Progress In Poultry
"THROUGH RESEARCH"

THE EFFECTS OF CROWDING LAYING HENS IN CAGES

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Dozens of experiments have demonstrated reduced performance when laying hens are crowded in cages. These effects are due to colony size, cage size, cage space per hen, feeder space per hen, and general cage configuration. In addition, results are affected by the strain of chicken used in the experiment, the type of housing, and other factors.

The purpose of this experiment was to determine the progressive effects of increasing the number of hens in a 12-inch-wide by 18-inch-deep cage. In addition, we will demonstrate how these results can affect the poultryman economically.

EXPERIMENTAL DESIGN

Stock: 360 Shaver-288 White Leghorns

Duration of experiment: Fourteen 4-week periods, 20 to 76 weeks of age; October 7, 1975 to November 2, 1976.

Housing: California open-type with curtains and hot weather foggers. All cages were 12 inches wide and 18 inches deep with feeders in the front and Hart cups in the rear.

Treatments:

Treatment no.	Hens/ cage	Cage space/hen (sq. inch)	Feeder space/hen (inch)	Cages/ replicate	No. of replicates	Total hens
1	1	216	12	5	9	45
2	2	108	6	5	7	70
3	3	72	4	5	7	105
4	4	54	3	5	7	140
						360

Table 1. Performance results*

Item	Birds per 12" x 18" cage			
	1	2	3	4
Hen-day production (%)	73.2a	69.3ab	68.6ab	65.0b
Eggs per hen housed	284a	267ab	264b	241c
Mortality (%)	4.4a	5.7a	6.7a	15.7b
Average egg weight (g)	58.9a	59.1ab	59.7ab	60.5b
Total egg weight/hen housed (kg)	16.75a	15.77a	15.76a	14.56b
Average daily feed intake (1b)	.231a	.223b	.222b	.221b
Total feed/hen housed (1b)	89.8a	85.7ab	85.4ab	81.7b
Feed intake/dozen eggs (1b)	3.80a	3.87ab	3.88ab	4.09b
" " /24-oz dozen (1b)	3.65a	3.71a	3.69a	3.83a
" " /1b of egg (1b)	2.44a	2.48a	2.46a	2.55a
Albumen height (mm)	6.45a	6.45a	6.69a	6.62a
Haugh units	80.2a	79.8a	81.1a	80.6a
Cracked eggs (%)	2.6a	3.3a	3.0a	2.8a
Shell thickness (inch)	0.0148ab	0.0147b	0.0149ab	0.0151a
Shell score**	0.58a	0.64a	0.64a	0.59a

* Values followed by different letters in the same row are significantly different
  ($p < 0.05$).
**0 = smooth shell; 3 = very rough.

Table 2. Economic results*

Item	Birds per 12" x 18" cage			
	1	2	3	4
Feed cost[1] per hen housed ($)	6.29a	6.00ab	5.98ab	5.72b
Feed cost/dozen eggs (¢)	26.6b	27.1ab	27.1ab	28.6a
Average egg value[2] (¢)	43.4a	43.3a	43.7a	43.9a
Egg income minus feed cost per hen housed ($)	3.99a	3.65ab	3.61ab	3.08b

* Values followed by different letters in the same row are significantly different
  ($p < 0.05$).
1/ Feed cost: $7 per 100 lbs.
2/ Egg prices: Large, 45¢/dozen; Medium, 40¢/dozen; Small, 25¢/dozen.

