Final Report

Project code: 22-404

Prepared by: Dr Peta Taylor

Date: June 2024

Why do meat chicken breeders feather lick? Reducing abnormal behaviours through effective enrichment

22-404

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Researcher Contact Details

Name: Dr Peta Taylor
Organisation: The University of Melbourne
Phone: +61 8344 9102
Email: peta.taylor@unimelb.edu.au
Website: https://findanexpert.unimelb.edu.au/profile/677558-peta-taylor

In submitting this report, the researcher has agreed to Poultry Hub Australia publishing this material in an edited form.

Poultry Hub Australia Contact Details

Poultry Hub Australia
CJ Hawkins Homestead, Ring Road
University of New England
Armidale NSW 2350
02 6773 1855
poultryhub@une.edu.au
www.poultryhub.org

Project Summary

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Project Title	Why do chickens feather lick? Reducing abnormal behaviours through effective enrichment
Project No.	22-404
Date	Start: 01/01/2023 End: 01/07/2024
Project Leader(s)	Peta Taylor and Carolyn DeKoning
Organisation	The University of Melbourne, SARDI
Email	peta.taylor@unimelb.edu.au
Project Aim	1. Understand the challenges and limitations of providing specific enrichment for meat chicken breeders in Australian commercial conditions. 2. Understand feather licking in commercial conditions, including potential risk factors and develop an ethogram of the behaviour
Background	Breeding chickens in the meat chicken industry can display abnormal behaviours (Riber et al. 2017). The expression of such abnormal behaviours has been associated with stress, reduced welfare states and poor performance (Broom 2007). Feather licking (sucking) is a term utilised by the Australian poultry industry to describe a behaviour expressed by meat chicken-breeding hens and roosters. However, it is rarely mentioned in scientific literature. The primary concern is that feather licking is a precursor to severe feather pecking cannibalism and/or feather damage, leading to a greater risk of injury during mating. This project aimed to understand feather licking behaviour and examine how environmental enrichment could reduce the development of this behaviour or redirect it away from conspecifics.
Research Outcome	Many feather-directed behaviours (FDB) were discussed with industry experts, however, often without specificity (i.e. grouping behaviours). FDB likely have varying causation and impacts on welfare. As such, grouping these behaviours during discussions and in research can lead to confusion. Observations of behaviour on commercial farms showed that feather licking was an infrequent, gentle behaviour that targets various areas of the body. It was more common in production. Repetitive gentle feather pecking was synonymous with descriptions of stereotypic gentle feather pecking in the literature and with descriptions of 'feather licking' or 'feather sucking' during the industry survey. This behaviour was frequently observed on one rearing farm in the cockerel flock, and was repetitive and appeared to be non-functional. Environmental enrichment (EE) should target cockerel flocks, to redirect FBD towards objects, and minimise the spread of damaging FDB which may start with repetitive gentle feather licking.
Impacts and Outcomes	Recommendations for meat chicken breeder EE programs to target feather licking behaviour based on the aetiology of the behaviour and industry perspectives.

Publications	Taylor, P. S., Hemsworth, P. H., Morgan, N., & DeKoning, C. (2024). Research note: Expert opinions of feather sucking and licking behaviour in meat chicken breeder birds. *Poultry Science*, 103692.

Executive Summary

Feather licking (and sucking) is a term utilised by the Australian poultry industry to describe a behaviour expressed by meat chicken-breeding hens and roosters. However, it is rarely mentioned in the scientific literature. The primary concern is that feather licking is a precursor to severe feather pecking cannibalism and feather damage, leading to a greater risk of injury during mating. This project aimed to understand feather licking behaviour and how environmental enrichment could reduce the development of this behaviour or redirect it away from conspecifics. This project had two components: a survey of experts and on-farm behavioural observations.

We surveyed 17 industry experts to identify knowledge gaps and misconceptions, and generate hypotheses regarding feather licking behaviour, including possible outcomes for bird welfare, and potential interventions to disrupt or prevent the expression of feather licking. All the survey participants, except one, had seen feather sucking/licking behaviour (94.1%), and most suggested that the behaviour occurs most frequently during rearing. Participants presented varying concerns about this behaviour, ranging from the perspective that it was 'normal' to concerns about mating injuries due to damaged feathers, increased risk of feather pecking and cannibalism, and stress indicated by the expression of repetitive (seemingly) functionless behaviours. 'Feather licking', 'feather sucking', 'feather eating' and 'feather pecking' were terms used interchangeably, leading to confusion by participants about the cause and implications of the target behaviour. The most common factors reported as the cause were boredom (52.9%), nutritional deficiencies (47.1%) and feed restriction (41.2%), and more than 80% of respondents agreed that stress contributes towards feather sucking.

Behavioural observations of commercial meat chicken breeders were conducted via video recordings from four farms across the production cycle. Weekly scan sampling observations focused on feather-directed behaviours (FDB). Continuous focal sampling monitored behaviour in more detail and provided improved ethogram descriptions for some FDB. Numerous FDBs were identified and were found to differ between flocks, bird ages and time of day. Feather eating, feather pecking, and feather licking were distinct behaviours observed. However, we identified two forms of feather licking: 'gentle feather licking' was defined as gently combing a feather of another bird in a slow sweeping motion, keeping the feather in the mouth for 1–4 seconds before releasing; and 'repetitive gentle feather licking' was defined as gripping a feather (its own or a conspecific's) in its beak for one second before releasing and repeating the action, forming a sequence of rapid, consistent pecks. These behaviours were often directed at the tip of the tail feathers, and conspecifics did not move away from the initiator. In both cases of feather licking, the feather was not removed or eaten.

Although industry experts often discussed feather licking synonymously with feather eating, and feather pecking (severe and gentle), these behaviours were distinct in commercial flocks. Each of these behaviours likely has varying aetiologies (i.e. nutritional deficiency or stress) but may lead to similar outcomes on the flock (i.e. cannibalism). Epidemiological approaches are required to better understand the risk factors associated with an outbreak of each of the behaviours, and a good understanding of the distinction between each behaviour is required.

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Part 1 Expert opinions of feather sucking and licking and the potential for environmental enrichment to reduce the behaviour in meat chicken breeder birds

P. S. Taylor, P.H. Hemsworth, N. Morgan, and C. DeKoning

These results have been partially published in Poultry Science (Taylor et al. 2024) with a focus on feather licking behaviour in meat chicken breeders. However, we report the broader findings and include discussions on effective environmental enrichment.

Introduction

Feather sucking is a term utilised by the Australian poultry industry to describe a behaviour expressed by meat chicken breeding hens and roosters. However, it is rarely mentioned in scientific literature. Another term that is used, albeit still infrequently, is the term 'feather licking' (Leeson and Walsh 2004). The scientific literature does not provide a clear and detailed description of feather licking or feather sucking. Nevertheless, conversations with industry representatives in Australia indicate that feather sucking is relatively prevalent among commercial flocks of meat chicken breeders, with producers expressing varying levels of concerns – for example, the concern that feather licking is a precursor to severe feather pecking and cannibalism and/or damages feathers leading to greater risk of injury during mating. Although 'feather licking' is a more appropriate terminology, due to the chickens' anatomy (i.e. the presence of a choanal split means chickens cannot suck (Heidweiller et al. 1992), the term feather sucking is used throughout this manuscript to reflect the terminology used in the Australian poultry industry and during the project interviews.

Feather sucking is absent in growing meat chickens and, to the best of our knowledge, laying hen flocks. Feather sucking could be considered an abnormal behaviour as Mason (1991) defines abnormal behaviours as either statistically rare behaviours, behaviours that are different from other populations, behaviours that lack function, or a behaviour that causes harm to the animal. The expression of such abnormal behaviours may help animals cope with an inadequate environment or could be caused by dysfunction (i.e. of the nervous system), or maybe maladaptive behaviours (i.e. normal adaptive responses that occur inappropriately) (Mason 1991). If the feather sucking behaviour permits animals to cope with an inadequate environment, then restricting the expression of such behaviour through, say, environmental enrichment should not be considered, and reducing the underlying motivation would be a higher priority. However, if improvements to the environment are not feasible for various reasons (e.g. providing *ad libitum* food to meat chicken breeders), then redirecting the behaviour may be required, particularly if there are negative consequences for the conspecific that has its feathers sucked (e.g. damaged feathers). As such, there is a necessity to understand the causation and effects of feather sucking in meat chicken breeding flocks.

Intervention programs to disrupt the expression of this behaviour may include the provision of various Environmental Enrichments (EE). However, very little is known about the effectiveness of EE programs for meat chicken breeders – see Riber et al. (2017). Additionally, even for species where there has been extensive scientific investigation into effective EE programs, very few enrichment items outlined in the scientific literature as effective have been adopted in the livestock industries, including meat chickens – see Taylor et al. (2023). This indicates a disconnect between industry and the scientific communities. Understanding the practicalities and limitations of providing specific EE items to meat chicken breeders is required before scientific assessments are conducted. Understanding the

commercial limitations will permit such development of EE tools that can be tested and utilised on commercial farms.

In preparation for future experiments concerning feather sucking, we interviewed industry experts. Few participants were surveyed, due to the small number of people working across the meat chicken breeder industry and our focus on Australian commercial conditions.

Objectives

We aimed to identify knowledge gaps and misconceptions, and generate hypotheses regarding feather licking behaviour, the possible outcomes for bird welfare, and potential interventions to disrupt the expression of feather licking behaviour.

Methodology

All research generated from this study was approved by the University of Melbourne's Human Ethics Review Committee (2022-25630-35696-3).

Industry survey

An industry survey was designed to understand feather sucking, environmental enrichment (EE) to reduce feather sucking, and the practicalities of providing EE to meat chicken breeders. The survey was based on a scientific review of the literature and informal preliminary discussions with local industry representatives.

Experts in the field of meat chicken breeders were targeted, including consultants, managers, and veterinary and welfare specialists from the major meat chicken integrators in Australia. Additionally, poultry researchers (national and international) with a focus on meat chicken breeder welfare, enrichment or abnormal behaviours were identified through a Google search, Google scholar search, and through conversations with industry representatives. An expert was defined as an individual that had worked with meat chicken breeders for more than three years.

A total of 16 international and 20 domestic industry experts were contacted and requested to complete an online survey. Of the 36 potential participants, we recruited 18 people (n = 5 international participants; n = 13 local participants). Two respondents joined the meeting together with the interviewer and as their answers may have been affected by the other person in the meeting we pooled their responses together and reported a sample size of 17 responses.

The survey took between 60 and 90 minutes to complete and included four sections: i) demographics; ii) feather sucking; iii) enrichment to reduce feather sucking; and iv) practicality of providing EE to meat chicken breeders (see Appendix 1 for all survey questions). The survey interviews were conducted over 6 weeks, and all were completed through an online virtual meeting platform except for one, which was conducted independently online through Qualtrics XM (Provo, UT, USA).

Data were compiled into an Excel spreadsheet and descriptive statistics are reported.

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'will permit the development of EE tools …'

Commented [WW3]: Note 2: The next sentence in the original has been deleted, as it duplicates the following para under Objectives.

Commented [WW4]: Note 3: Heading hierarchy: 'Industry survey' is nested under Methodology; 'Demographics' is nested under Results.

This mirrors the Table of Contents structure.

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Results

Demographics

Most of the respondents were males, over 46 years of age, and worked for an Australian chicken meat integrator (n = 3 organisation 1; n = 2 organisation 2, n = 2 organisation 3; Table 1). Most respondents (41.2%, n = 7) had worked with meat chicken breeders for 5–10 years and more than 20–30 years with poultry overall (35.3%, n = 6; Table 1). There were 41.2% (n = 7) academics, and 29.4% (n = 5) general managers/directors interviewed, and 17.6% (n = 3) respondents had the word 'welfare' in their job title (Table 1).

Table 1 Demographics of survey participants

Demographic	Frequency	Percent (%)
Sex		
Female	5	29.4
Male	12	70.6
Age		
18–25	0	0
26–35	2	11.8
36–45	2	11.8
46–55	6	35.3
56–65	6	35.3
66 +	1	5.9
Experience with poultry		
3–5 years	1	5.9
5–19 years	5	29.4
20–30 years	6	35.3
30 + years	3	17.6
Experience with breeders specifically		
3–5 years	1	5.9
5–10 years	7	41.2
11–20 years	3	17.6
21–30 years	3	17.6
30 + years	3	17.6
Position/title		
General manager/director	5	29.4
The term 'welfare' was in position title	3	17.6
Service person	1	5.9
Manager of breeding stock	2	11.8
Livestock manager	2	11.8
Veterinarian	1	5.9
Academic	7	41.2
Organisation		
Australian chicken integrator	7	41.2
Breeding company	2	11.8
Consultancy	3	17.6
University	6	35.3
Animal welfare organisation	1	5.9
Location		
Australia	12	70.6
Outside of Australia	5	29.4

Descriptions of feather sucking behaviour

Almost all the participants had observed feather sucking (n = 17, 94.1%). Most participants indicated that feather sucking occurs in a few flocks (53.5% of respondents) or most flocks (33.3% of respondents), with few respondents indicating that it occurs in all flocks (6.7%). Of note, the definition of 'few' or 'most' flocks was ambiguous and relied on the interpretation of the respondents. Terms used to describe feather sucking included picking, playing, sucking, licking, biting, sliding, touching, stroking, nibbling, chewing, and allosucking. However, two participants (11.8%) mentioned that feather sucking is an erroneous term as "*Birds have a cleft pallet so they can't suck*". When participants were asked "*What is feather sucking*?", the most common themes mentioned were 'diet, food restriction or hunger' and the location where feather sucking occurs was 'tail' (Figure 1).

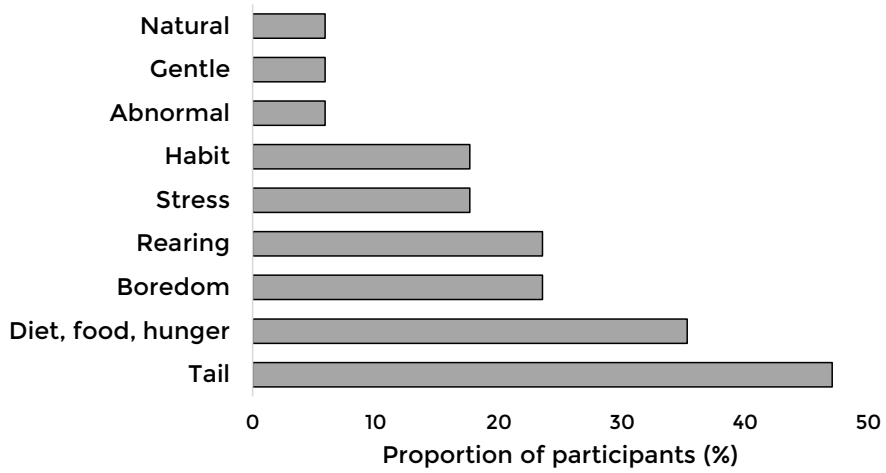


Figure 1 Proportion of participants that mentioned various themes when asked "what is feather sucking?"

