North Carolina Cooperative Extension Service

NC STATE UNIVERSITY

College of Agriculture and Life Sciences
Extension Poultry Science
Scott Hall/Campus Box 7608
Raleigh, North Carolina 27695

919-515-2621 (phone)
919-515-7070 (fax)

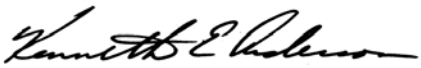
# FINAL REPORT OF THE THIRTY FIRST NORTH CAROLINA LAYER PERFORMANCE AND MANAGEMENT TEST

Vol. 31, No. 4
May 1996

The North Carolina Layer Performance and Management Test is conducted under the auspices of the Cooperative Extension Service at North Carolina State University and the North Carolina Department of Agriculture. The flock is maintained at the Piedmont Research Station, Salisbury, North Carolina. Mr. Raymond Coltrain is Piedmont Research Station Superintendent; Mr. David Joyce is Resident Manager of the flock; and Dr. K. E. Anderson is Project Leader. The purpose of this program is to assist poultrymen in evaluation of commercial layer stocks and management systems.

The data presented herein represents the analysis of the first production cycle, molt, second production cycle, and combined cycles of the 31st North Carolina Layer Performance and Management Test. Performance summary tables are available examining open and closed housing types, population size, cage length, and density which examines combined results of cage length and population.

**For further information contact:**



Dr. Kenneth E. Anderson
Poultry Science Department
North Carolina State University
Box 7608
Raleigh, NC 27695-7608

# TABLE OF CONTENTS

**31ST NORTH CAROLINA LAYER PERFORMANCE AND MANAGEMENT TEST**

**Protocol Procedures Used**

**Entries:**

Thirteen entries were accepted in accordance with the rules and regulations of the test. Nine white-egg and four brown-egg strains participated.

**Dates of Importance:**

The eggs were set on November 16, 1993 at the Piedmont Research Station (NCDA) Poultry Unit. The flock was hatched on December 8, 1993 and moved to laying facilities during April 4 to 7, 1994 at 17 weeks of age. The age of the flock at transfer was lowered to approximately 17 weeks due to current trends in the industry and requests of the breeding companies to move the flock prior to excessive egg production in the rearing houses.

First cycle production records commenced on April 12, 1994 (18 weeks of age) until molt was induced on February 14, 1995. The molt records commenced on February 14, 1995 (62 weeks of age) and ended on March 14, 1995 (66 weeks of age). The second production cycle commenced on March 14, 1995 and concluded on December 11, 1995 (105 weeks of age). This report includes production data summarized 18 to 62 weeks, 62 to 66 weeks, 66 to 105 weeks, and 18 to 105 weeks.

**Pullet Housing:**

House 6 - is an environmentally controlled brood-grow facility with 4 banks of triple-deck cages. Each side of each bank was assigned a row number, and each 3-cage section within each row and level/row was assigned a replicate number. For statistical analysis, pairs of rows were designated as blocks. Thus, each block consisted of two rows containing 8 replicates on each level, plus one extra cage on each level of each row. The white-egg and brown-egg strains were randomly assigned to the replicates in the house. Entrant strains were assigned to the replicates in a restricted randomized manner with the restrictions being that all strains were approximately equally represented in all rows and levels. Chicks were brooded in the center level of cages on paper within each of the replicate series (i.e. the 3 cage levels) within each row. Each center-cage-level replicate was filled with 90 white-egg (30 per 61 x 51 cm cage) and 90 brown-egg (30 per 61 x 51 cm cage) pullets on the day of hatch. At 42 days of age, 1/3 of the birds in each brooding replicate were moved to the top cages, and 1/3 were moved to the bottom cages for a final rearing allowance of 310 $cm^2$ (48 $in^2$) for the white-egg and brown-egg pullets.

House 8 - is an open-sided brood-grow facility with six rows of 122 cm wide by 102 cm deep single deck cages with each cage assigned a replicate number. The white-egg and brown-egg strains were randomly assigned to the replicates in each house. Entrant strains were assigned to the replicates in a restricted randomized manner with the restrictions being that all strains were approximately equally represented in all rows. Forty white-egg or brown-egg females were started and grown in each replicate with a final rearing space allowance of 310 $cm^2$ (48 $in^2$). Refer to the 31st North Carolina Layer Performance and Management Test Growing Report (Vol. 31, No. 2) for details of pullet management, nutrition, and performance.

Pullets from all strain and pullet housing combinations were moved to both laying houses randomly over a three-day period. Photoperiod in both laying facilities was 16.5 hours light, 7.5 hours dark, with artificial illumination provided by compact fluorescent lamps.

**Test Design:**

The test was a factorial arrangement of treatments. Strain, layer housing, and population are general descriptions of the main effects. Density is a combination (interaction) of cage size and hen population per cage.

Strain

Samples of fertile eggs were provided from the breeding companies. All eggs were set and hatched concurrently. A total of nine white egg strains and four brown egg strains participated in the test. See the 31st Hatch Report (Vol. 31, No. 1) for details.

Layer Housing

Two lay houses (4 and 5) were utilized for the production periods. House 4 is a high rise, environmentally controlled facility with three banks of four-deck high cages. Each side of each bank was designated as a row, and each row was divided into nine eight-foot replicate blocks/level. The replicate blocks contain cages that are either 61 or 81 cm wide. All cages are 35.5 cm deep. House 5 is a standard height open-sided laying house with a flush manure handling system. It has two banks of triple deck cages and two banks with four levels of cages. Again, each side of a bank was designed as a row and each row was divided into nine eight-foot replicate blocks/level. The replicate blocks contain cages that are either 61 or 81 cm wide. All cages are 35.5 cm deep. Both houses contain feeder systems which allow feed consumption to be determined per replicate block. The white-egg and brown-egg strains were assigned to the replicates in a restricted randomized manner, with the restrictions being that all strains were approximately equally represented in all rows, levels and cage sizes.

Density

Four densities were used throughout the test. Hens were housed at either 310 $cm^2$ (48 $in^2$), 361 $cm^2$ (56 $in^2$), 413 $cm^2$ (64 $in^2$), or 482 $cm^2$ (75 $in^2$).

Population

Two hen populations were utilized for both brown-egg and white-egg layers, of 6 or 7 hens per cage. The hen population of 6 hens per cage resulted in replicates containing 24 or 18 hens per replicate depending on cage lengths of 61 cm or 81 cm. The 6 hen per cage population allowed for the densities of 361 $cm^2$ and 482 $cm^2$. The hen population of 7 hens per cage resulted in replicates containing 28 or 21 hens per replicate depending on cage lengths of 61 cm or 81 cm. Cage densities within the 7 hen per cage group were 310 $cm^2$ (48 $in^2$) and 413 $cm^2$ (64 $in^2$).