Table 3. Traits having significant linear correlations with hens per cage

Trait	Correlation coefficient (r)	Intercept (a)	Slope (b)
Hen-day production	-.577***	75.47%	- 2.57
Eggs/hen housed	-.699***	297.4	-13.40
Mass of eggs/hen housed	-.594***	17.38 kg	- .66
Average egg weight	.415*	58.3 g	.51
Feed/ hen day	-.524**	.2328 lb	- .0034
Feed/ dozen eggs	-.403*	3.70 lb	.086
Percent mortality	.479**	- .197%	3.388

   * = P < 0.05
  ** = P < 0.01
 *** = P < 0.001

Table 4. Observed versus predicted results

Item	Birds per 12" x 18" cage							
	1		2		3		4	
	Obsvd.	Pred.	Obsvd.	Pred.	Obsvd.	Pred.	Obsvd.	Pred.
Hen-day production (%)	73.2	72.9	69.3	70.3	68.6	67.8	65.0	65.2
Eggs/hen housed	284	284	267	271	264	257	241	244
Kg eggs/hen housed	16.75	16.72	15.77	16.06	15.76	15.39	14.56	14.73
Average egg weight (g)	58.9	58.8	59.1	59.3	59.7	59.8	60.5	60.3
Feed/hen day (lb)	.231	.231	.223	.223	.222	.221	.221	.221
Feed/dozen eggs (lb)	3.80	3.78	3.87	3.87	3.88	3.95	4.09	4.04
Percent mortality	4.4	3.2	5.7	5.4	6.7	9.0	15.7	14.9

Feed consumption per hen day and percent mortality show significant curvilinear relationships with hens per cage.

$$\text{Feed per hen day} = .22089 + 10^{(-1.2342 - .75181\,X)} \qquad R = .591 \quad (P < 0.001)$$

$$\text{Percent mortality} = 10^{(.28772 + .22146\,X)} \qquad R = .519 \quad (P < 0.01)$$
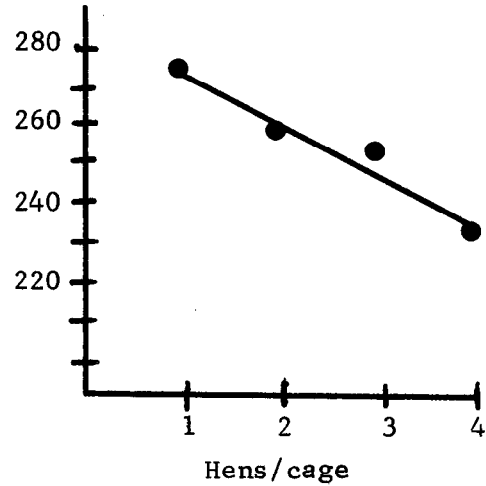
where X = hens per cage