Most participants referred to sucking on a conspecific and few participants mentioned birds sucking of their own feathers, *"not always one-to-one, there can be groups of feather sucking or all in a row"*. Some participants used analogies that referred to the behaviour as a coping mechanism for specific stressors including, "*It's the same as children that suck their thumb, once the stress has gone, they will keep doing it until they grow out of it"*. Two respondents (from outside of Australia) noted that feather sucking was related to the speed of growth of the birds/strain, *"[I] have never seen in the slow-growing strains, only in the faster-growing strains"* and *"[I] see more in the faster-growing hybrids than the slow".* Nearly half of the participants differentiated feather pecking and feather sucking (n = 7, 41.2%). For example, "*Stroking and nibbling the feathers of another bird … not pecking or pulling, something different but it does lead to feather damage"* and *"One bird has the feather of another bird within its beak from bottom to the top, it's hard to differentiate feather sucking, feather licking and gentle feather pecking, but the result is that the feathers look wet".* However, 23.5% of participants (n = 4) did not differentiate between these behaviours, defining feather sucking as sucking, pecking or eating feathers. When asked if there are varying forms of feather sucking, 57.1% (n = 8) of participants agreed that there were different forms, and 42.9% (n = 6) reported that there is only one form of feather sucking. The most common themes mentioned about the forms of feather sucking were 'gentle' and

'aggression' (Figure 2). Nearly one-third of respondents (29.4%, n = 5) reported that they had not observed any other abnormal behaviours in meat chicken breeders. The other 70.6% of participants reported other abnormal behaviours, including stereotypic pecking (58.3%, n = 7), cannibalism (23.5%, n = 4), panic smothering or piling (11.8%, n = 2), and head flicking, eating abnormal items (plastic, wood shavings), pacing, mating with a dead chicken or pecking at the air (each mentioned by one participant only).

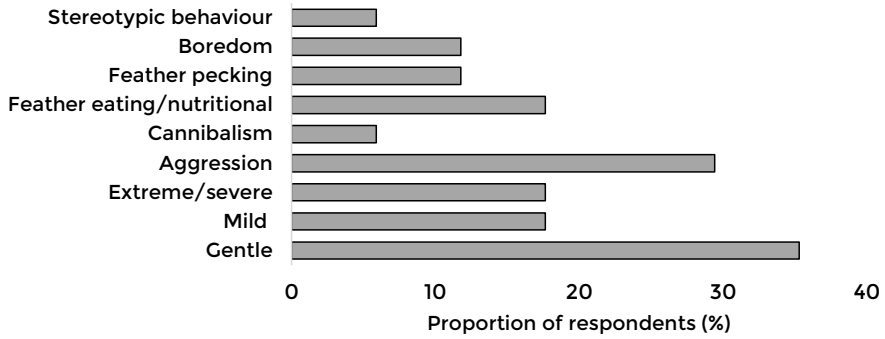


Figure 2 The proportion of respondents that mentioned specific themes when asked if there were various forms of feather sucking

More than half of the participants (60%, n = 9) indicated that feather sucking differed between sexes, 33.3% (n = 5) were unsure ('maybe'), and one respondent indicated that there was no effect of sex on feather sucking behaviour (6.7%, n = 1). Most respondents felt that females were more likely to feather suck than males, *"More feather sucking in male lines than female lines but females, of all lines, tend to be more persistent in doing it [feather sucking]".* Some respondents indicated that the sex differences were reflective of aggressive male competitive behaviours, *"Males will pick but not suck"* and "*Males are more likely to fight than suck".* Other respondents related the differences in sex to the level of feed restriction, *"Don't seem to see it in males, but they get a lot more feed in the first four weeks than females do".* Importantly, opinions regarding sex differences may reflect a bias due to the higher female-to-male ratio in production flocks. Most participants reported that feather sucking occurs more frequently in rearing (80.0%, n = 12), a few suggested it is observed equally in rearing and production (13.3%, n = 2), and one participant indicated that it is more frequent during the production phase (6.7%, n = 1). Respondents suggested that feather sucking starts between 6 and 8 weeks of age (n = 2) or 10 and 16 weeks of age (n = 5) and follows specific events such as the implementation of feed restrictions (n = 5), vaccinations and handling (n = 1), after transfer from rearing to production sheds (n = 1), or when they are bored (n = 1).

When respondents were not given any prompts (i.e. open-ended questions), the most common reasons provided for why meat chicken breeders feather suck were 'boredom', 'nutritional deficiencies' and 'feed restriction' (Figure 3).

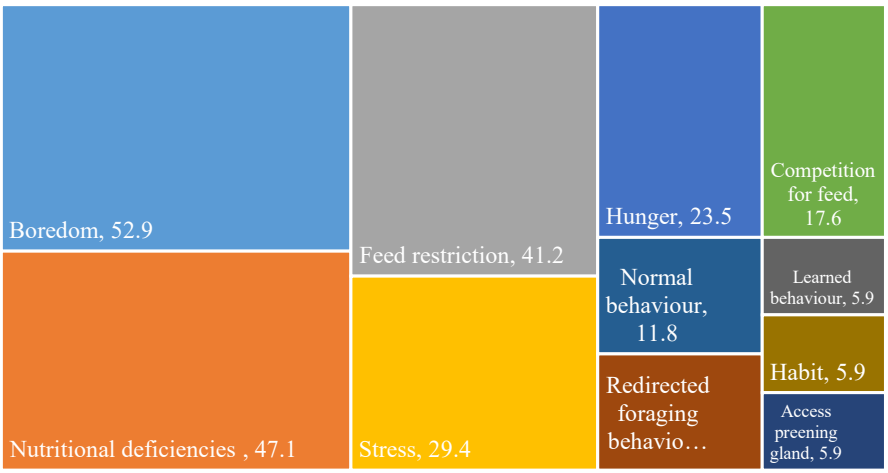


Figure 3 Perceived causes of feather sucking and the proportion of participants that named each cause

When respondents were provided with a list of factors, a high proportion of respondents ranked 'hunger', 'stress', 'boredom' and 'nutritional deficiency' as the cause, or factors that contribute to, feather sucking (Figure 4). 'Nutritional deficiencies' was the only factor where respondents answered either *yes* or *no*, all other factors had a least one *maybe* response (Figure 4).

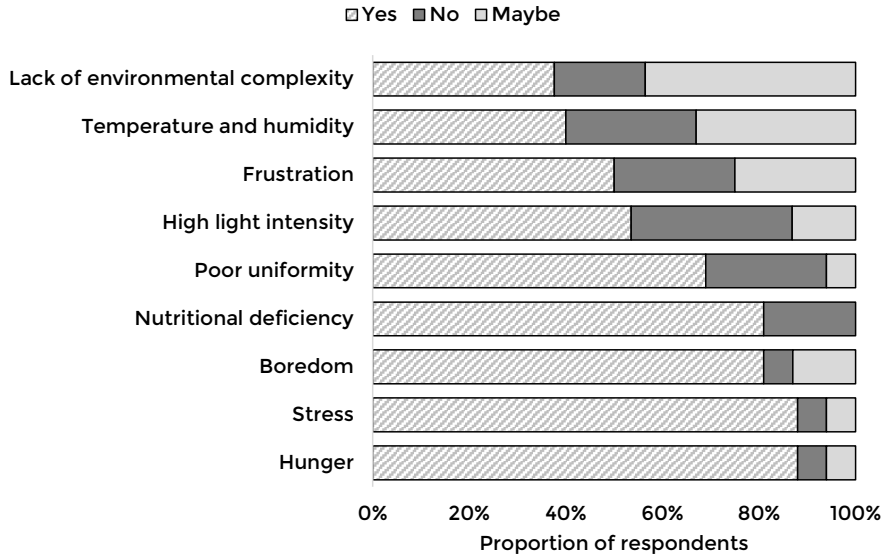


Figure 4 The proportion of respondents that thought various factors did (yes, grey striped proportion of bars), did not (no, dark grey solid proportion of bars) or might (maybe, light grey solid proportion of bar) cause or contribute to feather sucking

Respondents indicated that feather sucking is associated with stress. Most respondents differentiated between acute and chronic stress but were not always in agreement about the relationship between each and feather sucking. For example, when asked if feather sucking was associated with stress, one participant responded, “Yes, chronic stress”, whereas another suggested that an acute stressor will cause feather sucking, “One disruptive event can lead to this behaviour, don’t look at chronic stress, you’ll miss it [feather sucking]“ and “I think it’s like feather pecking, or tail biting in pigs, a single stressor can add to other stressors to get to a tipping point”.

We hypothesised that feather sucking is caused by stress and therefore asked respondents to comment on the most severe stressor: i) during rearing; ii) during production; and iii) throughout their whole life. Participants reported that ‘feed restriction’ was the most severe stressor during rearing (Figure 5). However, there was a lack of consensus between respondents on the most severe stressor during the production phase (Figure 5). ‘Over-mating, females hassled by roosters and mating ratio’ were named as the most common stressors during production, followed closely by ‘feed restriction/hunger’ and ‘mating aggression (male to female)’ (Figure 5). ‘Feed restriction’, ‘hunger’ and ‘feed competition’ were ranked as the biggest stressors for breeder chickens throughout their whole life by most of the respondents (Figure 6).

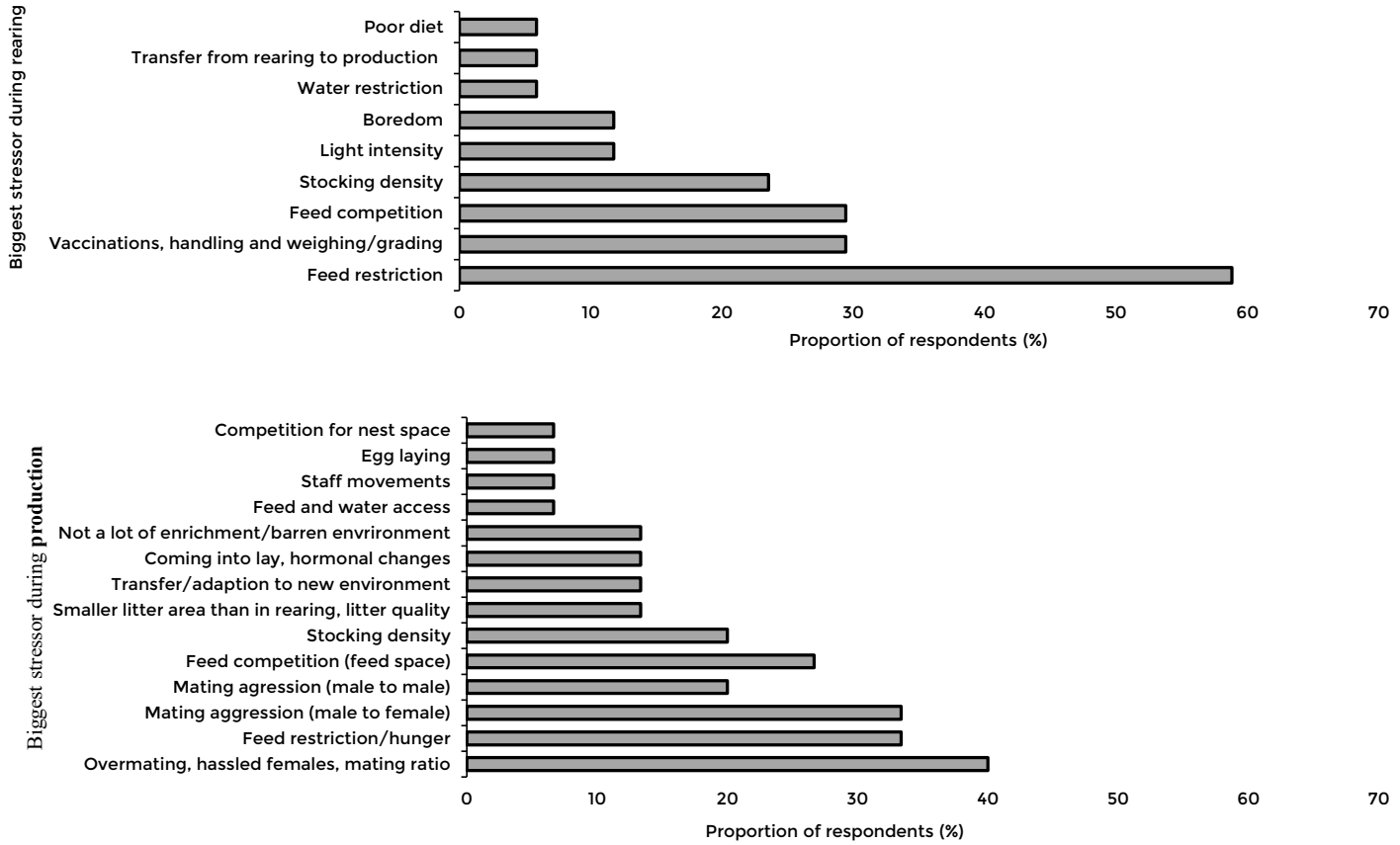


Figure 5 The proportion of respondents that named specific factors when they were asked "What is the biggest stressor during rearing (top) and production (bottom)?"

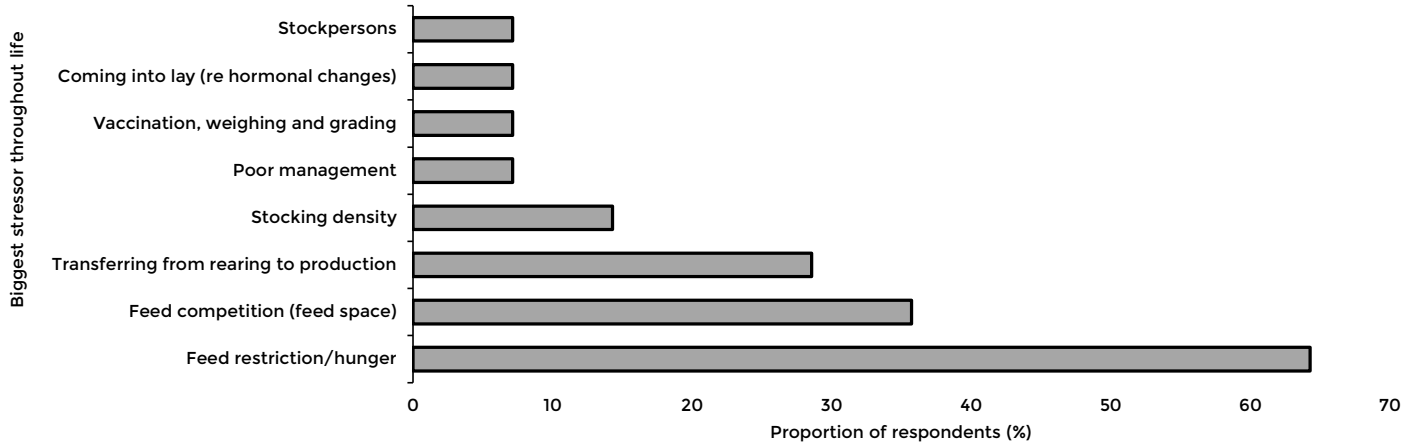


Figure 6 The proportion of respondents that named specific factors when they were asked "What is the biggest stressor for meat chicken breeders throughout their whole life?"

