

COMPLYING WITH PROPOSITION 2  
CHORE TIME<sup>®</sup> MODULAR MANURE BELT CAGE SYSTEM MODIFICATIONS  
AND THE EFFECTS

Presented to the  
Faculty of the Agribusiness Department  
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of the Requirements for the Degree  
Bachelor of Science

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## ABSTRACT

The California poultry industry is at a turning point due to the approaching deadline of Proposition 2 taking effect in 2015. The method of choice to be implemented to stay in business is called an enriched colony cage system. This system is very popular in E.U production, however has yet to be implemented in the United States. Thus, for the purpose of this project the modification of Chore Time® equipment at the Cal Poly poultry unit to resemble colony cages was the taken approach.

The fiscal impact the new law will have on California egg farmers can only be estimated. This project focused on how new density requirements will have an impact on feed consumption, egg production, feed conversion and mortality. Through 111 days of research birds were isolated in a controlled environment where feed was calculated and distributed, eggs were gathered and mortality monitored.

The research found that when comparing feed consumption, 16 bird densities having 144in.<sup>2</sup> per bird reveal a significant difference at the 1% level when compared to the remaining groups. Furthermore, feed to egg conversions for 16 birds cage densities reveal a significant difference at the 1% level when compared to the other bird densities. Thus, it can be assumed that there will be an increase in cost of production resulting from an increase in cage densities if colony cages at lower bird densities are to be implemented.

## APPROVAL PAGE

TITLE: Complying with Proposition 2 - Chore Time<sup>®</sup> Modular Manure  
Belt Cage System Modifications and the Effects

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## CHAPTER 1

### *INTRODUCTION*

The California 2008 state election contained a ballot measure called “Proposition 2”. This measure had residents vote on the following summarization; *“Requires that calves raised for veal, egg-laying hens and pregnant pigs be confined only in ways that allow these animals to lie down, stand up, fully extend their limbs and turn around freely. Exceptions made for transportation, rodeos, fairs, 4-H programs, lawful slaughter, research and veterinary purposes. Provides misdemeanor penalties, including a fine not to exceed \$1,000 and/or imprisonment in jail for up to 180 days.”* This proposition passed with a 63.3% majority and will take effect in 2015.

Since this new law was very vague, Californian farmers with egg-laying hens were left wondering what would be considered compliant as per the Proposition 2. Farmers not only expressed their concern about meeting new space requirements but also how they would compete on a national level with other states that were not under the same restrictions. The egg industry on a whole is very competitive, thus costs of production must be relatively comparable between farmers. Therefore, by forcing a single state out of the fifty United States to produce in a politically regulated environment, California will have a difficult time competing with the rest of the country which is not so restricted.

### **PROBLEM STATEMENT**

Is complying with Proposition 2 a feasible scenario in which egg farmers will be able to compete in the national economy?

## **HYPOTHESIS**

Acting in accordance with Proposition 2 will result in California egg farmers increasing costs of production. These costs will be transferred to the consumer and possibly result in an outsourcing of eggs into the California market, leading to the possible collapse of the California egg-laying industry.

## **OBJECTIVES**

- 1) To evaluate feed conversion, feed intake, mortality and egg production of hens with respect to various cage densities, both current density requirements and estimated projected density requirements for 2015.
- 2) To determine the economical benefits or detriments of complying with Proposition 2 and using lower cage densities.
- 3) To compare pre-Proposition 2 costs and production levels to estimated post-Proposition 2 costs and production levels.

## **SIGNIFICANCE OF THE STUDY**

California egg-laying farmers account for about 6% (Young, “Prop 2 Passes”) of the national egg market and there are approximately 30 egg-laying farmers in California, nearly all of which are family owned (Economic Impact in California, 3). California egg farmers tend to an approximate 19.4 million birds that produced an estimated 4.9 billion eggs in 2007, which is estimated to be worth \$323 million (Economic Impact, 3). Currently only 66% of California table eggs are produced in state and the remaining 34% is produced in other states and shipped into California (Economic Impact, 3). With the passing of proposition 2 it is anticipated that the

amount of out of state imported eggs will increase drastically if other states are not required to comply with proposition 2 making it difficult for California egg farmers to continue production. Currently, 3,561 people are employed by California farmers of egg-laying hens and in 2007 paid an estimated \$11.8 million in state taxes (Economic Impact, 4). The current total economic output is estimated at \$648 million and California egg farmers pay an estimated \$4.2 million in local property taxes (Economic Impact, 4).

