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"THROUGH RESEARCH"

A STUDY OF CAGE SHAPE, SIZE AND STOCKING DENSITY

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During the past twenty years, many experiments have been conducted to study the effects of stocking density in various types of cages. However, most studies have been limited to only one cage type with varying numbers of hens per cage.

The present experiment was designed to study seven different cage types intermingled within the same house. Two to four stocking densities were used with each type of cage.

Experimental Procedure

Cage Dimensions

Width	Depth	Repli-cates	Cages/ Repli-cate	Hens/Cage
12"	18"	6	4	3 & 4
18"	12"	6	4	3 & 4
12"	12"	6	4	2 & 3
15"	12"	5	4	3 & 4
24"	12"	5	5	4, 5 & 6
18"	18"	6	4	5 & 6
24"	18"	5	2	6, 8, 10 & 12

Location: University of California, Moreno Ranch, Riverside County.

Housing: California open-type with curtains and hot weather foggers.

Feeding: Ad libitum hand feeding with front feeder.

Watering: One Hart cup on every other partition for all cages except 24-inch wide cages which had one cup for every partition.

Duration of Experiment: November 1977 to September 1978 (44 weeks).

Stock: 1595 Shaver 288 White Leghorns.

Age: 20 to 64 weeks of age.

Experimental Design: Completely randomized with five or six replicates of each treatment.

Measurements: Daily-egg production, feed consumption and mortality. Every 4 weeks—egg size and egg breakage.

Results and Discussion

The stocking density results are summarized in Tables 1 - 6 by cage type. Statistical analyses of differences are within tables only. Means in the same row with different lower case letters are significantly different (P<.05) on Duncan's multiple range test; means with the same letter are not different.

Table 1. 12" wide x 18" deep vs. 18" wide x 12" deep with 3 and 4 hens per cage

Trait	Conventional cages (12" w x 18" d)		Shallow cages (18" w x 12" d)	
	3/cg	4/cg	3/cg	4/cg
Hen-day production (%)	66.9	68.9	71.1	70.0
Hen-housed eggs	196.2	200.0	207.0	199.8
Egg weight (g)	58.4	58.7	57.6	58.9
Large and above (%)	71.7	74.5	67.1	75.1
Feed per hen-day (lbs)	.231	.234	.235	.234
Feed per dozen (lbs)	4.17	4.10	3.97	4.03
Mortality (%)	11.1	11.5	11.1	16.7
Cracked eggs (%)	4.1	3.8	3.2	4.4
Feed cost per dozen (¢)	25.0	24.6	23.8	24.2
Egg income minus feed cost per hen-housed ($)	2.82	2.98	3.10	3.04
			(No significant differences)	

Table 2. 12" wide x 12" deep with 2 and 3 hens per cage

Trait	Hens per cage	
	2	3
Hen-day production (%)	75.0	72.3
Hen-housed eggs	211.9	200.6
Egg weight (g)	58.1	58.8
Large and above (%)	69.1	72.9
Feed per hen-day (lbs)	.238	.239
Feed per dozen (lbs)	3.82	3.98
Mortality (%)	14.6	16.7
Cracked eggs (%)	1.5a	4.5b
Feed cost per dozen (¢)	22.9	23.9
Egg income minus feed cost per hen-housed ($)	3.47	3.09

Table 3. 15" wide x 12" deep with 3 and 4 hens per cage

Trait	Hens per cage 3	Hens per cage 4
Hen-day production (%)	72.8	69.1
Hen-housed eggs	212.8	194.7
Egg weight (g)	58.5	59.3
Large and above (%)	74.9	76.9
Feed per hen-day (lbs)	.239	.237
Feed per dozen (lbs)	3.95	4.12
Mortality (%)	8.3	17.5
Cracked eggs (%)	4.4	4.6
Feed cost per dozen (¢)	23.7	24.7
Egg income minus feed cost per hen-housed ($)	3.33	2.87
	(No significant differences)	

Table 4. 24" wide x 12" deep with 4, 5, and 6 hens per cage

Trait	Hens per cage 4	Hens per cage 5	Hens per cage 6
Hen-day production (%)	72.0	69.8	69.7
Hen-housed eggs	208.7	198.2	195.0
Egg weight (g)	58.6	58.3	58.2
Large and above (%)	71.6	72.3	67.9
Feed per hen-day (lbs)	.238	.236	.229
Feed per dozen (lbs)	3.96	4.06	3.95
Mortality (%)	10.0	14.4	16.0
Cracked eggs (%)	4.0	2.8	2.7
Feed cost per dozen (¢)	23.8	24.4	23.7
Egg income minus feed cost per hen-housed ($)	3.23	2.98	3.00
	(No significant differences)		

Table 5. 18" wide x 18" deep with 5 and 6 hens per cage

Trait	Hens per cage 5	Hens per cage 6
Hen-day production (%)	68.7	66.2
hen-housed eggs	199.8	186.2
Egg weight (g)	58.3	58.8
Large and above (%)	73.3	71.2
Feed per hen day (lbs)	.230	.233
Feed per dozen (lbs)	4.03	4.23
Mortality (%)	11.7	16.7
Cracked eggs (%)	4.3	4.5
Feed cost per dozen (¢)	24.2	25.4
Egg income minus feed cost per hen-housed ($)	3.02	2.59
	(No significant differences)	