**Layer Management and Nutrition:**[1]

Layer diets are identified as Diets D, E, F, G, H, I, M, N, O, P, and Q. Formulations are presented in the succeeding section. Feed was offered *ad libitum* in accordance with the following guidelines:

MINIMUM DAILY INTAKE OF NUTRIENTS PER BIRD AT VARIOUS STAGES OF PRODUCTION

| Production Stage | > 87% and Pre-Peak | 87-80% | 80-70% | <70% |
|---|---|---|---|---|
| White-Egg Layers | | | | |
| Protein (g/day) | 19 | 18 | 17 | 16 |
| Calcium (g/day) | 3.8 | 3.8 | 4.0 | 4.0 |
| Lysine (mg/day) | 820 | 780 | 730 | 690 |
| TSAA (mg/day) | 700 | 670 | 630 | 590 |
| Brown Egg Layers | | | | |
| Protein (g/day) | 20 | 19 | 18 | 17 |
| Calcium (g/day) | 3.8 | 3.8 | 3.8 | 4.0 |
| Lysine (mg/day) | 830 | 820 | 780 | 730 |
| TSAA (mg/day) | 710 | 700 | 670 | 630 |

LAYING HOUSE FEEDING PROGRAM

| Rate of Production | Consumption Per 100 Birds/Day (kg) | Diet Fed: White-Egg Strains | Diet Fed: Brown-Egg Strains |
|---|---|---|---|
| Weeks 19-20 | < 9.52 | D | D |
| Pre-Peak and > 87% | < 9.52 | F | E |
| | 9.57-10.39 | G | F |
| | 10.43-11.29 | I | H |
| | 11.34-12.20 | N | M |
| | 12.25-13.11 | P | O |
| | >13.15 | Q | Q |
| 80-87% | < 9.52 | G | F |
| | 9.57-10.39 | H | G |
| | 10.43-11.29 | M | I |
| | 11.34-12.20 | O | N |
| | 12.25-13.11 | Q | P |
| | >13.15 | Q | Q |
| 70-80% | < 9.52 | H | G |
| | 9.57-10.39 | I | H |
| | 10.43-11.29 | N | M |
| | 11.34-12.20 | P | O |
| | 12.25-13.11 | Q | Q |
| | >13.15 | Q | Q |

**A new feed supplier was secured for the 31st NCLP&MT. This has eliminated feed quality problems affecting the performance of the hens on test.**

| | | | |
|---|---|---|---|
| < 70% | < 9.52 | I | H |
| | 9.57-10.39 | M | I |
| | 10.43-11.29 | O | N |
| | 11.34-12.20 | Q | O |
| | 12.25-13.11 | Q | Q |
| | >13.15 | Q | Q |
| Post-Molt < 70% | < 9.52 | G | F |
| | 9.57-10.39 | H | G |
| | 10.43-11.29 | M | I |
| | 11.34-12.20 | O | N |
| | 12.25-13.11 | Q | P |
| | >13.15 | Q | Q |

LAYING PERIOD DIETS

| | Diet Identification[1] | | | | |
|---|---|---|---|---|---|
| | Layer Diets | | | | |
| Ingredient | D | E | F | G | H |
| | Pounds Per Ton | | | | |
| Corn | 772.07 | 819.01 | 934.81 | 1000.11 | 1068.72 |
| Corn Gluten Meal | 100.0 | 75.00 | 85.00 | 90.00 | 90.00 |
| Soybean Meal | 603.43 | 581.58 | 530.80 | 466.26 | 412.42 |
| Wheat Midds | 145.62 | 150.00 | 100.14 | 109.38 | 110.93 |
| Calcium Carbonate | 200.49 | 194.30 | 188.83 | 184.03 | 178.56 |
| DiCalcium Phos. | 21.20 | 23.15 | 24.36 | 24.02 | 24.91 |
| Sodium Bi-Carb. | 16.74 | 16.66 | 17.72 | 17.54 | 17.52 |
| Salt | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Methionine | 3.54 | 4.50 | 4.82 | 5.45 | 5.06 |
| Lysine | | 1.31 | | 1.90 | 2.66 |
| Choline Chloride | 5.49 | 5.35 | 5.27 | 5.20 | 5.10 |
| Vitamin premix | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Mineral premix | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Fat | 120.42 | 118.14 | 97.25 | 85.11 | 73.12 |
| Mold Inhibitor | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Tracer | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Total | 2000 | 2000 | 2000 | 2000 | 2000 |
| | | | | | |
| Protein % | 22 | 21 | 20 | 19 | 18 |
| ME kcal/kg | 2925 | 2925 | 2925 | 2925 | 2925 |
| Calcium % | 4.10 | 4.00 | 3.90 | 3.80 | 3.70 |
| T. Phos. % | .59 | .60 | .59 | .58 | .58 |
| Lysine % | 1.14 | 1.15 | 1.02 | 1.00 | .95 |
| TSAA % | .90 | .90 | .90 | .90 | .85 |

LAYING PERIOD DIETS

| | Diet Identification[1] | | | | | |
|---|---|---|---|---|---|---|
| | Layer Diet | | | | | |
| Ingredient | I | M | N | O | P | Q |
| | Pounds Per Ton | | | | | |
| Corn | 1136.49 | 1211.94 | 1233.32 | 1215.69 | 1318.20 | 1390.16 |
| Corn Gluten Meal | 100.00 | 85.00 | 50.00 | 50.00 | 25.00 | 25.00 |
| Soybean Meal | 346.86 | 314.14 | 300.80 | 223.71 | 216.04 | 162.24 |
| Wheat Midds | 109.19 | 103.88 | 147.81 | 256.18 | 200.00 | 200.00 |
| Calcium Carbonate | 178.31 | 168.03 | 158.33 | 155.44 | 150.20 | 145.85 |
| DiCalcium Phos. | 26.00 | 25.88 | 24.14 | 19.60 | 20.30 | 18.78 |
| Sodium Bi-Carb. | 17.56 | 17.69 | 16.77 | 14.52 | 15.70 | 15.71 |
| Salt | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Methionine | 4.56 | 4.32 | 3.36 | 2.20 | 1.97 | 1.58 |
| Lysine | 3.80 | 3.91 | 1.97 | 1.80 | 2.61 | 3.37 |
| Choline Chloride | 5.04 | 4.91 | 4.71 | 4.60 | 4.46 | 4.37 |
| Vitamin premix | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Mineral premix | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Fat | 61.19 | 49.30 | 47.79 | 45.26 | 34.79 | 21.94 |
| Mold Inhibitor | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Tracer | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Total | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 |
| | | | | | | |
| Protein % | 17 | 16 | 15 | 14 | 13 | 12 |
| Me kcal/kg | 2925 | 2925 | 2925 | 2925 | 2925 | 2925 |
| Calcium % | 3.7 | 3.5 | 3.3 | 3.2 | 3.1 | 3.0 |
| T. Phos % | .58 | .57 | .56 | .54 | .52 | .50 |
| Lysine % | .90 | .85 | .75 | .65 | .65 | .60 |
| TSAA % | .80 | .75 | .65 | .55 | .50 | .45 |

