EFFECT OF HOUSING BODY WEIGHT AND REARING RELATIONSHIP ON SUBSEQUENT PERFORMANCE OF EGG-TYPE CHICKENS

by

RICHARD ORRIN BAILER

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Approved by:

Albert W. Adams
Major Professor

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INTRODUCTION

There is a trend toward housing egg production strains of chickens under conditions of high bird densities in multiple-bird cages because more return is obtained per dollar invested than when birds are housed in single-bird cages or floor pens (Champion and Zindel, 1968; and Tower and Roy, 1969).

Studies have shown when chickens are confined under crowded conditions, social and biological interactions may develop that affect performance. Several researchers have reported the loss of production associated with crowding may differ significantly between strains. This is an indication of genotype-environmental interactions (Adams and Jackson, 1970; Biswas and Craig, 1970; Craig, 1970; and Marr and Green, 1970).

Since housing layers at high bird densities appears to be an accepted commercial practice, investigations into methods of reducing social and biological stress under these conditions would be very beneficial to the egg production industry.

Reported here are the effects of housing pullets in cages according to body weight on laying house performance. As part of this experiment birds which were pen mates during brooding and rearing were caged together and compared to birds which were strangers during brooding and rearing. It was postulated that if birds could be housed where less social interaction was present, production would improve.

REVIEW OF LITERATURE

EFFECTS OF STRAIN, DENSITY, POPULATION SIZE, AND HOUSING SYSTEMS

The relationship between strain of layers and housing environment has been a subject of extensive investigation. Wilson et al. (1967), experimenting with two commercial strains of S. C. White Leghorn pullets, studied the effects of cage size and number of birds per cage on production characteristics. Egg production was significantly ($P < .01$) less with three birds per cage than with one or two birds per cage. Egg production of the two strains was different for the bird densities observed. Egg weight and quality characteristics were affected little by the treatments. Major differences were due to strain effects. Increasing bird density resulted in smaller body weights from 19 to 65 weeks of age and greater mortality.

Cook and Dembnicki (1966) reported on a study involving five commercial White Leghorn stocks and one Rhode Island Red stock hatched and reared together and housed in laying cages using three housing regimes; single, double, and five-bird colony cages. There were highly significant differences among the housing regimes for hen-housed egg production during a 280-day laying period. Pullets housed in single cages had a 32- and 59-egg advantage in production over the pullets housed in double or colony cages, respectively. Large differences were also observed between stocks and housing regimes for laying mortality, with mortality increasing as density increased. There was no evidence of interaction between stocks and housing regimes for body weight and egg quality traits. There was a highly significant interaction of stock and housing regime for hen-housed egg production.

The loss of productivity associated with crowding may differ significantly between strains indicating genotype-environmental interactions;

suggesting some strains of S. C. White Leghorns can adapt to battery cages better than others. In a study by Gowe (1956), seven strains of S. C. White Leghorn pullets were hatched and reared together and housed in a three deck, individual cage laying battery unit and in floor pens. A highly significant interaction between strains and locations (floor pen and battery) with respect to survivor egg production and body weight was observed. There was no evidence of any interaction between strains and locations for the following traits; hen-housed egg production, sexual maturity, egg weight and laying house mortality.

In a similar study, Francis (1957a) compared five commercial strains of S. C. White Leghorns and two hybrids housed at several bird densities. Results suggested the strains of Leghorns tested adapted to cages better than the hybrids.

It has been shown that more return on capital and labor can be obtained by housing birds in cages at high bird densities. In an early experiment, Lowry et al. (1956) found that pullets housed in individual cages had significantly lower mortality, lower production, heavier eggs, and a higher incidence of blood spots than their sisters housed in floor pens.

Bailey et al. (1959) compared the performance of four egg production stocks housed in cages and floor pens. They reported egg production of the caged birds was 1.3 percent higher than that of the birds in floor pens. Average egg weight was significantly heavier in the cage housed birds, their average body weight was 116.4 gm. greater, and they required 0.146 lb. less feed to produce a pound of eggs than those in floor pens. There were no significant differences in laying house mortality. Differences in response to housing method for the four stocks were statistically significant.

