EFFECTS OF DECLAWING AND CAGE SHAPE ON PRODUCTIVITY, FEATHERING AND FEARFULNESS OF EGG-TYPE LAYERS

by

KEITH P. VANSKIKE

Assoc., Barton County Community College, 1978
B.S., Kansas State University, 1980

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Animal Sciences and Industry

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1982

Approved by:

Albert W. Adams
Major Professor

ACKNOWLEDGMENTS

The author wishes to dedicate this Master's work to his parents, Grace and William VanSkike, and to his grandparents, Mary and Harry VanSkike, and Marjorie and H. P. Dickson. Their love and continued encouragement have given me a deep appreciation for people and they have taught me that all work can be fulfilling.

Deepest appreciation is extended to Dr. A. W. Adams, my major professor. His willingness to work and his answers to my needs through his open-door policy have guided my thoughts throughout my studies.

Sincere thanks goes also to Drs. Paul Sanford, Jim Craig and Kenneth Kemp, for serving as advisors upon my committee. Expertise in their areas of interest, their time and friendly conversations have helped my program flow smoothly.

Thanks is extended to instructor Amos Kahrs, superintendent of the Avery Poultry Research Center, and his assistants, Myron Lawson and Holger Moorman. Their assistance in the management of the hens in this study and help in collection of data have been appreciated.

Special recognition is extended to John Carey, fellow student. His background in the poultry industry and willingness to share with me his thoughts have been very encouraging.

Thanks is given to Luann Wood for the typing of the rough and final copies of this manuscript.

A note of special thanks is offered to Miss Karen Thomas. Her assistance given me in summarizing data, typing, general gopher and true companionship shall not fall by the wayside.

To all of these people, I am very grateful.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

Confinement systems for poultry production are needed in a world where efficient utilization of resources is a primary concern. Social and physical stresses resulting from these production systems require more exacting management procedures. Alterations of cage systems have made feed and water more accessible without necessarily increasing individual space per bird.

In the commercial egg production industry, a 90 degree reversal of the conventional cage provides a cage shape which is wider than deep. Supposedly this system allows more equal feeder access for all cagemates, thereby possibly reducing excess movements thus improving feed usage. This type of cage also reduces the distance the eggs must roll to the collection tray, minimizing egg breakage.

Slight alterations of the body morphology, such as debeaking, declawing and dubbing may aid in reducing accidential or intentional injury between confined birds. Claws are a useful structure for hens kept on range or floor production systems, however, claws become extremely long in caged systems and may be a contributing cause of bird injury, feather loss, depression of productivity and egg shell damage. The cage shape and body alterations may act together to improve bird productivity in high density cage environments.

The following study examined the effects of declawing and cage shape on the productivity, feathering, and nervousness of a commercial strain of layers.

REVIEW OF LITERATURE

Effects of Declawing Upon Productivity - Ruszler and Kiker (1975) reported that detoed, cage reared pullets had significantly heavier body weights, higher mortality (6.17% vs. 4.64%), and matured one week earlier than normal pullets. Detoeing did not significantly affect feed consumption. Detoed hens produced significantly more eggs (2.1%) during the production cycle and suffered significantly less mortality (2.6%) than normal hens. No differences in overall feed consumption, body weight, feed efficiency or mortality were found between detoed and normal chicks reared in cages (Compton et al., 1981a). Claw removal posed an initial stress in their study as reflected by reduced feed consumption and weight gains in the first 3 weeks, however, declawed pullets exhibited precocious laying behavior during the latter portion of the rearing period.

Martin et al. (1976) noted that detoed layers in colony cages produced significantly more eggs (21.9%), higher income over chick and feed costs and decreased feed consumed per dozen eggs when compared to intact layers. Caged layers with two toes removed produced significantly more eggs (15.6) than intact layers (Carter et al., 1980). Birds with one toe removed produced more eggs than intact females, though not significantly. Sefton (1977) removed the terminal phalanx from half of the birds in nine experimental matings and noted that they produced significantly fewer extra large eggs (3.5%) and significantly more medium eggs (4.1%) than the intact controls.

Ruszler and Quisenberry (1979) noted that increasing flock size in cages from 7 to 10 birds usually depressed performance, while detoeing at housing usually enhanced performance. Average egg size, percent large eggs, and body weights were significantly depressed (.6 g, 3.7%, 25 g, respectively for detoed vs. intact birds). However, feed efficiency was significantly poorer for the declawed birds. Toe treatment did not have a significant effect upon mortality, egg production and broken or shell-less eggs. In a second trial, detoeing significantly improved livability, hen housed production, percent large eggs, (2.0%, 1.7%, 2.1%, respectively for declawed vs. intact hens). Declawed hens weighed significantly less after 1 year of production (25 g) than intact hens. No significant differences were seen in the percent hen-day production, feed efficiency, average egg size and broken or shell-less eggs. Subjective evaluations indicated that declawing could be beneficial under high bird densities in cages, since they noted a greater response to declawing in 10-bird cages compared to 7-bird cages.

Compton et al. (1981b) hypothesized that claw removal alleviated some stress in cages as declawed birds had significantly lower plasma corticosterone and higher estradiol levels than intact birds, but only during the last week of production. Declawed hens showed significantly less mortality (5%), significantly lowered body weights (143 g), and earlier sexual development than intact hens. Declawing had no significant effect on egg production, feed consumed, feed efficiency, average egg weight, and number of cracked eggs. They questioned the validity of declawing as a management tool.

Ingram and Wilson (1981) observed that the removal of either none, inside and back or just the back toes of day-old broiler breeder males had no significant effect upon their early mortality or the egg production, feed consumption and mortality of hens mated to them. Removing two toes from the males impaired their balance, causing a loss in fertility.

Adams and Stadelman (1978) reported the removal of two or three toes from two strains of turkeys fed different diets had no significant effect upon the incidence of weak legs and body weights at 20 weeks of age. Removal of three toes from day-old roaster-type turkeys had no significant effect upon mortality, 9-week body weight, feed conversion, carcass grade and monetary returns (Proudfoot et al., 1979). An average of combined weights of both sexes showed that detoed turkeys had significantly lowered body weights at 14 weeks of age (5,111 vs. 5,214 g) than intact turkeys.

Greene and Eldridge (1975) noted no excessive downgrading from the removal of two toes from turkey hens grown in semi-confinement. In another trial, they noted no significant differences for weight gain, feed conversion or incidence of leg problems among toms with none, two or three toes removed and grown in total confinement. They noted slightly more grade A carcasses and more mortality for each toe removed. Owings et al. (1972) showed that 24-week old toms with three toes clipped had smaller body weights, improved feed conversion, less overall mortality and more grade A carcasses than intact toms. The differences were not significant. Based on a 2-year survey of three turkey processing plants, they reported equal or significantly more grade A carcasses with detoed toms and hens compared to intact turkeys of the same sex. One plant showed significantly lowered body weights for detoed males compared to intact males in two consecutive years.