MOLT PERIOD DIETS

Diet Identification

| Diet Codes | Molt Diets M1 | Molt Diets M2 |
|---|---|---|
| Ingredients | ----------Pounds Per Ton---------- | |
| Corn | 1287.3 | 1289.4 |
| Soybean Meal | 363.4 | 490.6 |
| Wheat Midds | 200.0 | |
| Limestone | 78.4 | 170.1 |
| Dical Phos. | 40.8 | 36.2 |
| Salt | 8.0 | 5.0 |
| Lysine | 1.2 | .4 |
| Methionine | 2.5 | 2.3 |
| Vitamin Premix | 2.0 | 2.0 |
| Mineral Premix | 1.0 | 1.0 |
| Mold Inhibitor | 2.0 | 2.0 |
| Choline Chloride | 12.4 | |
| Tracer | 1.0 | 1.0 |
| Protein % | 16. | 17.5 |
| ME kcal/kg | 2866 | 2866 |
| Calcium % | 2.00 | 3.69 |
| Total Phos. % | .74 | .66 |
| Lysine % | .85 | .95 |
| TSAA % | .65 | .70 |

**Data Collection Schedule and Procedures:**

Egg Production--All eggs that had the potential of being marketed were credited toward the test unit's (replicate) egg production, regardless of the shell condition at the time of collection. All eggs were collected and recorded daily. Egg production was summarized at twenty-eight day intervals, and was calculated and reported on a hen-day basis.

Egg Weight--At twenty-eight day intervals, all eggs produced in the previous 24-hour period were weighed and sorted by size (See egg size distribution). Percentages of eggs within each size category, average egg weight (g), and egg mass (g) were calculated and reported.

Egg Quality--At twenty-eight day intervals, all eggs produced within the previous 24 hours were examined by candling light and graded according to current USDA standards for egg quality. Eggs were graded at the point of production with no handling prior to examination. Egg income was calculated using three-year regional average prices for farm value of eggs based on egg production and quality evaluation.

Feed Consumption--All feed offered for consumption was recorded for each unit. At twenty-eight day intervals, feed not consumed was weighed and feed consumption was calculated. Daily feed intake (kg/100 hens/day) was calculated and reported for each strain. Feed costs were based on average regional prices and were calculated and summarized for complete production cycles.

Mortality--All mortalities were recorded daily, categorized as to the cause, and obvious accidents were not included in reported mortalities. An analysis of the causes of mortality isolated the differences to the mortality level (see table following). The percentages in this table represent the causes of mortality as part of the total mortality which occurred.

**CAUSE OF MORTALITY IN THE 31st NCLP&MT AS A PERCENTAGE OF TOTAL**

| Strain | Prolapse/Cannibalism | Molt | Normal | Other |
|---|---|---|---|---|
| White | % | % | % | % |
| Hy-Line (W-36) | 16.7$^{BC}$ | 4.7$^{D}$ | 72.6$^{AB}$ | 6.0 |
| Hy-Line (W-77) | 10.6$^{C}$ | 29.9$^{A}$ | 57.9$^{BCD}$ | 1.6 |
| H & N (Nick Chick) | 25.7$^{AB}$ | 13.7$^{BCD}$ | 59.7$^{ABC}$ | 0.8 |
| Bovans (White) | 9.3$^{C}$ | 11.0$^{CD}$ | 76.6$^{A}$ | 3.1 |
| ISA (Experimental) | 25.5$^{AB}$ | 15.3$^{ABC}$ | 56.9$^{CD}$ | 2.2 |
| ISA (Babcock B-300) | 17.3$^{BC}$ | 18.6$^{ABC}$ | 62.4$^{ABC}$ | 1.6 |
| Shaver (White) | 39.8$^{A}$ | 18.6$^{ABC}$ | 38.4$^{D}$ | 3.2 |
| Shaver (2000) | 29.5$^{AB}$ | 19.6$^{ABC}$ | 47.8$^{CD}$ | 3.1 |
| Dekalb (Delta) | 26.5$^{AB}$ | 26.5$^{AB}$ | 43.6$^{CD}$ | 3.5 |
| Brown | | | | |
| Bovans (Brown) | 13.0 | 20.1 | 60.8 | 6.0 |
| ISA (Brown) | 21.4 | 15.3 | 57.5 | 5.8 |
| H & N (Brown Nick) | 16.3 | 14.3 | 65.7 | 3.7 |
| Hy-Line (Brown) | 16.8 | 8.8 | 71.2 | 3.2 |

$^{A,B,C,D}$ - Different letters denote significant differences (P<.01).

A severe trim technique at 6 days was used, however, due to the differences in chick size among the strains at this time could have affected the trim. The table above gives the breakdown of mortality by four general classes: prolapse/cannibalism, molt period losses, normal mortality, and other (unable to determine cause).

**Statistical Analyses and Separation of Means:**

Analyses of variance (ANOVA) were performed on all data. Separate analyses were conducted for white-egg and brown-egg strains. Significant differences (P < .01) within white and brown egg strains are noted by differing letters among columns of means. All data were subjected to ANOVA utilizing the General Linear Model (GLM) procedure of SAS, with main effects of strain, layer house, and cage size and population. Density analysis is derived from the cage size and population interaction. First and second order interactions were tested for significance. Mean differences were separated via the PDIFF option of the GLM procedure.

## DESCRIPTION OF DATA TABLE STATISTICS

First cycle performance of white-egg and brown-egg strains are shown on Tables 1-24. The molt period performance of the white and brown egg strains are shown on Tables 25 to 32. Second cycle performance of the white-egg and brown-egg strains are shown on Tables 33-56. Overall performance data are shown on Tables 57-80 with production curves and feed intake shown on Figures 1-13.

**Breeder (Strain):**

Short identification codes of the breeder and strain of the stock were developed. See more complete information following data tables.

**Layer House:**

"Open" denotes performance in the curtain-sided flush facility. "Closed" denotes performance in the controlled environment high rise facility.

