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# PROGRESSIVE FEEDING BEHAVIORS OF PULLETS WITH OR WITHOUT BEAK TRIMMING

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**Summary:** This study quantifies feeding behavior of W-98 White Leghorn pullets (1-3 weeks old) as influenced by the management practice of beak trimming. The feeding behavior was characterized using a newly developed measurement system and computational algorithm. Beak trimmed (BT) pullets and non-trimmed (NT) pullets exhibited significantly different eating behavior over the ages of 8 to 21 days with regard to meal size and meal duration. Beak-trimmed birds tended to eat larger and longer meals, although the differences between the BT and NT birds were not constant with age (significant interaction between beak type and age, $P<0.05$). No significant differences across beak types or ages were detected for ingestion rate or interval between meals. The BT and NT pullets had similar amount of daily feeding time (1.1 - 1.2 hr/day). However, the number of meals per day differed, 28 meals/day for the BT pullets vs. 35 meals/day for the NT pullets. Baseline feeding behavior information of this nature may help better quantify and ensure welfare of the animals through exercising proper engineering design or management considerations.

**Keywords:** *Animal welfare, Ingestion, Poultry, Beak-trimming*

## INTRODUCTION

The assessment of animal well-being should engage available scientific evidence concerning the feelings of the animals that can be derived from their structure, functions and behavior (Brambell, 1965). These response assessment criteria include a need for sensitivity to all stimuli, responsive over different time periods and levels of stimulus, and suitable repeatability for scientific assessment (Gates and Xin, 2001). Although many stimuli need to be included to evaluate well-being it is necessary to analyze the characteristics in individual studies to gain a better understanding of each stimulus' effect on the animal. Compilation of the fundamental data can then be applied to management practices to possibly improve the welfare of animals.

Beak trimming is a common practice in the poultry industry. Producers could possibly lose up to 25-30% of pullets due to cannibalism and vent pick-outs if a beak trimming program is not implemented (Glatz, 1990). Pullets that are beak trimmed are less active and feeding behavior is depressed 1 wk after the removal of one-half of the beak (Kuo. et al., 1991). This type of behavior can last beyond 18 weeks of age. An alternative to beak trimming as suggested by Glatz (2000) is an effective light program. However, if a breakout should occur it may be impossible to control cannibalism thereafter. Persyn (2003) provided a detailed review of literature regarding beak trimming.

In the past video recording and analysis has been used to monitor feeding behavior of pullets. However, this methodology is time-consuming, costly, tedious and prone to errors (Gates and Xin, 2001). By using the electronic measurement system and computational algorithm developed by Xin and Ikeguchi (2001, unpublished report), feeding behavior of pullets can be quantified, including the number of meals, meal size, meal duration, ingestion rate and meal intervals. Collection of such behavioral information represents an attempt toward searching for an objective, quantitative, and non-invasive means to measure animal welfare, which continues to challenge the academic community and the animal industry alike. The objective of this research was to comparatively quantify feeding behavior of pullets with or without beak trimming, which could reveal information about management or design decisions that would lead to enhanced animal welfare.

## MATERIALS AND METHODS

### System Set-Up

The testing room (4.6L × 2.7W × 2.6H m) used for this study was environmentally controlled. The thermal conditions were monitored and recorded every 5 minutes with portable data loggers (HOBO H8 Pro Series RH/Temp. Onset Computer Corp, Pocasset, MA, USA[1]) and a temperature/RH probe (Model HMP35C, Campbell Scientific Inc., Logan, UT, USA) placed in the testing room. A thermoneutral air temperature of 28°C (± 1°C) was vented into the room and maintained by a computer monitoring system. Minimum ventilation rates were used in the room in addition to 4 humidifiers (Vicks® Vaporizer, Kaz) to achieve a desired RH of 30-40%. About 5 lx of illumination throughout the testing rooms was provided for an 18-hr light period (9:15PM to 3:30PM). The illumination at bird level was periodically checked with a digital light meter (model DLM2, Cole Parmer Instrument Co., Vernon Hills, IL).

The experimental pullets were housed individually in 2 rows of 7 wire-mesh cages. The cages provided a floor space of approximately 498 $cm^2$. Each cage was equipped with a nipple drinker. All-purpose (12-gauge) wire in 2.5 cm spacing was attached vertically to the front of the cage to provide the pullets' access to the feed (fig. 1). Plastic feeders measuring (14L × 14W × 9H cm) with a u-shaped access opening were attached to 10 electronic balances (2200 ± 0.1 g, model GX 2000, A&D Company

[1] Mention of vendor or product names is for presentation clarity and does not imply endorsement by the authors or their affiliations, or exclusion of other suitable products.

Limited, Tokyo, Japan) by Velcro® strips (Fig. 1a). Cages occupied by spare pullets had feeders positioned and attached to the front of the cage to not interfere with the electronic scales.

The electronic balances each had an analog output of 0-2.2 VDC corresponding to the weighing capacity, which was connected to the electronic data logger (model CR10X, CSI, Logan, UT, USA). The balances had an automatic response adjustment that adapts to vibration and drafts in the environment. The balances were set to continuous comparison mode, which included near zero readings. Balance sample readings were recorded at 1 s intervals. The data were then automatically retrieved to a PC every 2 hr using the PC208W program (CSI, Logan, UT, USA) and the resultant files were saved and backed up once every 24 hr.