Effects of Declawing on Bird Injury, Feather Loss, and Nervousness -Hill (1975) "scored" the feet of 69-week old hens declawed at day-old and housed in nine density and population size combinations. The incidence of sore feet was significantly greater with increasing numbers of birds per cage and decreasing space per bird. Compton (1981b) noted declawed hens had significantly poorer foot "scores" compared to intact birds in cages at 69 weeks of age, 3.9 vs. 6.2, respectively for declawed and intact hens. They felt that hens needed claws for support and declawing may have reduced the area of effective support, thus the poorer foot condition of the declawed hens. North (1978) noted the clipping of the toes of male turkey breeders may be advantageous in reducing injuries to females during mating. Ingram and Wilson (1981) however, reported no specific differences in mortality and production of female, chicken broiler breeders that were mingled with males. Removal of two toes from males severely affected their balance.

Leeson and Morrison (1978) found a significant correlation between body feather weights and conversion of feed into eggs. The more efficient birds had significantly heavier post slaughter feather weights than those less efficient, 81.5 vs. 67.6 g, respectively. Compton et al. (1981b) noted that feather cover was slightly better but not significantly for declawed hens compared to intact layers in cages at 72 weeks of age.

A type of nervous behavior noted by Hansen (1976), begins with increasing nervousness at about 100 days after housing. A definite form of "hysterical" behavior is seldom seen in less than 140 days after housing. He categorized hysterical behavior when hens suddenly fly about, squawk and try to hide. Pain may be a contributing factor between the fine line of nervousness and hysterical responses. In community cages, adjacent hens may not be disturbed unless they too are in a hysterical state. In large floor flocks, the hysterical state may begin at one point and progress through the flock in waves. Hughes (1961) described this hyperexcitability for litter reared birds as synonymous with "snake in the house," where the duration of each episode may be only 10-40 sec. The primary cause of mortality is from piling and occasionally tears inflicted by claws. Flocks of 20 and 40 hens in colony cages developed hysterical outbreaks, at which time Hansen (1976) noted hens with broken feathers and torn backs. He merely "trimmed" back the claws and the hysteria was controlled for 6 to 12 weeks. None of the hens in 1-, 6-, or 15-bird cages showed hysterical behavior. In a second trial, Hansen (1976) noted no hysterical outbreaks in declawed hens housed at populations of 17, 30, and 40 females per cage, though some nervousness was observed. Nine out of 12 groups of intact hens became hysterical, some as early as the fifth period post housing. Ruszler and Quisenberry (1979) noted no hysterical behaviors in either declawed or intact layers placed 7 and 10 birds at an area of 290 cm^2 per hen in order to induce stress. Their definition of hysteria was any extreme level of fright that resulted in flightiness and the birds' attempt to escape from the cage.

Compton (1981b) felt that social strife may have been reduced for declawed hens, but only at the end of the production cycle. He felt claw removal may have effectively reduced "...the personal space required by each hen...", therefore, decreasing the number and or intensity of interactions among cage mates. Since hysterical episodes and feather loss were seen in the second generation of selected White Leghorn stocks with claws intact, Craig (J. V. Craig, 1981, personal communication) removed the claws from hens in generations 4 and 6. He noticed a generation by housing interaction. Declawed hens from generations 4 and 6 in colony cages averaged 84% as much full-year egg mass as hens in floor pens. Second generation hens with intact claws averaged only 63% as great full-year egg mass as hens in floor pens. Although circumstantial, he attributed much of this relative improvement to the removal of claws.

<u>Effects of Cage Shape on Productivity</u> - Bell (1972) housed 3 and 4 birds per cage in conventional (30.5 X 40.6 cm) and shallow (45.7 X 30.5 cm) cages. He noted a highly significant reduction (12.6% less) in mortality for the hens in shallow cages, resulting in a 7.9% advantage in hen-housed production over the hens in conventional cages at the end of 48 weeks of lay. Hens in shallow cages had slightly better feed conversion and less

than half as many cracked eggs as layers in deep cages. No differences were seen in total feed consumption. Lee and Bolton (1976) reported that medium- and light-body weight hens housed in shallow (61.0 X 30.5 cm) cages converted feed significantly better and consumed 4% less feed, without an adverse effect upon production, than the same strains housed in deep (40.5 X 46.0 cm) cages. They reasoned that with the extra feed trough space in the shallow cages, all birds could feed at the same time, thereby reducing competition at the feeder, feed spillage, and unwanted energy expenditure. Mortality was slightly greater for light-weight strains in shallow cages compared to those in deep cages, however, the opposite effect was noted for the medium-weight layers. Body weight gains were greater for both strains in shallow cages compared to those strains in the deep cages. The shallow caged medium-weight layers were significantly heavier than those deep caged birds of the same strain. Fewer cracked and broken eggs were laid by both strains in the shallow cages. They attributed this to the shorter distance that the egg would roll to the collection tray and less chance of two eggs colliding, since the shallow cages were narrower from front to back and wider from side to side.

In comparing conventional (40.6 X 45.7 cm) and shallow (61.0 X 30.5 cm) cages with four medium-weight layers per cage, Hughes and Black (1977) observed two types of caged layer activity; 1) feeding activity with birds either pecking at or swallowing the feed, and 2) bird movement within the cage. Hens in shallow cages showed significantly more feeding activity with 45.6% of the birds feeding at any one time compared to 39.9% for the conventional cages. Significantly more movements per bird per hour were noted, 12.15 vs. 6.98 respectively, for conventional caged hens compared to shallow caged hens. Movements in the conventional cages occurred more frequently along the frontal and the back dimensions of the cage, but less between the front and back as compared to the reverse cage.

Bell et al. (1981) noted highly significant correlations between feeder space per hen and various production traits. They compared four combinations of cages with dimensions of 25.4 and 30.5 cm widths and depths with two birds per cage, and a fifth treatment with three birds in a 30.5 cm square cage. Each additional centimeter of feeder space per hen gave .4% fewer cracked eggs, 2.3% less mortality, reduced egg weight by .25 g per egg, increased egg mass by .26 kg per hen-housed, more feed per hen-housed by .46 kg, and 5.6 more eggs per hen-housed. In comparing their light hybrid commercial layers at three birds per cage in either conventional (30.5 X 45.7 cm) or reverse (45.7 X 30.5 cm) cages, Hughes and Black (1976) reported higher (approaching significance) hen-housed egg production from light hybrid layers housed in reverse (45.7 X 30.5 cm) cages, than those in conventional (30.5 X 45.7 cm) cages. Production was observed from 30 to 70 weeks of age separately for cages with or without mortalities replaced in order to observe any effects without the interference from mortality. Numerically, less mortality was observed for layers in the conventional cages compared to those in reverse cages. Layers housed in the reverse cages produced significantly fewer cracked eggs (1.0%) than those in deep cages. They concluded that the higher production of hens in shallow cages was due to feeding behavior rather than differences in mortality. They noted that more birds were present at the front of the reverse cages than at the front of the deep cage. Feeding behaviors indicated that a higher percent of birds in shallow cages fed at any particular given moment in the day.

Muir (1976) conducted two trials in which he housed three birds per conventional (30.5 X 45.7 cm) and reverse (45.7 X 30.5 cm) cage of either high (35.6 cm) or low (30.5 cm) cage heights. In the first trial, no significant differences were noted between hens in the four cage treatments for egg production, feed conversion, livability, and average egg weight. However, feed consumption was significantly higher for the layers in the 35.6 cm high reverse cages which reflected their numerically higher rate of lay. Both groups of reverse caged hens were heavier at 72 weeks than the conventional caged hens, however, only the reverse-high caged layers were significantly heavier than the conventional-low caged layers. In a second trial, no differences were seen between treatments for 72 weeks body weights or average egg weights. Layers in the reverse-low cages laid significantly more eggs than those in the other treatments and were the most efficient. Of the four cage types, birds in the reverse-high cages consumed significantly more feed while those in the conventional-high ate significantly less feed. He suggested that competition for feeding space in the conventional vs. reverse cages aided increased feed consumption for the latter.