**Population and Density Allocations:**

| White and Brown Hens per Cage | Cage Size Width Depth | Floor Space per Bird | Feeder Space per Bird | Water Nipples per Cage |
|---|---|---|---|---|
| 6 | 61 cm x 35.5 cm | 361 $cm^2$ (56 $in^2$) | 10.2 cm 4 in | 3 |
| 6 | 82 cm x 35.5 cm | 482 $cm^2$ (75 $in^2$) | 13.7 cm 5.4 in | 3 |

| White and Brown Hens per Cage | Cage Size Width Depth | Floor Space per Bird | Feeder Space per Bird | Water Nipples per Cage |
|---|---|---|---|---|
| 7 | 61 cm x 35.5 cm | 310 $cm^2$ (48 $in^2$) | 8.7 cm 3.4 in | 3 |
| 7 | 82 cm x 35.5 cm | 413 $cm^2$ (64 $in^2$) | 11.7 cm 4.6 in | 3 |

**Hen Housed Eggs per Bird:**

The total number of eggs produced divided by the number of birds housed at 133 days.

**Hen Day Egg Production:**

The average daily number of eggs produced per 100 hens per day.

**Egg Mass:**

The average daily production of egg mass in grams per hen day.

**Mortality:**

The percentage of birds which died during each production cycle. Mortality which occurred during the molt period were reported separately. The total mortality consists of all mortality which occurred during the first and second cycles and molt.

**Feed Consumption:**

The kilograms of feed consumed daily per 100 hens.

**Feed Conversion:**

The grams of egg produced per gram of feed consumed.

**Egg Weight:**

The average egg weight of period samples in grams per egg.

**Egg Income:**

The calculated income per hen housed at 133 days, from egg production using three-year regional average egg prices as follows:

| Grade | Size | Cents/Dozen |
|---|---|---|
| A | Extra Large | 72.8 |
| A | Large | 72.8 |
| A | Medium | 63.4 |
| A | Small | 52.5 |
| A | Pee Wee | 26.2 |
| B | All | 26.2 |
| Cracks | All | 38.6 |

**Egg Size Distribution:**

These are the USDA size classifications of the eggs. There has been no blending of egg size in this test to maximize the number of USDA large eggs. The proportion of the eggs falling into the following size categories:

| Size Category | Ounces/Dozen |
|---|---|
| Pee Wee | < 18 |
| Small | 18 - 21 |
| Medium | 21 - 24 |
| Large | 24 - 27 |
| Extra Large | > 27 |

**Grade Information:**

The average grade of eggs according to USDA grading standards.

**Feed Cost:**

The calculated feed cost per hen housed at 133 days, using average price per ton.

| Diets | Price Per Ton |
|---|---|
| D | 171.70 |
| E | 165.10 |
| F | 158.40 |
| G | 154.40 |
| H | 151.40 |
| I | 145.20 |
| M | 140.60 |
| N | 133.30 |
| O | 129.50 |
| P | 127.20 |
| Q | 131.20 |
| M1 | 149.20 |
| M2 | 154.20 |

**Metric Conversions**:

1 lb = 453.6 g
1 lb = .4536 kg

1 g = .03527 oz
1 kg = 2.204 lb

1 oz = 28.35 g

1 g = 1000 mg

1 kg = 1000 g

TABLE 1. EFFECT OF LAYING HOUSE ON PERFORMANCE OF WHITE-EGG STRAINS, 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Laying House | Feed Cons. (kg/100 hens/d) | Feed Conver. (g egg/ g feed) | Eggs Per Bird Housed | Egg Production (HD%) | Egg Mass (g/HD) | Mortality (%) | Age at 50% Production (Days) |
|---|---|---|---|---|---|---|---|---|
| Hy-Line (W-36) | Closed | 10.4 | .43 | 229.5 | 75.8 | 45.1 | 4.2 | 155 |
| | Open | 10.5 | .42 | 227.9 | 74.8 | 45.0 | 2.3 | 155 |
| | Average | 10.4$^{D}$ | .43$^{BC}$ | 228.7$^{BC}$ | 75.3$^{B}$ | 45.1$^{E}$ | 3.3$^{D}$ | 155$^{AB}$ |
| Hy-Line (W-77) | Closed | 11.3 | .41 | 230.2 | 75.8 | 46.2 | 3.4 | 144 |
| | Open | 11.1 | .42 | 239.3 | 78.6 | 47.5 | 3.0 | 142 |
| | Average | 11.2$^{B}$ | .41$^{CD}$ | 234.8$^{AB}$ | 77.2$^{AB}$ | 46.8$^{BCD}$ | 3.2$^{D}$ | 143$^{E}$ |
| H & N (Nick Chick) | Closed | 11.5 | .40 | 229.0 | 77.1 | 47.2 | 7.5 | 155 |
| | Open | 11.6 | .41 | 232.5 | 78.9 | 48.7 | 10.8 | 153 |
| | Average | 11.5$^{A}$ | .41$^{D}$ | 230.7$^{ABC}$ | 78.0$^{A}$ | 47.9$^{AB}$ | 9.2$^{AB}$ | 154$^{ABCD}$ |
| Bovans (White) | Closed | 10.8 | .42 | 231.9 | 77.5 | 45.8 | 4.8 | 153 |
| | Open | 10.7 | .42 | 229.7 | 77.4 | 45.9 | 5.9 | 151 |
| | Average | 10.7$^{C}$ | .42$^{BC}$ | 230.8$^{ABC}$ | 77.4$^{AB}$ | 45.9$^{DE}$ | 5.4$^{CD}$ | 152$^{D}$ |
| ISA (Experimental) | Closed | 10.7 | .43 | 224.9 | 75.0 | 47.0 | 7.1 | 155 |
| | Open | 10.7 | .44 | 225.6 | 76.2 | 47.8 | 10.7 | 151 |
| | Average | 10.7$^{C}$ | .44$^{A}$ | 225.3$^{C}$ | 75.6$^{B}$ | 47.4$^{ABC}$ | 8.9$^{AB}$ | 153$^{CD}$ |
| ISA (Babcock B-300) | Closed | 11.1 | .43 | 234.0 | 79.6 | 48.0 | 11.0 | 142 |
| | Open | 11.1 | .43 | 231.3 | 78.4 | 47.4 | 12.7 | 143 |
| | Average | 11.1$^{B}$ | .43$^{AB}$ | 232.6$^{ABC}$ | 79.0$^{A}$ | 47.7$^{AB}$ | 11.8$^{A}$ | 142$^{E}$ |
| Shaver (White) | Closed | 11.2 | .40 | 225.3 | 75.7 | 45.9 | 8.9 | 157 |
| | Open | 11.2 | .40 | 227.8 | 75.5 | 46.2 | 9.0 | 155 |
| | Average | 11.2$^{B}$ | .40$^{D}$ | 226.6$^{C}$ | 75.6$^{B}$ | 46.0$^{E}$ | 9.0$^{AB}$ | 156$^{A}$ |
| Shaver (2000) | Closed | 11.5 | .40 | 223.2 | 74.1 | 46.5 | 7.5 | 156 |
| | Open | 11.6 | .41 | 228.9 | 77.1 | 48.3 | 8.9 | 153 |
| | Average | 11.6$^{A}$ | .40$^{D}$ | 226.0$^{C}$ | 75.6$^{B}$ | 47.4$^{ABC}$ | 8.2$^{BC}$ | 154$^{ABCD}$ |
| Dekalb (Delta) | Closed | 11.2 | .43 | 237.7 | 77.9 | 48.7 | 2.9 | 154 |
| | Open | 11.1 | .44 | 238.5 | 78.9 | 48.9 | 4.7 | 151 |
| | Average | 11.1$^{B}$ | .43$^{AB}$ | 238.1$^{A}$ | 78.4$^{A}$ | 48.8$^{A}$ | 3.8$^{D}$ | 153$^{CD}$ |
| All Strains | Closed | 11.1 | .42 | 229.5 | 76.5 | 46.7 | 6.4 | 152 |
| | Open | 11.1 | .42 | 231.3 | 77.3 | 47.3 | 7.6 | 150 |
| | Average | 11.1 | .42 | 230.4 | 76.9 | 47.0 | 7.0 | 151 |