Four video cameras (Panasonic, wv-CP410) were used to continuously monitor and record the birds' duration and frequency at the feeders in the testing room. Camera 1 was focused on an entire row of pullets. The second and third cameras viewed one beak trimmed pullet and one non-trimmed pullet, respectively. Camera 4 shared a full picture of neighboring pullets with different beak types. Images from the four cameras were displayed on a color video monitor via a Quad System (Panasonic, WJ-420) and were recorded on a time-lapse VCR (Panasonic, AG-6730, recording speed of 72 hr/tape), as depicted in Figure 1b. Because viewing these video recordings is time-consuming and tedious, the recordings were selectively used for algorithm validation purposes only, or back-up in case of uncertainty with the recorded feeder data.

**Experimental Pullets**

Hy-Line W-98 White Leghorn pullets at an initial age of 8 days were procured from a cooperating company in Iowa. There were a total of 18 pullets of which 9 were non-trimmed (NT) in the control group and the other 9 pullets were beak trimmed (BT). The BT pullets were trimmed 2 mm (on day 8) from the nostrils as recommended by Hy-Line (2002), just prior to being brought to the Livestock Environmental and Animal Physiology (LEAP) Lab II at Iowa State University. During the first day body mass was recorded and the pullets were labeled with an identification number written on their wing band. Upon arrival in LEAP II and allocation to the cages, monitoring of feeding behaviors began and continued for the next 14 days. Feed use was monitored daily and individual feeders were refilled between 10:00-10:50 am. At the end of the trial, body mass was recorded again.

**Analysis of Feeding Characteristics**

Ingestion characteristics of the pullets and the differences between beak-trimmed and non-trimmed birds were evaluated using the analysis protocol developed by Xin and Ikeguchi (unpublished report, 2001), including meal size (MS, g/pullet), meal duration (MD, s), ingestion rate (IR, g/min-pullet), and meal interval (MI, s). In order to measure the feeding characteristics of interest, it was necessary to determine the beginning and ending time of each meal as well as the weight of the feed on the scale before and after each meal. A threshold of 0.2 g in feeder weight change was used for determination of a true feeding event. A time span of at least 15 s during which the recorded feed weight remained stable was used to define the break between two adjacent feedings/meal events. Daily feed use values as determined from the algorithm and the manual weighing of the feeders in the beginning and end of the day were within 5%. Samples of feeding event signals are shown in Figure 2. The feeder weight data recorded during the hours after 3:30PM and before 9:15PM were excluded from the analysis due the inactivity of the pullets when the lights were off.

MS, MD, IR, and MI distributions were heavily skewed to the right for each bird. Thus statistical analysis of the ingestion characteristic data was conducted on the natural logarithm scale to dampen the effect of rare but large outlying observations and to obtain roughly constant error variance as required by our statistical analysis methods. A mixed linear model analysis was conducted for each ingestion characteristic using the *mixed* procedure of Statistical Analysis System (SAS) version 8.2. The model included terms for the fixed effects of beak type (NT vs. BT), age (8 to 21 days), and interaction between beak type and age. Also included in the model were random effects for bird nested within beak type and the interaction between age and bird nested within beak type. This is a standard mixed linear model that allows for correlation among the observations that come from a single bird as well as additional correlation among observations that come from a single bird on a single day. In addition to the analysis of the MS, MD, IR, and MI data, initial body mass, final body mass, daily feed use, number of meals per day, and total time spent on feeding were measured for each pullet and analyzed by two-sample t-tests to check for statistically significant differences between BT and NT pullets.

## RESULTS AND DISCUSSION

The comparative feeding characteristics of the pullets with each beak type are summarized in Tables 1 and 2. The frequency distributions of each feeding characteristic are presented in Figure 3 (MS), Figure 4 (MD), Figure 5 (IR), and Figure 6 (MI), respectively. Figures 3-6 cumulatively reflect at least 90% of the data points. By graphically excluding the top 10% or less in some cases, it allows for the more intriguing or highest frequencies to be emphasized.

Table 2 contains the p-values for assessing the significance of beak type, age, and beak-type-by-age interaction effects for each of the ingestion characteristics (MS, MD, IR, and MI). The significance of the beak-type-by-age interaction effect for MS indicates that the effect of beak trimming on meal size is not constant throughout ages 8 to 21 days. In particular, Figure 7 suggests that the difference between the meal sizes of BT and NT birds tended to be larger around 12 days of age than around 8 or 17 days of age. The significance of the beak type effect for MS indicates that, if we ignore interaction and average over days, the BT pullets tended to have larger MS than NT pullets. Because there is significant interaction between beak type and age, this is not necessarily the case for all ages; for example, Figure 7 suggests that the BT pullets tended to have larger MS at 9 days of age. Similarly, if we ignore interaction and average over beak types, the significant age effect indicates that the MS distribution did not remain constant across age. This is consistent with what appears in Figure 7 to be a slight trend toward increased MS with increased age. P-values less than 0.05 for the comparison of beak types at each age are also shown on Figures 7-10 (P-values larger than 0.05 are denoted NS to indicate no significant difference at the 0.05-level). These P-values provide additional descriptive information about ages where trimmed and non-trimmed pullets seem to differ most.

The results for MD in Table 2 and Figure 8 can be interpreted much like the results for MS. This is not surprising because MS and MD are naturally positively correlated. (Within-bird correlations between MS and MD range from 0.31 to 0.49; all are statistically significant at the 0.001 level.) No significant effects were detected for IR or MI although there is weak evidence of age and interaction effects for IR.

