

Progress Report on USDA-WRIPM Project

“Economic Analysis of Host-based Ectoparasite Control”

Investigators: B. A. Mullens (Entomology, UC Riverside), D. R. Kuney (UCCE, UC Davis), J. A. Mench (Animal Science, UC Davis), N. O’Sullivan (Hyline International, Dallas Center, Iowa)

Report Date: 17 October 2008

The Problem: Control of ectoparasitic lice and mites on hens is now exclusively via chemicals, and resistance, registration issues and societal pressures are rendering them much less effective. Animal welfare issues simultaneously are changing how animals are housed and handled (e.g. the current California Proposition 2). This includes the welfare concern regarding beak-trimming. We have evidence that beak-intact hens can modulate their own ectoparasite populations through grooming, possibly lessening or eliminating the need for chemical treatment and helping defuse the animal welfare issue. The present studies examine comprehensively the economics of production by beak-intact versus trimmed hens that are challenged by ectoparasites. If hens can control their own parasites below a level of economic damage, this will stimulate industry efforts to develop and use more docile strains that can be held without trimming.

Progress to Date:

The study was designed for 2 years (2006-2008). All the trials have been done on schedule. We requested a no-cost extension for a third year to continue working on the statistical analyses, which are quite involved, and to complete the hen behavior monitoring. The behavior monitoring is being done in Joy Mench’s laboratory at UC Davis and is going well.

The basic experimental unit is a pair of hens in a cage; producers do not use single hens in cages. These are arranged in separate but identical poultry houses according to the parasite treatment (uninfested controls, the body louse *Menacanthus stramineus*, or the northern fowl mite *Ornithonyssus sylviarum*), since the possibility of contamination is too high to risk running the parasite treatments in the same house. Hens were Hyline’s W36 (now CV20), a popular commercial strain developed for its docile nature and production characteristics. We raised the hens from 1-d old chicks until they entered a trial at about 20 weeks of age, providing them with a full range of normal vaccinations and beak-trimming them (or not) in order to compare that effect. There thus were 6 treatments: Beak-intact controls, trimmed controls, intact with lice, trimmed with lice, intact with mites, and trimmed with mites.

There were 6 cages (12 hens) per trial per treatment, and the entire experiments were done 3 times (fall 2006, spring 2007 and spring 2008). Each trial ran for 10 weeks, 7 days per week. The response variables include hen body weights, weekly egg numbers, individual egg weights, weekly egg mass, consumed feed, spilled feed, weekly feed conversion (every gram of feed is accounted for as consumed or spilled), and packed cell volume (a rough measure of anemia). Soon we will have measures of 20 behavioral variables as well, quantified to provide both frequency and body-site specificity with regard to grooming and certain important behaviors such as feeding or aggressive pecking. Hens were filmed before parasites were added (week 1) and at 2, 6 and 10

weeks. We have temperature data every 30 min.

An additional trial was done in fall 2007 to test age of beak-trimming (normal 1 week trim versus trimming at about 8 weeks of age, which some producers do use). We did get sufficient ectoparasite population information from this trial to determine that time of beak-trimming does not have a major impact on ectoparasite numbers over time, although the analyses are ongoing. Halfway through the 10 week trial, however, the hens decreased feed consumption and stopped laying eggs, although there was no mortality. This of course was very worrisome to us. The problem eventually was traced to a bad batch of feed we had bought from a large commercial mill, which had no detectable sodium (a huge mistake for a mill to make). Needless to say, this was infuriating and caused the almost total loss of that particular trial as an economic assessment. The main 3 trials do stand nicely on their own, and all used hens beak trimmed at 7-10 days of age, the industry standard.

We are attaching some representative graphs which convey the general findings, pending ongoing multivariate (nonlinear mixed models) data analyses. The analysis so far runs to 414 pages! When complete these analyses will be the most detailed ever done with poultry ectoparasites.