All of the above revenues as well as an entire industry could be lost by Proposition 2, depending on what interpretations will be made at the 2015 deadline. Farmers, however, are asking for Proposition 2 interpretations to be address earlier than 2015 to allow them time to prepare for building costs and declining production. As of 2009 no interpretations have been clarified and agreed upon and it is likely interpretations may not come until the proposed deadline.

## CHAPTER 2

### *LITERATURE REVIEW*

#### **PROPOSITION 2 AND IT'S AFTER EFFECTS**

November 10, 2008 is marked as one of the most changing days in the egg-laying poultry industry. In California, Proposition 2 was passed by a 2/3<sup>rd</sup>s majority with the Humane Society of the United States as its advocate. As a result of Proposition 2, California egg producers were forced to come up with a system to house egg laying birds that would comply with the Proposition's vague language. Fast forward a year and industry producers are still wondering what the first step will be and if it will be an accepted one.

One industry leader, J.S. West and Companies announced in September 2009 that it would invest \$3.2 million into the first Prop 2 compliant hen housed system; however, Prop 2 sponsors refuted the idea of any cage system ("Prop 2 hen house proposed"). This was the first step anyone in industry made to comply with Proposition 2. An article in the Sacramento Bee Newspaper said Eric Benson, the company's president, believed this system would comply with Proposition 2 and was meant to "force debate" because the proposition is so vague (Downing). The ACEF, Association of California Egg Farmers, said "egg producers seeking to comply with Proposition 2 need to know what space requirements are" ("California producers").

Currently, UEP standards to be certified require producers to allow 67 square inches per bird and with J.S West and Companies proposed housing system each bird is allowed 116 square inches as well as use of perches, scratching areas and a privacy area to lay their eggs ("Prop 2 hen house proposed"). The Humane Society upon receiving news of J.S. West moving forward with a larger cage system "acted with astonishment because of the investment the company is

making in a housing system that will not satisfy the standards established by Prop 2” (“Prop 2 hen house proposed”). The Humane Society further went on to say “Prop 2 proponents ‘have always been crystal clear that the measure requires cage-free housing.’ However, Benson told Feedstuffs last week that this was a bit of a distortion. ‘We argued that (Prop 2) may outlaw (conventional cages) but never agreed (whether) it would allow this type of housing’ that West has proposed to build. He said West believes its new house will pass Prop 2’s muster” (“Prop 2 hen house proposed”).

Although cage free housing is what the Humane Society claims to be the only interpretation of Proposition 2, Promar offers another. First, keep in mind that current cage free production requires 1.5 square feet (216 square inches) per bird. This number is subject to downward adjustments to 1.0-1.2 square feet (144-173 square inches) if there are additional perching areas above floor level (Economic Impact, 5). Secondly, chickens have a wingspan of 28 inches when fully extended. “Therefore, a reasonable interpretation of the practical effect of the language in the initiative is that each hen, whether caged or cage-free, would be required to have a minimum of 784 square inches of space (28 x 28) which is 5.4 square feet” (Economic Impact, 6). If this were a true interpretation this would make both cage and cage free production illegal in California. Thus, it can be assumed that interpretation is varied and dependant solely on legal interpretation when it is made.

Since J.S. West and Companies came forward with their proposed building plans no further clarification has taken place. Industry leaders have voiced that their intentions are to convert their systems to larger cages and at all costs veer away from the un-specified cage free system which will make it nearly impossible for 95% of producers to stay in production (Economic

Impact, 2). Again, the 2015 deadline will most likely be the time at which acceptable housing requirements will be determined.