A,B,C,D,E - Different letters denote significant differences (P<.01), comparisons made among strain average values. Differences among individual laying house and strain averages are not significant.

TABLE 2. EFFECT OF LAYING HOUSE ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF WHITE-EGG STRAINS, 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Laying House | Egg Weight (g/egg) | Pee Wee (%) | Small (%) | Medium (%) | Large (%) | Extra Large (%) |
|---|---|---|---|---|---|---|---|
| Hy-Line (W-36) | Closed | 58.6 | 2.5 | 5.8 | 18.1 | 45.5 | 29.5 |
| | Open | 59.0 | 2.2 | 4.9 | 16.5 | 43.0 | 33.3 |
| | Average | 58.8$^{C}$ | 2.4$^{A}$ | 5.3$^{A}$ | 17.3$^{AB}$ | 44.2$^{AB}$ | 31.4$^{D}$ |
| Hy-Line (W-77) | Closed | 60.5 | 1.2 | 3.9 | 16.1 | 40.4 | 37.9 |
| | Open | 60.0 | 1.5 | 3.5 | 16.9 | 40.8 | 37.2 |
| | Average | 60.2$^{B}$ | 1.3$^{B}$ | 3.7$^{B}$ | 16.5$^{B}$ | 40.6$^{CDE}$ | 37.5$^{BC}$ |
| H & N (Nick Chick) | Closed | 60.1 | 1.8 | 4.9 | 14.2 | 42.1 | 37.5 |
| | Open | 60.8 | 2.0 | 3.5 | 12.6 | 40.8 | 41.5 |
| | Average | 60.5$^{B}$ | 1.9$^{AB}$ | 4.2$^{AB}$ | 13.4$^{C}$ | 41.4$^{BCD}$ | 39.5$^{B}$ |
| Bovans (White) | Closed | 58.4 | 2.4 | 5.4 | 19.0 | 47.2 | 26.5 |
| | Open | 58.6 | 2.3 | 4.8 | 18.3 | 46.2 | 28.3 |
| | Average | 58.5$^{C}$ | 2.3$^{A}$ | 5.1$^{A}$ | 18.7$^{A}$ | 46.7$^{A}$ | 27.4$^{E}$ |
| ISA (Experimental) | Closed | 61.8 | 1.9 | 3.5 | 11.1 | 38.3 | 45.3 |
| | Open | 62.0 | 1.5 | 2.9 | 10.6 | 37.3 | 47.7 |
| | Average | 61.9$^{A}$ | 1.7$^{AB}$ | 3.2$^{B}$ | 10.9$^{E}$ | 37.8$^{EF}$ | 46.5$^{A}$ |
| ISA (Babcock B-300) | Closed | 60.0 | 1.2 | 4.5 | 14.3 | 44.0 | 35.6 |
| | Open | 60.2 | 1.2 | 3.2 | 14.2 | 43.4 | 36.7 |
| | Average | 60.1$^{B}$ | 1.2$^{B}$ | 3.8$^{B}$ | 14.3$^{C}$ | 43.7$^{ABC}$ | 36.2$^{BC}$ |
| Shaver (White) | Closed | 59.5 | 2.6 | 4.2 | 14.2 | 45.9 | 33.5 |
| | Open | 60.1 | 2.8 | 4.1 | 12.2 | 44.2 | 37.0 |
| | Average | 59.8$^{B}$ | 2.7$^{A}$ | 4.2$^{AB}$ | 13.2$^{CD}$ | 45.0$^{A}$ | 35.3$^{C}$ |
| Shaver (2000) | Closed | 61.9 | 2.1 | 3.2 | 11.6 | 35.9 | 47.1 |
| | Open | 61.8 | 1.9 | 3.9 | 9.7 | 36.7 | 47.3 |
| | Average | 61.8$^{A}$ | 2.0$^{AB}$ | 3.6$^{B}$ | 10.6$^{E}$ | 36.3$^{F}$ | 47.2$^{A}$ |
| Dekalb (Delta) | Closed | 61.7 | 1.5 | 3.7 | 10.7 | 39.1 | 45.1 |
| | Open | 61.2 | 1.1 | 3.0 | 11.8 | 41.7 | 42.3 |
| | Average | 61.4$^{A}$ | 1.3$^{B}$ | 3.3$^{B}$ | 11.3$^{DE}$ | 40.4$^{DE}$ | 43.7$^{A}$ |
| All Strains | Closed | 60.3 | 1.9 | 4.3 | 14.4 | 42.0 | 37.6 |
| | Open | 60.4 | 1.8 | 3.8 | 13.6 | 41.6 | 39.0 |
| | Average | 60.3 | 1.8 | 4.1 | 14.0 | 41.8 | 38.2 |

A,B,C,D,E,F - Different letters denote significant differences (P<.01), comparisons made among strain average values.
Differences among individual laying house and strain averages are not significant.