Results:

Beak-intact hens in general were heavier than their trimmed counterparts, despite the early trimming we did. This increased body weight was correlated with larger eggs, but also with higher overall laying rates (as shown for all 3 trials pooled in Fig. 1). The intact hens also came into production slightly earlier, as can be seen in the egg production at weeks -2 and -1 (Fig. 1). Beak-intact hens also spilled about 50-150 g more feed per week than trimmed hens did (data not shown), an effect well known to producers and one reason almost all of them trim even the W36. For consumed feed, however, the feed conversion efficiency was similar or slightly better (lower values are better conversion of feed to egg mass) for the intact hens than for the trimmed ones (Fig. 2). This entered into the economic calculations, as seen below.

Ectoparasite trends over time were similar among trials. The overall (all trials) trend for mites is shown in Fig. 3 and for lice in Fig. 4. First, one sees the extremely clear difference in ectoparasite numbers for intact versus trimmed hens, in agreement with most of our previous (unpublished) trials. Second, one sees mites peak at 4-5 weeks and then decline. This is due to the immune system engaging and controlling the mites. However, the immune response itself “costs” the hen substantially in terms of resources, and in fact we feel is largely responsible for the economic damage in commercial flocks (Mullens et al., *Vet. Parasitology*, in press). The lice, on the other hand, tend basically to increase steadily through the test period, with a possible decline by week 10.

The hens in trial 3 were heavier than hens in trials 1 and 2, which were rather light anyway by commercial standards (data not shown). While louse numbers were entirely consistent among the 3 trials, mite numbers were distinctly higher in trial 3, most notably on the beak-intact hens (Fig. 5). This was surprising, and we need to look closely at the videos to help interpret this. However, we suspect the much larger hens were more crowded in the same-size cages used in trials 1 and 2. Even the beak-intact hens therefore may have been prevented from grooming properly, and of course there are many other possible interactions with stress, food competition etc.

In general (all 3 trials pooled), one could see what appear to be reductions in feed conversion efficiency (higher numbers), particularly for mites on beak-trimmed hens (Fig. 6). These were most evident during the period when the immune system was actively engaging and reducing mite numbers (Fig. 3), from weeks 4-9. This makes sense from the standpoint of resource utilization and limitation, as suggested earlier. One also sees reductions in egg numbers (and to some extent size- those data not shown), particularly for mites on trimmed hens during this period of infestation (Fig. 7).

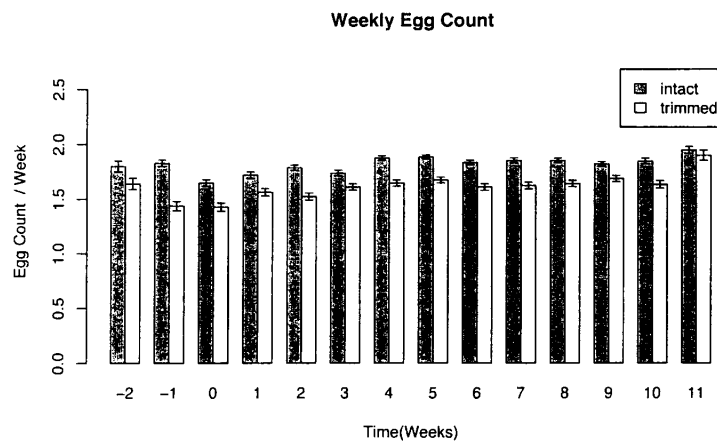


Fig. 1. Daily number of eggs per cage (2 hens) for beak-intact versus beak-trimmed hens (all 3 trials and all treatments pooled), presented by week of the trial.

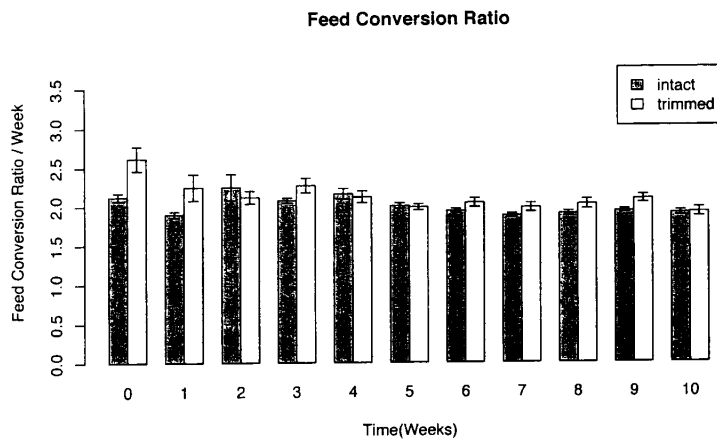


Fig. 2. Feed conversion ratios (grams of consumed feed per gram of egg mass) for beak-intact versus beak-trimmed hens (all trials and treatments pooled).