The following graphs illustrate the relationship between hens per cage and various performance traits. The plotted line represents predicted results; the points represent observed results.
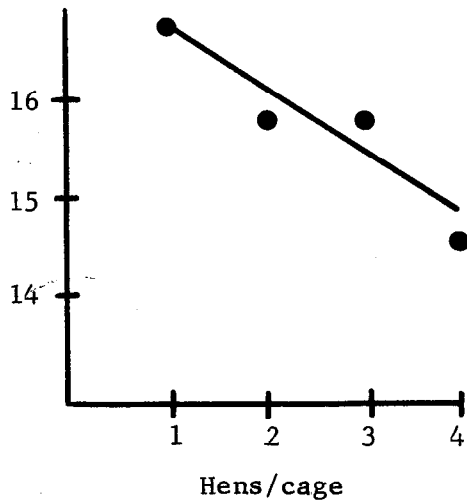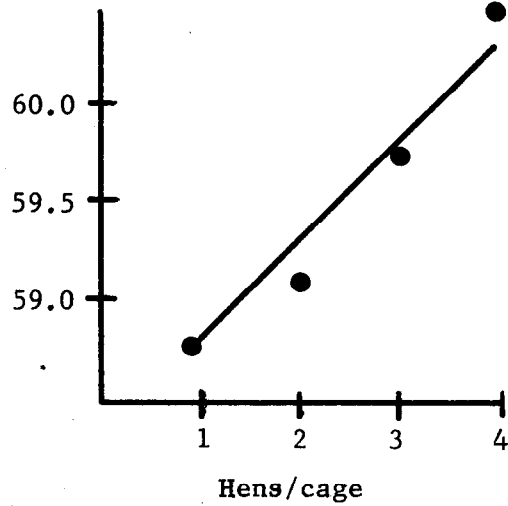
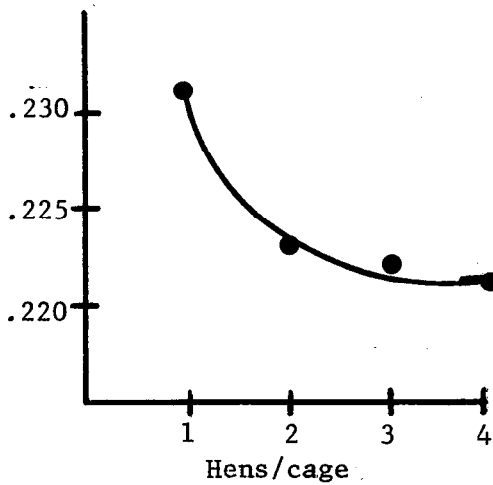1. Percent hen-day production
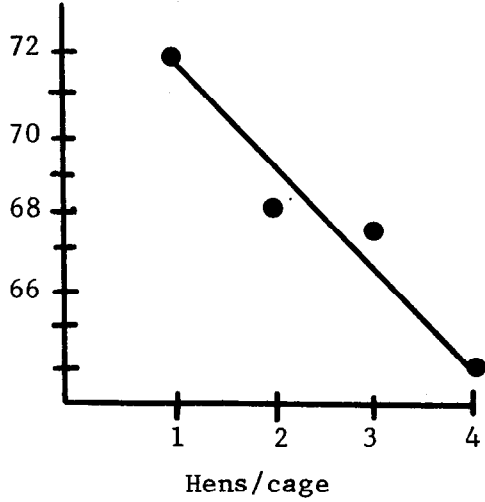
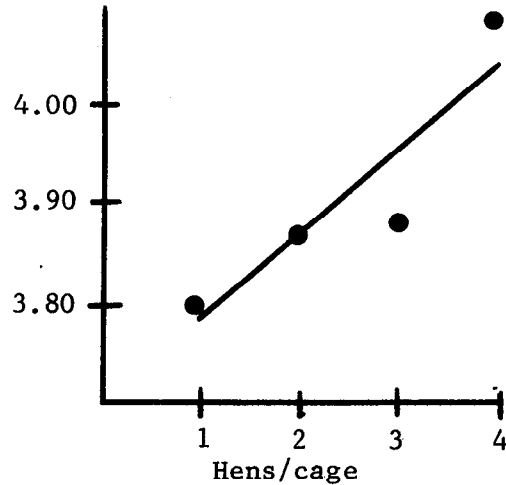2. Eggs-per hen housed

3. Kg eggs per hen housed
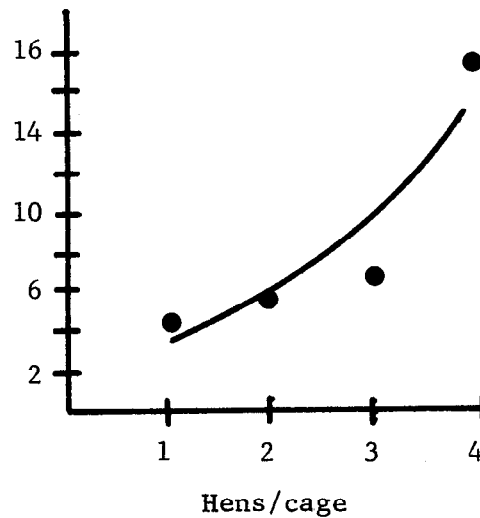
4. Average egg weight (g)

5. Feed per hen per day (lb)

6. Feed per dozen eggs (lb)

7. Percent mortality

ECONOMIC INTERPRETATION

The efficiency of a single hen per cage is evident, but the poultryman must ask the question, "How can I maximize the returns from my equipment?" Two hens obviously will cost twice as much initially, but feed costs and egg returns will be somewhat less than twice because of reduced feed consumption and reduced rate of lay when the second bird is placed in the cage. At some point the extra bird will not be justified.