There were mixed responses from participants regarding the implications of feather sucking. These ranged from "It's a big issue for us in Australia ; "[feather sucking] leading to feather loss and damage … so it is a concern as it may jeopardise its ability to protect itself from mating"; "Of all of the things that are a problem for broiler breeders having your tail sucked is a problem that is small, but this is an abnormal behaviour [suggesting] that the environment isn't satisfying"; "I haven't thought of it as a problem"; and "it's not concerning … unless it moves into feather pecking … vent pecking and damage and cannibalism".

Preventing feather sucking

Commented [WW8]: **Note 4: Heading levels (1)**

In the original version, this heading and the next one further down on this page (Environmental enrichment for meat chicken breeders) were formatted as 'Normal text'.

As they actually function as sub-section headings, they have been formatted in this version as Level 4 headings. This means that, if you so wish, they could appear in the Table of Contents. Though the TOC can be left perfectly well as is, based on Levels 1-3 alone.

The TOC has exhibited some odd behaviour with page numbering during the review, so it might be best left alone.

Please also see Queries 16 & 22 below.

As shown in Table 2, there was also considerable variation in the responses from participants regarding the most effective methods to prevent feather sucking or interrupt feather sucking once it has started. Most respondents indicated that it was too difficult to interrupt the behaviour once it was seen in the flock and, importantly, one respondent asked "Why would you want to stop it? It's a symptom, what good does it do to stop the symptom? If you do that, you may make other things worse. Work against the cause and not the symptom".

Table 2 The proportion of respondents that proposed specific methods to prevent feather sucking

Proposed method to prevent feather sucking	**Proportion of respondents % (n)**
Reduce feed competition	31.3 (5)
Adequate nutrition	31.3 (5)
Optimal/adequate environment	25.0 (4)
Alter light intensity and/or colour of the light	18.8 (3)
Improve uniformity (the small ones look weak)	12.5 (2)
Slow emptying gut (whole grain or fibre)	12.5 (2)
Redirect their behaviour to foraging and exploration	12.5 (2)
Reduce hunger	6.2 (1)
Feed every day	6.3 (1)
Why would you want to stop it? It's a symptom, treat the cause and not the symptom	6.3 (1)
Reduce boredom, give them something to do	6.3 (1)
Reduce stocking density	6.3 (1)
Breed against behavioural traits	6.3 (1)
Improve mating ratio	6.3 (1)
The proposed method to interrupt feather sucking	
Alter light intensity and/or the colour of the light	57.1 (8)
Nothing, it's too difficult to stop once it has started	50.0 (7)
Optimise nutrition	28.6 (4)
Feed every day	14.3 (2)
Provide enrichment	14.3 (2)
Increase fibre content to keep feed in their system	7.1 (1)
Apply tar to tails	7.1 (1)

Environmental enrichment for meat chicken breeders

To understand participants' opinions on the potential for EE to reduce feather sucking behaviour, we asked participants about current practices, definitions of EE and possible limitations when providing breeder chickens with EE.

When asked to define EE, most participants referred to 'natural behaviour', although there were varied responses (Figure 7).

Figure 7 Word cloud showing the words mentioned by participants when asked to describe the term Environmental Enrichment – the size of the font reflects the proportion of respondents that mentioned the term, i.e. the bigger the word the more participants that mentioned the word

Perches were the most provided EE to commercial meat chicken breeders. However, perches were often only provided during rearing, with elevated slats perceived as perch-like structures that were provided during the production cycle (Figure 8). Pecking enrichments were commonly provided, such as pecking blocks, compact discs (CDs), litter, haybales and coloured chains (Figure 8). Although CDs were used by various organisations, one participant suggested that they provided little benefit to the birds and proposed that it may be related to either the item itself or the density required to have an overall effect on the flock, "*We have trialled CDs, the light reflects off them, but there is no benefit, such a big number of birds and a small number of CDs others might not see it".* Some respondents listed some items that could be considered standard housing items, rather than EE, such as feeders, drinkers, and nest boxes (Figure 8).

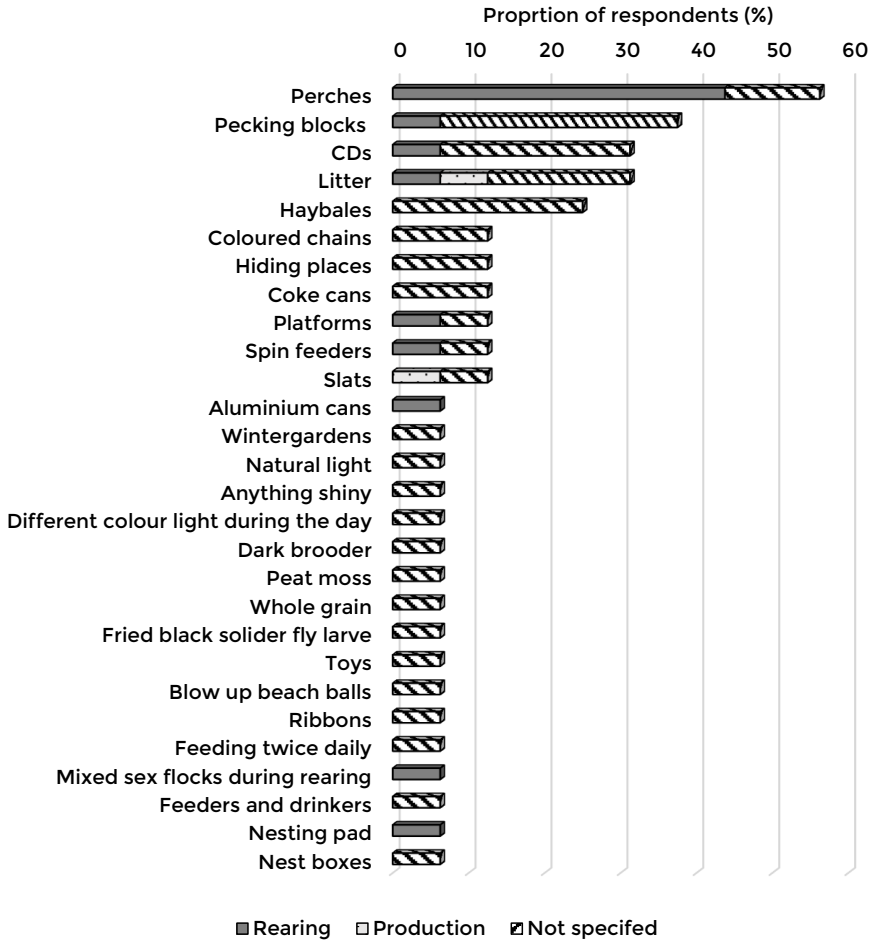


Figure 8 Environmental enrichments that are provided to meat chicken breeders throughout rearing (solid grey bars), production (purple dotted bars) and when the respondent did not specify in which part of the production cycle (white striped bars) that the enrichment was provided

Biosecurity risks were reported as the greatest barrier to providing EE to meat chicken breeders (Table 3). When respondents were asked if any other barriers had not been mentioned, OH&S (n = 1) and room in the shed (n = 1) were noted.

Table 3 The proportion (% (n)) of respondents that ranked each perceived barrier to providing environmental enrichment to meat chicken breeder birds from 1 (not at all a barrier) to 5 (major barrier).

	Ranked score				
	1	**2**	**3**	**4**	**5**
Increased biosecurity risk	12.5 (2)	6.3 (1)	6.3 (1)	25.0 (4)	50.0 (8)
Increased time needed to set up enrichments	15.4 (2)	30.8 (4)	7.7 (1)	30.8 (4)	15.4 (2)
Ability to source appropriate materials in the quantity required	7.7 (1)	38.5 (5)	7.7 (1)	46.2 (6)	0.0 (0)
Cost	21.4 (3)	28.6 (4)	14.3 (2)	14.3 (2)	21.4 (3)
Increased time needed to maintain enrichment	23.1 (3)	7.7 (1)	30.8 (4)	15.4 (2)	23.1 (3)
Enrichments become ineffective with time	20.0 (3)	0.0 (0)	53.3 (8)	13.3 (2)	13.3 (2)

Respondents reported no concern regarding the positioning of EEs in the rearing shed (16.7%, n = 2), with 16.7% (n = 2) stating 'anywhere' would be alright, but that it should be evenly distributed (33.3%, n = 4) and one respondent (8.3%, n = 1) suggested in the middle of the shed would be optimal. However, respondents voiced various concerns regarding the location of the EE in the production house, with concerns about the litter and nest box areas (Figure 9). Some respondents justified why the litter area should be avoided, "*If you attract birds [in production] down to the litter, the litter will go off" and "Males are patrolling the litter area, so females don't go there".*

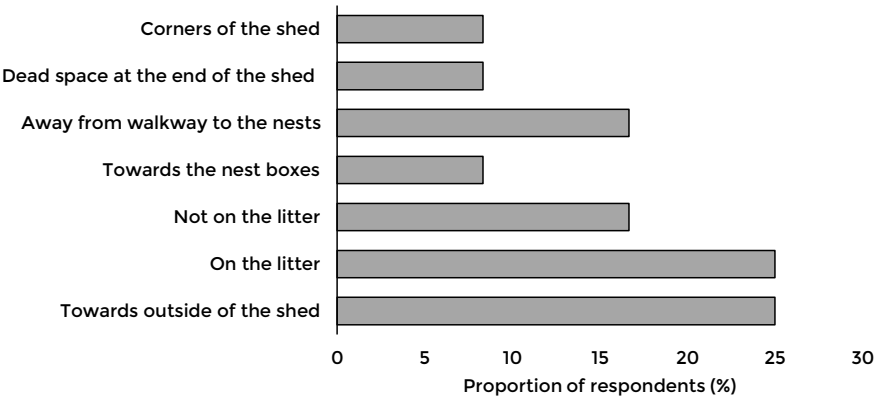


Figure 9 The proportion of respondents that suggested locations to provide environmental enrichment or locations to avoid during the meat chicken breeder production cycle

The perceived practicality and efficacy scores for each EE provides insight into which EE items should be the focus for future experiments, and which items require further consideration regarding design and implementation. No items were ranked as effective and practical to implement (Figure 10).

Haybales, scattered grain and wintergarden and outdoor ranges were perceived as effective, but were considered impractical for meat chicken breeders, due to the shed footprint required and biosecurity risks. Some items were considered very practical to implement, such as music, pecking chains and laser lights, but were perceived as unlikely to influence feather sucking (Figure 10). Overhead shade cloth, natural light and increased human contact were considered impractical and unlikely to impact feather sucking (Figure 10).

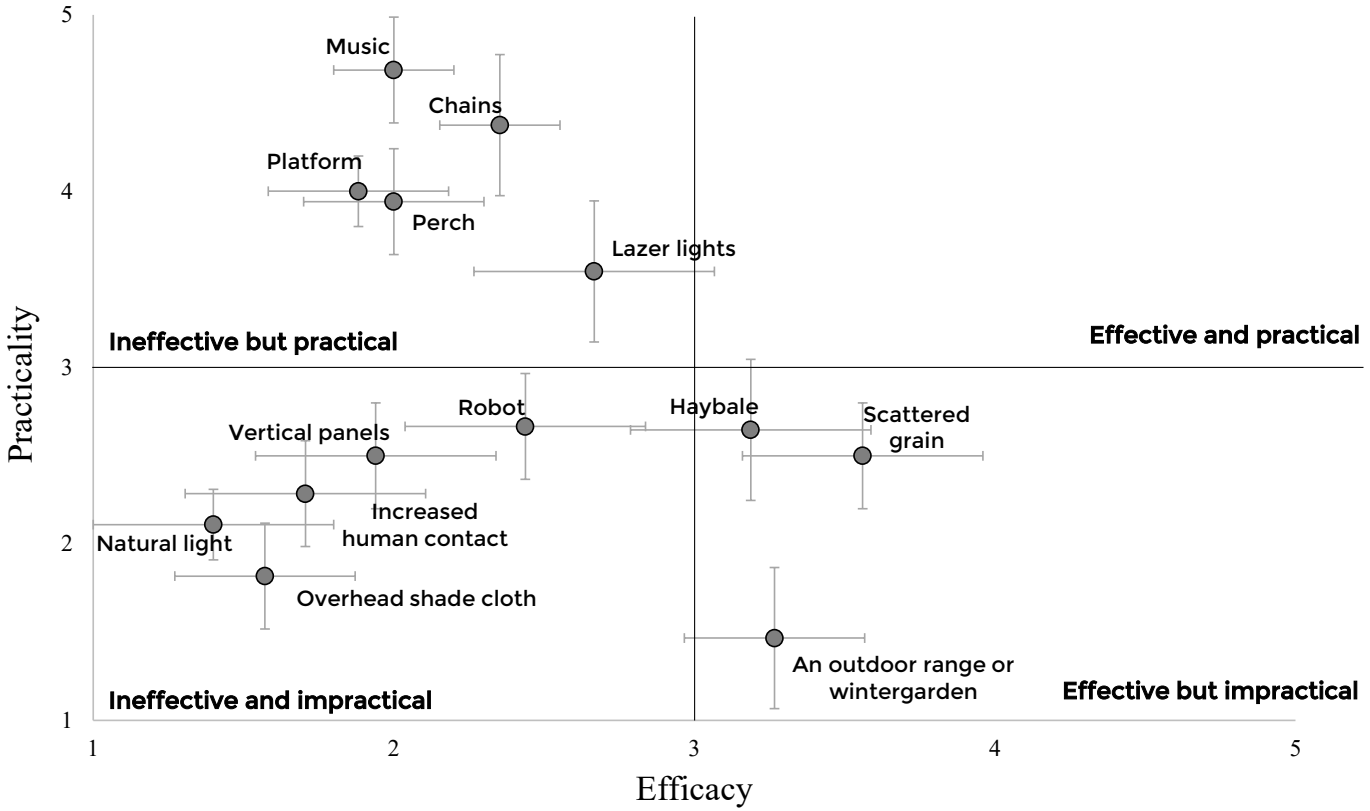


Figure 10 Average scores for the efficacy of environmental enrichment (EE) to reduce feather sucking and the practicality to implement EE.

Quadrants indicate arbitrary categories outlining the perception of EE that are ineffective and impractical, ineffective but practical, effective but impractical and effective and practical.

Discussion

This manuscript explored the perspectives of experts (industry and academic) regarding feather sucking (also referred to as feather licking) by meat chicken breeding birds. Additionally, we aimed to understand the barriers, challenges and opportunities to provide environmental enrichment that can effectively reduce feather sucking in Australian commercial conditions. The results of these interviews suggest that feather sucking occurs mostly during rearing, is more frequently performed by female birds than males, is associated with stress, and could be reduced by providing an appropriate EE. We acknowledge that further observations on commercial breeder flocks are required, however, the self-reported anecdotal evidence collated throughout this study generated hypotheses that through future research may improve our understanding of feather sucking including causation and the impacts on bird welfare.