TABLE 3. EFFECT OF LAYING HOUSE ON EGG QUALITY, INCOME AND FEED COSTS OF WHITE-EGG STRAINS, 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Laying House | Grade A (%) | Grade B (%) | Cracks (%) | Loss (%) | Egg Income ($/hen) | Feed Costs ($/hen) |
|---|---|---|---|---|---|---|---|
| Hy-Line (W-36) | Closed | 95.2 | 2.3 | 2.3 | 0.1 | 12.98 | 5.06 |
| | Open | 95.5 | 2.0 | 2.4 | 0.0 | 12.81 | 5.09 |
| | Average | 95.4 | 2.1 | 2.4 | 0.1 | 12.90$^{B}$ | 5.07$^{CD}$ |
| Hy-Line (W-77) | Closed | 95.0 | 2.0 | 2.9 | 0.1 | 13.01 | 5.56 |
| | Open | 95.8 | 1.5 | 2.7 | 0.0 | 13.60 | 5.47 |
| | Average | 95.4 | 1.8 | 2.8 | 0.0 | 13.31$^{AB}$ | 5.51$^{A}$ |
| H & N (Nick Chick) | Closed | 95.2 | 2.4 | 2.4 | 0.0 | 13.01 | 5.40 |
| | Open | 96.0 | 1.7 | 2.3 | 0.0 | 13.32 | 5.38 |
| | Average | 95.6 | 2.1 | 2.3 | 0.0 | 13.16$^{AB}$ | 5.39$^{A}$ |
| Bovans (White) | Closed | 95.4 | 2.1 | 2.4 | 0.0 | 13.04 | 5.18 |
| | Open | 96.1 | 1.5 | 2.5 | 0.0 | 12.93 | 5.08 |
| | Average | 95.8 | 1.8 | 2.4 | 0.0 | 12.99$^{B}$ | 5.13$^{CD}$ |
| ISA (Experimental) | Closed | 95.3 | 2.6 | 2.1 | 0.0 | 12.84 | 5.09 |
| | Open | 95.6 | 2.1 | 2.1 | 0.2 | 12.93 | 4.91 |
| | Average | 95.4 | 2.4 | 2.1 | 0.1 | 12.88$^{B}$ | 5.00$^{D}$ |
| ISA (Babcock B-300) | Closed | 94.2 | 3.5 | 2.3 | 0.0 | 13.15 | 5.24 |
| | Open | 95.8 | 1.8 | 2.2 | 0.1 | 13.06 | 5.17 |
| | Average | 95.0 | 2.7 | 2.2 | 0.1 | 13.11$^{B}$ | 5.20$^{BC}$ |
| Shaver (White) | Closed | 96.2 | 1.9 | 1.7 | 0.1 | 12.81 | 5.20 |
| | Open | 96.0 | 2.1 | 1.8 | 0.0 | 12.95 | 5.17 |
| | Average | 96.1 | 2.0 | 1.8 | 0.0 | 12.88$^{B}$ | 5.18$^{BC}$ |
| Shaver (2000) | Closed | 94.6 | 2.6 | 2.7 | 0.0 | 12.64 | 5.44 |
| | Open | 96.3 | 1.5 | 2.2 | 0.0 | 13.07 | 5.35 |
| | Average | 95.5 | 2.0 | 2.5 | 0.0 | 12.86$^{B}$ | 5.39$^{A}$ |
| Dekalb (Delta) | Closed | 94.3 | 2.7 | 3.0 | 0.0 | 13.51 | 5.41 |
| | Open | 95.3 | 1.5 | 3.2 | 0.1 | 13.67 | 5.29 |
| | Average | 94.8 | 2.1 | 3.1 | 0.0 | 13.59$^{A}$ | 5.35$^{AB}$ |
| All Strains | Closed | 95.0 | 2.5 | 2.4 | 0.0 | 13.00 | 5.29 |
| | Open | 95.8 | 1.7 | 2.4 | 0.0 | 13.15 | 5.21 |
| | Average | 95.4 | 2.1 | 2.4 | 0.0 | 13.08 | 5.25 |

A,B,C,D - Different letters denote significant differences (P<.01), comparisons made among strain average values. Differences among individual laying house and strain averages are not significant.

TABLE 4. EFFECT OF POPULATION ON PERFORMANCE OF WHITE EGG STRAINS, 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Hens/ Cage | Feed Cons. (kg/100 hens/d) | Feed Conver. (g egg/ g feed) | Eggs Per Bird Housed | Egg Production (HD%) | Egg Mass (g/HD) | Mortality (%) | Age at 50% Production (Days) |
|---|---|---|---|---|---|---|---|---|
| Hy-Line | 6 | 10.5 | .43 | 232.0 | 76.4 | 45.8 | 2.9 | 156 |
| (W-36) | 7 | 10.3 | .42 | 225.4 | 74.2 | 44.3 | 3.6 | 154 |
| Hy-Line | 6 | 11.3 | .41 | 235.2 | 77.1 | 46.9 | 2.9 | 143 |
| (W-77) | 7 | 11.2 | .41 | 234.3 | 77.3 | 46.8 | 3.5 | 143 |
| H & N | 6 | 11.6 | .41 | 235.3 | 79.1 | 48.7 | 8.0 | 153 |
| (Nick Chick) | 7 | 11.5 | .40 | 226.2 | 76.9 | 47.2 | 10.3 | 155 |
| Bovans | 6 | 10.9 | .42 | 236.0 | 78.6 | 46.8 | 5.1 | 150 |
| (White) | 7 | 10.6 | .42 | 225.6 | 76.3 | 44.9 | 5.7 | 154 |
| ISA | 6 | 10.8 | .43 | 232.1 | 77.2 | 48.4 | 7.4 | 151 |
| (Experimental) | 7 | 10.6 | .43 | 218.5 | 74.0 | 46.3 | 10.3 | 155 |
| ISA | 6 | 11.3 | .43 | 234.3 | 80.1 | 48.4 | 12.9 | 142 |
| (Babcock B-300) | 7 | 11.0 | .43 | 231.0 | 77.9 | 47.0 | 10.8 | 143 |
| Shaver | 6 | 11.3 | .41 | 229.1 | 76.6 | 46.5 | 7.1 | 156 |
| (White) | 7 | 11.1 | .40 | 224.0 | 74.7 | 45.6 | 10.9 | 157 |
| Shaver | 6 | 11.7 | .41 | 229.8 | 76.4 | 48.0 | 7.0 | 153 |
| (2000) | 7 | 11.4 | .40 | 222.3 | 74.9 | 46.9 | 9.4 | 156 |
| Dekalb | 6 | 11.2 | .44 | 242.0 | 79.6 | 49.5 | 3.6 | 151 |
| (Delta) | 7 | 11.1 | .43 | 234.2 | 77.3 | 48.1 | 4.0 | 154 |
| All Strains | 6 | $11.2^{A}$ | .42 | $234.0^{A}$ | $77.9^{A}$ | $47.7^{A}$ | 6.3 | $151^{B}$ |
| | 7 | $11.0^{B}$ | .42 | $226.8^{B}$ | $75.9^{B}$ | $46.3^{B}$ | 7.6 | $152^{A}$ |

A,B - Different letters denote significant differences (P<.01).