## **EGG INDUSTRY HISTORY AND THE UNITED EGG PRODUCERS**

Like most industries, the egg industry is proactive about change and the enhancement of production. The United Egg Producers (U.E.P.) is the largest animal care certifying organization for egg production in the United States. Although U.E.P. certification is not mandatory in the industry, about 85% of egg producers in the U.S. are U.E.P. certified and many grocery stores only buy UEP certified eggs (Economic Impact, 5). The U.E.P. has proactively increased space for laying hens over the years and strives for uniform safety and treatment of laying hens. A poultry professor at California Polytechnic State University, San Luis Obispo, Dr. Robert J. Spiller, recalls that the U.E.P. proactively increased the minimum bird density in 2000 in response to a demand made by McDonalds, which was demanding more space for birds due to a successful picketing by P.E.T.A. outside many restaurants. The minimum density was increased over five years from 49 square inches per bird to, 69 square inches per bird, an increase of thirty percent. This is just one example of the UEP being proactive with respect to animal welfare on an industry wide perspective.

## **CAGE FREE SYSTEMS**

The Humane Society of the United States (H.S.U.S.) is now proposing that under Proposition 2 all California egg producers convert their current systems to cage free housing. Currently, cage free systems make up about 5% of the California egg market thus, 95% of California eggs are laid by hens housed in conventional cages and will be affected by Proposition 2 (Economic

Impact, 1). The reason conventional cages are the system of choice is not only for economical reasons but environmental and health purposes as well.

Cage free systems require more land and feed and generally have a higher risk of disease. If California producers were to convert their current conventional cages entirely to cage free systems, Chad Gregory, Senior Vice President of United Egg Producers, believes it would require “15 million more layers and 700,000 additional acres planted to corn and soybean” (“Prop 2 fuels ‘freight train’”). A switch to entirely cage free production in California would add a 25% or more increase in the cost of eggs, as well as a larger carbon footprint since cage free birds consume an estimated 15-25% more feed than conventional housed birds (“Cage free transition”). Furthermore, converting from a conventional cage to a cage free system as the Human Society claims is now the only way to comply with Proposition 2 would cost California egg producers \$7.5 billion, and would be ignoring all previous scientific research which points to the benefits of conventional housing systems (“Cage free transition”).

Promar International, an economic consulting firm based in Washington D.C., “noted that hens in modern cage housing have less disease, less need for medical treatment and less mortality than hens in cage-free housing” (“Cage free transition”). The egg industry has worked diligently and years of scientific research went into developing the housing system they now have. Industry leaders’ view switching to a cage free system as a step backwards. Don Bell, a poultry specialist at the UC Riverside believes “Prop 2 defied logic as well as science noting, that layers are social animals and they “may want to touch each other” (“Prop 2 fuels ‘freight train’”). Bell also went on to explain what was happening in other countries with regard to cage free housing, saying, “Sweden’s ban on cage housing has led to ‘significant’ increases in cannibalism, disease and mortality in its layer flocks and now Sweden is sourcing eggs from

neighboring countries that have cage housing systems to meet consumer demand” (“Prop 2 fuels ‘freight train’”).

Furthermore, according to the UEP website, cage free hens “often require more drugs than cage hens, because of their constant exposure and contact with litter and waste on barn floors” (“Myth vs. Fact”). Dr. Joy Mench, a professor at UC Davis, concurs and adds that hens in non-cage systems are “more likely than caged hens to develop open and painful sores on their feet because their feet are in contact with litter material and perches, which can become contaminated with excreta and infectious organisms” (Smith, “Cage and Cage free egg”). In addition, an article from *Molecular Nutrition and Food Research* found that eggs from free range or cage free birds “have a higher risk of being contaminated with increased levels of dioxins and DL-PCB than barn or cage eggs.” They hypothesized that “ingestion of soil particles from environmentally contaminated areas may contribute to elevated dioxin levels in free-range chicken eggs” and “available data show that current soil levels of dioxins and DL-PCB in residential and agricultural areas in Europe often appear to be too high to produce free-range eggs with dioxin levels below the current limit values in the EU” (Hoogenboom, Schoeters).