The first step in understanding the implications of feather sucking for bird welfare and the meat chicken breeder industry is to develop a working definition of the behaviour. There are only a few scientific reports that specifically refer to feather sucking (or licking), but these contain mostly descriptive anecdotal observations rather than clear ethogram descriptions (Leeson and Walsh 2004; Tuijl 2019; Zukiwsky *et al.* 2020). Semantic differences in terminology may have real-world, detrimental effects. Feather sucking throughout this project was often discussed synonymously with feather pecking and feather eating. For example, when respondents were asked "*What causes feather sucking?"* many indicated that nutritional deficiencies were likely to be a cause of feather sucking (47.1% of respondents). However, nutritional deficiencies may be more likely to reflect feather eating rather than feather sucking. Indeed, the mode of action to 'treat' feather sucking reported in the literature is to provide sulphur amino acids, based on the assumption that the birds are deficient in particular nutrients (Leeson and Walsh 2004). However, the authors also report that the benefits of nutrition interventions on feather sucking are rarely evident (Leeson and Walsh 2004). This anecdotal evidence, which is supported by the survey data, may reflect the consequences of 'pooling' behaviours together into broad definitions, including feather licking/sucking, feather eating and feather pecking. Understanding the aetiology and prevalence of feather sucking is not possible if the behaviours and terminology do not accurately reflect the behaviour.

Feather sucking may be multi-factorial or multi-etiological, with the former indicating that many factors *contribute* to causing the behaviour, and the latter indicating that various factors *cause* the behaviour. The main hypotheses generated from this survey were that feather sucking is caused by feed restriction, boredom or additive stressors. Meat chicken breeders are heavily feed-restricted to ensure that production and welfare are not compromised (Decuypere et al. 2010). As such, alleviating the negative consequences associated with feed restriction is difficult. There have been numerous research projects investigating alternative feeding regimes in meat chicken breeder birds, with some promising results. For example, reducing the crude protein levels in the diet resulted in a 137% increase in time spent eating and less time performing stereotypic pecking (Van Emous et al. 2015). Feeder space availability and stress after relocating birds to the production shed have been shown to have an impact on feather cover and quality, such that crowding around a feeder results in bald spots and small wounds (Van Emous and Veldkamp 2009) and may also be related to feather sucking behaviour.

Boredom may be relieved by providing opportunities to express natural behaviours and positively engage with the environment. Such opportunities can be achieved by providing effective EEs. Indeed, EE provided to meat chicken breeders has been shown to improve reproductive performance (cover panels (Leone and Estévez 2008)) and egg quality (plastic-wrapped wood shavings (Edmond et al.

2005)). However, the opportunities for improvements in breeder welfare through the provision of EE are underreported – see Riber et al. (2017). This may be related to a disconnect between industry and researchers regarding the barriers and practicality of providing EE. Future research may address boredom by providing EE programs that are informed by the expert perspectives provided in this study.

Stress was often referred to as a cause of feather sucking outbreaks in flocks. Indeed, additive stressors can result in the expression of stereotypic behaviours (Mason and Rushen 2006). Specific stressors that meat chicken breeders experience, reported in this survey by industry experts, included feed restriction, boredom, vaccination, mating (male-to-female and male-to-male), transfer to production facilities and stocking density. Flocks that experience more accumulative stressors, or flocks that are more sensitive to such stressors, may respond with an outbreak of abnormal behaviours. This could explain the reported variation between flocks in the expression of feather sucking.

Expert perspectives from the present survey suggested that feather sucking predominately targets the tail region of the birds, this may also reflect the bird's attempt to obtain nutrients from soiled feathers or perhaps the uropygial gland, as suggested by one participant. The uropygial gland (also called the preen gland or oil gland) is a complex mixture of lipids, wax, esters, hydrocarbons, triglycerides, sterols, free fatty acids, alcohols, and volatile organic compounds. The composition of the secretions is related to the age, sex and diet of birds (Sandilands et al. 2004). Sandilands and colleagues found that the fatty acid composition of the uropygial gland secretions of laying hens that were feather-pecked differed from hens that were not feather-pecked. Gvoždíková Javůrková et al. (2023) showed that feed restriction does not impact the relative proportion of fatty acids in the uropygial gland secretions, although this does not rule out that the secretions may attract feed-restricted birds. Although the function of gland secretions is still not fully understood, it may be an important factor in explaining the feather-sucking behaviour observed in breeder chicken flocks.

Commented [WW9]: Query 7: Correct?

The consequences of feather sucking remain unknown. There were mixed responses from the participants regarding the consequences of feather sucking on flock health and welfare, ranging from no concern – in agreement with statements by Leeson and Walsh (2004) – to major concerns, reporting that feather sucking leads to cannibalism and damaged feathers. The link between feather sucking, severe feather pecking and cannibalism is not fully understood and requires further investigation. It is known that feather cover is important for thermal insulation and to protect the skin, but it also appears to be essential for visual social cues and mating behaviour; anecdotal observations suggest that a female with poor feather cover will hide from males, avoiding further mating, thus reducing the reproductive performance of the flock (Ross Breeders 2001). The damage to the feather cover, either from feather sucking that leads to feather pecking and eating, or direct damage to the feathers from the sucking behaviour, requires further investigation to fully understand the risks for flock health and welfare. Certain management techniques that were reportedly used to control feather sucking are likely to negatively impact welfare, such as reducing light intensity and the application of tar to tail feathers. As such, identifying more humane control methods should be a short-term priority in addition to understanding causation.

Redirecting feather sucking behaviour from conspecific to other resources could be achieved by providing effective EE, which is an effective method to reduce abnormal behaviours and improve welfare (Taylor et al. 2023). However, there was little interest or commitment from respondents in this feather sucking survey regarding implementing environmental enrichment strategies in meat chicken breeder sheds. For example, only two respondents indicated that enrichments were (or could be) used to reduce feather sucking once it started in the flock. Furthermore, the word cloud of

Commented [WW10]: Note 5: 'effective' deleted here to avoid repetition.

Commented [PT11R10]: Can we please keep this in? We have recently argued the difference in environmental enrichment and effective environmental enrichment I think at this stage its best to include.

descriptions of EEs indicated that some respondents consider EE to be anthropomorphic. This shows a need for science to be communicated effectively to industry, and to gain a better understanding of where this misinformation comes from. We predict that this perception may be influenced by EEs that are introduced on farms to meet accreditation program regulations, and that may be easy to implement but are ineffective – for example, some point source pecking items that lack diversity and dynamic properties as described by the respondents in this study and elsewhere (Taylor et al. 2023). Evidence of effective and practical EEs is needed to help the industry to appreciate the value of EEs as a solution. However, such investigations must include details regarding the required density of the enrichment item and its optimal location. Both density and location were highlighted in the survey as reasons that previous EE programs failed or as a major barrier to implementing EE (i.e. the inability of production sheds to provide some environmental enrichment items regularly throughout the shed for all birds to have access to, or in a way that was not a safety concern for workers). The characteristics of these materials and resources that are attractive to chickens should be better understood, so future work can redesign such resources so that they are attractive to chickens but also meet the strict biosecurity criteria. Many respondents indicated that moving, shiny objects that the chickens can peck at are the best to use, as chickens tend to be attracted and do not habituate to them – for example, pecking blocks or laser lights. On-farm assessments of behaviour with EE programs are required to better understand the potential of EE to reduce feather sucking behaviour.

Commented [WW12]: Query 9: Correctly worded?

Commented [PT13R12]: Yes - thanks for checking

Commented [WW14]: Query 10: This reads better to convey the intended meaning, following 'are attractive to' in the line above. Correct?

The results of this survey suggest that to reduce feather sucking on commercial meat chicken breeder farms, EEs (that are not a biosecurity risk and are practical to implement on farms) should target hunger, boredom and minimising stress. However, before intervention studies, we recommend that a systematic behavioural analysis of feather sucking is conducted to help identify potential causal factors. Outcomes from this will inform the design of EE programs to reduce this abnormal behaviour. Finally, to align with overseas terminology and to help differentiate between feather licking/sucking, feather eating and feather pecking, we recommend that feather sucking is consistently referred to as feather licking, as anatomically birds are incapable of sucking feathers. This small but significant change in the use of specific terminologies will increase clarity in conversations between stakeholders when discussing and observing behavioural problems in meat chicken breeder flocks.

Recommendations

Recommendations have been developed based on the expert opinions and scientific knowledge available:

1. Researchers should provide clarity regarding feather licking via a systematic behavioural analysis across four commercial flocks.
2. To better understand the aetiology of feather licking, behavioural observations should include a focus on
    a. sex of recipient and initiator
    b. time of day – especially concerning feeding
    c. the number of birds involved and if a bird is only feathering licking conspecifics or is also self-directed
    d. identify the location on the body that is being licked
    e. identify any events preceding feather licking behaviour
    f. differentiate (if possible) feather licking from preening, feather pecking and feather pulling.

Commented [WW15]: Query 11: In accordance with the recommendation in the preceding para (and the following Part2 heading), in this list of recommendations should the terms 'feather licking' and 'licked' be used instead of 'feather sucking' and 'sucked'?

Currently, this list uses both 'feather licking' and 'feather sucking'.

Commented [WW16]: Query 11: In accordance with the recommendation in the preceding para (and the following Part2 heading), in this list of recommendations should the terms 'feather licking' and 'licked' be used instead of 'feather sucking' and 'sucked'?

Currently, this list uses both 'feather licking' and 'feather sucking'.

3. Enrichment programs
    a. Should target natural behaviours, this is to meet the definitions outlined by participants.
    b. Should be introduced slowly to avoid scaring the birds and panic smothers and should be distributed evenly and at a density that all birds can access.
    c. Should be ranked effective and practical by survey participants, therefore will likely include scattered grain, laser lights or haybales. However, the enrichments will be redesigned to address any practicality concerns raised (i.e. biosecurity) and increase attraction/use by the birds.
    d. Interventions should target the rearing phase where feather sucking is most frequently observed. Specifically, between the ages of 8 and 10 weeks.

Part 2 Behavioural observations of feather licking behaviour

Introduction

Abnormal behaviour, such as feather licking (FL) and feather pecking, has been reported in meat chicken breeder flocks (De Jong and Guemene 2011; De Jong *et al.* 2012). FL has been proposed to be a redirected foraging behaviour and may lead to FP (Ross Breeders 2001). A redirected behaviour has been defined as a behaviour that is directed towards an (apparently) inappropriate target (Taylor 2010). Although beak trimming and conditioning treatments can be utilised to minimise damage to other birds, this does not treat the underlying motivation to forage, and beak treatment is often perceived negatively by consumers and the public. There are very few research articles that attempt to reduce the abnormal behaviour of feather licking. Indeed, a thorough description and aetiology of feather licking and feather pecking behaviour is lacking and underreported in the parent stock literature.

Leeson and Walsh (2004) reported that FL has no serious consequences for the bird and that the cause is rarely known. The authors also provide anecdotal observations that the common mode of action to 'treat' feather licking is to provide sulphur amino acids, based on the assumption that the birds are deficient in particular nutrients, although the authors also report that such nutrition interventions are rarely beneficial (Leeson and Walsh 2004). This approach may be reflective of confusion around feather-directed behaviours, for example, differences between feather eating and feather licking. Taylor et al. (2024) report evidence that 'pooling' feather-directed behaviours is common amongst experts in the Australian chicken meat industry, which may lead to confusion regarding the causation of feather-directed behaviour (FDB) outbreaks and consequences for welfare.

The impact of FL on feather quality has not been quantified. Feather cover is important for thermal insulation and to protect the skin but also appears to be an essential cue for various social behaviours such as mating. Since anecdotal observations suggest that a female with poor feather cover is likely to hide from males, thus avoiding mating and consequently reducing the reproductive performance of the flock (Ross Breeders 2001).

A useful first step in understanding the implications of FDBs for bird welfare and the breeder industry is to develop a working definition. Table 4 outlines a description of feather licking type behaviours in the scientific literature. Although none are categorised as feather licking, some may include the behaviour within the description. For example, Arrazola et al. (2020)'s description of gentle feather pecking is "*pecking another bird's feathers without feathers being pulled out….. recipient bird as it is moving away*", or Girard et al. (2017)'s definition of feather pecking is "*one bird used its beak to grasp and pull the feather of another bird. A feather can be from any area of the bird's body except the wing*".

Commented [WW17]: Note 6: This originally read Table 1, which is 'Demographics of survey participants'.

Commented [WW18]: Query 14: In the quoted text, should this read 'without feathers being pulled out' … 'recipient bird as it is moving away'?

Nielsen et al. (2011) refer to tail pecking and separates allo pecking and pecking the tail of a conspecific (Table 4) and found that 0.2–10.5% of a breeder's behavioural time budget was spent tail pecking (dependent on the diet). Furthermore Nielsen et al. (2011) reported only 10 independent incidents of pecking other parts of a conspecific body, suggesting that birds have a preference to target the tail feathers of conspecifics for licking, pecking or eating.

Clear distinctions that can be made from Table 4 are that licking/preening behaviour may be repetitively directed towards the bird itself (self-preening, self-feather licking) or on a conspecific, and that it should exclude any description that includes the removal or consumption of a feather.

Table 4 Pecking classifications and descriptions from poultry research ethograms reported in the scientific literature

Terminology	Description	Abnormal behaviour	Animals	Citation
Gentle feather peck	Pecking another bird's feathers without feathers being pulled out or the recipient bird moving away.	Y	Broiler breeder pullets	(Arrazola *et al.* 2020)
	The beak of one bird makes contact with the feathers or skin on the back, wings, tail, or other region of another bird in an exploratory manner, without causing the recipient bird to move away.	N	Broiler breeder pullets	(Zukiwsky *et al.* 2020)
Stereotyped gentle feather peck	Three or more gentle pecks are delivered at intervals 1 second or less at a single body target.	Y	Laying hens	(Newberry *et al.* 2007)
Exploratory gentle feather peck	Bird makes gentle beak contact with the feathers of another bird without visibly altering the position of the feathers. Bird usually stands behind or to the side of the recipient, who makes no apparent response.	Y	Laying hens	(Newberry *et al.* 2007)
Stereotypic preening	Repeated feather licking at a specific spot on their own body.	Y	Broiler breeder pullets	(Arrazola *et al.* 2020)
Peck other bird	Pecking at parts other than the tail feathers or tail region of other birds, following the bird if it moves.	N	Broiler breeder pullets	(Nielsen et al. 2011)
Peck at own tail	Craning neck towards own rear and pecking at own tail feathers.	N	Broiler breeder pullets	(Nielsen et al. 2011)
Feather peck	Bird uses its beak to grasp and pull the feather of another bird. A feather can be from any area of the bird's body except the wing.	N	Broiler breeder pullets	(Girard et al. 2017)
Aggressive peck	A rapid peck is directed towards the head of another bird with a sharp downward stabbing motion. Each peck is recorded, including whether given or received by the focal bird.	N	Laying hens	(Newberry *et al.* 2007)

	A rapid and forceful thrusting motion in which the beak of one bird makes contact with the head or neck of another bird.	N	Broiler breeder pullets	(Zukiwsky *et al.* 2020)
Severe feather peck	Bird grips and pulls or tears vigorously at a feather of another bird with beak, causing the feather to lift up, break or be pulled out. Bird usually stands behind or to the side of the recipient, who reacts to the peck by vocalising, moving away or turning towards the pecking bird. Each peck is recorded, including whether given or received by the focal bird.	Y	Laying hens	(Newberry *et al.* 2007)
	A thrusting motion of the beak of one bird that makes contact with the plumage of another bird, causing the recipient to move away, and/or resulting in vigorous pulling or removal of feathers or skin.	Y	Broiler breeder pullets	(Zukiwsky *et al.* 2020)
Severe pecking	Forcefully and quickly pecking another bird, causing the recipient bird to move away.	N	Broiler breeder pullets	(Arrazola *et al.* 2020)
Tail peck	Pecking or sucking the tail feathers or pecking at the tail region of other birds and following the birds if they move.	N	Broiler breeder pullets	(Nielsen et al. 2011)
Object pecking	Repeatedly pecking a specific inanimate spot (i.e. wall, perch or shavings).	Y	Broiler breeder pullets	(Arrazola *et al.* 2020)
Peck fixture	Pecking in a stereotyped manner, that is, several uniform pecks without moving its body, at fixtures in the pen.	Y	Broiler breeder pullets	(Nielsen *et al.* 2011)
Feeder peck	Beak motion directed at a feed trough or the base or walls of the precision feeding system, performed in a stereotypic manner that did not result in ingestion of feed.	Y	Broiler breeder pullets	(Girard et al. 2017)
Drinker peck	Beak motion directed at a drinker in a stereotypic manner that did not result in ingestion of water.	Y	Broiler breeder pullets	(Girard et al. 2017)
Pen wall peck	Beak motion directed at the pen wall in a stereotypic manner.	Y	Broiler breeder pullets	(Girard et al. 2017)

The abnormal behaviour column indicates whether the behaviour was referred to as abnormal behaviour or stereotypy in the publication.