Although not always significant, Swanson and Bell (1977) noted trends towards improved performance with hens in reverse (45.7 X 30.5 cm) cages compared to those in conventional (30.5 X 45.7 cm) cages housed three or four per cage. More definite advantages were seen in hen-housed production, feed efficiency, and egg income over feed costs. Shape of the cage had little or no effect upon the egg size or shell quality. Hill and Hunt (1978) compared the production of two strains of S.C.W.L. commercial layers in cages with 10 combinations of stocking size, population densities, and two shapes. One combination compared three females per cage (30.5 X 45.7 cm) to its reversal. Hens in the reverse cages laid 14 fewer eggs and less egg mass per bird, had heavier body weights, had poorer feed conversion, and had 1.5% more cracked and loss eggs, all of which were significant. Nonsignificant differences were more mortality, less feed consumption and fewer grade A eggs for reverse caged hens. To keep a constant density, Baiao and Campos (1979) replaced mortality of 2- and 3-bird cages housed in 25 X 40 cm and 25 X 30 cm cages and their reversals. Hen-day production was significantly higher for hens in both reverse cages with slightly better livability compared to that of hens in conventional shaped cages. Martin et al. (1981) found that white-egg layers housed three or four females per reverse (40.6 X 30.5 cm) cage ate 2 g per bird day more feed, had 2.1% more cracked eggs, had 1.7% fewer B quality eggs and weighed 59 g heavier than layers in deep (30.5 X 40.6 cm) cages. All differences were significant. Brown-egg layers housed in the reverse cages laid more eggs per bird with less mortality.

Hill and Hunt (1980) reported that hens in deep (30.5 X 45.6 cm) cages laid significantly more cracked eggs when compared to those in normal reverse cages and reverse cages with feeder space restricted equal to that of the deep cages. Leghorns housed in deep and restricted reverse cages had significantly lower mortality, feed consumption and body weights compared to reverse caged layers. Hen-day production was comparable for all cage types. In comparing a conventional (30.5 X 50.8 cm) cage to its reversal with and without restricted feeder space to that of 30.5 cm, Ouart (1980) found no effect of cage shape or feeder space upon egg production, mortality, feed consumption, feed conversion, or cracked eggs. Cage shape did not affect change in body weight gains to 66 weeks of age. However, increasing feeder space in the reverse cages to 50.8 cm resulted in significantly increased (6.3%) weight gains.

Muir and Gerry (1976) housed three brown egg layers in conventional (30.5 X 45.7 cm) cages, half full fed and half restricted by 5%. They also housed three birds in reverse (45.7 X 30.5 cm) cages, a third full fed, a third fed the same amount of feed as those in the conventional cages, and a third fed 95% of the amount of feed given to the conventional full-fed birds. Within each cage shape, restriction of feed caused a reduction of egg production and feed consumption, improved feed conversion, and less weight gains from 22 to 72 weeks of age, though not always significant. No differences were seen for livability or egg weights. Comparing cage shapes with the same feed allotment, all reverse cages had significantly higher egg production and better feed conversion with approximately half as many cracked eggs as those layers in the deep cages.

Muir *et al*. (1980) experimented with brown-egg layers in four dimensions of cages, three population sizes and two feeding regimes. Numerically heavier body weights, higher rate of lay, less feed consumed per hen per day, better livability, and fewer cracked eggs were seen with three birds per reverse (45.6 X 30.5 cm) cage compared to their conventional (30.5 X 45.7 cm) counterparts at 76 weeks age. The hens in reverse cages required significantly less feed to produce a dozen eggs, 2.05 kg *vs*. 2.15 kg respectively, for reverse cage *vs*. conventional cage. Only in their conventional cage with three females could a maximum of two birds feed at any one time. They noted that the productive performance may not only be influenced by available space to feed during peak feeding, but also by the numbers of birds in the cage.

Carey *et al*. (1981) compared conventional (30.5 X 45.7 cm) and reverse (45.7 X 30.5 cm) cages where four hens per cage were either fed *ad libitum* or fed 90% of *ad libitum*. Significant differences were seen in that birds in conventional cages laid at 9% greater rate, they ate 9 g per day more feed, and had 3% better feed conversion than the hens in reverse cages. Hens in conventional cages showed slightly improved livability and more total egg mass than hens in reverse cages.

Effects of Cage Shape on Feather Loss, and Nervousness -Adams *et al.* (1978) devised a feather condition scoring method consisting of photographs depicting degrees of dorsal surface (back and wing) feather loss on chickens. They used an experimental strain of S.C.W.L. breeders housed at two colony cage sizes, two male:female ratios, and at two ages. There were no significant differences between strains for feathering at 40 weeks. However, significant differences were seen favoring better feather coverage for birds housed at smaller flock sizes, even though floor spaces per bird were comparable, and birds housed at 20 weeks of age had significantly better feathering than those housed at 12 weeks of age in larger flocks. Birds with the most feather damage seemed to be most fearful. Hughes and Black (1976) modified the feather scoring system of Hughes and Duncan (1972), where a score of zero represented complete feathering and six, complete denudation. They observed that light-hybrid S.C.W.L. hens housed three per cage showed slightly better feather cover in a reverse cage (45.7 X 30.5 cm) at 54 weeks than a deep cage. By 70 weeks of age there was significantly less feather loss for the reverse caged hens than the deep caged hens. In a subsequent trial, Hughes and Black (1977) observed similar results when using a medium-weight strain of layers at four per cage in conventional (40.6 X 45.7 cm) and shallow (61.0 X 30.5 cm) cages. Shallow caged layers were significantly better feathered than the conventional caged layers. They also observed that along with reduced activity, better feather cover afforded more efficient utilization of feed. Hill and Hunt (1978) devised a feather coverage score where 1, 2, and 3 represented, respectively: 0-33%, 34-66%, and 67-100% feather coverage. No differences in neck and underside feather loss of S.C.W.L. hens housed in conventional (30.5 X 45.7 cm) cages and its exact reversal were seen. However, the birds in the reverse cages had significantly better feather coverage for the back, wing, and tail areas compared to layers in conventional cages. They especially attributed wing feather wear to the fact that birds spent most of their time towards the front of the cage, rubbing wings against themselves and cage partitions. They also tested these birds for fear response according to Sefton (1976). After measuring responses on 2 consecutive days in 2 successive weeks at the end of the 12th and 15th periods, they found that layers in conventional cages were significantly more fearful than those in reverse cages. Ouart (1980), utilizing the feather score method devised by Adams et al. (1978), compared the feather cover of hens in deep (30.5 X 50.8 cm) and its reversal with the feeder space restricted to 30.5 cm. He found numerically better feather coverage for the shallow caged layers with feeder space restricted. In comparing the layers in the shallow cages, numerically better feather scores were noted for layers in shallow cages with restricted (30.5 cm) feeder space compared to those with 50.8 cm of space. Ouart (1980) utilized the nervous scoring method developed by Hansen (1976) to compare the nervousness of layers in his study. He found deep and shallow cage orientations with 30.5 cm of feed space resulted in higher nervous scores for layers in the shallow cages. For layers in shallow cage orientation, he found higher nervousness scores for 50.8 cm of feed space compared to just 30.5 cm.