A comparison of floor, cage and range rearing of caged layers was reported by Shupe and Quisenberry (1961). Highest mortality was obtained from birds reared in cages and the lowest from those in floor pens. Birds reared in floor pens had significantly lower body weights than those reared in colony cages. Birds in colony cages laid at a higher rate than those in the other housing regimes. Eggs from the floor flocks were significantly lighter than those from cages. For the entire laying period, birds in floor pens had lower body weight and smaller eggs, but the birds from the individual cages laid significantly more eggs.

According to Lowe and Hayweng (1964) as density increased from one bird in an 8- x 8-inch cage to five in a 24- x 18-inch cage, mortality increased and egg production decreased. Body weights were greater at the higher density.

In a study evaluating the effect of cage density on performance, Moore et al. (1965) housed layers in five housing systems; one and two birds per 8- x 16-inch cage, three and four birds per 16- x 16-inch cage, and floor pens with 1.44 square feet of floor area per bird. They reported density was highly significant in relation to pounds of feed per dozen eggs and hen-housed production. Birds having the smallest cage area required the least feed to produce a dozen eggs. As bird density increased production decreased. Density had no significant effect on mortality.

In a study of the effect of dubbing on production pullets Logan (1965) observed caged birds, both dubbed and non-dubbed, laid 10 less eggs and had 7.8 percent lower mortality than did birds housed in floor pens. Floor birds attained smaller body weights, laid smaller eggs and laid eggs lower in blood spot scores than their sisters in cages.

Magruder and Nelson (1966) housed birds in 16 types of cages (10 colony and 6 single) at six densities (60, 64, 72, 90 and 128 square inches of floor area per layer). Hens in single cages averaged two additional eggs (hen-housed) and three more eggs (hen-day) than hens in the colony cages. When cages with two layers were compared to cages with one layer the birds housed two in a cage had better egg production and three percent greater livability. Hens with 60 square inches of cage space laid an average of 70.5-percent large eggs compared to 72.2-percent for hens having 128 square inches.

Champion and Zindell (1968) and Tower and Roy (1969) reported when the floor area per bird was held constant for single and multiple cages, income over feed cost per unit of cage space was maximized by using multiple cage units.

The effects of cage size and bird density on performance were investigated by Quisenberry (1968). As he increased cage size and bird numbers, production went down, feed required to produce a dozen 2-ounce eggs increased, and mortality increased. Consequently, he recommended the use of smaller cages with three to four birds per cage at 1/3 to 1/2 square foot per bird. He concluded the smaller cage size can return better performance at high density situations.

In a study of caged layers Adams and Jackson (1970) used two densities, two cage sizes and two population sizes. They found significant strain differences for hen-housed egg production, average egg weight, sexual maturity, mortality, and Haugh unit values. The lowest egg production and highest mortality were observed in large cages (71.1 x 81.3 cm.) housed at a high population density. The highest egg production and lowest mortality was observed in small cages (30.5 x 45.7 cm.) housed at low population densities. The birds at the low density also matured earlier.

Ruszler and Quisenberry (1970a) studying layers in cages at different population densities found no significant differences between body weights, protein conversion and feed efficiency. Increased density depressed hen-day and hen-housed egg production to a greater extent than did the increase in population numbers. They concluded the minimum biological threshold to be 348 $cm.^2$ of floor area per bird.

Mather and Gleaves (1970) reported egg production in cages was significantly influenced by both density and stocks. A decrease in egg production was observed as birds per cage increased.

Marr and Green (1970) conducted two experiments to investigate the effects of cage size, space per bird and social density on performance of laying hens. In the first experiment there were no significant differences in egg production or egg weight among social densities of two, three, four, five, six and seven hens with comparable space per bird. For the second experiment, hens were housed three per 10- x 18-inch cage (60 square inches per bird) in the presence and absence of a roost pole. They produced significantly less eggs than the controls housed two per 8- x 16-inch cage. The results showed commercial type laying hens are affected more by space and shape of a cage in relation to capacity, than by the number of birds per cage.