Commented [WW19]: Query 15: Licking?

Commented [PT20R19]: I'll leave this one as it is a direct quote/language from these published papers

Objectives

To better understand the aetiology of feather licking, behavioural observations should include a focus on:

- sex of the recipient and initiator
- the time of day – especially around feeding
- the number of birds involved
- identifying the location on the body that is being licked
- identifying any events preceding feather licking behaviour.
- differentiating feather licking from preening and feather pecking, feather pulling and feather eating.

Methodology

Bird behaviour was recorded in commercial sheds; two video cameras in each of the eight sheds (Table 5).

The behaviour of the birds in each shed was recorded by two cameras (8MP Ultra 4K Eyeball WizSense, Dahua, CCTV Masters, Bankstown, NSW) mounted on each side of the shed approximately 20–50 m down the length of the shed above head height. Cameras were connected to an NVR (Smart 2.0m P2P, Dahua, CCTV Masters, Bankstown, NSW) that was stored in a control room adjacent to the shed.

Cameras were mounted in the sheds before birds were placed, to minimise biosecurity risks and disturbing the birds. Data were transferred from the local computer to an external hard drive every fortnight and analysed by three trained observers. Interobserver reliability was assessed at three different time points to ensure that the ethogram and observations were reliable.

Behavioural analysis

Scan sampling

The scan sampling method aimed to describe when and how feather-directed behaviour (FDB) starts and spreads throughout a flock and determine if FDBs were related to other behaviours (i.e. foraging or spot pecking).

Weekly scan samples were collected across 18–20 weeks in both rearing and production from both cameras inside each shed. To capture a good representation of flock behaviour, three shed areas were monitored on each side of the production shed (Figure 11), including an area close to the wall containing male feeders and litter, an area away from the wall containing female feeders and litter, and another area on the slats containing female feeders.

Commented [WW21]: Note 7: 'between the observers' redundant here; deleted.

Commented [WW22]: Query 16: Heading levels (2)

Some time was devoted to the heading structure in the report, ending in things being left as they were originally.

In the original version, the consecutive 'Behavioural analysis' and 'Scan sampling' headings are styled as Level 3, but there is no text under 'Behavioural analysis' in its own right at the level 3 hierarchy.

The original Table of Contents gives the expectation that there will be text under the heading 'Behaviour analysis' as a section independent of the following sub-sections.

However, in this version the Level 3-Level 3 sequence has been retained, as nesting the following subsections leads to some confusion here and later under Results, where similar topics would then appear as a different heading hierarchy. There would also be some second-guessing about topic relationships.

It is not something that would be really apparent to the reader.

Is this OK?

Table 5 Lighting and feeding conditions for each flock observed

Farm	Shed Flock	Sex	Hours of light	Lights on	Light intensity	Feeding time	Feeding schedule	Feeders
Rearing Farm 1	A	F	8‡	07:00	10 lux	07:00†	7:0 (1–3 WOA) SAD (4+ WOA)	Track
	B	M	8‡	07:00	10 lux	07:00†	7:0 (1–3 WOA) SAD (4+ WOA)	Pan
Rearing Farm 2	C	F	8‡	06:15	10 lux	06:45†	7:0 (1–3 WOA) SAD (4+ WOA)	Track
	D	M	8‡	06:15	10 lux	00:45†	7:0 (1–3 WOA) SAD (4+ WOA)	Pan
Production Farm 1	E & G	Mixed	8–15	07:00–7:30	10–65 lux	7:00–7:30	7:0	F: Chain†; M: Pan†*
Production Farm 2	G & H	Mixed	8–14	05:30–05:45	10–65 lux	11:30–11:45	7:0	F: Chain†; M: Pan†*

F = Pullets.

M = Cockerels.

Mixed = Mixed sex (Dams and Roosters).

WOA = Weeks of age.

SAD = Skip-a-day.

* Feeders raised within 1 hour of feeding.

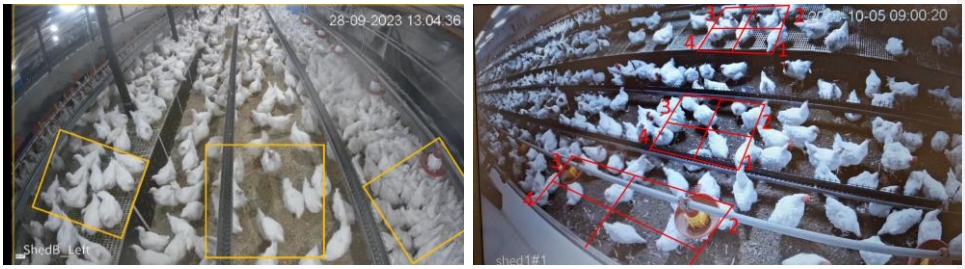
† Lights off to fill feeders (and lower where required).

‡ Lighting starts 24 hours from day old, which is reduced by 1 hour each day until reaching 8 hours of light.

Commented [WW23]: Query 17: The two rows (7:0 and SAD) are grouped together correctly for each of Rearing farms 1 and 2?

Commented [WW24]: Query 18: Assuming that this is 'weeks of age' and that it should be consistently 'WOA'. Correct?

Table 5 is the only place where this abbreviation occurs.



Farm 1 – Production shed **Farm 2 – Production shed**

Figure 11 Images from a production shed with the overlay image of the observation areas (red boxes) in all areas; close to the wall containing male pan feeders and litter (1), away from the wall containing female track feeders and litter (2) and the area on the slats with female feeder

Two shed areas were monitored on each side of the rearing shed, including an area adjacent to the wall and one away from the wall which both contained feeders (Figure 12).

Male rearing **Female rearing**

Figure 12 Female (right) and male (left) rearing sheds with the overlay image of the observation areas (red boxes) in both areas; close (1) and far (2) from the wall

Scan samples were completed on one day each week (non-feed days when skip-a-day feeding was practised) at four timepoints: 15 minutes before feeding, 1 hour after the feed was delivered, 5 hours after the first feed, and 15 minutes before lights out.

Unfortunately, due to technical issues, the female rearing flock on Farm 1 only recorded one timepoint (15 minutes before feeding) and therefore is missing most of the observation points.

Behaviours of interest including feather-directed behaviours that are defined in Table 6 were quantified.

Table 6 Ethogram for scan sampling methodology

Behavioural category	Behaviour	Description
Feather directed behaviour	Preening	A bird places its beak on one of its feathers running it along the shaft of the feather repeatedly. The feather is not removed or eaten.
	Feather licking	A bird places its beak on another bird's feather running it along the shaft of the feather repeatedly. The recipient doesn't move away. The feather is not removed or eaten.
	Gentle feather pecking	Gentle rapid peck to another bird. The recipient doesn't move away.
	Severe feather pecking	With a short sharp peck at another bird, the recipient moves away. The feather may or may not be removed, but it is not eaten.
	Loose feather in beak	Bird holds feather in beak but does not eat it.
	Feather eating	Bird consumes feather – may have been taken from another bird or the ground.
Spot pecking	Spot pecking feeder	Repetitively (> 3 consecutive pecks) pecking at any part of the feeder when empty.
	Spot pecking walls	Repetitively (> 3 consecutive pecks) pecking at any part of the walls.
	Spot pecking slats	Repetitively (> 3 consecutive pecks) pecking at any part of the slats.
Litter directed behaviour	Pecking the litter	Repeated pecks (≥ 3 continuous pecks) at the litter (Note: Not foraging, which includes bouts of pecking and scratching the litter/floor).
	Foraging	Pecking and scratching the litter/floor
Resting	Resting – standing	Standing (two feet in contact with the ground) in a non-vigilant state, performing no other listed behaviours.
	Resting – sitting	Sitting (breast in contact with the floor) in a non-vigilant state, performing no other listed behaviours.
Active	Locomotion	Walking or running, wings may or may not be flapping.
Other	Mating	Rooster mounts or attempts to mount hen.
	Pacing	Locomotion in a clear path (< 1m), which is repeated (≥ twice). A bout ends when the bird travels > 1m or performs another behaviour.
	Beak swiping	Swiping beak on a surface (not conspecific or self) from one side to the other a minimum of 2 times.
	Flocking	3 or more birds moving/running in the same direction.
	Threat	The neck is stretched vertically in hens and more horizontally in cocks. The feathers of the neck are completely erect.
	Other	Other behaviour not in ethogram, i.e. vigilance.
	Unknown	Behaviour cannot be determined.

Continuous sampling methodology

Commented [WW25]: Query 19: As above re heading levels.

Focal sampling (i.e. continuously monitoring birds that are feather licking for a specific period) was used to answer the following questions:

- What is the duration of the behaviour?
- How many animals are involved?
- Which sex is feather licking and which sex is the recipient?
- What location on the bird is targeted?
- What behaviours precede feather licking?

The time points for focal sampling were chosen based on the scan sampling data, and the time points when FDB occurred were selected. The time of the scan sample was used as time 0 for focal observation, and the first 5 animals showing feather-directed behaviour were selected as the focal animals. Focal animal behaviour was quantified for 5 continuous minutes. Boris software (Friard and Famba 2016) was used to record continuous behaviours, including a series of behaviours and modifiers (Table 7). Additionally, the sex of the initiator and recipient was recorded for each FDB observed.

Commented [WW26]: Query 20: Reads correctly as amended?

Table 7 Ethogram for focal sampling methodology

Behaviour	Description	Modifier
Feather lick	Stroking, combing, or sweeping motion where the beak moves along the feathers. The movement is slower compared to a peck.	1, 2, 3
Feather peck	1–3 consecutive rapid pecks that contact another bird's feathers or body.	1, 2, 3
Pulling feather out	Removing feather(s) from conspecific.	1, 2, 3
Feather eating	Eating a feather obtained either from the ground, plucked from a bird, or taken from a bird that has it in its beak,	
Preening	A combination of pecks, licks, and head movements over a wide body area (> 10cm). Unlike, feather licking the behaviour is directed at more than one feather.	
Holding a feather	Bird holds feather in beak but does not eat it.	

Modifier #1 = Location targeted on conspecific.
Modifier #2 = Behavioural change in conspecific.
Modifier #3 = Number of birds that are also directing FDB at the conspecific.

Statistics

Three software packages were used to collate, clean, present and analyse the data (Microsoft Excel, SPSS and RStudio).

Where possible, comparisons were made, specifically the scan sampling data. Comparisons of specific behaviours, or behavioural categories, between production and rearing farms were assessed with a binomial distribution that accounted for the number of birds in the observation area (i.e. X birds performing the behaviour of interest was the numerator and the total birds present in the observation grid was the denominator). These analyses included farm, sex (where appropriate), age/week and time of day.

Commented [WW27]: Query 21: behaviours of interest?

Results

Scan sampling

Feather-directed behaviour

Only 3.4% of behaviours in rearing were feather-directed (n = 284 events from 9944). Slightly more FDBs were observed in production (Table 8). The most common FDB was self-preening (Table 8). Feather eating was rarely observed (Table 8).

Table 8 Proportion of chickens performing feather-directed behaviours throughout rearing and production

	Rearing	Production
All feather-directed behaviour (%)	**3.4 ± 0.4 (0–100)**	**7.9 ± 0.3 (0–100)**
Preening (self)	2.4 ± 0.3 (0–100)	7.4 ± 0.3 (0–100)
Preening conspecific	0.0 ± 0.0 (0–7)	0.2 ± 0.0 (0–20)
Feather eating	0.0 ± 0.0 (0–4.5)	0.0 ± 0.0 (0–7)
Feather pulling/pecking	0.9 ± 0.2 (0–50)	0.3 ± 0.0 (0–7)
Loose feather in beak	0.1 ± 0.0 (0–17)	0.0 ± 0.0 (0–14)

Values are raw means ± SEM with range displayed in brackets.

There was no difference in the amount of FDB between Farm 1 and Farm 2 flocks during rearing ($p = 0.768$). However, there were more FDB in Farm 1 production flocks than in Farm 2 production flocks (EMM: Farm 1 0.10 ± 0.004; Farm 2 0.05 ± 0.002; χ_2 (1), 163.8, $p < 0.001$).

There were more FDB observed in cockerel flocks during rearing than in pullet flocks (EMM: cockerel 0.03 ± 0.003; pullet 0.02 ± 0.003; χ_2 (1), 8.46, $p = 0.004$).

The majority of the FDB was self-directed preening (Figure 13). Preening a conspecific was not seen in pullet flocks, only in cockerels and during production (Figure 13).

Commented [WW28]: Query 22: Heading Levels (3)

As above at Heading Levels (2), the same issue with heading hierarchy. The heading level 3 sequence has been retained

Is this OK?

Commented [WW29]: Query 23: 'Table 7' was repeated here. This has been amended to Table 8, as have the three cross-references in the preceding para.

Please double check that this is correct.

In the original, the table numbering sequence corrects itself at Table 9.

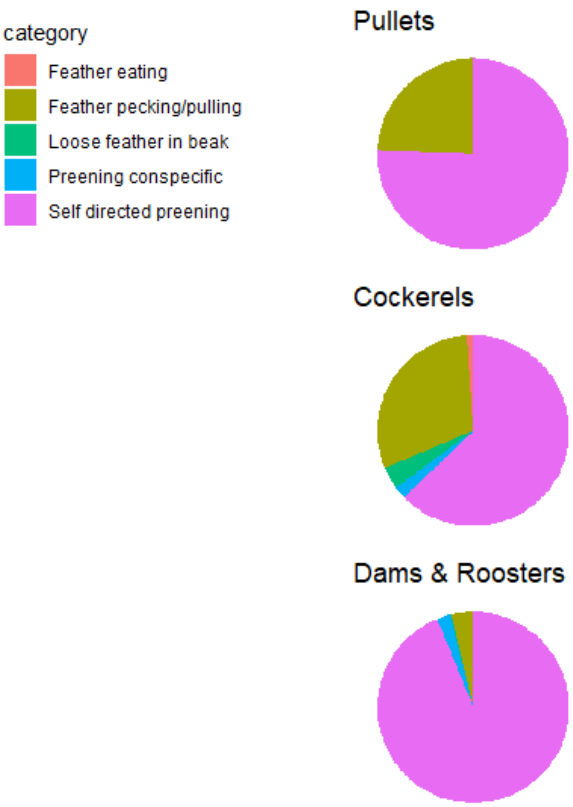


Figure 13 The proportion of feather-directed behaviours (FDB) observed during rearing in pullet and cockerel sheds and during production (dams and roosters)

There was a time-of-day effect on the level of FDB during rearing (χ_2 (3), 9.64, p = 0.02), with less FDB observed in the evening 15 minutes before the lights went out compared to 24 hours after feed arrived (p = 0.009), 25 hours after feed arrived (p = 0.003), and a tendency for 29 hours after feed arrived (p = 0.061).