Sefton (1976) observed fearfulness in 10 matings of S.C.W.L. at 60 and 64 weeks of age, by moving a pencil back and forth in front of a cage for 60 sec. Those birds pecking the pencil were given a score of zero, and the remaining birds were scored according to their position in the cage at the end of the 60 sec. period. A score of one being those birds facing the front of the cage; two, those facing the sides; three, those facing the back; and those birds in flight, given a four. He suggested that fearfulness was influenced more by the number of cage mates rather than the space provided per bird. Three birds housed at 460 cm^2 per bird had significantly higher fear scores than two birds housed at 460 cm^2 and 575 cm^2 per bird. Negative estimates for fear and production were shown for nine of the mating classes, two of those being significant and an overall average correlation of -.47. Two of the three cage types gave negative correlation estimates for fear and production, though none were significant. He concluded that a relationship existed between fear and production within genotype, but it varied among genotypes.

Choudary et al. (1972) noted the fewest cage mate interactions between birds housed in long and narrow colony cages than those in nearly square cages. The birds in the long, narrow cages seemed more easily frightened and exhibited "piling" up in one end of the cage by the slightest movement of the observer. They noted feather loss and skin bruising associated with "flighty" behaviors. Using a medium-weight strain of layers, Hughes and Duncan (1972) noted an association between fearfulness and "feather pecking" damage. Their feather cover scoring represented numbers from 0 (no sign of feather loss) to 4 (extensive skin denudation and hemorrhage). Their fear scores represented the birds reaction to a pencil presented at the front of the cage. They showed that birds with the least feather pecking damage, had the lowest fear response. The correlation (.484) was highly significant. They concluded that fearfulness was produced by the action of pecking by cagemates or other stimuli.

MATERIALS AND METHODS

Six-hundred day-old female S.C.W.L. (Babcock 300[R]) chicks were received from a commercial hatchery on May 20, 1980 at the Avery Poultry Research Center, Kansas State University, Manhattan, Kansas. The chicks were dubbed and vaccinated for Newcastle, bronchitis, and Marek's diseases. They were randomly assigned to one of three toe treatment groups; (1) no claws removed (control), (2) the middle claw removed from each foot, and (3) the middle and inside claws removed from each foot. Removal of claws at the terminal phalanx was done with a hot blade debeaker. The chicks were wingbanded for toe treatment identification and placed in floor pens in a naturally ventilated, curtain-sided brooding-rearing house. Wood shavings litter was used. The chicks were fed the KSU 20 and 18% crude protein starter and grower rations ad libitum from 0 through 8 and 9 through 20 weeks, respectively, and supplied with free flowing waterers. The chicks were given a 14-hr. light day to 3 weeks of age, and natural daylength the duration of the rearing period. The chicks were precision debeaked at 10 days of age, vaccinated for fowl pox at 8 weeks and weighed every 4 weeks to monitor body weight. Touch-up

---

[R]Registered trademark for a strain of Single Comb White Leghorns, Babcock Poultry Farm, Inc., Ithaca, New York, 14850.

debeaking and declawing were done at 16 weeks. All pullets were moved into the experimental cages at 20 weeks. The pullets were housed in two types of single tier cages in two back-to-back double rows located along the north and south walls of a naturally ventilated curtain-sided house. A total of 36 cages were allocated per side of each double-sided row. Half were randomly designated as deep (25.4 wide X 45.7 cm) and half as reverse (45.7 wide X 25.4 cm) cages for a total of 144 cages.

An equal number of birds from each declawed treatment were placed three per cage in each of the deep or reverse cages. An equal number of cages of the six different toe treatment X cage shape combinations were within each side of each double-sided row. All mortalities were replaced by birds from the same toe treatment X cage shape environments in order to maintain a constant floor space of 387 cm^2 per bird. The experimental design is indicated in Table 1.

At housing, the pullets were placed on a 17 hr. photoperiod and were fed the KSU 18% crude protein layer ration (appendix, A-1). Body weight and feed consumption data were recorded for the birds in two randomly selected cages per treatment combination per side of a row. The birds were weighed at housing and again at the end of the study (66 weeks). Feed was dispensed *ad libitum* to each cage on a volume basis

Table 1. Toe treatments, cage shape, number of cages and birds per treatment combination

Trt. design	Claws removed	Cage shape, cm (width X depth)	Total cages per treatment combination	Females per treatment combination[1]
1	0	45.7 X 25.4	24	72
2	0	25.4 X 45.7	24	72
3	1	45.7 X 25.4	24	72
4	1	25.4 X 45.7	24	72
5	2	45.7 X 25.4	24	72
6	2	25.4 X 45.7	24	72

[1]Three females per cage.

and was weighed in and out, on a gross weight basis, at the end of every 28-day period. The hens not on feed monitoring were hand fed *ad libitum*. Egg production was recorded for all cages 3 consecutive days per week. Mortality was recorded continuously for all cages. Egg quality was measured by gathering all the harvestable eggs from all cages for 3 consecutive days per 28-day period. Eggs were classified according to USDA standard for individual shell eggs (USDA, 1977) as being Grade A, Extra Large, Large, Medium, Small, and undergrades (body checks, cracked and bloods). Total weights of these eggs were recorded at this time.

Feather cover scores were taken of all hens at 66 weeks of age. The observer matched the feather condition of the birds with a series of photographs (Adams *et al*., 1978). Feather condition was recorded by two methods; (1) three birds of a cage were observed simultaneously and the average score recorded (collective feather score-CFS), and (2) birds in each cage were scored individually and the scores then averaged (individual feather score-IFS). Also at 66 weeks of age, latency of birds to return to feeding after exposure to a novel stimulus was observed in half (12 cages) of the cages of each treatment combination in both sides of a double-sided row. A cage was randomly selected as the starting point and every sixth cage (equivalent to six deep cage widths) was observed in succession until arriving at the original starting point. Four complete "rounds" were made in order to measure all cages in this fashion. Each "round" was divided between two observers so that neither person was observing on the same side of a row at any one time for that respective "round." Feeders of the cages to be observed in the double-sided row were covered by prefitted sectioned covers 12 hr. prior to the start of observations. The observer would stand approximately 45.7 cm in front of the cage to be observed, remove the feeder cover with his hand, strike three times on the top of the cage, and commence three stop watches. Cumulative times measured were the time elapsed before one bird began to feed, the time elapsed before any two birds began to feed simultaneously, and time before any three birds began to feed simultaneously or two to be feeding and one bird attempting to feed or exhibiting a non-avoidance type behavior. The latter category was used since it seemed difficult for three birds to feed simultaneously in the deep (25.4 cm width) cages. Each cage was observed for a maximum of 10 min.