TABLE 5. EFFECT OF POPULATION ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF WHITE-EGG STRAINS, 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Hens/ Cage | Egg Weight (g/egg) | Pee Wee (%) | Small (%) | Medium (%) | Large (%) | Extra Large (%) |
|---|---|---|---|---|---|---|---|
| Hy-Line | 6 | 58.8 | 2.2 | 5.7 | 18.2 | 43.4 | 31.3 |
| (W-36) | 7 | 58.7 | 2.5 | 5.0 | 16.4 | 45.1 | 31.5 |
| Hy-Line | 6 | 60.4 | 1.5 | 4.4 | 15.7 | 41.1 | 37.4 |
| (W-77) | 7 | 60.0 | 1.1 | 3.0 | 17.4 | 40.1 | 37.7 |
| H & N | 6 | 60.6 | 1.9 | 4.0 | 13.6 | 42.7 | 38.6 |
| (Nick Chick) | 7 | 60.3 | 1.9 | 4.4 | 13.2 | 40.2 | 40.4 |
| Bovans | 6 | 58.8 | 2.3 | 5.5 | 17.8 | 46.9 | 27.7 |
| (White) | 7 | 58.2 | 2.3 | 4.7 | 19.5 | 46.5 | 27.0 |
| ISA | 6 | 62.0 | 1.5 | 2.9 | 11.0 | 37.3 | 47.3 |
| (Experimental) | 7 | 61.8 | 2.0 | 3.6 | 10.7 | 38.4 | 45.6 |
| ISA | 6 | 60.1 | 1.5 | 3.9 | 14.3 | 44.1 | 35.8 |
| (Babcock B-300) | 7 | 60.0 | 0.9 | 3.7 | 14.3 | 43.3 | 36.5 |
| Shaver | 6 | 59.8 | 2.6 | 3.8 | 13.2 | 46.6 | 34.2 |
| (White) | 7 | 59.9 | 2.8 | 4.5 | 13.2 | 43.5 | 36.4 |
| Shaver | 6 | 61.9 | 1.7 | 3.4 | 11.0 | 36.4 | 47.3 |
| (2000) | 7 | 61.8 | 2.3 | 3.8 | 10.3 | 36.3 | 47.1 |
| Dekalb | 6 | 61.4 | 1.1 | 3.7 | 11.0 | 41.6 | 42.5 |
| (Delta) | 7 | 61.5 | 1.4 | 3.0 | 11.5 | 39.2 | 44.8 |
| All Strains | 6 | 60.4 | 1.8 | 4.2 | 14.0 | 42.2 | 38.0 |
| | 7 | 60.3 | 1.9 | 4.0 | 14.0 | 41.4 | 38.6 |

*There are no significant differences among these means.

TABLE 6. EFFECT OF POPULATION ON EGG QUALITY, INCOME AND FEED COSTS OF WHITE-EGG STRAINS, 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Hens/ Cage | Grade A (%) | Grade B (%) | Cracks (%) | Loss (%) | Egg Income ($/hen) | Feed Costs ($/hen) |
|---|---|---|---|---|---|---|---|
| Hy-Line | 6 | 96.2 | 2.0 | 1.8 | 0.0 | 13.14 | 5.14 |
| (W-36) | 7 | 94.6 | 2.3 | 3.0 | 0.1 | 12.66 | 5.01 |
| Hy-Line | 6 | 95.1 | 2.1 | 2.7 | 0.1 | 13.33 | 5.56 |
| (W-77) | 7 | 95.7 | 1.4 | 2.9 | 0.0 | 13.28 | 5.47 |
| H & N | 6 | 96.0 | 1.9 | 2.1 | 0.0 | 13.50 | 5.54 |
| (Nick Chick) | 7 | 95.3 | 2.2 | 2.5 | 0.0 | 12.83 | 5.24 |
| Bovans | 6 | 95.7 | 2.0 | 2.3 | 0.0 | 13.28 | 5.25 |
| (White) | 7 | 95.8 | 1.6 | 2.5 | 0.0 | 12.70 | 5.01 |
| ISA | 6 | 96.1 | 2.0 | 1.8 | 0.1 | 13.33 | 5.13 |
| (Experimental) | 7 | 94.8 | 2.7 | 2.4 | 0.1 | 12.44 | 4.88 |
| ISA | 6 | 94.2 | 3.6 | 2.2 | 0.1 | 13.16 | 5.21 |
| (Babcock B-300) | 7 | 95.9 | 1.8 | 2.3 | 0.0 | 13.06 | 5.19 |
| Shaver | 6 | 96.2 | 2.1 | 1.7 | 0.0 | 13.05 | 5.26 |
| (White) | 7 | 96.1 | 2.0 | 1.9 | 0.0 | 12.71 | 5.11 |
| Shaver | 6 | 94.4 | 2.3 | 3.2 | 0.1 | 13.03 | 5.55 |
| (2000) | 7 | 96.5 | 1.8 | 1.7 | 0.0 | 12.68 | 5.24 |
| Dekalb | 6 | 95.4 | 1.6 | 2.9 | 0.1 | 13.87 | 5.42 |
| (Delta) | 7 | 94.2 | 2.5 | 3.3 | 0.0 | 13.31 | 5.28 |
| All Strains | 6 | 95.5 | 2.2 | 2.3 | 0.1 | 13.30[A] | 5.34[A] |
| | 7 | 95.4 | 2.0 | 2.5 | 0.0 | 12.85[B] | 5.16[B] |

A,B, - Different letters denote significant differences (P<.01).

TABLE 7. EFFECT OF CAGE SIZE ON PERFORMANCE OF WHITE-EGG STRAINS, 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Cage Length (cm)[1] | Feed Cons. (kg/100 hens/d) | Feed Conver. (g egg/ g feed) | Eggs Per Bird Housed | Egg Production (HD%) | Egg Mass (g/HD) | Mortality (%) | Age at 50% Production (Days) |
|---|---|---|---|---|---|---|---|---|
| Hy-Line | 61 | 10.2 | .42 | 221.7 | 73.0 | 43.4 | 3.3 | 156 |
| (W-36) | 81 | 10.7 | .43 | 235.7 | 77.6 | 47.0 | 3.2 | 154 |
| Hy-Line | 61 | 11.0 | .41 | 230.0 | 76.1 | 46.0 | 4.8 | 142 |
| (W-77) | 81 | 11.4 | .41 | 239.6 | 78.3 | 46.7 | 1.6 | 144 |
| H & N | 61 | 11.4 | .41 | 224.3 | 76.6 | 47.2 | 10.1 | 155 |
| (Nick Chick) | 81 | 11.7 | .41 | 237.2 | 79.4 | 48.7 | 8.2 | 153 |
| Bovans | 61 | 10.5 | .42 | 226.8 | 76.5 | 45.1 | 6.7 | 151 |
| (White) | 81 | 10.9 | .42 | 234.8 | 78.3 | 46.6 | 4.0 | 153 |
| ISA | 61 | 10.6 | .43 | 214.8 | 73.3 | 46.0 | 12.0 | 153 |
| (Experimental) | 81 | 10.9 | .44 | 235.7 | 77.9 | 48.7 | 5.7 | 152 |
| ISA | 61 | 10.9 | .42 | 226.2 | 76.7 | 46.2 | 12.3 | 144 |
| (Babcock B-300) | 81 | 11.4 | .43 | 239.1 | 81.3 | 49.2 | 11.4 | 141 |
| Shaver | 61 | 11.1 | .39 | 215.2 | 72.9 | 44.4 | 9.8 | 156 |
| (White) | 81 | 11.3 | .41 | 237.9 | 78.3 | 47.7 | 8.2 | 157 |
| Shaver | 61 | 11.3 | .40 | 213.8 | 72.7 | 45.5 | 10.3 | 155 |
| (2000) | 81 | 11.8 | .41 | 238.3 | 78.6 | 49.3 | 6.1 | 154 |
| Dekalb | 61 | 11.0 | .43 | 230.9 | 76.5 | 47.6 | 4.7 | 152 |
| (Delta) | 81 | 11.3 | .44 | 245.4 | 80.3 | 50.0 | 2.9 | 153 |
| All Strains | 61 | $10.9^{B}$ | .42 | $222.6^{B}$ | $74.9^{B}$ | $45.7^{B}$ | $8.2^{A}$ | 152 |
| | 81 | $11.3^{A}$ | .42 | $238.2^{A}$ | $78.9^{A}$ | $48.3^{A}$ | $5.7^{B}$ | 151 |