Ruszler and Quisenberry (1970b) looked at the effects of putting perches in cages on production characteristics of layers. They found, after perches were placed in the cage, a highly significant increase in hen-housed egg production. Significant interactions were found for both hen-day and hen-housed production between perches and densities, and perches and population size. Addition of perches also gave increased livability and an increase of 7.4 eggs per hen.

EFFECT OF SOCIAL BEHAVIOR

Social stress and peck order status within strains can significantly influence productivity of individuals (Guhl 1953). When strange birds are placed together in a pen, fights occur by twos until each bird has engaged all others. The winner has the right to peck the loser and the latter usually avoids the former. Thus peck orders are established. In high density situations the peck order determines who eats and drinks at a particular time.

Guhl et al. (1960) selected birds for high and low levels of aggressiveness based on the results of initial paired encounters used as a measure of relative aggressiveness. Two different strains of White Leghorns were used in a one way cross in the parental generation to reduce excessive inbreeding. Selection was carried to the fourth generation. Beginning with the second selected generation the two lines showed significant differences in the percentage of encounters won and lost as well as in high or low ranks in the peck order. Heritability estimates of 0.22 and 0.18 were obtained based on the percentage of contests won and individuals dominated, respectively.

Tindell and Craig (1959) found that hens from highly aggressive strains performed at lower levels when competing with their own kind than when intermingled with less aggressive strains, but less aggressive strains performed better when kept in separate flocks. The more aggressive strain was heavier at five months of age, ate more often, matured earlier, and had higher egg production rate for the first four months.

The effect of performance as related to aggressiveness was the topic for further study by Craig and Toth (1969). White Leghorn and Rhode Island Red pullets from high and low aggressive strains were selected. They were compared for productivity under conditions of stable and unstable flock membership. No adverse effects on productivity were detected in the unstable flocks undergoing weekly reorganization. Early maturity was observed in the more aggressive strains of both breeds. The high dominance White Leghorn strain had heavier adult body weights. The opposite was found to be true for the Rhode Island Reds.

Morgan and Bonzer (1959) studied the productive and reproductive performance of five genotypic groups of hens housed in cages for eight month periods for two consecutive years. Each year some of the hens were kept in floor pens from November through February. On March first the hens housed in cages were moved to floor pens and vice versa. The floor layers showed little response to the change in environment when put in cages but the caged layers suffered a drastic decline in egg production as well as low fertility and hatchability of all eggs set when moved to floor pens. The probable stress factors involved were social rehabilitation, environmental adaptability and the interaction of these factors with genetic constitution.

Biswas and Craig (1970) studied the differential effects of two types of environments (cages and floor pens) on performance of strains previously selected for high and low social dominance for five generations and subsequently maintained as closed flocks. The high strain pullets were found more variable than the lows when hen-housed egg production, rate of lay and mortality were examined. Significant interaction of housing method (cages vs. floor pens) and strain were found for hen-housed egg production for all three periods, rate of lay and age at first egg. Crowding decreased hen-housed egg production and increased mortality in all cases. High strain pullets were low in production compared to low strain pullets in floor pens and three birds per cage. High strain pullets in individual cages were more or equally productive. The two strains differed significantly for all traits analyzed.

Subsequently Craig (1970) confirmed the presence of genotype-environmental interactions in layers housed in individual cages and floor flocks. Significant interactions between strains and housing environments were found for age at 50-percent production and for part-year hen-day and hen-housed rates of production. In individual cages the high social dominant strain reached 50-percent rate of lay 1.8 weeks before the low strain. In floor flocks, however, the high social dominant strain was 1.4 weeks older. Similarly, the high strain pullet laid 5.2-percent more eggs per hen-housed rate of lay through 41 weeks of age in cages but in floor flocks they averaged 13.3-percent less.