Toe treatment and cage shape were main effects in the analysis of variance and rows were considered as block effects. Sources of variation were toe treatment, cage shape, row, and toe treatment X cage shape interaction. Dependent variables were mortality, egg production, egg quality and size, age at 50% production, average egg weight, g of egg per g of feed consumed, g of feed consumed per hen day, percent change in body weights, feather cover scores, and latency to feeding times. Duncan's multiple range test determined specific significant mean differences and within subclass correlations were computed between IFS and CFS. Because some of the birds that were originally weighed had died, body weight data was unbalanced, thus, unequal subclass analysis of variance was used for body weight data.

RESULTS AND DISCUSSION

Analysis of variance data for egg production, age at 50% production, mortality, and body weight change are shown in appendix (A-2).

Egg Production - Hens with 1 and 2 claws removed laid 5.2 and 8.0 more eggs, respectively, than the intact hens during the 44-week production cycle (Table 2). These differences approached significance ($P \leq 0.06$). The trend for improvement in egg production from declawing agrees with the results of Compton *et al.* (1981b), Ruszler and Kiker (1975), and Martin et al. (1976) who found that declawed layers produced significantly more eggs than intact layers. Carter *et al.* (1980), using similar declawing treatments, found that layers with two claws removed produced 15.6 more eggs per hen-housed than intact layers.

Data presented in Table 2 show that hens in reverse and in deep cages had similar egg production rates. A lack of a significant effect of the cage shape on egg production agrees with one trial performed by Muir (1976) and Ouart (1980) where conventional caged hens were compared to reverse caged layers.

Sexual Maturity - Differences between declawing treatment means and cage shape means were not significant for age at sexual maturity. The declawed hens matured approximately 3 days earlier than the intact hens (Table 2).

Table 2. Means for eggs laid per hen, age at 50% production, mortality, percent body weight change, and average egg weight

No claws removed	Eggs laid[1] (per hen)	Age to 50% production (days)	Mortality (%)	Body wt.[2] change (%)	Average egg wt. (g)
0	229.2^{a3}	167.7^{a}	13.9^{a}	33.9^{a}	60.4^{a}
1	234.4^{a}	164.5^{a}	9.0^{a}	27.5^{a}	59.6^{b}
2	237.2^{a}	164.8^{a}	10.4^{a}	31.0^{a}	59.5^{b}
Cage shape					
Reverse	234.1^{a}	165.9^{a}	12.9^{a}	31.5^{a}	59.7^{a}
Deep	233.1^{a}	165.5^{a}	9.3^{a}	30.0^{a}	60.0^{a}

[1]Cage total/3 females per cage.

[2](Body wt. at housing - body wt. at 66 wk. of age ÷ housing wt.) X 100.

[3]Means within a treatment-column cell with different superscripts differ significantly ($P \leq 0.05$).

Precocial laying behavior has been observed by Compton *et al*. (1981a) who noted earlier egg laying in declawed pullets though corticosterone, estradiol levels and body weight were not significantly different from the intact pullets at housing. Ruszler and Kiker (1975) reported that declawed pullets were significantly heavier at 20 weeks of age and they matured one week earlier than intact pullets.

Mortality - Although differences in mortality were noted between declawed and intact hens and between hens in deep and shallow cages (Table 2), they were not significant (P>0.05). Ruszler and Quisenberry (1979) and Compton *et al*. (1981b) reported that declawed layers had significantly better livability compared to intact layers. In a similar study, Baiao and Campos (1979) replaced all mortalities in 2- and 3-bird cages and noted significantly higher hen-day production and slightly better livability for the hens in reverse cages compared to those in conventional cages. Bell (1972) reasoned that the 7.9% advantage in hen-housed production for his reverse caged hens was due to their significant reduction (12.6%) in mortality compared to the conventional caged hens. Mortality could not be related to egg production in this study because mortalities were replaced. Hill and Hunt (1980) noted significantly higher mortality for their reverse caged hens compared to hens in deep cages. Carey *et al*. (1981) found that four layers housed in reverse cages suffered slightly more mortality than conventional caged layers. The significant ($P<0.01$) row effect (Table A-2) was due to improper application of an insecticide in one row.

Change in Body Weights - No significant differences were seen in body weight change from 20 to 66 weeks of age due to declawing or cage shape. There was an unexplainable significant ($P<0.05$) row effect (Table A-2), however, body weight means for rows were not separated. Means in Table 2 show that intact hens had numerically greater body weight changes than the hens in the declawed groups. Compton et al. (1981b) and Ruszler and Quisenberry (1979) found that intact hens gained significantly more weight compared to declawed hens. Our results showed no significant effect of cage shape upon body weight change at 66 weeks of age. Similar results were reported by Ouart (1980) in one trial comparing conventional caged layers to layers housed in reverse cages with feed space equal to that of the conventional caged hens.

Egg Weight - The intact hens produced significantly ($P\leq0.05$) heavier eggs (60.4 g) than hens with one or two claws removed, 59.6 and 59.5 g, respectively (Table 2). The fact that declawed hens initiated egg production earlier then the intact hens may account for their smaller egg weights. Ruszler and Quisenberry (1979) noted that declawing significantly lowered average egg weights in one trial but had little effect in a second trial. Compton et al. (1981b) reported no differences in average egg weights between declawed and intact layers. The lack of a significant effect of cage shape upon egg weight agrees with Muir (1976) and Muir and Gerry (1976).

Feed Consumption and Utilization - Analysis of variance (Table A-3) shows that among the main effects, only cage shape significantly ($P<0.05$) affected feed consumption (g of feed consumed per hen-day) and only row significantly ($P<0.05$) affected feed utilization (g of egg produced per g of feed consumed). The data recorded in Table 3 show that hens in deep cages consumed significantly ($P\leq0.05$) more feed per hen-day (106.3 g) than hens in reverse cages (102.9 g). No differences were noted in feed utilization due to cage shape. In contrast, Carey *et al.* (1981) noted that conventional caged hens ate significantly more feed (9 g per hen per day) and had 3% better feed conversion than reverse caged layers. Lee and Bolton (1976) found significantly better feed conversion and lower feed consumption by hens in shallow cages than those in deep cages. They suggested that reducing energy expense in the shallow cages was the important factor involved. Hill and Hunt (1978) found significantly poorer feed conversion and numerically less feed was consumed by reverse caged hens compared to deep caged hens. Ouart (1980) found no effect of cage shape upon feed consumption or feed conversion. The data did not substantiate why there was a significant row difference for feed utilization.

The means show (Table 3) that numerically less feed was consumed by intact layers compared to declawed hens, which may be related to their numerically poorer egg production (Table 2). Compton et al. (1981b) found no effect of declawing upon feed consumption or feed conversion. Ruszler and Quisenberry (1979) noted that declawed hens had significantly poorer feed conversions than intact layers in their first trial, however, no difference was noted in their second trial. Martin et al. (1976) noted that declawed layers produced significantly more eggs with significantly less feed than intact layers.

Table 3. Means for feed consumption and feed utilization

Claws removed	Feed consumed per hen day (9)	G of egg produced per g of feed consumed (g)
0	103.1[a1]	0.429[a]
1	104.2[a]	0.433[a]
2	106.4[a]	0.429[a]
Cage shape		
Reverse	102.9[a]	0.431[a]
Deep	106.3[b]	0.429[a]

[1]Means within a treatment-column cell with different superscripts differ significantly ($P \leq 0.05$).