The high dioxin levels also lead to another problem. Since it has been revealed that in the EU there are limited areas of production for cage-free eggs, and with any cage system being outlawed, availability of eggs is shrinking forcing the EU to look to other countries to meet the demand for eggs in their areas. Furthermore, importing eggs from other countries would not have been necessary if cage production was allowed. The above problems concern California egg producers; they hope to find a different method of producing eggs for consumption in an alternate, larger cage system, opposed to a cage free method.

If a cage free egg industry in California is to be implemented it will be smaller than the current egg industry due to the substantial amount of producer revenue it will take to switch systems. A cage free system requires more land, higher input costs and higher fixed costs than the current system. Californians want local, fresh food and limiting egg producer's ability to produce will limit their ability to meet this desire. Cage free eggs are a niche market but to ban any other type of egg farming will decrease egg production, and raise consumer prices for eggs, and increase production costs, thus leading to less state and federal revenues and possible importing of eggs from other states and countries to meet consumer demand. Lastly, because cage free production requires more land and the birds tend to consume more feed, a larger carbon foot print will result just to maintain the same production levels California is currently generating.

### **ENRICHED COLONY CAGES**

When asked about cage systems and how birds are restricted, Dr. Joy Mench of the UEP advisory committee and a professor at UC Davis explained that the EU has taken recent steps to use “furnished cages” as opposed to conventional cage systems. Dr. Mench explained that this type of cage system is “very promising” emphasizing, however, that they are “more expensive to install and manage and result in higher egg prices to consumers” (Smith, “Hen Housing Systems”). This type of furnished cage is similar to the “enriched colony cage” J.S. West is implementing on their egg operation.

Enriched colony cages began in the EU in the past decade because of animal welfare mandates passed overseas. According to an article released at Wattagnet.com the 2009 IEC conference reviewed EU progress on switching conventional cages to enriched colony cages or

cage free eggs. Of the current “278 million hens in the EU only 7% are housed in colony cages” (“Conference reveals colony”). When asked about behavior research, the IEC responded that research of animal behavior is still underway but noted that its costs 10% more to produce eggs in the colony cage system without enjoying the price premiums cage free eggs get to enjoy (“Conference reveals colony”).

Since there is limited information based on colony cages and hen performance in such an environment a research project examining the effects a caging system such as a colony cage has on birds was most suitable. To gain a better understanding of how laying hens behave in a colony housing system minor changes will be made to conventional cages to convert them to larger “colony” type cages at the Cal Poly Poultry Unit.

## CHAPTER 3

### *METHODOLOGY*

The California egg producers have two approaches to Proposition 2. The Humane Society claims Proposition 2 requires cage free housing for all birds, whereas, industry leaders state the meaning behind Proposition 2 requires larger cages with a lower bird density. If the interpretation by the egg industry is correct then is there a way for current producers to modify their current cage systems to meet Proposition 2 requirements? If the industry switches to larger colony size cages, what effects will occur with respect to feed intake, feed conversion, egg production, and mortality? What are the economical benefits or detriments that relate to the outcomes of the previously stated observations? Lastly, what will the side by side pre and post Proposition 2 costs of production look like? All of these questions are being considered in developing a method for researching a hypothesized outcome as the result of Proposition 2 passing in California.

### **RANDOM ASSIGNMENT**

The Cal Poly laying facility on campus currently houses around 5,000 Hy-line W-36 laying hens. All of the hens in the building are the same age. To test the hypothesis previously presented five various cage densities will be established and two housing systems used. Before modification of the cages took place random selection was used to determine where colony cages were to be constructed. Only cages selected for the control treatment were left un-modified. Placement of bird densities in the modified cages, in respect to location in the building, was also decided by random selection.

## EXPERIMENTAL DESIGN

The first system, in which the control groups will be placed, is the “conventional” cage (22 x 24 in.) with the current UEP density of around 7 birds per cage at 67 square inches per bird. There will be 16 cages or 4 sets (four cages per set) of control groups. Diagram 3-A depicts what a “set” looks like.