## CONCLUSIONS

The beak-trimmed (BT) pullets seemed to have different ingestion behavior as compared with the non-trimmed (NT) pullets during the two weeks immediately following beak trimming at 8 days of age. The biggest differences in meal size and meal duration existed during the week immediately after trimming. The BT pullets tended to have larger meal sizes, longer meal durations, and slightly slower ingestion rates than the NT pullets. BT and NT pullets spent a similar amount of time at the feeder per day. Both BT and NT pullets had similar daily and cumulative feed intake during the testing period.

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Table 1. Average body mass, daily feed use, number of meals per day and total hours spent on feeding per day for the non-trimmed or beak trimmed pullets.

| Body Mass and Feeding Characteristics | Non-Trimmed | | Beak Trimmed | | P-Value* |
|---|---|---|---|---|---|
| | **Mean** | **SE** | **Mean** | **SE** | |
| **Initial Body Mass, g** | **70** | **<0.001** | **70** | **0.007** | **NS** |
| **Final Body Mass, g** | **200** | **0.005** | **180** | **0.01** | **NS** |
| **Daily feed use, g/hen****| **20.1** | **0.4** | **18.6** | **1** | **NS** |
| **Number of Meals/day**** | **35** | **1** | **28** | **2** | **0.006** |
| **Total time spent on feeding, hr/day**** | **1.1** | **0.1** | **1.2** | **0.1** | **NS** |

* *NS: Means not significantly different.*

** *Averages over the period of 8-21 days of age*

Table 2. P-values for testing the significance of beak type, age, and beak-type-by-age interaction effects for each of the ingestion characteristics. Values in bold are significant at the 0.05 level.

| Ingestion Characteristic | Beak Type | Age | Interaction |
|---|---|---|---|
| **Meal Size, g/meal-pullet** | **0.0003** | **0.0188** | **0.0403** |
| **Duration, s/meal** | 0.0517 | **0.0051** | **0.033** |
| **Ingestion Rate, g/min-pullet** | 0.1058 | 0.0606 | 0.0627 |
| **Interval, s** | 0.1134 | 0.2679 | 0.6085 |

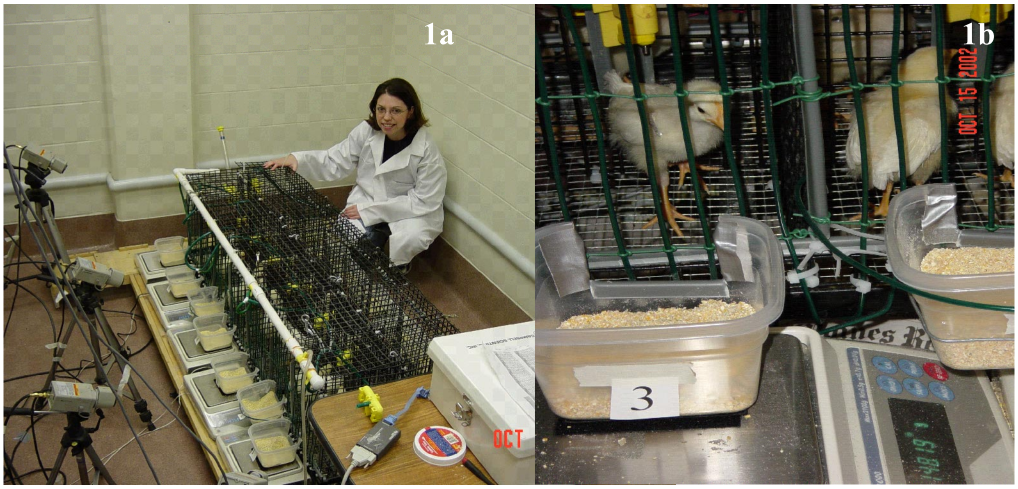



Figure 1. a) Photographic view of the testing room showing ten individual feeding stations and monitoring video cameras, b) Close-up view of feeding station.

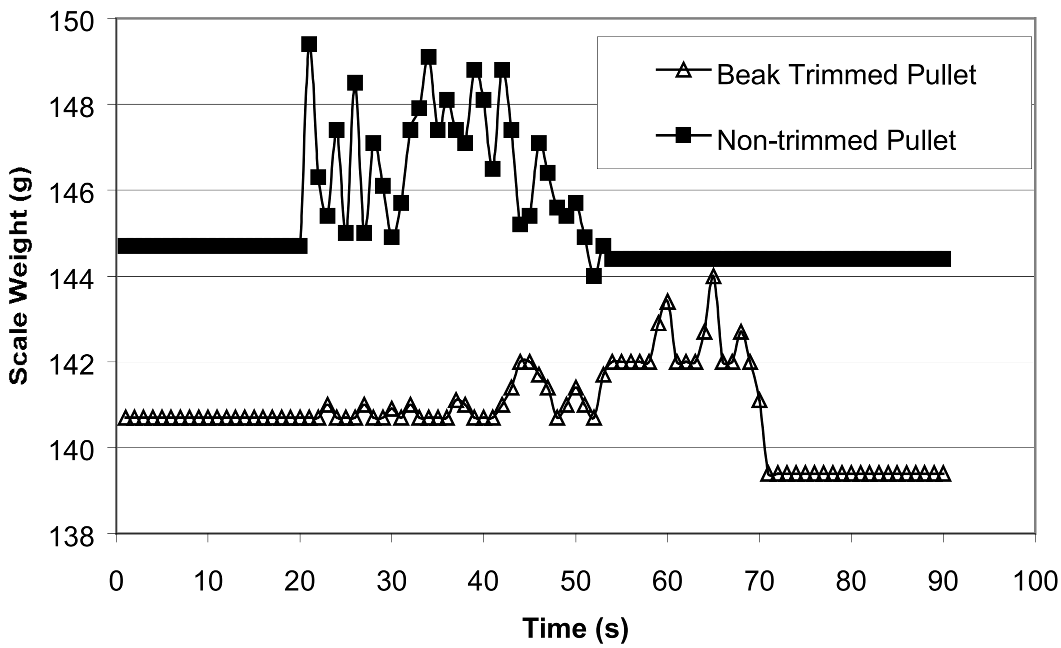



Figure 2. Sample raw data of feeder weight associated with feeding events of the pullets.