Egg Quality - Only the percentage of medium eggs was significantly affected ($P<0.05$) by declawing (Table A-4). Data in Table 4 show that intact hens laid significantly ($P\leq0.05$) fewer medium sized eggs (14.2%) than the hens with one claw removed (18.6%) or two claws removed (18.9%). These results are in general agreement with Sefton (1977), and Ruszler and Quisenberry (1979) who observed a trend for declawed hens to lay fewer extra large and large eggs and more medium eggs. No significant differences between declawing treatments were found for body checked or cracked eggs, which agrees with Ruszler and Quisenberry (1979) and Compton et al. (1981b). This trend agrees with Swanson and Bell (1977) and Ouart (1980) who found no effect of cage shape on shell quality and cracked eggs, respectively. In contrast, Lee and Bolton (1976), Hill and Hunt (1980), and Muir and Gerry (1976) noted significantly fewer cracked eggs produced in reverse cages than in deep cages. Hill and Hunt (1978) and Martin et al. (1980), however, reported opposite results.

A significant treatment by cage interaction was noted for production of blood spot eggs (appendix A-4). Hens with 0, 1, and 2 claws removed produced 1.8, 1.9, and 3.3% blood spot eggs, respectively, within the reverse cages. In contrast, hens with 0, 1, and 2 claws removed produced 2.3, 1.5, and 1.3% blood spot eggs, respectively, in the deep cages. The declawed hens produced

Table 4. Means for percentages of Grade A eggs, body checks, cracked and blood spot eggs

Claws removed	Grade A: Extra Large	Large	Medium	Small	Body-checks	Cracks	Blood spots
0	3.8[a]	74.3[a]	14.2[a][1]	1.8[a]	2.2[a]	1.4[a]	2.00[a]
1	3.1[a]	70.7[a]	18.6[b]	1.8[a]	2.2[a]	1.5[a]	1.7[a]
2	2.7[a]	70.3[a]	18.9[b]	1.5[a]	2.1[a]	1.6[a]	2.4[a]
Cage shape							
Reverse	3.3[a]	70.4[a]	18.2[a]	1.8[a]	2.1[a]	1.4[a]	2.3[a]
Deep	3.1[a]	73.2[a]	16.2[a]	1.6[a]	2.2[a]	1.6[a]	1.7[a]

[1]Means within a treatment-column cell with different superscripts differ significantly (P = 0.05).

fewer blood spot eggs in deep cages compared to reverse cages. The excessive competition for feeder space and the depth of the conventional cage may require more of a need for declawing. Hughes and Black (1977) noted significantly more movements per bird per hour with four medium-weight layers housed in conventional cages compared to those housed in reverse cages. Excessive bird movement may cause injuries and subsequent pain which may lead to more nervousness, resulting in a higher incidence of blood spots.

Feather Scores - Analysis of variance data on individual hen feather scores (IFS) and collective feather scores (CFS) are in the appendix (Table A-3). Cage shape and row affected IFS while only row affected CFS ($P<0.01$), probably due to a larger standard deviation (data not shown) for the CFS. Reverse caged layers showed significantly ($P\leq 0.05$) better feather coverage (IFS) 7.60 vs. 7.28, than hens in deep cages (Table 5). These results agree with Hughes and Black (1976, 1977), Hill and Hunt (1978), and Ouart (1980).

The significant row effect noted for the feather score determination was consistent for the same two rows involved. These two rows had significantly ($P\leq 0.05$) poorer feather coverings than the other two rows (data not shown). A possible explanation is that these rows were nearest to the main entrance to the building and

Table 5. Means for individual and collective feather scores and latency to return to feeding times

			Time taken to return to feeding (sec)		
Claw removed	Individual feather[1] score	Collective feather[1] score	1 bird[3]	2 birds	3 birds
0	7.57^{a}[2]	7.40^{a}	72.5^{a}	95.4^{a}	200.6^{a}
1	7.39^{a}	7.19^{a}	87.3^{a}	158.8^{a}	311.5^{a}
2	7.38^{a}	7.28^{a}	106.2^{a}	188.9^{a}	254.7^{a}
<u>Cage shape</u>					
Reverse	7.60^{a}	7.40^{a}	103.7^{a}	165.5^{a}	241.8^{a}
Deep	7.28^{b}	7.17^{a}	73.6^{a}	129.9^{a}	269.4^{a}

[1]Larger number value represent better feather coverage.

[2]Means within a treatment-column cell with different superscipts differ significantly ($P \leq 0.05$)

[3]Number of birds feeding simultaneously.

roadway traffic, thus inducing more bird movement and feather abrasion. No other variables analyzed, however, were consistent in affecting these same two rows.

No significant differences were noted for feathering by either scoring method between the three claw treatments (Table 5). Compton *et al.* (1981b) also noted no significant differences in feather scores for declawed *vs.* intact layers, however, the declawed hens did have significantly poorer "foot scores" (3.9 *vs.* 6.2) compared to intact hens. They suggested that declawing reduced the area of support for these hens, thereby causing more injury to the feet. Subjective observations indicated many hens used the outside claw of one foot in "grasping" the vertical walls of the cage during feeding, especially in the deep cages where there was greater competition for feeding space than in the shallow cages.

Within subclass estimates of correlation among the two scoring methods were examined (Snedecor and Cochran, 1978) to determine how these two methods varied together. Pooled within subclass correlation estimates were made of three claw treatment-cage shape-row groups, as noted in appendix (Tables A-5, A-6). One group (N = 15) had a pooled correlation estimate of .95, a second group (N = 7) an estimate of .66, and a third group (N = 1) an estimate of .23. A fourth combination had an undefined estimate since the subjectiveness of our test did not allow a standard deviation for one score. It was noted in comparing IFS *vs*. CFS within each claw treatment-cage shape group that the individual scores were always higher than the average cage scores (Table 5). It should be noted for future use of either of these scoring methods, that more deep cages were involved in the lower (r = .66) pooled estimate of correlation. There were more observations noted for the group with the higher pooled correlation estimate and there seemed to be equal representation of claw treatment-cage shaped-row groups. The data suggested that the individual feather scoring method may be more accurate than the collective feather scoring method because it detected a significant cage shape effect (Table 5).

Latency to Return to Feeding - To measure fear responses, the time required for birds to return to feeding after exposure to a novel stimulus was measured. Murphy (1978) described this approach in measuring fear stimuli related to the latency for birds to return to feeding after exposure to a novel stimulus, such as a loud noise. The analysis of variance of these data is given in appendix (Table A-7). Neither claw treatment nor cage shape had a significant effect on latency to feeding. Numerically longer times were taken for 1, 2, and 3 declawed birds to return to feeding than for the same number of intact layers (Table 5). Ruszler and Quisenberry (1979) noted no flightiness or hysterical behaviors in either intact or declawed hens housed at 290 cm^2 of floor area per hen with 7 and 10 birds per cage. In general, if latency to feed is a measure of fear or flightiness, our results agree with theirs. Hughes and Duncan (1972) noted that those birds with the lowest "fear scores," also suffered the least "feather pecking" damage, with a significant correlation ($r = .48$).