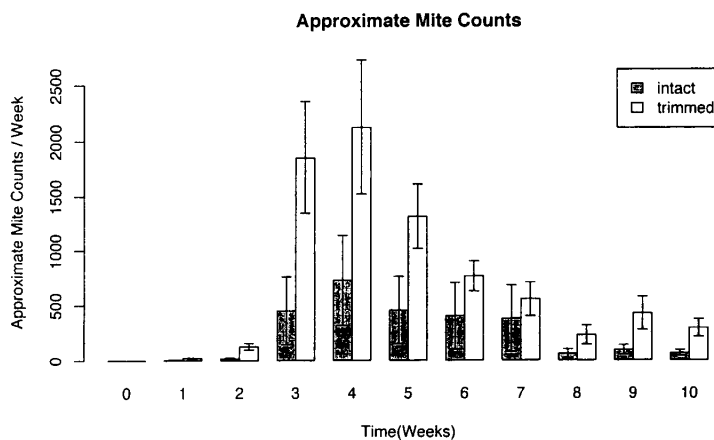


Fig. 3. Mite counts (trials pooled) based on back-converted mite visual scores (approximated) for hens first infested on week 1. Hens were beak-intact or beak-trimmed.

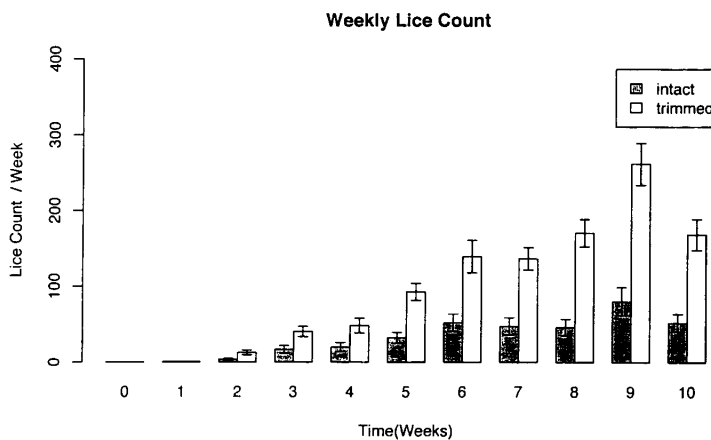


Fig. 4. Louse counts for beak-intact versus beak-trimmed hens for all trials pooled versus time; hens infested at week 1.

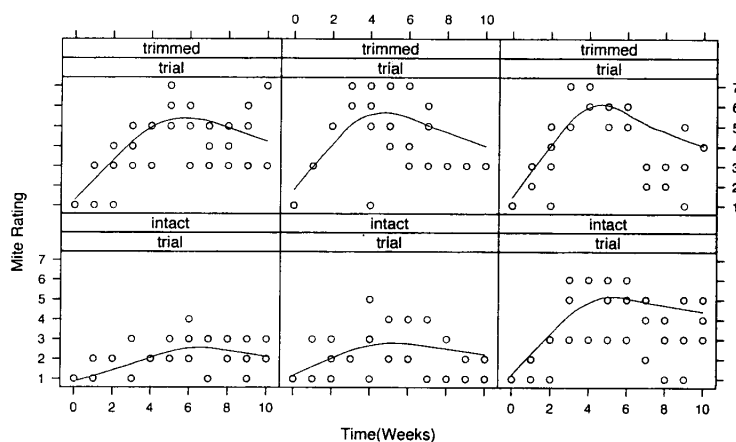


Fig. 5. Mite counts (many overlapping values not shown) and statistically-fitted curves for hens in three trials; trimmed hens above and intact hens below.