Craig and Guhl (1969) investigated the possibility that territorial behavior was present in large flocks of production pullets. If selected pullets were spending disproportionate amounts of time in specific areas relative to the observed group as a whole territorial behavior would exist. They found in a flock of 400 pullets ($P < 0.005$) territorial behavior could be observed; in flocks of 200 pullets ($P < 0.10$) it was not clear cut and in flocks of 100 pullets territorial behavior could not be identified.

DENSITY AND PHYSIOLOGICAL EFFECTS

The incidence of cage layer fatigue among seven egg production strains was studied by Francis (1957b). The incidence between strains was highly significant, varying from 0.65 to 3.95-percent. Recovery depended upon strain and early removal from the cage.

Siegel (1959) studied egg production characteristics in chickens at two floor areas for their possible relationship to adrenal function. He recorded significant reduction in egg production when the floor area was decreased. This reduction was not because fewer birds were laying. The adrenals of the more densely populated birds were significantly heavier. A histological observation was made and the increase in weight was due to hyperplasia in the cortical area. He decided the stress due to crowding was sub-acute and well within the adaptive capabilities of the bird. Pituitary and thyroid weights were not affected by the increase in population density.

A study on the hormonal effects of density was conducted by Siegel (1960). He confined incross White Leghorn males to floor pens with floor areas of 1.0, 0.8, 0.6, and 0.4 square foot per bird for periods of 1-12 weeks. Autopsies were performed weekly and bi-weekly to determine effects of confinement on adrenal, pituitary and bursa weights. Significant adrenal hypertrophy and histochemical evidence of hypersecreation were found in the groups housed at 0.4 square foot of area per bird. Pituitary weights were significantly higher and bursa weights lower in groups housed at the higher population densities for 12 weeks.

Elmslie et al. (1966) compared the performance of commercial layers in battery cages at different stocking rates. They observed that the incidence of fowl hysteria disappeared when the number of birds per cage and the size of cage were reduced. As the stocking rate increased mortality increased. Cage size had little or no influence on mortality. It was found that any advantage from extra room to move was more than overtaken by the adverse effects of large flock size.

Thornberry (1970) studied the effect of increased population stress in caged layers on blood serum cholesterol levels. From his observation he decided 16 birds per cage might be the population size where cholesterol begins to increase. He suggested that the high mortalities associated with high bird densities might partly account for the higher cholesterol levels in the blood serum.

Studying the incidence of fowl hysteria in caged layers Hansen (1970) found that population density was a contributing factor in such outbreaks. The most outbreaks occurred when 40 birds were housed per, 3-x 5-foot cage, the least when 20 birds were housed per, 3-x 5-foot cage. No fowl hysteria was observed in single and six bird cages.

EFFECT OF BODY WEIGHT

Miller and Quisenberry (1959) compared three egg production stocks for production characteristics as they related to efficiency of egg production. They reported rate of production was significantly correlated with the feed required to produce a pound of eggs. The heavier Leghorns consistently required more feed to produce a unit of eggs than did either of the two lighter hybrid groups. The same correlation was found for body weight; minimum body weight giving the best results.

The problem of getting maximum efficiency out of layers has led to investigations on performance of birds within a flock having different body weights. Bell (1968) housed caged layers according to 18-week body weight. His weight classification included extra light, light, medium, heavy, extra heavy, and mixed control. He found the lightest group laid 48 less eggs per hen housed and had higher mortality than all the other classes. Egg weight and feed efficiency were in direct proportion to the 18-week body weights.

No significant differences in egg production or percent mortality were observed when layers were housed within cages at uniform body weights, (Massey and Noles, 1969). They concluded the cost of housing birds at uniform weights is not justified.

Quisenberry (1970) compared pullets and laying hens for optimum body weight. He found significant interactions between strains and body weight classes. The light classes tended to gain very little more than the mediums, and the mediums little more than the heavies. Production and egg size went up as body weight increased. Body weight had little effect on feed efficiency. Mortality decreased as weight went up. In a subsequent study, Doran (1971) studied the effects of body weight at housing and the type of diet on various strains of egg production-type birds. Three weight classes (light, medium, and heavy) and three rations were compared. The light weight birds matured later than the heavy weight birds. The heavy weight birds laid the largest eggs but had the poorest feed efficiency.