There was also a time-of-day effect on the level of FDB during production (χ_2 (3), 367.58, p < 0.001; **Figure 14**). The least amount of FDB was observed 1 hour after the feed arrived compared to 15 minutes before and 5 hours after the feed arrived and 15 minutes before lights out (all p < 0.001).

Commented [WW30]: Query 24: The cross-reference for Figure 14 should probably appear in this para rather than/as well as at line 1 in the preceding para. It is this para that contains the time points set out at Figure 14.

Those referred to in the previous para are for different times of the day.

At this juncture 'TP' (for TP1–TP4) should also be defined, as it is not defined in the figure title or footnote. This figure has the first instance of 'TP' in the report. Assuming that TP is 'time point'. This will then cover off Figures 15 and 18, and further commentary.

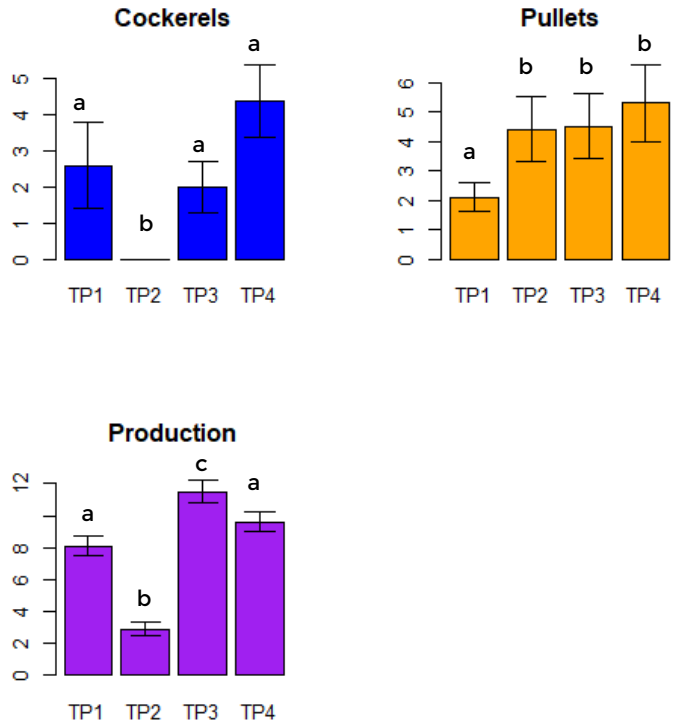


Figure 14 Feather-directed behaviours (FDB) as a function of time of day: 15 minutes before feeding (TP1); 1 hour after feeding (TP2); 5 hours after feeding (TP3); 15 minutes before lights out (TP4). The differing superscript indicates a difference in FDB across time-of-day.

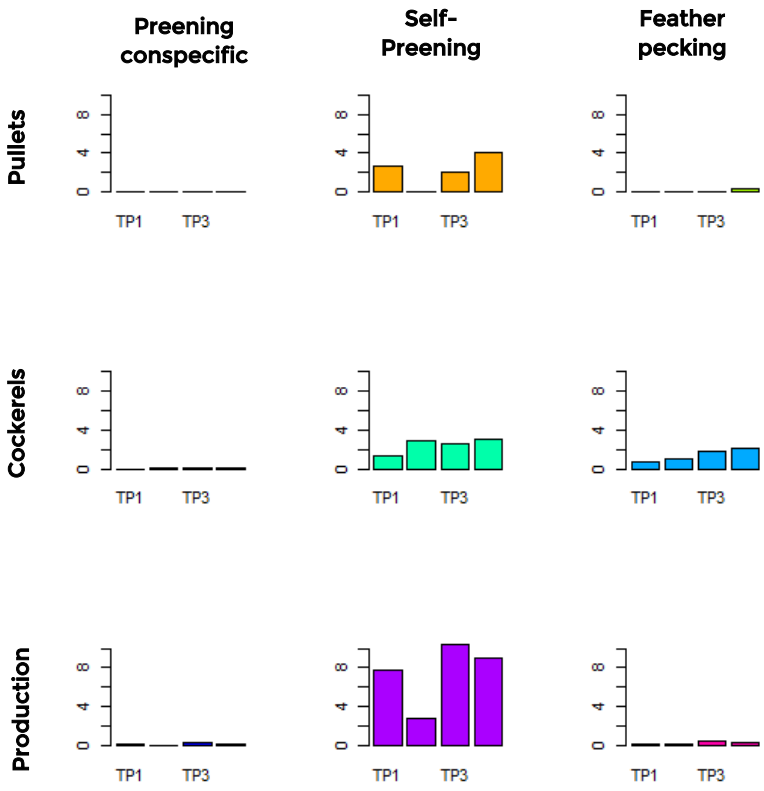


Figure 15 Feather-directed behaviours (FDB) expressed during rearing (pullets and cockerels) and production, 15 minutes before feeding (TP1), 1 hour after feeding (TP2), 5 hours after feeding (TP3) and 15 minutes before the dark period (TP4)

Preening decreased after feeding in pullets and production flocks (Figure 15) but not in cockerel flocks. Feather pecking slightly increased from 15 minutes before feeding to 15 minutes before the dark period during rearing in cockerels, and to a lesser degree in pullets (Figure 15). Of note, observations were taken on off-feed days during SAD feeding in rearing. Non-feed and feed days are not compared here but are pooled.

Other behaviour

Figure 16 Image of a 'scrum'. Birds forage and ground peck in a central area or a circle formation. Heads are focused on the litter and tails are lifted into the air

We observed a behaviour that we labelled a 'scrum', where birds foraged in a circle (Figure 16). We believed this may have been important for FDB, as it was (anecdotally) observed that birds would walk around the 'scrum' and interact with the tip of the tail feathers that were sticking up in the air. This was predominately observed in the male rearing flocks, between 5 and 10 weeks of age (Figure 17), which also coincides with industry reports of the age when feather licking (FL) starts (see Part 1 of this final report).

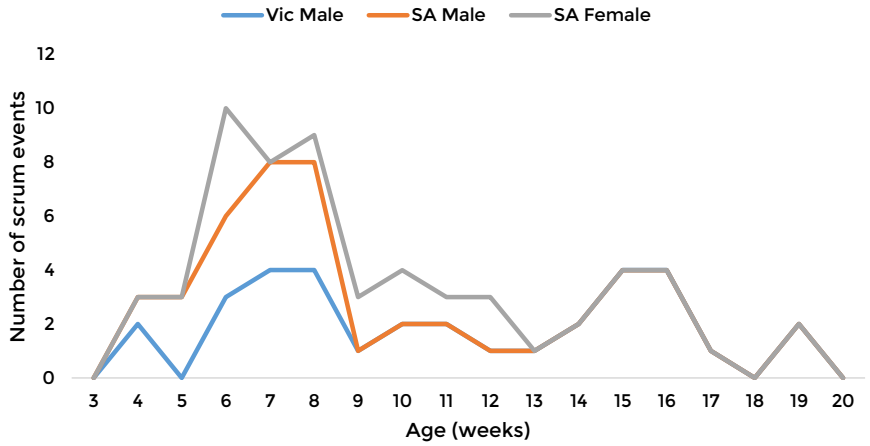


Figure 17 The number of 'scrums' that were observed during a scan sample in cockerel rearing flocks (Farm 1 – blue line; Farm 2 – orange line) and pullet flocks (grey line).

There was more foraging when there was a scrum present across all rearing flocks (Table 9). There were slightly more FDB observed when there were scrums present in cockerel flocks on Farm 1, but not on Farm 2 (Table 9).

Table 9 The proportion of birds in each rearing flock that were performing feather-directed behaviours (FDB), spot pecking or foraging/pecking at the litter whether there was a scrum formation or not

		FDB	Spot pecking	Foraging or pecking litter
Farm 1 cockerels	Scrum	1.0 ± 0.3	0.2 ± 0.1	16.2 ± 1.1
	No scrum	0.4 ± 0.1	0.9 ± 0.1	5.8 ± 0.3
Farm 2 cockerels	Scrum	0.1 ± 0.04	0.0 ± 0.00	3.9 ± 0.31
	No scrum	0.1 ± 0.01	0.1 ± 0.02	0.8 ± 0.05
Farm 2 pullets	Scrum	0.1 ± 0.05	0.1 ± 0.00	4.6 ± 0.36
	No scrum	0.1 ± 0.01	1.3 ± 0.07	0.8 ± 0.04

Behavioural time budgets

Pullets spent a lot of the time during scan sampling either spot pecking or pecking the litter (Figure 18). Cockerels spent less time spot pecking than pullets but between 40 and 60% of cockerels were pecking at the litter during scan sampling (Figure 18). The feeders were raised for cockerels during rearing, but not pullets. This may explain why pecking behaviour was directed at the feeders (i.e. spot pecking) in the pullets and towards the litter for cockerels. Of note, feeders were still lowered on non-feed days for cockerels, which could explain the slight increase in spot pecking during TP2 (Figure 18).

Spot pecking increased one hour after the feed was provided in production flocks. This may have been actual feeding behaviour, although we expect feed to be consumed within one hour after it was first provided. We could not determine the amount of feed present from the video records. As such, pecking at the feeder may be incorrectly labelled as 'spot pecking'.

More birds in production flocks were active (locomotion) 15 minutes before feed was provided, suggesting anticipation of feed arrival (Figure 18).

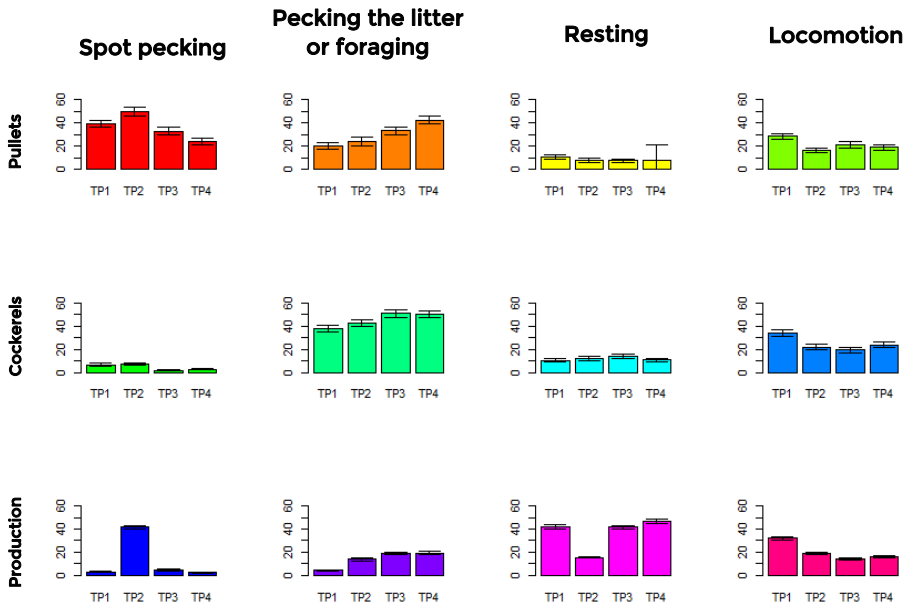


Figure 18 The proportion of pullets, cockerels and mixed roost and dam flocks that were performing specific behaviours 15 minutes before feeding (TP1), 1 hour after feed time (TP2), 5 hours after feed was provided (TP3) or 15 minutes before the dark period (TP4)

Of note, observations were conducted on 'non-feed days' during SAD in rearing.

Pecking behaviours

Most of the spot pecking observed during rearing and production targeted the feeders. However, this was likely a sampling bias, as the observation areas contained more feeder space than walls or slats (Table 10).

Commented [WW31]: Note 8: The reference to Table 1 after Table 10 here has been deleted. Table 1 is 'Demographics of survey participants'.

Table 10 The proportion (raw mean ± SEM; (range)) of birds in rearing and production flocks that were spot pecking during each scan sample observation.

	Rearing	Production
All spot pecking	**16.3** ± 0.9 (0–100)	**13.1** ± 0.6 (0–100)
Spot pecking empty feeder	15.2 ± 0.9 (0–100)	13.1 ± 0.6 (0–100)
Spot pecking wall	0.0 ± 0.0 (0)	0.2 ± 0.0 (0–33)
Spot pecking slats	NA	0.2 ± 0.0 (0–20)

Litter-directed behaviour (foraging and ground pecking) was more prevalent during rearing (39.3 ± 1.2 % birds) than during production (14.0 ± 0.6 % birds).

Continuous focal sampling

Feather licking and feather pecking

Our working definition of feather licking (FL) was 'stroking, combing, or sweeping motion where their beak moves along the location of the feathers. The movement is a slower movement than a peck.' This differed from feather pecking, which was defined as '1–3 consecutive rapid pecks that contact another bird's feathers or body'.

FL was observed between one bird and another, two birds simultaneously (Figure 19), or groups of birds where FL was observed involving one or more conspecifics (Figure 20).

Commented [WW32]: Query 26: Does this amended text read correctly? Using the abbreviation 'FL' as a verb feels quite odd.

This originally read: 'groups of birds FL one or more conspecifics'

FL bouts ranged between 0 and 11 times per five-minute observation period, and each bout lasted an average of 11.5 ± 1.8 s. There were no noticeable changes in the frequency of FL behaviour over time in production flocks (Table 11). There was a sex bias for both FL and FP during production, indicating that over 95% of initiators and recipients were female. This is likely a sampling bias with a high female-to-male ratio (10:1) in production flocks.