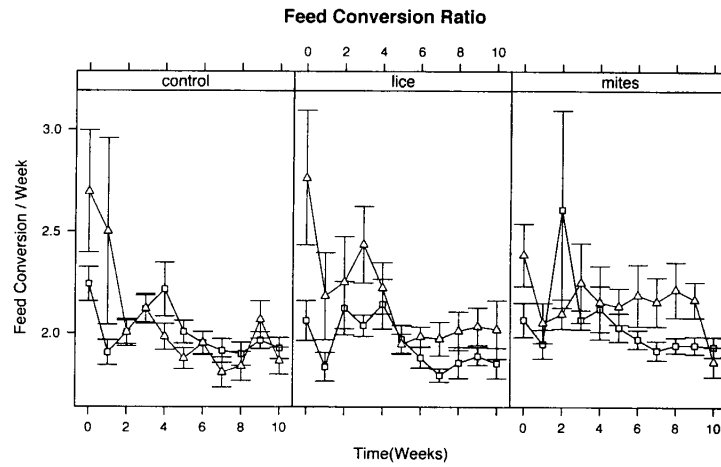


Fig. 6. Feed conversion ratios (based on consumed feed) for all 3 trials with beak-intact (square symbols) and beak-trimmed (triangles) hens exposed to lice, mites, or uninfested.

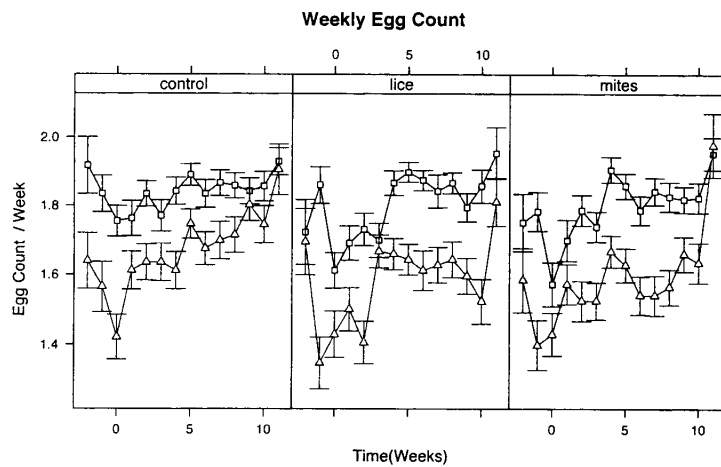


Fig. 7. Daily number of eggs per cage (2 hens) for beak-intact versus beak-trimmed hens (all 3 trials pooled), presented by week of the trial.

Economics of Production:

Flock Performance Indexing (FPI) was done of each of the 6 treatments and for each experiment. Summary data are shown in the following figures, in the order egg production, egg weight, feed conversion efficiency, and profit (gross income). These are preliminary and will be adjusted more carefully for current market prices at the time of the test and for different basic scenarios (High feed costs and low egg prices, high feed and high prices, low feed and low prices, and low feed and high prices). Currently they are at least all on the same scale and thus show some interesting trends.

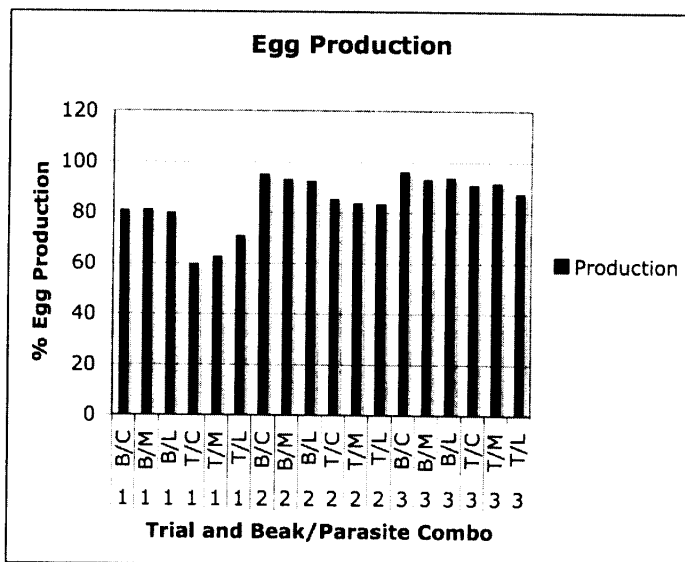


Fig. 8. Average weekly egg production (10 week period) for each of 3 trials exposing beak-intact (B) or beak-trimmed hens (T) to no parasites (control, or C), Lice (L) or Mites (M).