In a study with pullets reared in cages, Fowler and Quisenberry (1970) measured the effects of pullet weight on laying performance. The pullets were divided into seven body weight classes at 22 weeks of age and housed in multiple bird cages at a constant density of 309.7 $cm.^2$ per bird. Egg production was positively correlated with body weight. A significant interaction was found between cage size and pullet weight for egg production. Initially the light birds laid more eggs in the large cages whereas in all other classes, smaller cages were superior. Rate of body weight gain was negatively related to initial body weight. Egg weight and livability were positively correlated with initial body weight. Body weight gain, egg production, egg weight, and livability were superior for birds in the small cages when compared to those in the intermediate or large size cages.

Anonymous (1971) weighed pullets at 20 weeks of age and divided them into light, medium, or heavy body weight categories, plus a control consisting of equal proportions of the preceding three categories. The pullets were housed in cages and measured separately for egg production, feed intake, and egg size. They concluded that there was no difference in production, feed or profitability from the different weight categories. The birds with the largest body weight laid the largest eggs. However, these birds consumed more feed so at the end of the experiment the financial result was about the same for the heavy and light birds.

EXPERIMENTAL METHODS

A commercial strain [1/] of White Leghorn type chicks was used in this study. The chicks were hatched December 5, 1968 and delivered to Manhattan on December 6, 1968 where they were dubbed, and then delivered to the experimental site[2/].

The chicks were evenly divided between seven floor pens (7.3 x 5.5 m.). They were precisioned debeaked at a week of age and redebeaked at housing (22 wk.). Twenty and 16-percent protein all-mash rations were fed ad libitum during respective brooding and rearing periods. Continous lighting was supplied for the first six weeks. Natural light was used for the remainder of the rearing period.

The laying cages were located in a naturally ventilated, combination cage and floor laying house. There were four rows of cages with half of each row consisting of large cages 71.1 x 81.3 cm. (32" x 28") in width and depth, back to back, and the other half of small cages 30.5 x 45.7 cm. (12" x 18") in width and depth, back to back.

At housing birds were selected at random and individually weighed to establish the approximate range of weights. From these weights, three weight classifications were established: 1550 gm. and below (light), 1551 to 1700 gm. (medium), and 1701 and over (heavy). The experiment was limited to three weight classifications in order to keep the method economical enough for possible adaptation to commercial operations. The pullets housed in each pen for the light, medium, and heavy groups were selected at random from the rearing pens. An intermingled group was selected by taking two pullets from each of the

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[1/] Heisdorf and Nelson, Reimers, Inc., Buhler, Kansas

[2/] Kansas State Penitentiary, Lansing, Kansas seven brooder pens for the large cages and one from each of three brooding pens for the small cages. A control group was established by housing pen mates without regard to body weight. Obvious culls were removed at the time of housing.

Each of the five treatments was assigned at random to three adjacent large cages per side and five adjacent small cages per side. Birds were housed in all four rows of large cages (12 pullets per cage) and in two rows of small cages (3 pullets per cage). The light group was eliminated from the small cages because there were not enough birds to fill all the cages. Bird densities were 464.6 and 481.7 $cm.^2$ of floor area per bird for the large and small cages, respectively. The experimental design is shown in Table 1.

Table 1. Experimental design

Cage size	No. birds/ cage	Cage floor area/bird	No. cages/ replicate	No. of re- plicates	No. of birds/ treatment
(cm.)		($cm.^2$)			
30.5 x 45.7	3	464.6	5	4	60
71.1 x 81.3	12	481.7	3	8	288

Throughout the experimental period of 47 weeks a minimum of 14 hours of light per day was supplied by natural and artificial light. A standard all-mash ration calculated to contain 16 percent protein and 2764 kcal. of metabolizable energy per kilogram was provided <u>ad libitum</u>. The only time a bird was removed from a cage was if death occurred. No birds were replaced.