Cage shape did not significantly affect the latency to feeding behavior (Table 5). Numerically more time was taken for 1 and 2 birds to return to feeding in the reverse cages compared to the same number of birds in the deep cages. Possibly for two birds, a competitive drive to feed is more obvious in the deep cages. In contrast, numerically more time was taken for three birds to return to feeding in the deep cages compared to the same number of birds in the reverse cages. Since any active movement made by that third bird in the deep cage towards the feeder was considered a non-avoidance behavior, it is suggested that their longer time to feeding (compared to three birds in reverse cages) reflects competition for feeding or a fear of other birds or the observer. An unexplained significant ($P \leq 0.05$) row effect was noted for latency to return to feeding times for two birds. Numerical trends were seen between rows for the other two feeding categories. All birds in the row nearest the main entrance to the building and roadway returned to the feeder on the average, sooner than birds in the other row. Possibly they became adapted to more exposure to environmental stimuli.

REFERENCES

REFERENCES

Adams, A. W., J. V. Craig and A. L. Bhagwat, 1978. Effects of flock size, age at housing, and mating experience on two strains of egg-type chickens in colony cages. Poultry Sci. 57:48-53.

Adams, R. L. and W. L. Stadelman, 1978. Effects of toe clipping turkeys on leg weakness and weight gains. Poultry Sci. 57:1113(abstract).

Baiao, N. C. and E. J. Campos, 1979. Normal vs. reverse cage for layers: Effects on bird's performance. Poultry Sci. 58:1033-1034(abstract).

Bell, D., 1972. Reverse cage demonstrates striking income advantage. Poultry Digest 31:326-328.

Bell, D. D., D. R. Kuney and L. A. Yates, 1981. An evaluation of small cages for commercial egg production. Poultry Sci. 60:1622(abstract).

Carey, J. B., A. W. Adams and J. V. Craig, 1981. The effect of cage design and feeding level on performance of commerical egg laying chickens. Poultry Sci. 60:1635(abstract).

Carter, T. A., G. A. Martin, J. R. West and J. B. Ward, 1980. The effect of toe amputation on layer performance. Poultry Sci. 59:1559(abstract).

Choudary, M. R., A. W. Adams and J. V. Craig, 1972. Effects of strain, age at flock assembly, and cage arrangement on behavior and productivity in White Leghorn type chickens. Poultry Sci. 51:1943-1950.

Compton, M. M., H. P. VanKrey, P. L. Ruszler and F. C. Gwazdauskas, 1981a. The effects of claw removal on growth rate, gonadal steroids, and stress response in cage reared pullets. Poultry Sci. 60:2120-2126.

Compton, M. M., H. P. VanKrey, P. L. Ruszler and F. C. Gwazdauskas, 1981b. The effects of claw removal and cage design on the production performance, gonadal steriods, and stress response in caged laying hens. Poultry Sci. 60:2127-2135.

Greene, D. E. and L. F. Eldridge, 1975. Effect of toe clipping on market grade of confinement reared turkeys. Poultry Sci. 54:1767(abstract).

Hansen, R. S., 1976. Nervousness and hysteria of mature female chickens. Poultry Sci. 55:531-543.

Hill, A. T., 1975. Foot sore incidence among declawed leghorn-type layers, as affected by strain, density, and birds per cage. Can. J. Anim. Sci. 55:165-166.

Hill, A. T. and J. R. Hunt, 1978. Layer cage depth effects on nervousness, feathering, shell breakage, performance, and net egg returns. Poultry Sci. 57:1204-1216.

Hill, A. T. and J. R. Hunt, 1980. Cage orientation effects on layer performance. Poultry Sci. 59:1620(abstract).

Hughes, B. O. and I. J. H. Duncan, 1972. The influence of strain and environment upon feather pecking and cannibalism in fowls. Brit. Poultry Sci. 13:525-547.

Hughes, B. O. and A. J. Black, 1976. Battery cage shape: its effect on diurnal feeding pattern, egg shell cracking and feather pecking. Brit. Poultry Sci. 17:327-336.

Hughes, B. O. and A. J. Black, 1977. Diurnal patterns of feeding activity in laying hens in relation to dietary restriction and cage shape. Brit. Poultry Sci. 18:353-360.

Hughes, W. F. 1961. Preliminary observations on avian hysteria. Avian Dis. 5(3):351-352.

Ingram, D. R. and H. R. Wilson, 1981. Fertility and hatchability as influenced by claw removal of broiler breeder males. Poultry Sci. 60:2161-2164.

Lee, D. J. W. and W. Bolton, 1976. Battery cage shape: the laying performance of medium- and light-body weight strains of hens. Brit. Poultry Sci. 17:321-326.

Leeson, S. and W. D. Morrison, 1978. Effect of feather cover on feed efficiency in laying birds. Poultry Sci. 57:1094-1096.

Martin, G. A., J. R. West and G. W. Morgan, 1976. Effects of wing and toe amputation on layers. Poultry Sci. 55:2061(abstract).

Martin, G. A., T. A. Carter, J. R. West and J. B. Ward, 1981. Cage type and density effects in closed housing. Poultry Sci. 60:1694(abstract).

Muir, F. V., 1976. Performance of red X rock sex-linked females in reverse and conventional laying cages of varying heights. Poultry Sci. 55:1234-1237.

Muir, F. V. and R. W. Gerry, 1976. Reverse cages and restricted feeding can be used to increase profits with brown egg layers. Feedstuffs. 48(35):18-19.

Muir, R. V., R. W. Gerry and R. O. Hawes, 1980. Effect of cage dimension and feeding regimes on the performance of chickens laying brown eggs. Life Sciences and Agricultural Experiment Station, University of Maine at Orono. 27(1).

Murphy, Linda B., 1978. The practical problems of recognizing and measuring fear and exploration behavior in the domestic fowl. Animal Behav. 26:422-431.

North, M. D., 1978. Commercial chicken production manuel. 2nd ed. Avi. Publ. Co., Inc., Westport, CT.

Ouart, M. D., 1980. Effects of cage design and bird density on performance and behavior of egg-type chickens. PhD dissertation, Kansas State University Library.

Owings, W. J., S. L. Balloun, W. W. Marion and G. M. Thomson, 1972. The effect of toe-clipping turkey poults on market grade, final weight and percent condemnation. Poultry Sci. 51:638-641.

Proudfoot, F. G., H. W. Hulan and W. F. DeWitt, 1979. Response of turkey broilers to different stocking densities, lighting treatments, toe clipping, and intermingling the sexes. Poultry Sci. 58:28-36.

Ruszler, P. L. and J. T. Kiker, 1975. Toe clipping cage reared pullets and its effect on growth and egg production. Poultry Sci. 54:1346(abstract).

Ruszler, P. L. and J. H. Quisenberry, 1979. The effect of declawing two flock sizes of 23-week-old pullets on hysteria and certain production traits. Poultry Sci. 58:778-784.

Sefton, A. E., 1976. The interactions of cage size, cage level, social density, fearfulness, and production of Single Comb White Leghorns. Poultry Sci. 55:1922-1926.

Sefton, A. E., 1977. Toe clipping caged layers. Poultry Sci. 56:1756 (abstract).

Snedecor, G. W. and W. G. Cochran, 1978. Statistical methods. 6th ed. The Iowa State University Press, Ames, Iowa.

Swanson, M. H. and D. D. Bell, 1977. Layer performance in reverse vs. conventional cages. Poultry Sci. 56:1760-1761 (abstract).

U.S. Department of Agriculture, 1977. Egg Grading Manual. Agriculture Handbook No. 75.