Table 6. 24" wide x 18" deep with 6, 8, 10 and 12 hens per cage

Trait	Hens per cage 6	8	10	12
Hen-day production (%)	73.1 a	71.3 a	64.7 b	53.8 c
Hen-housed eggs	214.3 a	203.0 a	176.4 b	135.0 c
Egg weight (g)	59.0	58.4	59.1	58.6
Large and above (%)	72.9	73.5	75.8	70.7
Feed per hen-day (lbs)	.255 a	.240 b	.234 bc	.224 c
Feed per dozen (lbs)	4.19 ab	4.04 a	4.36 b	5.01 c
Mortality (%)	10.0 a	16.3 ab	24.0 bc	34.2 c
Cracked eggs (%)	3.6	2.8	2.7	3.1
Feed cost per dozen (¢)	25.1 ab	24.2 a	26.2 b	30.0 c
Egg income minus feed cost per hen-housed ($)	3.06 a	3.11 a	2.43 b	1.40 c

Within cage types, few of the differences observed were statistically significant with the exception of those in the 24" wide by 18" deep cages. This was due to the relatively small number of birds involved in each set of experiments.

Even though few statistically significant differences were shown in the comparisons of various stocking densities within cage systems, consistent trends were evident. Egg production was depressed in every instance except one when additional hens were added to a cage. This same observation was also true in respect to egg income minus feed costs. Mortality, on the other hand, increased with the addition of extra hens.

Cage Shape

Nine treatments utilized 12" deep cages and four treatments 18" deep cages (not including the 24" x 18" cages). These two types of cages were compared in separate analyses. (Table 7). Of particular significance is the 28 cents per hen additional income from the shallow cages.

This analysis showed a highly significant improvement in the hen-day rate of production, feed conversion, feed cost per dozen and egg income minus feed cost for the shallow cages. It also showed a significant increase in hen-housed egg production and higher feed consumption in the shallow cages.

Table 7. Shallow vs. deep cages

DESCRIPTIVE TRAITS	SHALLOW	DEEP
Depth of cage (inches)	12	18
Average hens per cage	3.8	4.5
Average feeder space per hen (inches)	4.9	3.4
Average floor space per hen (sq. inches)	58.7	61.2
PERFORMANCE TRAITS		
Hen-day production (%)	71.4	67.7 ***
Hen-housed eggs	203.3	195.5 *
Egg weight (g)	58.5	58.6 NS
Large and above (%)	72.0	72.7 NS
Feed per hen-day (lbs)	.236	.232 *
Feed per dozen (lbs)	3.98	4.13 **
Mortality (%)	14.0	12.7 NS
Cracked eggs (%)	3.6	4.2 NS
Feed cost per dozen (¢)	23.9	24.8 **
Egg income minus feed cost per hen-housed ($)	3.13	2.85 **

* Significant difference (P<0.05)   *** Significant difference (P<0.001)
** Significant difference (P<0.01)   NS Non-significant

Regression Analysis

Analysis of all systems (excluding the 24" x 18" cages) for the effects of floor space, feeder space, colony size and shape showed significant effects on several performance factors (Table 8).

Single and multiple regressions were run on four performance factors using all systems except the 24" x 18" cages. The best (highest R^2) of each of these is listed in Table 9.

In this analysis, feeder space per hen had the highest effect on egg income minus feed cost of all factors studied. Each additional inch of feeder space per hen resulted in an improvement in income of 16 cents per hen. Each extra hen per cage depressed income by 12 cents per hen and each additional inch of cage depth depressed income by 5 cents per hen.

Table 8. Correlations between cage factors and performance

Factor	Hen-day production	Feed per hen-day	Feed per dozen	Egg income minus feed cost
Hens per cage	-.639*	-.623*	.464	-.636*
Feeder space per hen	.753**	.487	-.734**	.755**
Floor space per hen	.253	.027	-.296	.406
Cage width	-.096	-.265	-.077	-.079
Cage depth	-.719**	-.580*	.665*	-.583*

* Significant (P<0.05)
** Significant (P<0.01)

Table 9. Regression equations [1]

	R^2
Hen-day production (%) = 80.77 - .94 H/C - .49 D	.723 **
Feed per hen-day (lbs) = .2418 - .0017 H/C	.388 *
Feed per dozen (lbs) = 4.36 - .075 FS/H	.539 **
EI-FC/H.H. ($) = 2.34 + .16 FS/H	.570 **
EI-FC/H.H. ($) = 3.50 - .12 H/C	.404 *
EI-FC/H.H. ($) = 3.66 - .05 D	.340 *

[1] H/C = hens per cage; D = depth in inches; FS/H = feeder space per hen in inches; EI-FC/H.H. = egg income minus feed cost per hen-housed.
* Significant (P<0.05)
** Significant (P<0.01)

Multiple regression analyses to determine the effects of hens per cage and floor space on egg income minus feed cost, eggs per hen-housed and mortality were run using <u>all 17 treatments.</u> These equations are shown and depicted graphically in Figures 1, 2 and 3.