Egg production per cage was recorded three days each week and mortality daily. Egg quality was measured at five preselected times during the experimental period. Eggs were sampled, delivered to Manhattan and stored in an egg cooler the same day. Weight, specific gravity, and Haugh unit values were determined the next day.

Hen-housed and hen-day production were based on 329 days of lay. Most cages were at 50 percent rate of lay at housing, and all cages were at 50 percent rate of lay the second week.

All data were calculated for significance by the use of analysis of variance for a mixed model (Snedecor, 1956) with row, side, cage size, and bird density effects assumed to be fixed. Treatment effects were assumed to be random.

A separate analysis was made for each cage size because one of the parameters (light weight group) was eliminated from the small cages. A combined analysis was run on the medium, heavy, intermingled and control groups to determine the effect of population size on performance.

RESULTS AND DISCUSSION

Egg Production -- The hen-day and hen-housed egg production averages are shown in Tables 2 and 3.

Table 2. Effect of treatment on percent hen-day production

Treatment	Cage Size: Small	Cage Size: Large	Trt. av.
	%	%	%
Light	--[1]	68.8	--
Heavy	68.3	66.6	67.5
Medium	70.1	68.8	69.5
Control (pen mates)	69.8	67.6	68.7
Intermingled	73.1	66.5	69.8
Av.	70.3	67.6	
Difference	2.7[2]		

[1] Insufficient birds to fill cages.

[2] Highly significant $P < .01$ level.

Table 3. Effect of treatment on percent hen-housed egg production

Treatment	Cage Size		Trt. av.
	Small	Large	
	%	%	%
Light	1/	55.3	--
Heavy	58.9	56.1	57.5
Medium	61.9	59.0	60.4
Control (pen mates)	60.8	56.1	58.5
Intermingled	60.1	55.6	57.9
Av.	60.4	56.4	
Difference	4.0		

1/ Insufficient birds to fill cages.

An analysis of variance in Table 4 shows there were no significant differences between the five groups housed in large cages for the traits measured.

Table 4. Analysis of variance for indicated traits (large cages)

MEAN SQUARES

Source of variation	d.f.	Hen-housed egg prod.	Hen-day egg prod.	Mortality
Row	3	10.6	13.4	31.6
Side	1	2.7	23.8	37.0
Treatment	4	51.7	30.5	85.9
Residual	111	36.8	25.4	168.6
Total	119	101.8	93.1	323.1

Source of variation	d.f.	Av. egg weight	Specific gravity	Haugh units
Row	3	0.0	0.1	5.7
Side	1	2.4	0.0	0.2
Treatment	4	7.8**	0.1	2.6
Residual	31	0.7	0.0	2.5
Total	39	10.9	0.2	11.0

** Significant ($P < .01$)

Similar results were obtained in the small cages (Table 5).

Table 5. Analysis of variance for indicated traits (small cages)

MEAN SQUARES

Source of variation	d.f.	Hen-housed egg prod.	Hen-day egg prod.	Mortality
Row	1	70.8	125.3	0.0
Side	1	59.5	2.4	0.0
Treatment	3	31.8	80.4	222.2
Residual	74	78.5	66.5	483.5
Total	79	240.6	274.6	705.7

Source of variation	d.f.	Av. egg weight	Specific gravity	Haugh units
Row	1	0.2	0.0	0.4
Side	1	0.3	0.0	5.0
Treatment	3	3.4	0.0	2.7
Residual	10	1.1	0.1	5.0
Total	15	5.0	0.1	13.1

A significant difference ($P < .01$) was found when the combined hen-day production averages for all groups were compared between the small and large cages.

The significant effect of population size on egg production confirms previous reports (Logan, 1965; Cook and Dembnicki, 1966; Wilson <u>et al</u>., 1967; and Adams and Jackson, 1970) that crowding reduces rate of lay.

When hen-housed egg production rates were compared in the small and large cages, differences approached significance ($P < .09$). This is attributed to a large error mean square for cage to cage mortality differences.