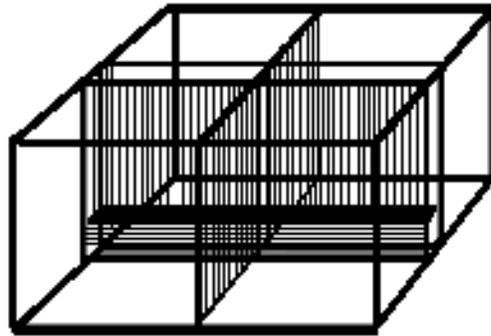


Diagram 3-A

The experimental densities will be housed in modified cages which will resemble colony cages. These cages are constructed by taking a “conventional” Chore Time® cage system and cutting out the middle partitions between the four cages. Thus, you have four conventional cages opened and converted into one large cage in which the hens can pass through each section. This is to be called the “colony” cage for this study and is depicted in Diagram 3-B below.

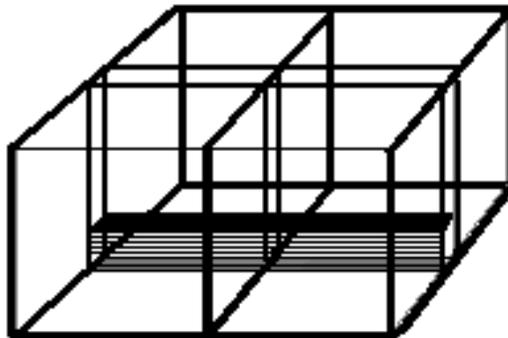


Diagram 3-B

The various densities to be placed in the “colony” cages will be 16, 20, 24, and 28 birds. Again, like the control group, there will be 4 sets or 4 replicas of each density. A total of 464 hens will be observed for a 90 day period.

The hens were randomly selected from the Cal Poly lay house and placed in the specified cages which were labeled and color coated by density. The table below is an overview of the research structure.

<b>Table 3-A</b>			
<b>Color</b>	<b>Birds Per Cage</b>	<b>Cage Style</b>	<b>Density</b>
Grey	28	Control-Conventional “set”	75.43 in. <sup>2</sup>
Red	28	Colony	82.29 in. <sup>2</sup>
Green	24	Colony	96 in. <sup>2</sup>
Orange	20	Colony	115.2 in. <sup>2</sup>
Blue	16	Colony	144 in. <sup>2</sup>

Before being placed into the cages birds were weighed in groups of 4 until the total density desired was reached. Then the average weight per “set” (four conventional cages) or a colony cage was recorded. This weight will be important to compare to at the end of the 90 day period when the birds are weighed again.

### **FEEDING HENS AND CALCULATIONS**

The hens will be fed by hand and eggs counted and gathered once a day everyday for the 90 day period. Since the feed is to be placed in a continuous trough, dividers made of cardboard and fixed with a ping pong ball are to be placed into the trough to keep feed placed in front of each specific colony cage or “set” thus, keeping the feed contained and available to only those

birds. The feeding process will be executed by procuring a five gallon bucket and placing one on both sides of each individual “set”. These buckets will be filled with exactly 25 lbs. of Cal Poly formulated and milled feed which is nutritionally balanced for the age and production level of the laying hens currently occupying the building. This feed is formulated by Dr. Brooke Humphrey, a leading poultry professor at Cal Poly. The feed will be weighed out on a weekly basis or as needed depending on consumption and then each addition is tabulated. At the end of each four week period, all of the troughs are vacuumed out to ensure all feed weight loss is due to consumption. The feed from the troughs is then added to the remaining feed in the buckets and then reweighed and recycled. This ending weight is then subtracted from the total amount of feed weighed out throughout the four week period. This will allow for a monthly feed consumption analysis and will help protect against error. The formula for calculating feed consumption per 100 birds per day is as follows:

$$\text{Feed consumption (per “set”) FCPS} = \frac{\text{Total feed consumed over time period}}{\text{Total days in time period}}$$