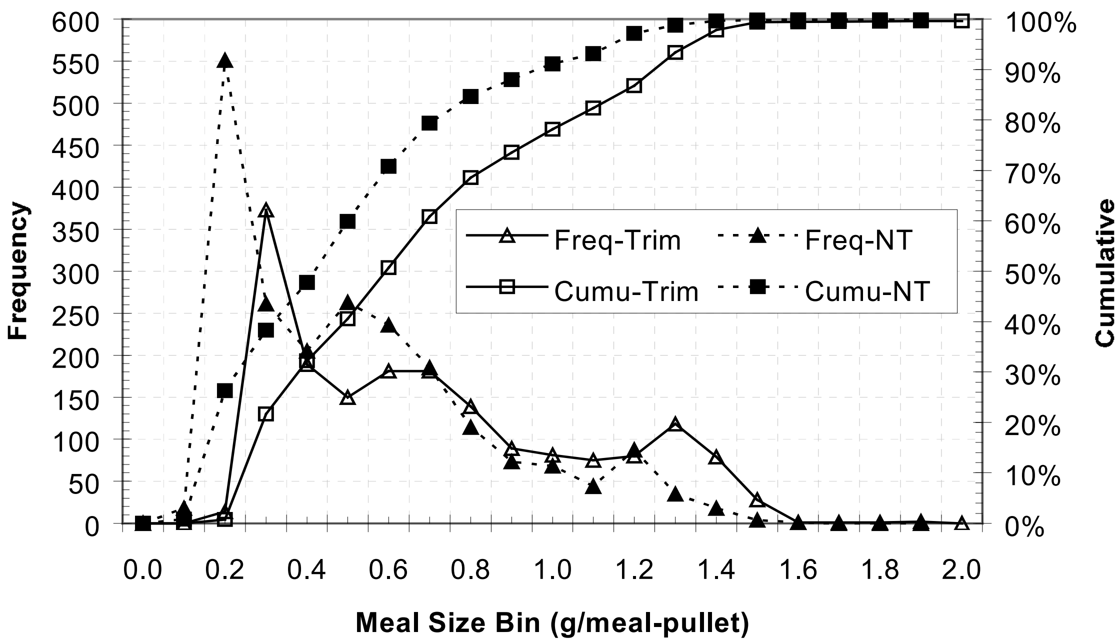



Figure 3. Frequency distribution of meal size for laying hens with trimmed or non-trimmed beak, based on 14-day feeding data of 5 hens per beak type (18L: 6D)

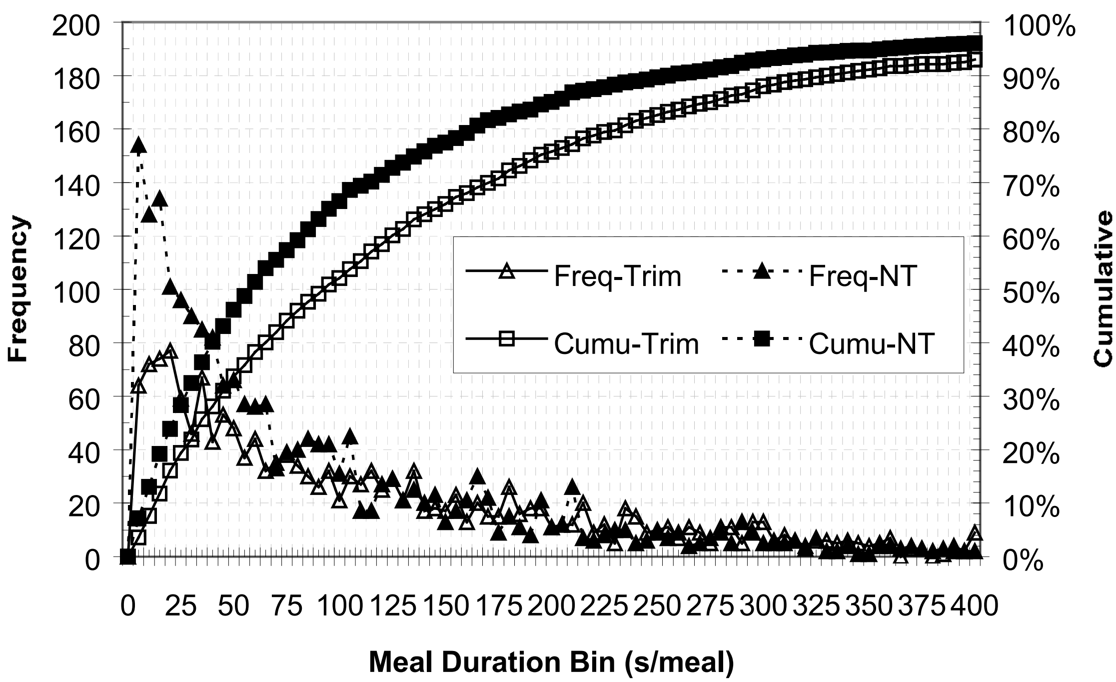



Figure 4. Frequency distribution of meal duration for laying hens with trimmed or non-trimmed beak, based on 14-day feeding data of 5 hens per beak type (18L: 6D).