APPENDIX

Table A-1. Formulation of KSU 18% crude protein layer ration

Ingredients	Amount per 909.05 kg (kg)
Corn, yellow, ground	268.18
Sorghum grain, ground	268.18
Soybean oil meal, 44% cp., solv. ext.	259.09
Alfalfa Meal, 17% cp., dehy.	22.72
Limestone	30.45
Oyster shell, flake	30.45
Dicalcium phosphate	22.72
Salt, Iodized	2.27
Trace Mineral mix (Z-10)	0.45
Vitamin and Methionine Premix (g)	

a.	Vit. A (10,000 USP/g)	300
b.	Vit. D_3 (15,000 ICU/g)	120
c.	Vit B_{12} (20 mb/lb)	240
d.	B-Complex	908
e.	D-L methionine	681

[1]Mg/lb; riboflavin 8000, pantothenic acid 14,720, niacin 24,000, choline chloride 80,000.

Table A-2. Analysis of variance for egg production, age at 50% production, mortality and unequal subclass analysis for percent body weight change

Source of variation	d.f.	Eggs laid (cage per cycle) M.S.	Age at 50% production (days) M.S.	Mortality (%) M.S.
Claw treatment	2	7241.80	151.10	300.88
Cage	1	294.70	5.44	492.84
Treatment X cage	2	1642.97	17.70	562.15
Row	3	2002.70	51.72	2034.44**
Error	135	2600.39	58.74	382.17

Source of variation	d.f.	Body wt. change (%) M.S.
Claw treatment	2	154.29
Cage	1	26.73
Treatment X cage	2	40.81
Row	3	208.86*
Error	38	61.95

*P<0.05, **P<0.01.

Table A-3. Analysis of variance for feed consumption and utilization, individual and collective feather scores

Source of variation	d.f.	Feed consumption (g per hen-day) M.S.	Feed utilization (g egg per g feed) M.S.
Claw treatment	2	42.80	.000085
Cage	1	136.86*	.000075
Treatment X cage	2	17.55	.000118
Row	3	69.51	.0032*
Error	39	28.86	.000882
Source of variation	**d.f.**	**Individual feather score M.S.**	**Collective feather score M.S.**
Claw treatment	2	.59	.53
Cage	1	3.64**	2.00
Treatment X cage	2	.2738	.1944
Row	3	1.8**	3.52**
Error	135	.4407	.8096

*P<0.05, **P<0.01.

Table A- 4. Analysis of variance for average egg weight, egg size distribution, body checked, cracked and blood spot eggs

			Grade A				
		Average egg wt. (g/egg)	x-large (%)	Large (%)	Medium (%)	Small (%)	Body checks (%)
Source of variation	d.f.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.
Claw treatment	2	12.34*	12.71	234.51	330.45*	1.57	.0140
Cage	1	2.45	.8711	290.70	145.81	1.73	.0178
Treatment X cage	2	0.69	5.03	62.23	47.96	6.47	1.89
Row	3	4.96	23.29	159.34	101.63	2.64	9.42
Error	135	3.87	9.94	100.68	78.24	6.20	6.96

		Cracks (%)	Blood spots (%)
Source of variation	d.f.	M.S.	M.S.
Claw treatment	2	.4128	5.11
Cage	1	2.28	15.47
Treatment X cage	2	.0013	19.12*
Row	3	.4897	1.24
Error	135	2.47	5.53

*$P<0.05$.

Table A-5. Test of hypothesis of common ρ and estimation of ρ, correlation between collective feather score and individual feather score methods--r values of .80 or greater

Sample (claw-cage-row)[1]	r	χ^2	Corrected pooled r
0-1-1	.96	22.66[2]	.95
0-1-2	.99		
0-1-4	.95		
1-1-2	.84		
1-1-3	.96		
1-1-4	1.0		
2-1-1	.89		
2-1-3	.90		
0-2-1	.83		
0-2-2	.99		
1-2-1	.99		
1-2-2	.83		
2-2-1	.95		
2-2-3	.87		
2-2-4	.93		

[1]claw, claws removed-0, 1, 2; cageshape, 1-reverse, 2-deep; row 1, 2, 3, 4.

[2]d.f. = 14, P = 0.05.

Table A-6. Tests of hypothesis of common ρ and estimation of ρ, correlation between collective feather score and individual feather score methods--r values of less than .80

Sample (claw-cage-row)[1]	r	χ^2	corrected pooled r
1-1-1	.67	.1744[2]	.66
2-1-2	.78		
0-2-3	.71		
0-2-4	.70		
1-2-3	.65		
1-2-4	.70		
2-2-2	.63		

Sample (claw-cage-row)[1]	r
0-1-3	0
2-1-4	.23

[1]claw, claws removed-0, 1, 2; cage shape, 1-reverse, 2-deep; row-1, 2, 3, 4.

[2]d.f. = 6, P = 0.05.

Table A-7. Analysis of variance for latency to return to feeding after a novel stimulus

		One hen (sec)	Two hens (sec)	Three hens (sec)
Source of variation	d.f.	M.S.	M.S.	M.S.
Claw treatment	2	6824.59	54644.03	73857.67
Cage	1	16275.09	22826.72	13667.56
Treatment X cage	2	36980.53	34784.53	67133.96
Row	1	62687.5	149422.22*	94178.00
Error	65	18582.62	27272.81	44709.28

*P<0.05

EFFECTS OF DECLAWING AND CAGE SHAPE ON PRODUCTIVITY, FEATHERING AND FEARFULNESS OF EGG-TYPE LAYERS

by

KEITH P. VANSKIKE

Assoc., Barton County Community College, 1978
B.S., Kansas State University, 1980

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Animal Sciences and Industry

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1982

ABSTRACT

An equal number of egg-type pullets, which had either none, 1, or 2 claws removed (middle or middle and inside toes) at day old, were housed (3 per cage) in deep (25.4 X 45.7 cm) or reverse (45.7 X 25.4 cm) cages at 20 weeks of age. The declawed hens produced numerically (approached significance) more eggs than the intact hens. Improved livability, earlier sexual maturity and less change in body weights from housing to 66 weeks of age were noted for the declawed hens. Declawed hens produced significantly ($P \leq 0.05$) smaller eggs, 59.6 and 59.5g, respectively for hens with 1 and 2 claws removed compared to intact hens (60.4g). The declawed hens ate more feed per hen-day than their intact counterparts, yet no differences were seen in feed utilization. Numerically poorer feather cover scores and longer latency to return to feeding times were noted for declawed hens.

No significant differences were seen between either cage shape for egg production, mortality, cracked eggs, feed utilization or change in body weights from housing to 66 weeks of age. The reverse caged layers consumed significantly ($P \leq 0.05$) less feed per hen-day 102.9 *vs.* 106.3g, with significantly ($P \leq 0.05$) better feathering 7.60 *vs.* 7.28 (individual feather score) compared to deep caged hens. The data suggested that the individual

feather scoring method may be more accurate than the collective feather scoring method, since it detected a significant cage shape effect. Pooled within subclass estimates of correlation between the two feathering score methods were done. Estimates revealed two separate pooled groups including more standard cages than reverse cages in the lower pooled correlations. Reverse caged hens showed numerically longer times for 1 and 2 birds to return to feeding than the same number of layers in the deep cage, yet the opposite results were seen for 3 birds to feed.