The lack of a significant effect of pullet body weight at housing on hen-day and hen-housed egg production is not consistant with results reported by Miller and Quisenberry (1959), Bell (1968), Quisenberry (1970), Fowler and Quisenberry (1970), and Doran (1971). They found significant differences between housing body weights and subsequent egg production. Our results are in agreement with Massey and Noles (1969) and Anonymous (1971), who could find no significant differences in egg production for different body weight categories.

One reason for this discrepancy may be the number of weight categories in our experiment. If more weight categories had been used, as was reported by other researchers, the extreme light and heavy birds might have differed significantly.

<u>Percent Mortality</u> -- Percent mortality varied little between treatments and cage sizes (Table 6).

Table 6. Effect of treatment on mortality

Treatment	Cage Size: Small	Cage Size: Large	Trt. av.
	%	%	%
Light	[1]	29.9	--
Heavy	28.3	25.7	27.0
Medium	21.6	25.3	23.4
Control (pen mates)	28.3	25.7	27.0
Intermingled	28.3	27.4	27.9
Av.	26.6	26.8	
Difference	0.2		

[1] Insufficient birds to fill cages.

None of the parameters approached significance with constant bird density. The high average mortality (26.3-percent) is attributed, from general observations, to leukosis and cannibalism.

The experiment conducted by Adams and Jackson (1970) using the same facility showed varied results for mortality. They found no significant differences between varied densities but did find significant cage size effects in experiment 1; the opposite was found for experiment 2. Massey and Noles (1969) observed no significant differences in mortality for body weight categories but Quisenberry (1970) found mortality decreased as body weight increased.

Egg Quality -- Average egg weight differed significantly between treatments in the large cages (Table 7).

Table 7. Effect of treatment on average egg weight (gm.)

Treatment	Cage Size		Trt. av.
	Small	Large	
	gm.	gm.	gm.
Light	1/	57.8[a] 2/	--
Heavy	60.2	60.6[b]	60.4
Medium	59.4	59.3[c]	59.3
Control (pen mates)	57.9	59.2[c]	58.5
Intermingled	59.3	59.4[c]	59.3
Av.	59.2	59.2	
Difference	0.0		

1/ Insufficient birds to fill cages

2/ Egg weight averages with different superscripts differ significantly at the $P < .05$ level. LSD value = 0.6 gm.

In the small cages no significant differences were found for the average egg weight. This can be attributed to the elimination of the light group from the small cages. Average egg weight increased as body weight increased. This was also reported by Bell (1968). Furthermore, no significant differences were found for specific gravity measurements and Haugh unit values (Tables 8 and 9).

Table 8. Effect of treatment on specific gravity measurements

Treatment	Cage Size: Small	Cage Size: Large	Trt. av.
Light	[1]	1.081	--
Heavy	1.081	1.081	1.082
Medium	1.083	1.083	1.082
Control (pen mates)	1.082	1.082	1.082
Intermingled	1.082	1.082	1.082
Av.	1.082	1.082	
Difference	0.0		

[1] Insufficient birds to fill cages.

Table 9. Effect of treatment on Haugh unit values

Treatment	Cage Size		Trt. av.
	Small	Large	
Light	1/	83.0	--
Heavy	85.1	83.4	83.6
Medium	83.8	83.0	84.0
Control (pen mates)	83.3	84.3	83.8
Intermingled	84.7	83.1	83.9
Av.	84.2	83.3	
Difference	0.9		

1/ Insufficient birds to fill cages.

Body Weight -- Body weight data were calculated for selected large cages (Table 10). The body weight differences among treatments were highly significant ($P < .01$) at the beginning of the experiment and significant ($P < .05$) at the end of the experiment. The pullets maintained their relative weight rank from the light to the heavy groups during the experimental period with a slight change in the medium, control and intermingled groups at the end of the experiment. Weight change was not significant. The percent weight gain approached significance. The weight average for the control and medium groups are very similar. The mediums gained more than the controls because they lacked the extreme heavies and lights present in the controls.

Table 10. Body weights of birds housed in large cages (gm.)