$$\text{Feed consumption (per bird in “set”) FCPBS} = \frac{\text{FCPS}}{\text{\# of birds in “set”}}$$

$$\text{Feed consumption (per 100 birds in “set”)} = \text{FCPBS} \times 100$$

### **GATHERING EGGS**

For this project the rows with experimental cages in the lay house are to be disconnected from the mechanical gatherer and zip ties are to be placed across the egg belt to keep eggs from rolling in front of other cages. Eggs in front of each colony cage or “set” are then counted on both sides everyday and eggs are then placed on the above egg belt to be mechanically conveyed

to the packer. Eggs from the packer were than mechanically washed and packed along with all of the other eggs.

### **CANDLING EGGS FOR CHECKS**

Towards the end of the 90 day period several flats of eggs from each density and from the control group are going to be marked so that candling of the eggs can take place effectively. The eggs from each “set” are to be gathered on several random days. The eggs will then be candled to see if there is a correlation between bird densities and hairline cracks, meat spots, bloodspots or other imperfections in the eggs. The results will be recorded and graphed for future review.

### **MORTALITY**

Over the 90 day period mortality will be gathered daily and recorded. After a bird is removed from a specific “set” the total number of birds in that group will be adjusted accordingly. By removing the bird from the group we will ensure an accurate calculation of both production levels and feed consumptions. Mortality must be found each day so that the exact amount of birds is always being used when calculating the previously mentioned statistics.

### **ASSUMPTIONS AND LIMITATIONS**

Since this project will be completed in the Cal Poly Poultry lay facility the biggest assumption is that the experimental cages, feed and eggs will not be altered by other students who have continuous access into the facility. Signs will be posted to explain that an experiment is in progress in hopes of preventing corruption of the data. Another assumption is that the random sample of laying hens to be used for the trial will be of an average health condition. This is an assumption because the flock consists of older laying hens that have been in production for some time.

## CHAPTER 4

### *DEVELOPMENT OF THE STUDY*

#### **DATA COLLECTION PROBLEMS**

During the collection of data, an unforeseen data collection interruption occurred which was able to be corrected during the process. While feeding the birds it was realized that some of the feed buckets had been moved by another student and placed in front of different and incorrect cages, thus, creating an error in feed calculations. However, this error was reversed later by numbering the buckets and checking them each time before they were refilled to ensure the correct buckets were in front of the correct cages. Furthermore, the project was extended from ninety days to one hundred and eleven days of research make up for the lost, incorrect data.

The above is the only problem that occurred during collection of data. Other than those assumptions and limitations previously stated the research was thoroughly executed and data recorded appropriately.

#### **ANALYSIS**

The observation of the 464 W-36 laying hens was extended from ninety days of research to one hundred and eleven days of research. Before birds were assigned to their groups they were weighed in groups of four; this information was recorded for each group. Every day the eggs were counted and feed administered at approximately the same time each day in order to reduce variation. Feed buckets were replaced with feed when deemed necessary as per density in the study groups, roughly every seven to ten days. Mortality was also checked daily to insure accurate documentation which would ensure precise production and feed consumption

calculations. During the last week all eggs were cautiously gathered onto flats and set aside for candling to check for any shell damage. Extra care was taken gathering these eggs to ensure that human error was not a confounding variable when analyzing the sample. Lastly, the birds were weighed to see if there were any significant changes or differences in weight during the research period between groups. Once again, the objectives of this project include; comparing feed intake, mortality, feed conversions and hen day production of each density, all of which were accomplished by implementing the above procedures.