1. $Y^1 = 3.31027 - .24317 \text{ (H/C)}$
    $+ .00308 \text{ (FL) (H/C)}$

    $R^2 = .7718***$

2. $Y^2 = 206.83 - 11.310 \text{ (H/C)}$
    $+ .17219 \text{ (FL) (H/C)}$

    $R^2 = .8546***$

3. $Y^3 = 12.544 + 3.8924 \text{ (H/C)}$
    $- .06380 \text{ (FL) (H/C)}$

    $R^2 = .9035***$

Y^1 = Egg income minus feed cost per hen-housed ($).
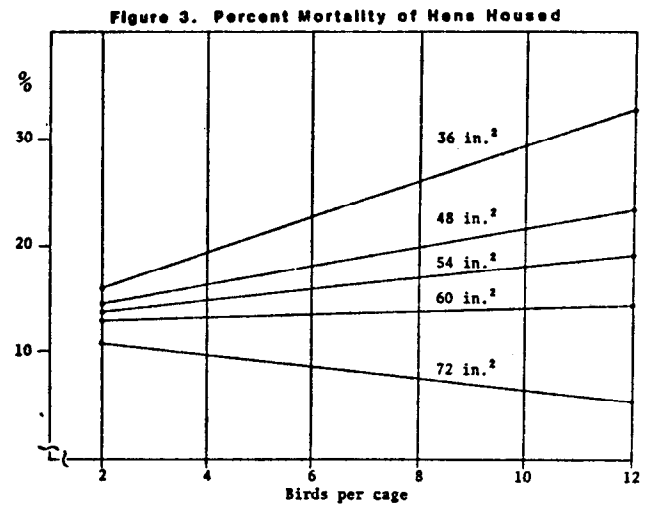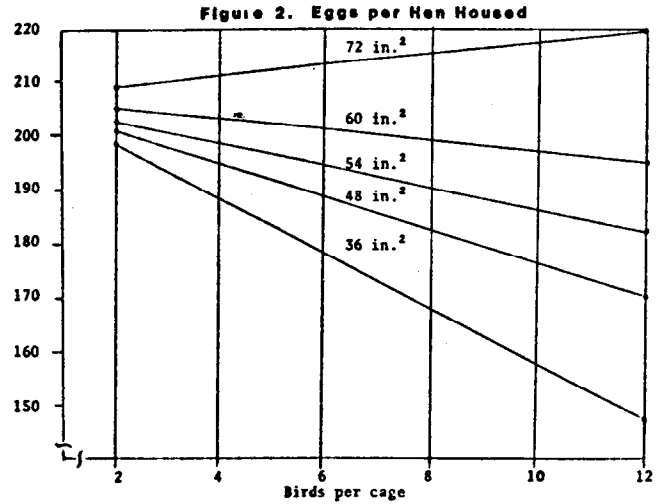
Y^2 = Egg per hen-housed.

Y^3 = % Died.

H/C = Hens per cage.

FL = Floor space per hen in square inches.

*** Statistically significant (P<0.001)

Figure 2. Eggs per Hen Housed

Figure 3. Percent Mortality of Hens Housed

Figure 1. Egg Income minus Feed Cost per Hen Housed
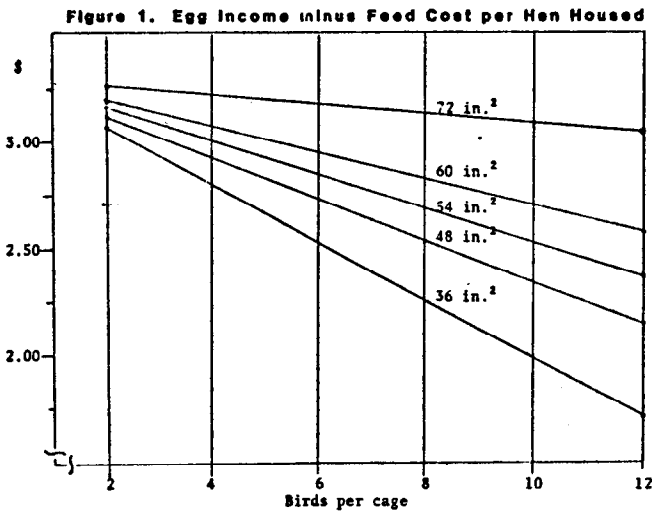
These figures illustrate the combined effects of decreasing floor space and increasing colony size on performance. Interestingly, when birds were given 72 square inches of floor space, mortality decreased with increasing colony size; eggs per hen-housed increased but profitability decreased.

Summary

This experiment points out the importance of feeder space, stocking density, floor space and cage depth on flock performance and economic returns. It also illustrates the complexity of the subject in that a variety of factors are interrelated. In addition to the factors studied, strain of chicken, nutrition and other environmental influences must be considered.

In this experiment profitability ranged from $1.40/hen to $3.47/hen--an overall difference of $2.07 between the best and worst treatments.

With the wide range of systems and management techniques in commercial use today, differences even larger than those observed in this experiment are likely to occur.

Selected References

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