Treatment	Beginning	Ending	Change	$\frac{\text{Weight change}}{\text{Beginning wt.}} \times 100$
Light	1419.0[a] 1/	1839.7[a]	420.7	29.6
Heavy	1814.7[c]	2106.0[b]	291.3	16.0
Medium	1595.3[b]	1944.0[ac]	348.7	21.8
Control (pen mates)	1677.7[cb]	1900.3[ac]	222.7	13.9
Intermingled	1622.0[b]	2000.3[bc]	378.3	23.3
Mean Squares	61552.2 2/	30915.2 3/	17919.9	116.0
LSD	147.3	151.7		

1/ Means with different superscripts differ significantly at the $P < .05$ level.

2/ Significant at ($P < .01$)

3/ Significant at ($P < .05$)

Pen Mates -- No significant differences were found between the control and intermingled groups for the traits measured. It was assumed the controls were familiar with each other even though the brooder pens housed 200 birds. It has been shown pullets appear to spend disproportionate amounts of time in specific areas relative to the observed group in flocks of 200 (Craig and Guhl, 1969). But at this population size there is not a clear cut line between territorial behavior and one order. In this experiment the density was greater than reported by Craig and Guhl (1969). Therefore it appears in this study flock rearrangement at housing had little effect on performance.

SUMMARY

A commercial strain of White Leghorn type pullets, reared on litter was housed (22 wk.) according to four body weight groups; 1550 gm. and below (light), 1551 to 1700 gm. (medium), 1701 gm. and over (heavy) and an unselected group (control). As part of this experiment birds which were pen mates during brooding and rearing were caged together and compared to cages of birds which were strangers during brooding and rearing. Birds from the various groups were housed at two population sizes at a constant bird density in small cages (31 x 46 cm.) and large (71 x 81 cm.) cages. Traits measured were percent hen-day and hen-housed egg production, percent mortality, average egg weight, specific gravity and Haugh unit values. Under the conditions of this experiment the results were:

1. Among the hens in the large cages, average egg weight was the only factor significantly affected by body weight.
2. There were no significant traits in the small cages.
3. Percent hen-day egg production was significantly greater in the small cages than in the larger cages.
4. Body weight differences among groups were significant at housing and at the end of the experiment.
5. The body weight groups maintained their relative weight rank from the light to heavy groups during the experimental period.
6. No traits were found significant from the comparison of housing pen mates vs. housing strangers together in separate cages.

The results of this experiment suggest the cost of housing pullets according to body weight is not justified. Furthermore, the practice of

housing brooder pen mates together has no advantage over putting strange pullets together at housing. As population size increased performance decreased at constant density.

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EFFECT OF HOUSING BODY WEIGHT AND REARING RELATIONSHIP ON SUBSEQUENT PERFORMANCE OF EGG-TYPE CHICKENS

by

Richard Orrin Bailer

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A commercial strain of White Leghorn type pullets, reared on litter, was housed (22 wk.) in 71.1 x 81.3 cm. cages (12 per cage) and 30.5 x 45.7 cm. cages (3 per cage). They were divided into four groups according to body weight: 1550 gm. and below (light); 1551 to 1700 gm. (medium); and 1701 gm. and over (heavy). An unselected group served as control. The light group was eliminated in the small cages. The traits measured were: percent hen-day and hen-housed egg production, percent mortality, average egg weight, specific gravity and Haugh unit values.

Among the hens in large cages, average egg weight was the only factor significantly affected by body weight. Average egg weights were 57.8, 59.3, 60.6 and 59.2 gm. for the light, medium, heavy and control groups, respectively.

In a comparison between the "small" and "large" cages, density constant, percent hen-day egg production was significantly greater in the "small" cages.

Body weight differences among groups were significant at housing and significant at the end of the experiment. The groups maintained their relative weight rank from the light to heavy groups during the experimental period.

As part of this experiment birds which were pen mates during brooding and rearing were caged together and compared to cages of birds which were strangers during brooding and rearing. The above traits were used to compare these housing methods. None of the traits were found to be significant.