**Table 4** Performance of white leghorn hens subjected to colony cage living at various densities <sup>1</sup>

Group <sup>2</sup>	Mortality	Hen-Day Production	Starting Body Weight	Ending Body Weight	Daily Feed Consumption	Feed Conversion (per 1 Dozen Eggs)	Undergrades
	#	%	lbs.	lbs.	lbs.	lbs.	%
1 <sup>3</sup>	1	87.54 <sup>A</sup>	4.2	3.9	25.2 <sup>A</sup>	3.39 <sup>A</sup>	5.74
2 <sup>4</sup>	1	86.93 <sup>ABC</sup>	4.1	3.8	24.4 <sup>B</sup>	3.24 <sup>BC</sup>	3.62
3 <sup>5</sup>	0	85.67 <sup>C</sup>	4.0	3.9	24.4 <sup>B</sup>	3.26 <sup>AB</sup>	2.55
4 <sup>6</sup>	1	86.63 <sup>BC</sup>	4.0	3.8	23.5 <sup>B</sup>	3.10 <sup>CD</sup>	5.38
5 <sup>7</sup>	3	88.39 <sup>A</sup>	4.0	3.8	23.6 <sup>B</sup>	3.09 <sup>D</sup>	4.27
6 <sup>8</sup>	0	88.33 <sup>A</sup>	4.0	3.8	24.1 <sup>B</sup>	3.11 <sup>BD</sup>	3.47

<sup>1</sup> Values with differing upercase superscripts are significantly different at the 1% level (P< .01).

<sup>2</sup> Each group was comprised of 4 replicates to limit the chance of small sample size error.

<sup>3</sup> Group 1 consisted of 16 hens within the modified 48 inches x 48 inches colony cage at a density of 144 inches<sup>2</sup>.

<sup>4</sup> Group 2 consisted of 20 hens within the modified 48 inches x 48 inches colony cage at a density of 115.2 inches<sup>2</sup>.

<sup>5</sup> Group 3 consisted of 24 hens within the modified 48 inches x 48 inches colony cage at a density of 96 inches<sup>2</sup>.

<sup>6</sup> Group 4 consisted of 28 hens within the modified 48 inches x 48 inches colony cage at a density of 82.29 inches<sup>2</sup>.

<sup>7</sup> Group 5 served as the control consisting of 28 hens within four of the standard 24 inches x 22 inches cage at a density of 75.43 inches<sup>2</sup>.

<sup>8</sup> Group 6 consisted of 28 hens with trimmed wing feathers within four of the standard 24 inches x 22 inches cage at a density of 75.43 inches<sup>2</sup>.

Table 4 reports the summarized results for the entirety of the research period. For all of the following results given, two-tailed t-tests were used to statistically analyze the research results. Looking first at mortality, the absence of superscripts indicates that there was no significant difference between the groups at either the  $P < .01$  or  $P < .05$  level. All birds were fed the same feed formulation provided by Cal Poly, to an even trough height throughout. All light, temperature and other possible confounding variables were held constant between the groups or were accounted for by the initial random assignment of the groups.

The next column reveals the Hen Day Production results, or eggs per bird per day as shown in an overall percentage. As indicated by the superscripts on the table, we can reject the null hypothesis that all groups are equal. There are several significant differences between the groups, for all of which we can say that we are 99% confident that the difference is not due to chance but to the bird density within the group. The lowest production was found in group 3 which consisted of 24 birds. The highest production was found in groups 1, 5, and 6 in which we found no significant difference at the  $P < .01$  level between the three groups. Groups 2 and 4 were in the middle of the groups and had no significant difference at the  $P < .01$  level between themselves.

The only explanation that we found to explain these statistically significant results was that commingling more birds together results in lower production. Group 3 and Group 4 consisted of 24 and 28 birds respectively and were the two lowest producing test groups. Production increases as density decreases within a single confinement no matter what the size of the actual confinement. This is shown by the two highest producing test groups, numbers 5 and 6 which both consisted of 28 birds but were housed in standard 22" x 24" cages with only 7 hens in each individual cage, and not the enlarged colony type cage. This is the only differing

variable that we found could lead to this statistically significant outcome. An explanation for this outcome could be tested in further applications of similar analysis in research.

No significant differences between starting body weights and ending body weights were found. The loss of weight by all birds in the various bird densities is believed to be due to a switch from feed being purchased from an outside source, to feeding rations milled at the new Cal Poly Feed Mill, and the lower protein diet that ensued.