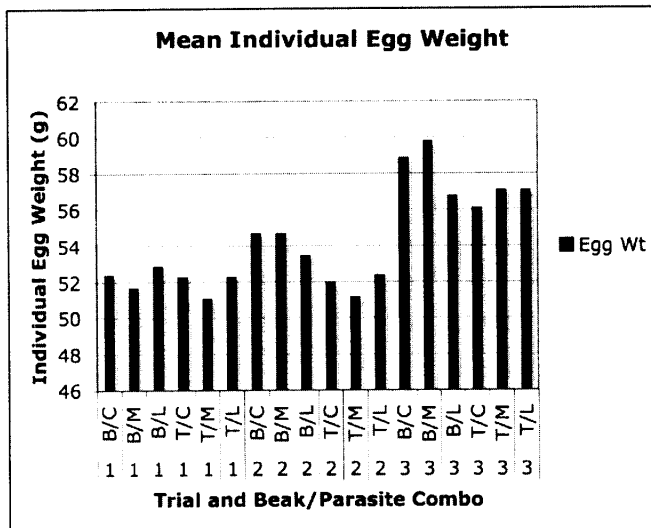


Fig. 9. Average individual egg weights (10 week trials) for each of 3 trials exposing beak-intact (B) or beak-trimmed hens (T) to no parasites (control, or C), Lice (L) or Mites (M).

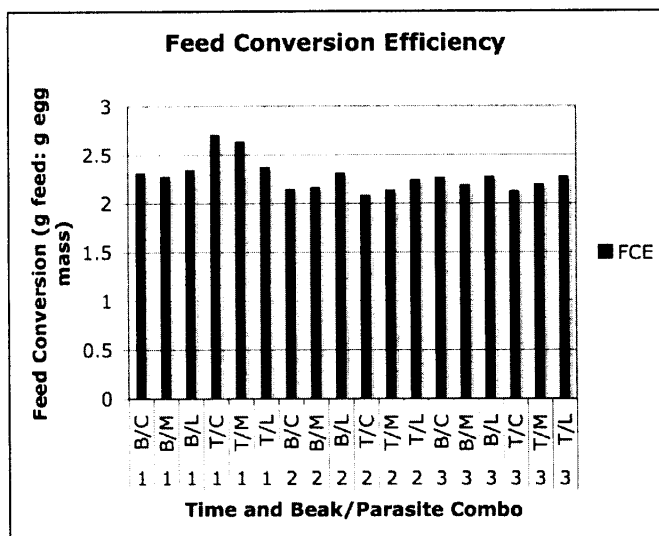


Fig. 10. Average weekly feed conversion efficiency (10 week trials) for each of 3 trials exposing beak-intact (B) or beak-trimmed hens (T) to no parasites (control, or C), Lice (L) or Mites (M).

