mechanisms) are discussed and possible ways of prevention via changing environment, management practices or genetic selection are pointed out.