Table 5 illustrates a method of answering this question. Prices for feed and eggs are the same as in Table 2. Analysis does not take into consideration other variable costs associated with each additional bird, such as labor, taxes, and medication. These would increase the costs of the greater density houses. Income from the sale of manure would increase their income.

Varying feed, pullet, and egg prices will shift the advantage from one density to another. It is essential that poultrymen select the density which relates best to their _average_ set of economic conditions. Table 6 summarizes income minus costs for various combinations of prices.

With the combination of prices analyzed, three or four hens per cage would be the recommended density. Lower margin combinations would favor the 3-bird cage, while higher margin situations would favor the 4-bird cage. However, care should be taken to include all costs and income in the analysis.

Table 5. Economic analysis

Item	Hens per cage			
	1	2	3	4
Available cages	10,000	10,000	10,000	10,000
Total investment	$120,000	$120,000	$120,000	$120,000
Annual cost (10-yr life)	$ 12,000	$ 12,000	$ 12,000	$ 12,000
Pullets purchased	10,000	20,000	30,000	40,000
Pullet cost ($2 each)	$ 20,000	$ 40,000	$ 60,000	$ 80,000
Feed cost/hen housed*	$ 6.29	$ 6.00	$ 5.98	$ 5.72
Total feed cost	$ 62,900	$120,000	$179,400	$228,800
Total cost (housing + pullets + feed)	$ 94,900	$172,000	$251,400	$320,800
Eggs per hen housed	284	267	264	241
Total dozens	236,667	445,000	660,000	803,333
Average value per dozen**	$ .434	$ .433	$ .437	$ .439
Total value	$102,713	$192,685	$288,420	$352,663
Fowl remaining	9,560	18,860	27,990	33,720
Total fowl value (35¢ each)	$ 3,346	$ 6,601	$ 9,797	$ 11,802
Total income (eggs + fowl)	$106,059	$199,286	$298,217	$364,465
Income minus costs	$ 11,159	$ 27,286	$ 46,817	$ 43,665

Cost of production per dozen

Housing	5.1¢	2.7¢	1.8¢	1.5¢
Pullets	8.5	9.0	9.1	10.0
Feed	26.6	27.0	27.2	28.5
Total	40.2¢	38.7¢	38.1¢	40.0¢

* Feed cost: $7 per 100 lbs.
** Egg prices: Large, 45¢/dozen; Medium, 40¢/dozen; Small, 25¢/dozen.

Table 6. Profits at various price combinations

Prices*			Hens per cage			
Pullets	Feed	Large eggs	1	2	3	4
$1.50	$6.00/cwt	40¢	$13,322	$32,196	$ 54,471	$ 56,217
		45	28,500	61,047	97,268	108,185
		50	36,988	76,696	120,471	136,550
	$7.00/cwt	40	4,327	15,036	28,817	23,499
		45	19,505	43,887	71,614	75,467
		50	27,993	59,536	94,817	103,832
$2.00	$6.00/cwt	40	8,322	22,196	39,471	36,217
		45	23,500	51,047	82,268	88,185
		50	31,988	66,696	105,471	116,550
	$7.00/cwt	40	- 673	5,036	13,817	3,499
		45	11,159	27,286	46,817	43,665
		50	22,993	49,536	78,817	83,832

*Fowl at 35¢ (maximum income for each combination is underlined).

SUMMARY

Obviously, all flocks are not equally affected by crowding. In some cases, performance will be more affected than was shown in this experiment and, in other cases, less. With high margins, a poultryman probably doesn't have to worry too much, but with moderate or low margins, crowding can be a very expensive practice.

Different cage sizes show similar reduced performance when hens are crowded. Poultrymen must be aware of this and not be satisfied with sub-optimal performance. Flocks are capable of producing over 250 eggs per hen housed by 70 weeks of age. Less production than this has to have a cause. Crowding may be that cause.

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