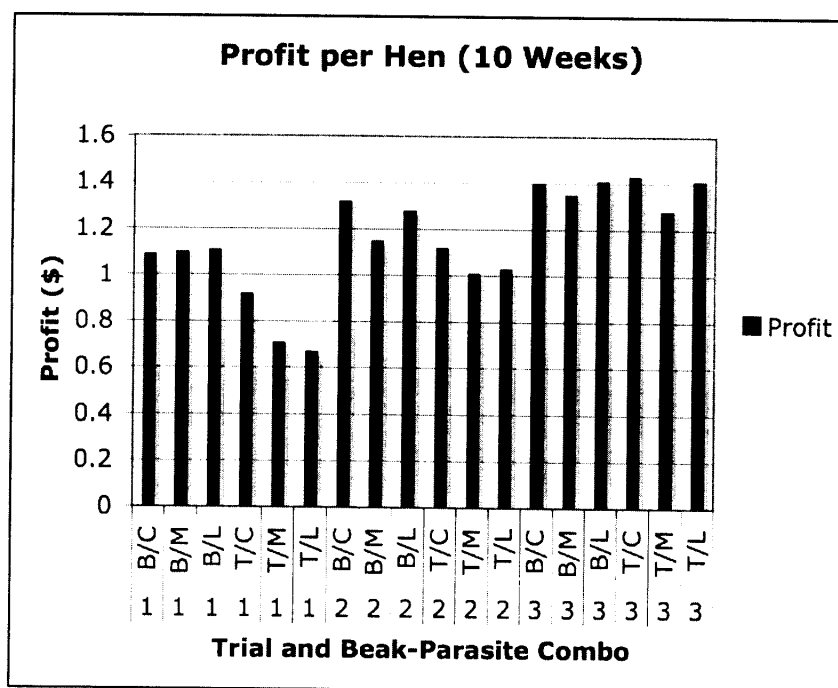


Fig. 11. Cumulative gross income per hen for each of 3 trials (10 weeks each) exposing beak-intact (B) or beak-trimmed hens (T) to no parasites (control, or C), Lice (L) or Mites (M).

First, the three trials clearly differed in certain absolute terms, as also mentioned above. The lighter hens in trial 1 also had lower egg production overall (Fig. 8). In this trial the differences in production between the beak-intact and trimmed hens were substantial. Production for the intact hens was similar for all three parasite treatments. For the trimmed hens, which had much higher numbers of both mites and lice (Figs. 3 and 4), production was reduced for all treatments, and actually was lowest for the control hens. In trials 2 and 3 the parasite treatments tended to reduce production slightly (by 1-3%) overall relative to uninfested controls of both beak-intact and beak-trimmed hens.

Individual egg weights (Fig. 9) also were lowest in trial 1 (lightest hens), and in general eggs were lighter from the smaller, trimmed hens. Trials differed as to whether they showed parasite effects on egg size. Mite-infested hens had lower egg weights in intact and trimmed hens in trial 1 and in trimmed hens in trial 2, but had equal or higher egg weights versus controls in intact hens I trial 2 and in both beak categories in trial 3. Lice showed reduced egg sizes only in beak-intact hens for trials 2 and 3.

Feed conversion efficiency, or FCE (Fig. 10) was poorer (higher numbers) for both mite and louse-infested trimmed hens in trial 1. FCE was poorer for louse-infested hens in trial 2 (intact and trimmed hens) and for louse-infested, trimmed hens in trial 3.

“Profit” (actually gross income) was an excellent integrative term for these studies, and is of course the “bottom line” for a producer. Presently, we have calculated this only for consumed feed. The intact hens waste more feed, so figures including spilled feed (even though they are somewhat specific to a particular feed trough design) will be calculated also. This will reduce the apparent advantage of beak-intact hens somewhat.

In trials 1 and 2, profit was higher for the beak-intact hens. In Trial 1, trimmed hens infested with either lice or mites were less profitable by a rather large (\$0.11 per hen for lice and 0.08 for mites). In trial 2, mite infestations were most costly, by \$0.17 for intact hens and by 0.11 for trimmed hens; lice caused reductions of \$0.04 and 0.08 for intact and trimmed hens, respectively. In trial 3 the lice caused no detectable damage, but the mites resulted in reductions of \$0.05 per hen for intact hens and 0.15 for trimmed hens.

In general then, mites appear to have a more repeatable and severe economic impact than lice. This is almost certainly due to their invoking the immune response. Lice do ingest some blood and tissue fluids from skin scrapings or pinfeathers, but appear not to trigger much of an immune response. It is interesting that there seems to be some cost of parasitism even in beak-intact hens, although not as severe as in trimmed hens. As we look closer, it is likely that the lower parasite numbers on intact hens still result in increased effort in grooming and probably somewhat of an immune response that may be costly for the hens.

These results, while quite interesting, are not yet fully developed and analysed and thus are not yet for dissemination to the scientific community at large or to the public. Anything related to hen welfare is a touchy topic, particularly at the moment, and we must have our “ducks in a row” (or perhaps I should say chickens) before releasing the information. The detailed analyses based on mixed models take time into effect much better than the grosser FPI values. The FPI values, on the other hand, do have a very strong central tendency effect (means of means) and have some value in looking at the “big picture”, especially with regard to the profit calculations.