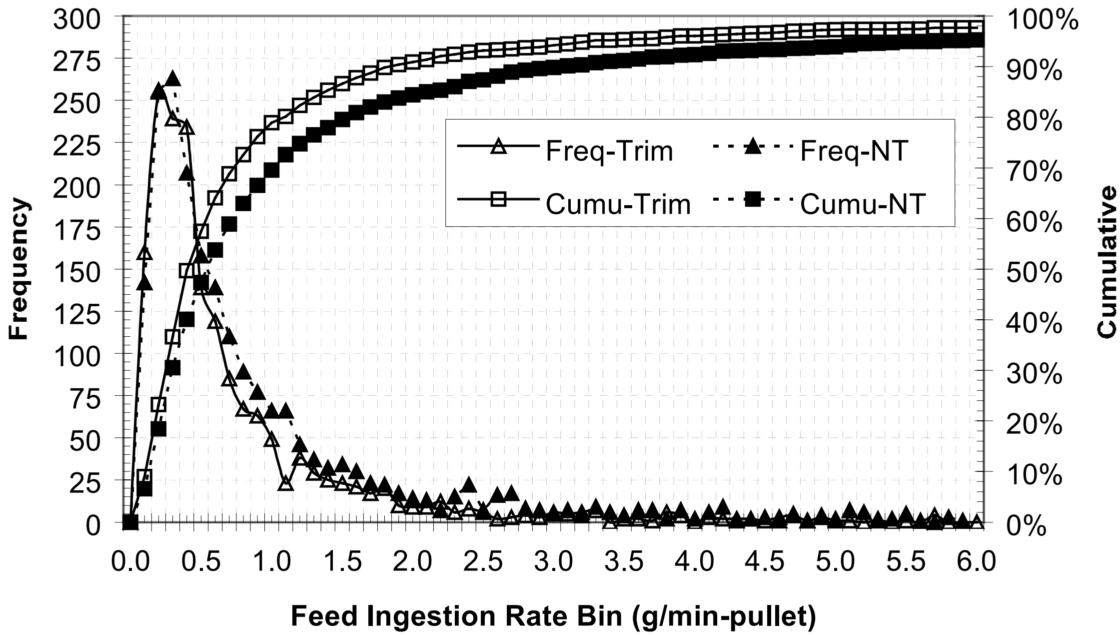



Figure 5. Frequency distribution of ingestion rate for laying hens with trimmed or non-trimmed beak, based on 14-day feeding data of 5 hens per beak type (18L: 6D).