Daily feed consumptions indicates Group 1 as significantly different at the  $P < .01$  level when compared to all other groups. We can therefore reject the null hypothesis that all groups are equal and we can say that 99% of the results found are due to the actual bird densities rather than chance alone. This result was anticipated due to the greater area available to the birds for moving about thus creating an increase in caloric demand.

Feed to egg conversion results confirm the hypothesis that more feed was consumed to produce eggs for the lower density cages. The statistical results found in this section are somewhat different than the results for feed consumption due to the fact that egg production is used in calculating feed conversions. This calculation allows groups who produced at a higher or lower level to be taken into account so that efficiency can be studied. Similar to feed consumption, we see the highest level in group 1, and then conversions drop lower with each increase in bird occupancy. Many of the groups differ from each other at a P value of  $< .01$  but the general observable differences are seen as higher conversions toward the lower density groups, and lower conversions toward the higher density groups. This outcome is once again due to a higher caloric demand when the hens are given more room.

No significant difference could be found in under grades using a two-tailed t-test analysis. Further collection and processing of eggs could be recorded and analyzed in order to include a larger sample which would produce more conclusive results.

## CHAPTER 5

### *SUMMARY, CONCLUSION AND RECOMMENDATIONS*

#### **SUMMARY**

**Table 5:**

Cost per dozen eggs produced at various densities

Cost Categories	Annual Cost for a 100,000 bird house	16 Birds	20 Birds	24 Birds	28 Birds
Feed	\$417,309.93	\$0.41	\$0.40	\$0.40	\$0.39
Bird Depreciation	\$136,193.20	\$0.13	\$0.13	\$0.13	\$0.13
Labor	\$42,705.00	\$0.04	\$0.03	\$0.03	\$0.02
Power	\$20,000.00	\$0.02	\$0.02	\$0.01	\$0.01
Building and Equipment	\$156,800.00	\$0.15	\$0.12	\$0.10	\$0.09
Total	\$773,008.13	\$0.75	\$0.70	\$0.67	\$0.64

After establishing the varying levels of feed consumption at each density, we adjusted all of the costs of producing eggs to agree with the corresponding hen density. To calculate costs of production, industry average costs for a 100,000 hen, environmentally controlled house were used. Each cost was adjusted to correspond with each specific density. Feed costs per ton were increased as feed consumption decreased, and costs per ton were decreased as feed consumption increased. The adjustment of feed costs was changed according to consumption in order to reproduce industry standards. In the industry, more expensive-higher protein feeds are fed to low consuming hens and vice versa to promote low body weight and efficient egg production. After all costs were adjusted we can see just how dramatic the effects of lower bird density can be. In a 100,000 bird house which has existing cages, costing approximately \$1,500,000, the

cost differential between 16 and 28 hens is 11 cents per dozen eggs produced. At 16 hens per cage the production cost is 75 cents per dozen while at 28 hens per cage the cost is 64 cents per dozen. The difference in cost is vastly due to higher feed consumption and many other relatively fixed costs which are spread over far fewer hens.

## **CONCLUSION**

If Proposition 2 maintains a lower bird density, larger cage requirement, then California egg farmers will not only have to reinvest into a new system under the new law, they will also have increased production costs due to the increase in feed consumption and other fixed costs resulting from the lower density housing. Since the hypothesis of higher feed consumption was proven to be statistically significant, it can be assumed that the cost to produce a dozen eggs will increase respectively.

## **RECOMMENDATIONS**

After considering the cost differential between current hen-housing practices and what may be required by California law due to Proposition 2, we found that higher densities are far more efficient at producing a cheap and safe food product for the consumer. This being said, the industry must decide on a national bird density so that the competitive playing field can be leveled. The best and most efficient density is obviously the higher of the groups but this may not be all that is necessary to decide on a specific density. When animal rights are playing such a large role in this selection process, we cannot decide on the correct density from cost of production data alone. We would recommend a maximum density of 96 inches<sup>2</sup> per bird for the entire commercial egg industry nationwide in order to satisfy the demand for cheap eggs that are produced in a humane manner.

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