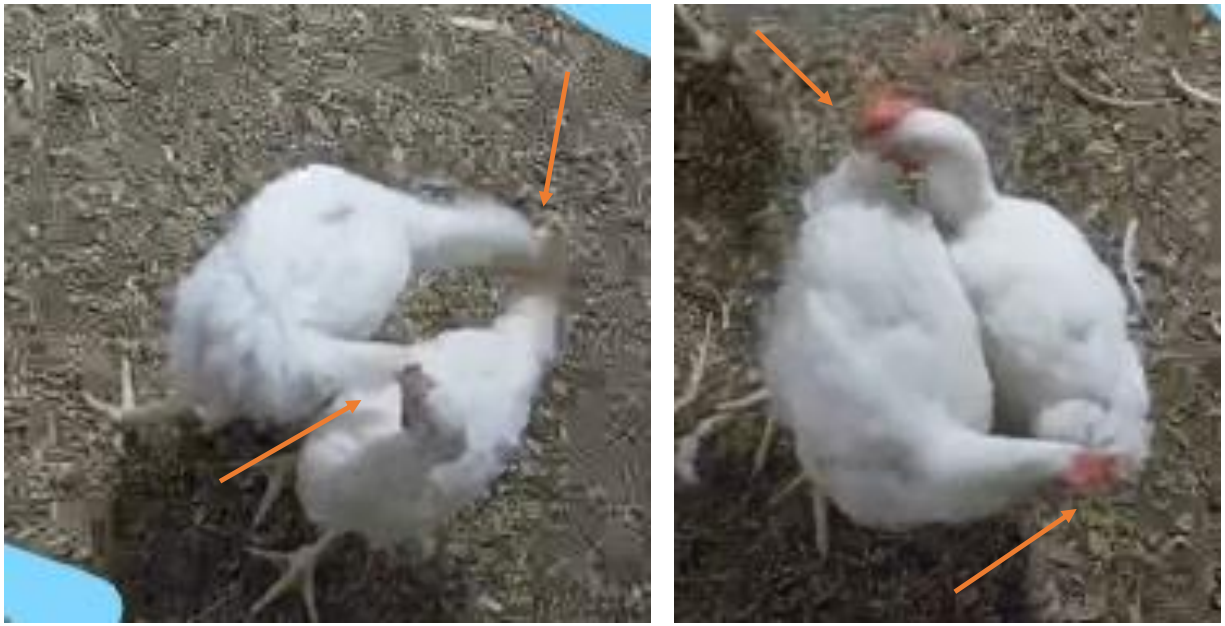


Figure 19 Examples of feather licking behaviour between pairs of cockerels captured during rearing (10–14 weeks of age)

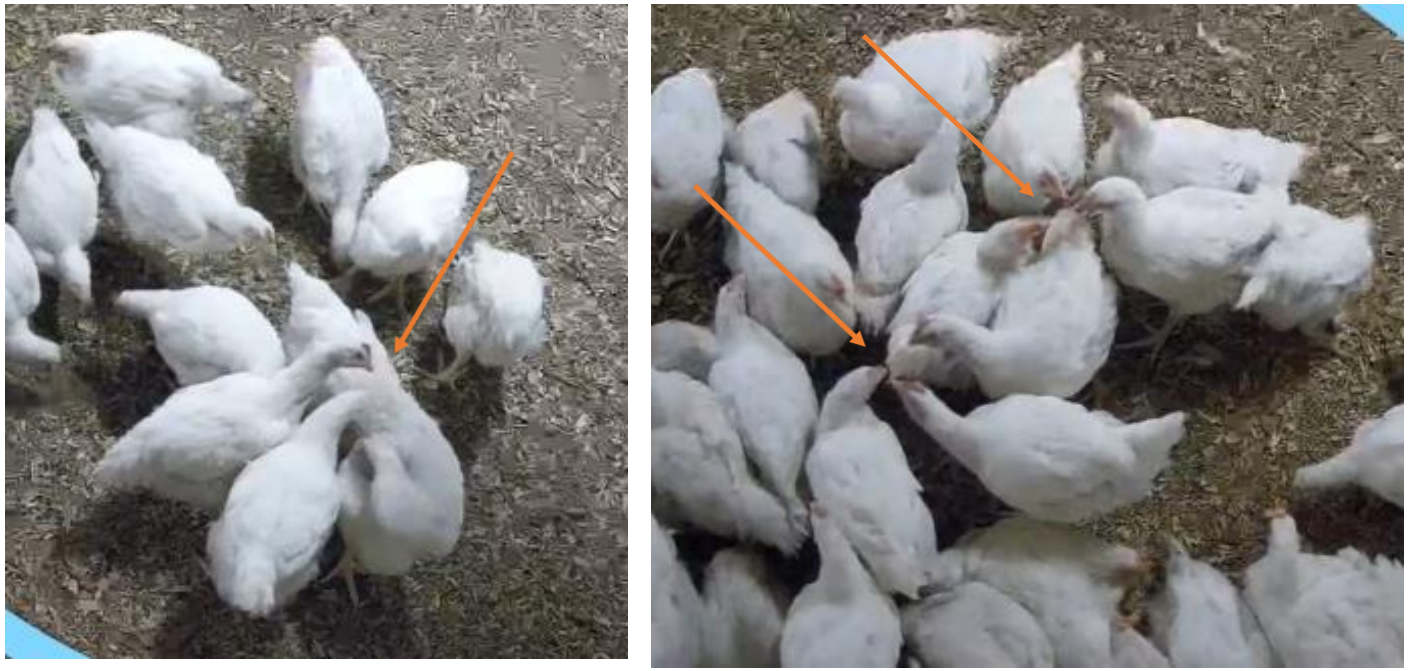


Figure 20 Examples of feather licking behaviour between groups of cockerels captured during rearing (10–14 weeks of age)

FL was rarely observed in the cockerel rearing flock on Farm 1 (Table 12). Conversely, FP was seen every week (n = 88 occurrences overall) with most focal birds (80–100% birds per observation) displaying the behaviour at least once. FL and FP bout lengths were similar during rearing on Farm 1 (3.3–3.9 s; Table 12).

FL was seen frequently during cockerel rearing on Farm 2, with bout lengths increasing from an average of 2.4 s in week 1 to 45.1 ± 17.5 s in week 15 (Table 12). Conversely, the frequency of FP decreased over time from 16 observations per observation to 0 (Table 12). However, FP bout length did not change.

FDB target areas. FL was predominately seen targeting the tip of the tail and wings in production. Conversely, feather pecking typically targeted the back and wings in production (Table 13). Pecking towards the back and wings may have been associated with mating aggression and behaviour, although, most of the initiators of FP (and FL) were female (Table 11).

In Farm 2, during rearing almost all the FL behaviour (91.4%) targeted the tip of the tail. Although most of the FP also targeted the tip of the tail during rearing on Farm 2 (57.8%), other areas were also regularly targeted, including the beak which accounted for 20% of all FP (Table 13).

Commented [WW33]: Query 27: This should refer to Table 12, as amended, instead of Figure 9.

Table 12 displays the relevant data. Figure 9 is 'The proportion of respondents that suggested locations to provide environmental enrichment or locations to avoid during the meat chicken breeder production cycle'.

Is this correct?

Table 11 The frequency of feather licking behaviour (FL), the proportion of birds (out of 5) and the duration of FL within a 5-minute observation period at different ages throughout the production cycle

	Age (weeks)	Frequency	Duration (s)			Sex of initiator			Sex of recipient	
			Mean ± SEM	Min	Max	Dams	Roosters	Total	Dams	Roosters
FL	30	3	12.5 ± 5.5	4.4	23.0	66.7% (n = 2)	33.3% (n = 1)	3	100% (n = 3)	0% (n = 0)
	36	6	12.9 + 2.5	3.1	20.3	100% (n = 3)	0% (n = 0)	3	66.7% (n = 4)	33.3% (n = 2)
	37	2	8.1 ± 3.8	3.3	19.3	100% (n = 5)	0% (n = 0)	5	100% (n = 1)	50.0% (n = 1)
	38	4	25.7 ± 10.6	10.7	40.8	100% (n = 2)	0% (n = 0)	2	100% (n = 4)	0% (n = 0)
	39	11	10.9 ± 3.9	0.1	29.2	100% (n = 3)	0% (n = 0)	3	100% (n = 3)	0% (n = 0)
	Total	*26*	*11.5 ± 1.8*	*0.1*	*40.8*	*93.7% (n = 15)*	*6.3% (n = 1)*	*16*	*83.3% (n = 15)*	*16.7% (n = 3)*
FP	30	28	12.3 ± 1.8	2.1	39.1	100% (n = 5)	0% (n = 0)	5	100% (n = 24)	0% (n = 0)
	36	6	7.1 ± 2.2	3.1	15.5	100% (n = 4)	0% (n = 0)	4	100% (n = 6)	0% (n = 0)
	37	6	6.5 ± 1.9	2.5	13.7	100% (n = 3)	0% (n = 0)	3	60% (n = 3)	40% (n = 2)
	38	7	8.5 ± 1.9	4.0	18.1	80% (n = 4)	20% (n = 1)	5	100% (n = 7)	0% (n = 0)
	39	8	2.7 ± 7.1	3.5	11.9	100% (n = 4)	0% (n = 0)	4	100% (n = 8)	0% (n = 0)
	Total	*55*	*9.9* ± 1.0	*2.1*	*39.1*	95.2% (n = 20)	4.8% (n = 1)	*21*	96% (n = 48)	4% (n = 2)

Commented [WW34]: Query 28: Correct?

Table 12 Observations of feather licking and feather pecking behaviours during 5-minute focal sampling intervals, including the frequency, the proportion of cockerels (out of 5) and the duration at different ages throughout rearing

		Feather licking					Feather pecking				
				Duration (s)					Duration (s)		
Location	Age (Weeks)	Frequency	Birds	Mean ± SEM	Min	Max	Frequency	Birds	Mean ± SEM	Min	Max
Farm 1	7	0	0	-	-	-	10	5	3.9 ± 0.3	2.6	5.3
	9	0	0	-	-	-	9	5	4.7 ± 0.7	3.2	9.8
	10	1	1	3.6	-	-	22	4	4.0 ± 0.4	1.4	9.9
	13	0	0	-	-	-	9	4	2.6 ± 0.4	1.0	4.3
	14	1	1	3.1	-	-	19	5	3.2 ± 0.3	0.2	5.2
	15	0	0	-	-	-	19	4	4.8 ± 1.0	0.1	17.9
Total F1		**2**	**2**	**3.3 ± 0.2**	**3.1**	**3.6**	**88**	**27**	**3.9 ± 0.3**	**0.1**	**17.9**
Farm 2	8	1	1	2.4	-	-	16	5	11.1 ± 3.2	1.1	40.1
	10	2	2	18.2 ± 3.8	14.4	22.0	15	5	17.7 ± 6.5	0.0	74.9
	12	1	1	16.8	-	-	12	5	8.3 ± 0.1	3.8	18.6
	13	23	5	28.8 ± 14.9	3.4	153.4	2	1	11.1 ± 3.2	2.2	2.4
	15	8	5	45.1 ± 17.5	5.0	354.2	0	0	-	1.1	40.1
Total F2		**35**	**14**	**30.8 ± 62.5**	***2.4***	***354.2***	**45**	**16**	**12.2 ± 2.5**	**0.0**	**74.9**

Note: There were no pullet observations during rearing and thus are not reported

Commented [WW35]: Query 29: Correct?

Commented [WW36]: Query 30: Correct sum?

Commented [WW37]: Note 9: All totals data have been amended to bold text/non-italic for consistency.

Table 13 Location on the recipient's body where feather licking (LF) and feather pecking (FP) were directed/received

Location on recipient	Feather licking			Feather pecking		
	Production	Rearing Farm 1	Rearing Farm 2	Production	Rearing Farm 1	Rearing Farm 2
Tip of the tail (%)	53.8 (n = 14)	0% (n = 0)	91.4% (n = 32)	5.5% (n = 3)	23.5% (n = 20)	57.8% (n = 26)
The base of the tail	3.8 (n = 1)	50.0 % (n = 1)	0% (n = 0)	3.6 (n = 2)	23.5% (n = 6)	4.4% (n = 2)
Back	7.7 (n = 2)	0% (n = 0)	0% (n = 0)	34.5% (n = 19)	7.1% (n = 14)	0.0% (n = 0)
Wings	30.8 (n = 8)	0% (n = 0)	2.9% (n = 1)	34.5% (n = 19)	16.5% (n = 23)	6.7% (n = 3)
Vent	3.8 (n = 1)	50.0 % (n = 1)	0% (n = 0)	5.5% (n = 3)	27.1% (n = 15)	4.4% (n = 2)
Back of the head	0% (n = 0)	0% (n = 0)	0% (n = 0)	3.6% (n = 2)	3.5% (n = 3)	0.0% (n = 0)
Beak	0% (n = 0)	0% (n = 0)	0% (n = 0)	3.6% (n = 2)	1.2% (n = 1)	20.0% (n = 9)
Unknown/other	-	-	5.7% (n = 2)	9.7% (n = 5)	3.5% (n = 3)	6.7% (n = 3)

How do recipients respond to FL?

Recipients would rarely move away when a bird licked their feathers in production and rearing but would often move away during rearing when they were pecked (Figure 21).

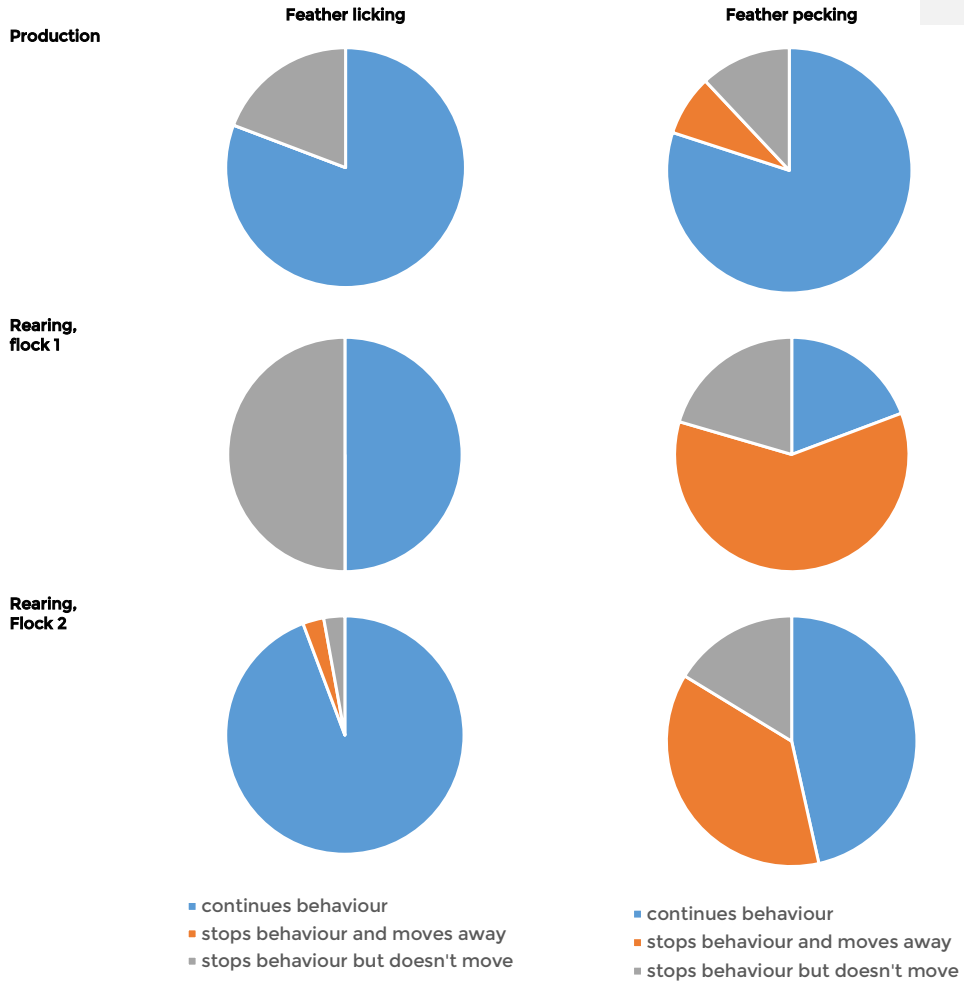
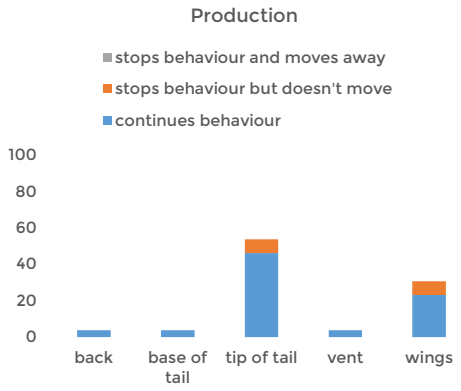
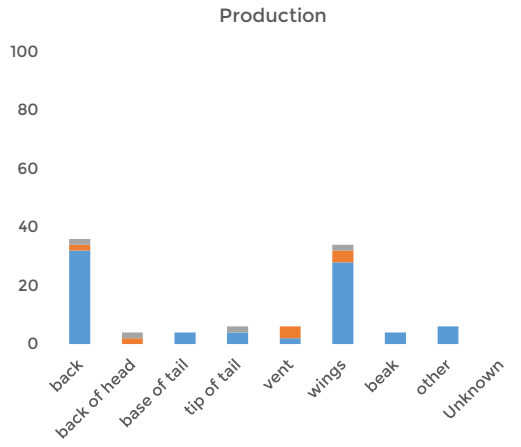
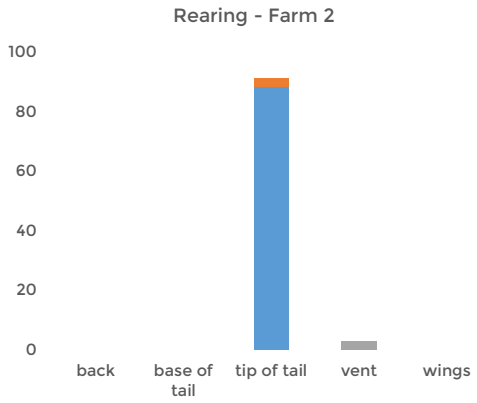
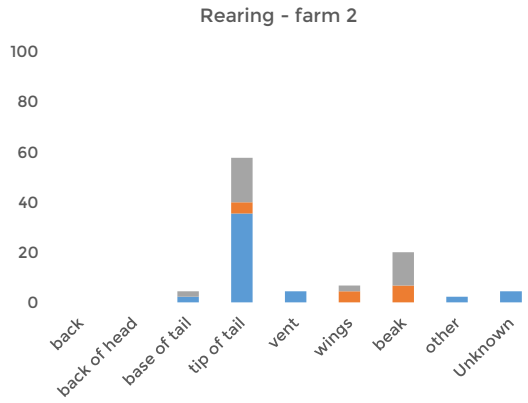