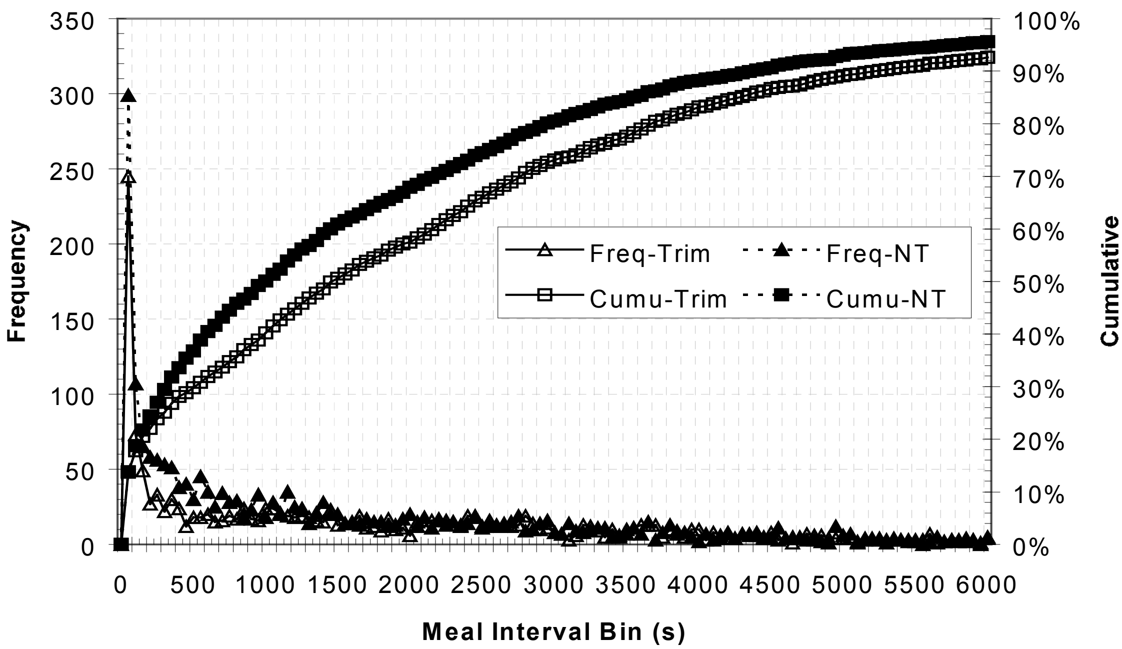
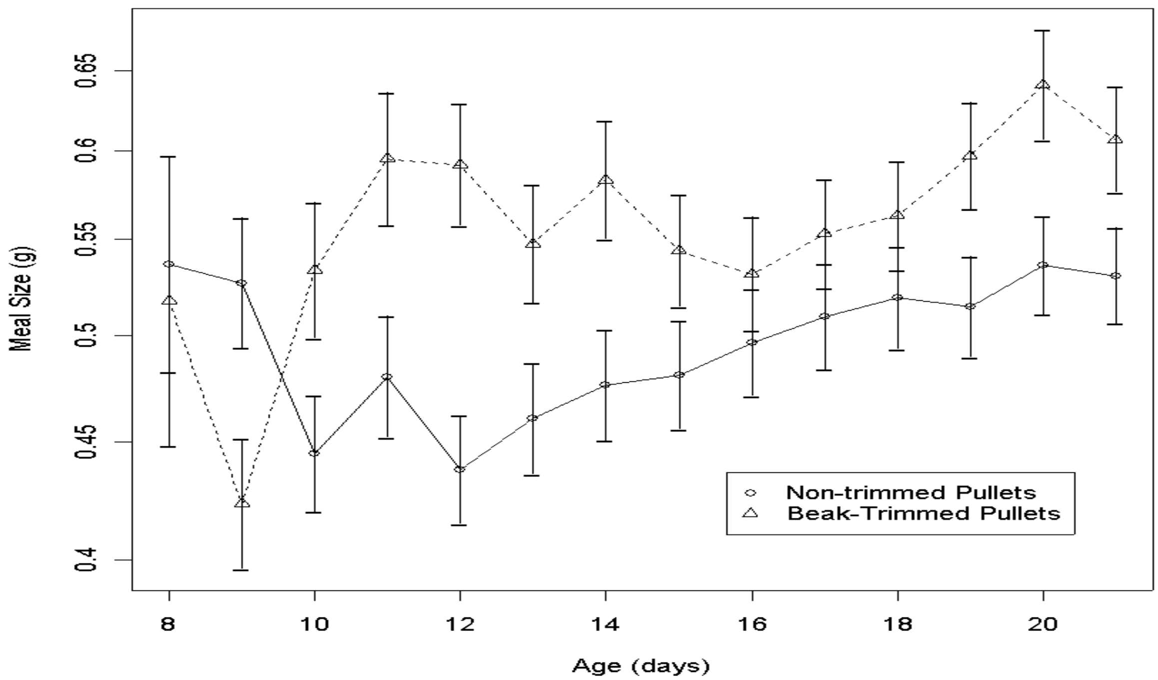
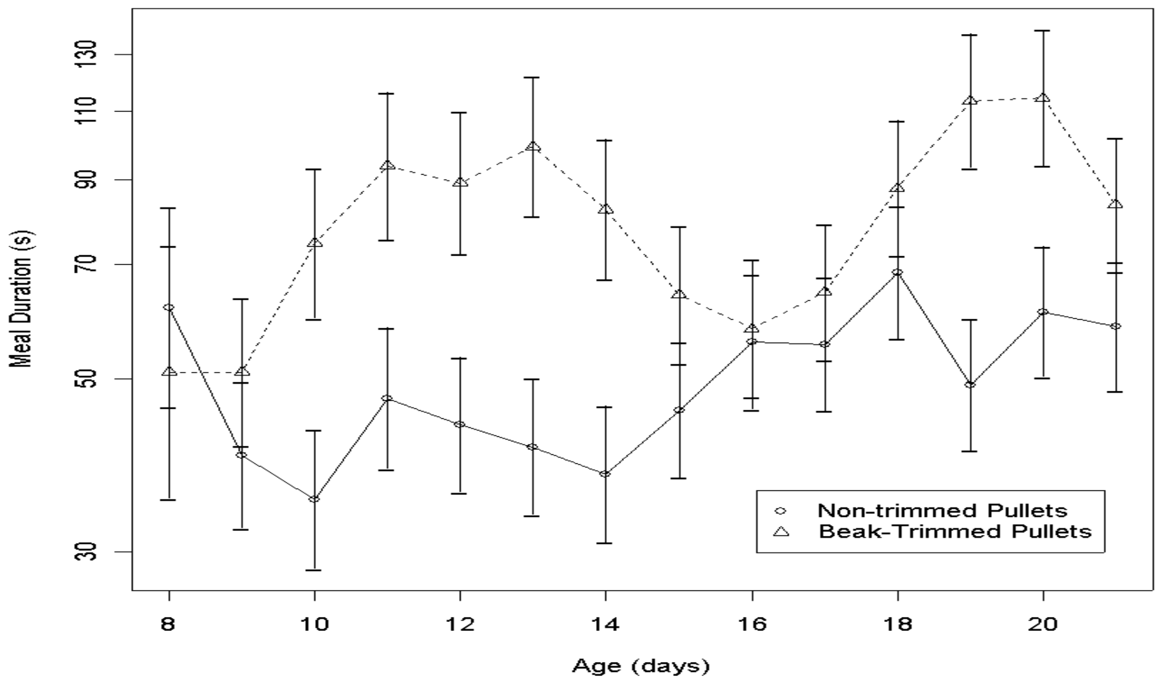



Figure 6. Frequency distribution of meal interval for laying hens with trimmed or non-trimmed beak, based on 14-day feeding data of 5 hens per beak type (18L: 6D).



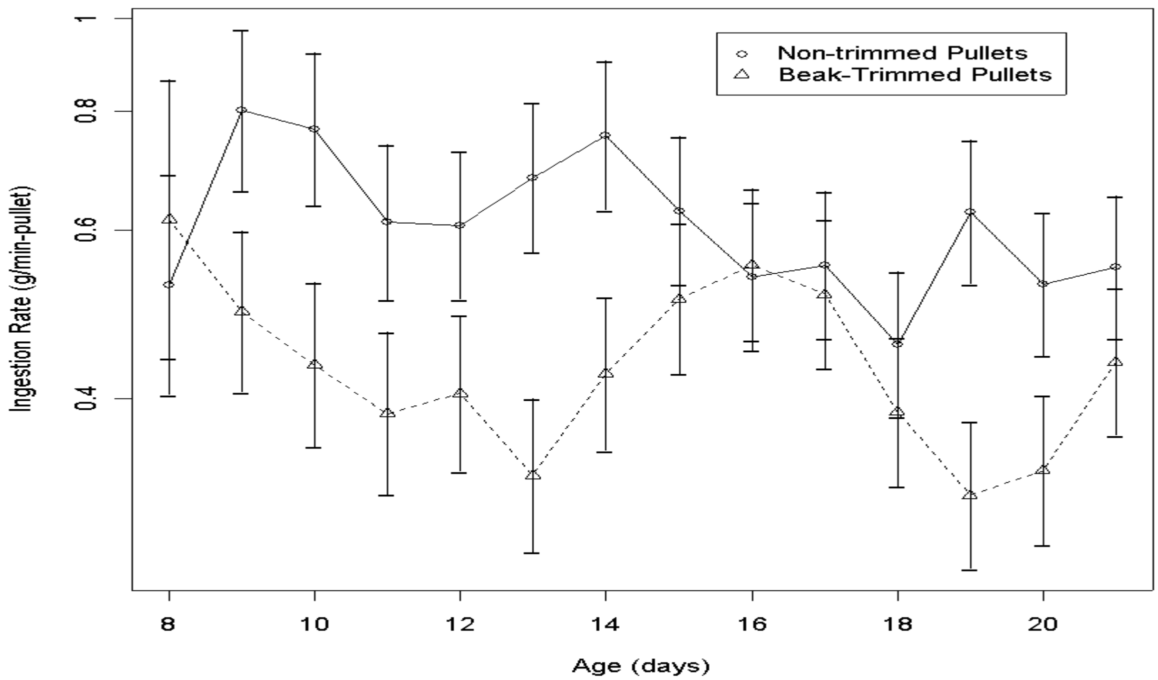

| Age, d | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P-value | NS | 0.02 | 0.04 | 0.02 | <0.01 | 0.03 | 0.01 | NS | NS | NS | NS | 0.04 | 0.02 | NS |

Figure 7. Estimated means of log meal size plus or minus one standard error computed from five non-trimmed and five beak-trimmed pullets from 8-21 days of age. The vertical axis is labeled in the original units for ease of interpretation. The P-values correspond to the t-tests for differences in beak type at each age. P-values greater than 0.05 are reported as NS to indicate non-significance at the 0.05 level.



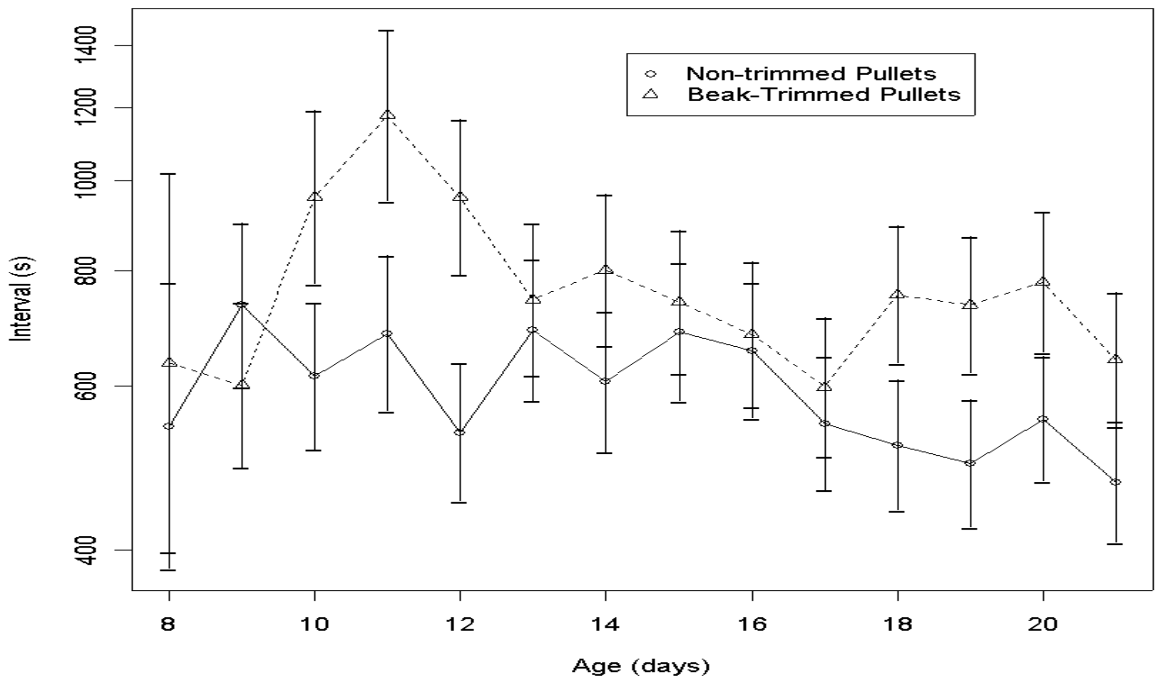

| Age, d | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P-Value | NS | NS | 0.02 | 0.03 | 0.02 | 0.01 | 0.01 | NS | NS | NS | NS | 0.01 | 0.04 | NS |

Figure 8. Estimated means of log meal duration plus or minus one standard error computed from five non-trimmed and five beak-trimmed pullets from 8-21 days of age. The vertical axis is labeled in the original units for ease of interpretation. The P-values correspond to the t-tests for differences in beak type at each age. P-values greater than 0.05 are reported as NS to indicate non-significance at the 0.05 level.