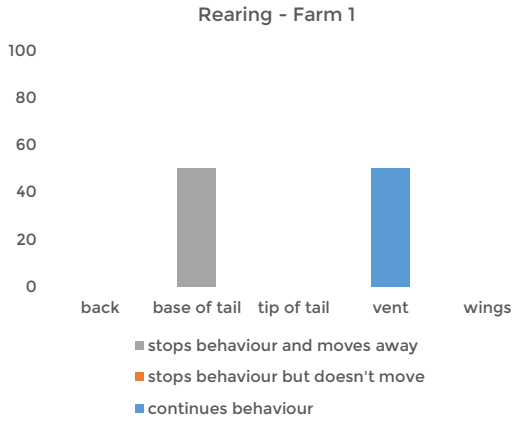
Figure 21 The proportion of FDB recipients that would continue a behaviour (blue), stop a behaviour but not move away (grey), or stop a behaviour and move away (orange) during production (top) or rearing











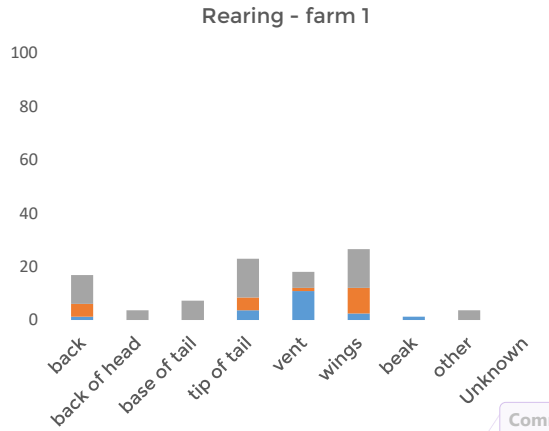


Figure 22 The proportion (%) of birds ceasing or continuing LF/FP behaviour by location on the recipient's body

Commented [WW38]: **Query 31:** Shouldn't this be Figure 22, as amended? Title also required – have drafted something here (in size 10 font to fit on the page).

Behaviour that precedes FDB

More than half (57.7%) of the behaviours that preceded FL in production flocks were inactive behaviours (resting – sitting = 34.6%; resting – standing = 23.1%) and 15.4% were preceded by preening (Figure 23). Conversely, nearly half the behaviours that preceded FLB in rearing (flock 2) were active (locomotion = 42.9%).

Figure 23 Behaviours that preceded feather licking behaviour in production and rearing flocks

Note that only two observations of FL were observed in rearing flock 1

Other feather-directed behaviours

Feather eating was only observed twice in production and four times during rearing on Farm 1. Despite much FDB in rearing flock 2, feather eating was never observed during the focal sampling. Feathers were eaten from a conspecific in 66.7% of the observations and only once (in 16.7% of observations) from the ground. There was no feather eating observed on Farm 2.

Holding a feather in the beak without consuming it was observed only during rearing; 11 times on Farm 1 and only once on Farm 2 (despite observing the most FDB in this flock).

Commented [WW39]: Query 33: Following on from the previous graphic, shouldn't this be Figure 23 (as amended)?

Commented [WW40]: Query 34: A few observations about the list of behaviours (bottom right of the graphic):

1. The text ('inactive') is truncated at sitting and standing. As per Table 6, they should also commence consistently with upper case.

2. Please consider whether the descriptors should be the same as those in the Table 6 ethogram and the preceding paragraph (i.e. 'resting – sitting' and 'resting – standing'). Important also as the ethogram is referred to again in the concluding para of Implications.

3. 'Vigilant' is not defined in the report. It is used only at Table 6, in the form of its opposite 'non-vigilant' to qualify 'resting – sitting' and 'resting – standing'. How does 'vigilant' work here as a discrete term, given that the listed behaviours appear to be mutually exclusive?

Commented [WW41]: Query 35: As this information re 'two observations' is sourced from Table 12, where it appears as for Farm 1 rather than flock 1, is any further explanation required here?

Pulling a feather from a conspecific was only observed 6 times, once during production and 5 times during rearing on Farm 1. There did not seem to be a specific area that the birds targeted when pulling a feather from a conspecific (vent, n = 1; tip of the tail, n = 2; head, n = 2).

Pulling a feather from a conspecific was never observed on Farm 2, despite a lot of FDB being observed.

In production birds, FL was gentle with short infrequent bouts. FL did not alter with age. The behaviours that preceded FL were typically inactive. Recipients did not move away in response to that feather licking behaviour but approximately 20% of the time the recipient stopped the behaviour they were performing after they were licked.

In rearing birds, particularly the cockerels from Farm 2, FL behaviour appeared to be a ***focused, rapid, and repetitive*** pecking-type behaviour, mainly directed at the tail of another bird.

From these observations, we developed two descriptions of the behaviours to distinguish the type of FL.

Feather licking

One bird takes the feather of another bird in its beak and performs a ***gentle combing or sweeping motion***, keeping the feather in the mouth for 1–4 seconds before releasing. A bout of this behaviour was one sweeping motion; occasionally the bout was repeated. This behaviour is similar to the motion when a bird is preening itself but directed at another bird.

Repetitive gentle feather pecking

One bird takes a feather from its beak, either its own or from a conspecific, and releases the feather within one second, then repeats this action more than once, forming a ***sequence of rapid, consistent pecking*** directed at itself or the other bird. The behaviour is less forceful than feather pecking and often directed at the tip of the tail feathers. The feather is not removed or eaten.

Discussion

We monitored the behaviour of 8 flocks of meat chicken breeders: four production mixed-sex flocks, and four flocks (two pullet and two cockerel flocks) during rearing. Through weekly scan samples, we observed various feather-directed behaviours including preening, feather licking, feather eating and feather pecking. Through targeted focal sampling, differences in feather licking behaviours were observed during rearing and production. Feather licking, which occurred primarily during production, involved long combing strokes that were gentle and relatively slow, and was typically observed when chickens were resting. Conversely, in one of the cockerel-rearing flocks, a gentle repetitive feather licking that targeted the tip of the tail was observed; this behaviour was typically observed when birds were active and was a rapid, consistent sequence of licking.

Feather licking differed across flocks, with gentle sweeping licking occurring in the production flocks observed in this study and a more rapid repetitive licking observed in one of the cockerel flocks. The feather licking behaviour observed in production flocks may be a redirected preening behaviour when birds are in close contact. The combing (stroking) motion of FL observed in production flocks, where the beak moves along the shaft of the feather, is clearly defined from a peck, where conversely the beak enters and leaves the same point of the body in addition to the speed of the interaction (pecking is rapid, licking is slower). Anecdotal reports of feather licking from farms often report 'wet feathers'

rather than the behaviour, which may result in confusion about flock behaviour and triggers for 'outbreaks' of specific feather-directed behaviours, such as feather pecking or feather licking.

The gentle feather pecking we identified in the current study in the cockerel flock aligns with the description of Arrazola et al. (2020) of gentle feather pecking, which the authors categorised as an abnormal repetitive behaviour (ARB). ARBs, which also include object pecking (referred to as spot pecking in the current study) and stereotypic preening, peaked in rearing between 8 and 10 weeks of age in chickens fed a quantitative restricted diet (restricted every day or a 4:3 diet; both graduated and fixed), compared to pullets that were fed a qualitatively restricted diet. However, the proportion of gentle feather pecking (as a function of ARBs) was not reported. This definition would suggest that stereotypic pecking increased in cockerels on Farm 2.

Rather than an increase in repetitive pecking between flocks in rearing, the gentle feather pecking behaviour may have been redirected from feeders (a redirected foraging behaviour) to conspecifics, as the feeder chains were raised daily in cockerel sheds, but not pullet or production sheds. Although the video observations were analysed on non-feed days, the feeders were still lowered at the same time as feed days, although they were empty. As such, the increase in spot pecking feeders during this time, and reduction in FDB seen in cockerels, could be explained by redirecting their foraging behaviours towards the feeders rather than the conspecifics, even when there was no feed present. The consequence of redirecting spot pecking from objects to conspecifics is unknown, however may lead to feather eating, feather pecking and cannibalism. An epidemiological approach is required to identify such risks. However, providing environmental enrichments that encourage pecking to be directed towards appropriate stimuli, but still allowing flexibility for producers to raise feeder lines, when necessary, could be beneficial.

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EE can reduce boredom and stress (Taylor et al. 2023), which may reduce the motivation to express ARB within a flock. However, feeding strategies to satisfy feeding motivations are likely to be more effective. Our research here suggests that EE programs should target cockerels during rearing. However, it should also be noted that providing animals with specific EEs during rearing without access to the EE in the production phase can cause significant stress (Hester et al. 2013). As such, suitable EE throughout rearing and production should be further investigated.

Implications

Continual improvements to the welfare of chickens in the meat chicken industry are critical to maintaining a social licence, as animal welfare is becoming increasingly important to consumers and the public and can dictate buying behaviour. Behavioural analysis is the first step to understanding the effectiveness of enrichment programs (i.e. there are unlikely production or health benefits if behaviour is not affected) and a reduction in abnormal behaviours itself can be a valid indicator of improvements to chicken welfare. Potential positive flow-on effects in the progeny are also anticipated. The health of meat chicken breeders, which can be compromised by stress, can dictate the health of their progeny. Therefore, reducing abnormal behaviours and stress, and improving welfare in parent flocks can have exponential effects on meat chicken performance.

Environmental enrichment (plastic-wrapped wood shavings or vertical panels) has been shown to improve egg quality (Edmond et al. 2005) and reproductive performance in breeding birds, leading to an additional 4.5 chicks/female (Leone and Estévez 2008), a significant economic benefit. Furthermore, 'welfare-friendly' products can gain access to various markets and may attract a premium (Fernandes et al. 2021). Scientific evidence, such as that proposed in the current study, can assist in supporting such claims of improved welfare.

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We provide evidence of abnormal behaviours that develop during rearing, particularly in some cockerel-rearing flocks. We also provide critical feedback from the industry regarding real-world challenges to providing environmental enrichment to meat chicken breeders. This project leads the way to develop evidence-based environmental enrichments for meat chicken breeders that target abnormal behaviour and improve the welfare of meat chicken breeders.

Additionally, this project provides commercially relevant ethogram descriptions of feather licking, pecking, and eating. Each of these behaviours is likely to be expressed in varying conditions and will have a variety of impacts on animal welfare, enabling specific interventions to be targeted accordingly. For example, nutritional interventions will likely address feather eating outbreaks but are unlikely to address feather licking. This project and clear ethogram descriptions allow producers and industry stakeholders to first understand the problem in a specific flock before trialling interventions that may be irrelevant and costly.

Recommendations

1. Ethological studies that monitor meat chicken breeder behaviour should include clear descriptions and differentiation of feather-directed behaviours; including feather licking, gentle feather pecking, severe feather pecking, and feather eating.
2. Enrichment programs should target cockerel pecking behaviours, specifically from 7 weeks of age onward.

Media and Publications

Taylor, P. S., Hemsworth, P. H., Morgan, N., & DeKoning, C. (2024). Research note: Expert opinions of feather sucking and licking behaviour in meat chicken breeder birds. *Poultry Science*, 103692.

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Poultry Hub Australia (PHA) for understanding and supporting when research moves and outcomes are realigned to ensure evidence-based decision-making. We believe this flexibility allows the researchers to adapt to what the data show as projects progress to suit the birds' and industry's needs.

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Commented [WW45]: Query 39: When there is further progress in research, or words to this effect?

About the Author

Peta Taylor is an Animal Science lecturer in the School of Agriculture, Food and Ecosystem, Sciences (SAFES) and a researcher in the Animal Welfare Science Centre at the Melbourne Veterinary School at the University of Melbourne. Peta has conducted numerous poultry behaviour and welfare research trials, predominantly on commercial farms, that are industry relevant. Peta's research aims to improve the welfare of meat chickens and laying hens, and encompasses effective environmental enrichment, free range housing systems, and abnormal behaviours such as piling and smothering. Her approach to assessing welfare includes combining ethology, physiology and neurobiology and she endeavours to understand affective states, what animals want and need and how such experiences can be provided in commercial settings.

Commented [WW46]: Query 40: 'endeavours' (as amended), or 'strives' reads better here. 'aims' is used already in the preceding sentence.

'attempts' implies an element of failure.

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Commented [WW47]: Query 41: Two observations:

1. Four references listed but not cited within the report:

Bernardino et al. 2021
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Vasseur et al. (2006)

2. With the listing of 'Breeders, R (2001) Parent Stock Management Manual: Ross 308', please see the two relevant queries within the report – Queries 8 & 12).

Commented [PT48R47]: Thanks Wayne. These should be appropriately amended now.

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