| Age, d | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P-value | NS | NS | 0.05 | NS | NS | 0.01 | 0.04 | NS | NS | NS | NS | 0.01 | NS | NS |

Figure 9. Estimated means of log meal duration plus or minus one standard error computed from five non-trimmed and five beak-trimmed pullets from 8-21 days of age. The vertical axis is labeled in the original units for ease of interpretation. The P-values correspond to the t-tests for differences in beak type at each age. P-values greater than 0.05 are reported as NS to indicate non-significance at the 0.05 level.




| Age, d | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P-value | NS | NS | NS | NS | 0.03 | NS | NS | NS | NS | NS | NS | NS | NS | NS |

Figure 10. Estimated means of log meal duration plus or minus one standard error computed from five non-trimmed and five beak-trimmed pullets from 8-21 days of age. The vertical axis is labeled in the original units for ease of interpretation. The P-values correspond to the t-tests for differences in beak type at each age. P-values greater than 0.05 are reported as NS to indicate non-significance at the 0.05 level.

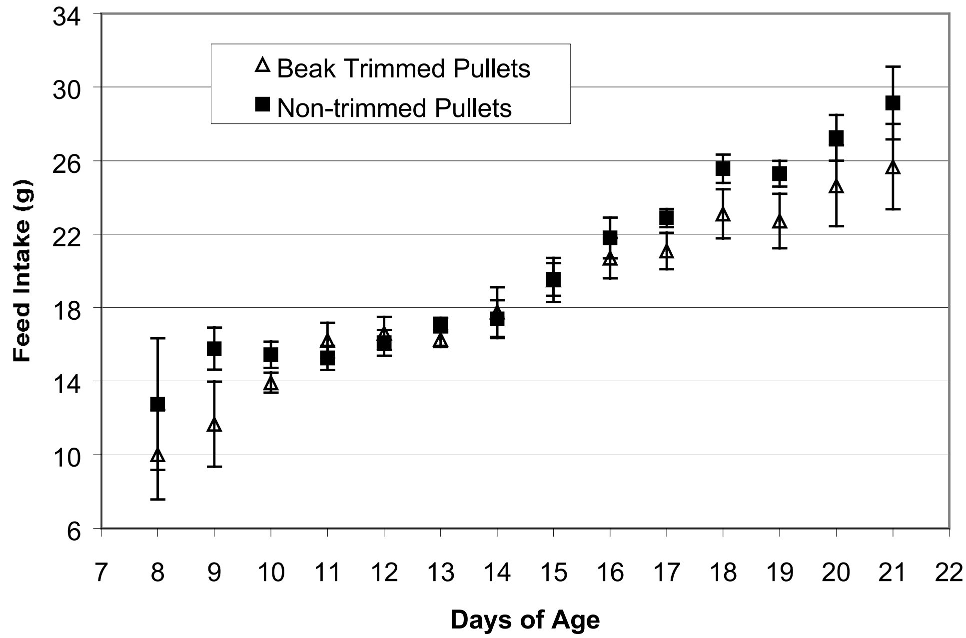



Figure 11. Daily feed intake and standard error of the mean for five non-trimmed or five beak trimmed pullets from 8-21 days of age.

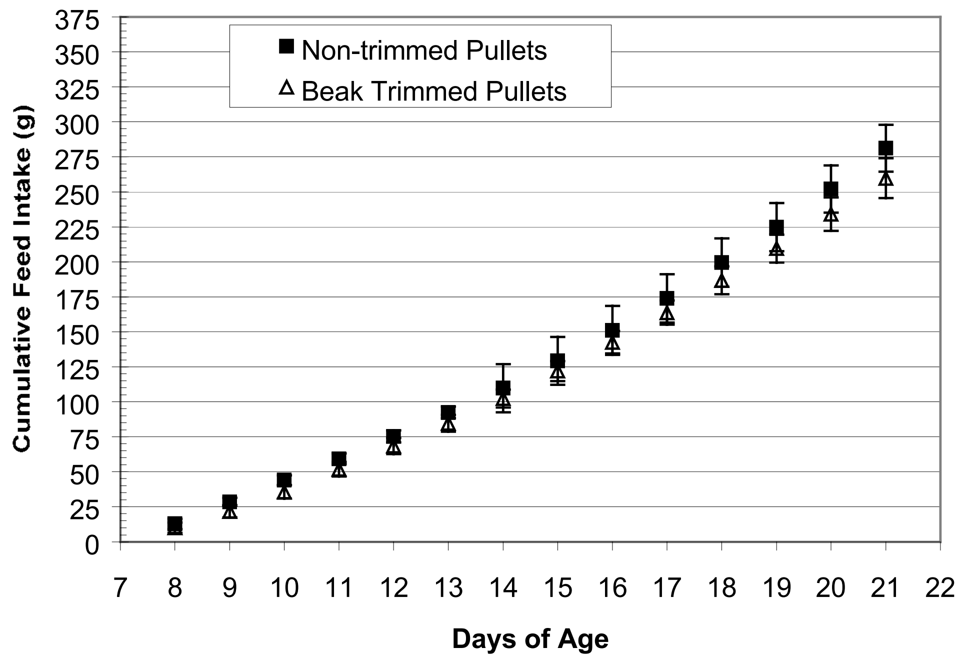



Figure 12. Cumulative feed intake and standard error of the mean for five non-trimmed or five beak trimmed pullets from 8-21 days of age.