[1]All cages are 35.5 cm deep with length being either 61 or 81 cm.
A,B, - Different letters denote significant differences (P<.01).

TABLE 8. EFFECT OF CAGE SIZE ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF WHITE-EGG STRAINS, 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Cage Length (cm)[1] | Egg Weight (g/egg) | Pee Wee (%) | Small (%) | Medium (%) | Large (%) | Extra Large (%) |
|---|---|---|---|---|---|---|---|
| Hy-Line | 61 | 58.6 | 2.3 | 5.3 | 18.5 | 43.8 | 30.9 |
| (W-36) | 81 | 59.0 | 2.4 | 5.3 | 16.0 | 44.6 | 31.9 |
| Hy-Line | 61 | 60.1 | 1.4 | 4.2 | 16.1 | 40.8 | 37.0 |
| (W-77) | 81 | 60.4 | 1.3 | 3.3 | 16.9 | 40.4 | 38.1 |
| H & N | 61 | 60.6 | 1.8 | 3.9 | 13.4 | 40.6 | 40.6 |
| (Nick Chick) | 81 | 60.3 | 1.9 | 4.5 | 13.4 | 42.3 | 38.4 |
| Bovans | 61 | 58.3 | 2.6 | 4.9 | 19.6 | 47.9 | 25.1 |
| (White) | 81 | 58.7 | 2.0 | 5.4 | 17.7 | 45.5 | 29.6 |
| ISA | 61 | 62.0 | 1.7 | 3.2 | 10.1 | 38.5 | 46.5 |
| (Experimental) | 81 | 61.8 | 1.7 | 3.3 | 11.6 | 37.1 | 46.4 |
| ISA | 61 | 60.0 | 1.5 | 3.9 | 14.4 | 43.0 | 36.4 |
| (Babcock B-300) | 81 | 60.2 | 0.9 | 3.7 | 14.1 | 44.4 | 35.9 |
| Shaver | 61 | 59.8 | 2.4 | 4.6 | 12.9 | 44.4 | 36.2 |
| (White) | 81 | 59.8 | 3.0 | 3.7 | 13.4 | 45.7 | 34.4 |
| Shaver | 61 | 61.8 | 2.0 | 3.6 | 10.0 | 37.2 | 46.9 |
| (2000) | 81 | 61.9 | 2.0 | 3.5 | 11.3 | 35.4 | 47.5 |
| Dekalb | 61 | 61.5 | 1.2 | 3.6 | 10.8 | 41.0 | 43.4 |
| (Delta) | 81 | 61.4 | 1.4 | 3.1 | 11.7 | 39.8 | 43.9 |
| All Strains | 61 | 60.3 | 1.9 | 4.1 | 14.0 | 41.9 | 38.1 |
| | 81 | 60.4 | 1.8 | 4.0 | 14.0 | 41.7 | 38.5 |

[1]All cages are 35.5 cm deep with length being either 61 or 81 cm.
*There are no significant differences among these means.

TABLE 9. EFFECT OF CAGE SIZE ON EGG QUALITY, INCOME AND FEED COSTS OF WHITE-EGG STRAINS, 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Cage Length (cm)[1] | Grade A (%) | Grade B (%) | Cracks (%) | Loss (%) | Egg Income ($/hen) | Feed Costs ($/hen) |
|---|---|---|---|---|---|---|---|
| Hy-Line | 61 | 95.8 | 1.6 | 2.6 | 0.0 | 12.56 | 4.94 |
| (W-36) | 81 | 95.0 | 2.7 | 2.2 | 0.1 | 13.23 | 5.20 |
| Hy-Line | 61 | 94.8 | 2.1 | 3.1 | 0.0 | 12.95 | 5.38 |
| (W-77) | 81 | 96.0 | 1.5 | 2.5 | 0.1 | 13.66 | 5.64 |
| H & N | 61 | 94.7 | 2.3 | 3.0 | 0.0 | 12.74 | 5.23 |
| (Nick Chick) | 81 | 96.5 | 1.8 | 1.7 | 0.0 | 13.59 | 5.55 |
| Bovans | 61 | 96.0 | 1.6 | 2.4 | 0.0 | 12.74 | 4.98 |
| (White) | 81 | 95.5 | 2.0 | 2.5 | 0.0 | 13.24 | 5.28 |
| ISA | 61 | 95.4 | 2.7 | 1.8 | 0.1 | 12.28 | 4.80 |
| (Experimental) | 81 | 95.5 | 2.0 | 2.4 | 0.1 | 13.49 | 5.21 |
| ISA | 61 | 94.4 | 3.4 | 2.1 | 0.1 | 12.67 | 5.04 |
| (Babcock B-300) | 81 | 95.6 | 2.0 | 2.3 | 0.1 | 13.54 | 5.36 |
| Shaver | 61 | 96.0 | 2.2 | 1.8 | 0.0 | 12.26 | 5.06 |
| (White) | 81 | 96.3 | 1.9 | 1.8 | 0.1 | 13.50 | 5.30 |
| Shaver | 61 | 95.2 | 2.2 | 2.6 | 0.0 | 12.15 | 5.19 |
| (2000) | 81 | 95.7 | 1.9 | 2.3 | 0.0 | 13.56 | 5.59 |
| Dekalb | 61 | 95.0 | 1.7 | 3.3 | 0.0 | 13.22 | 5.23 |
| (Delta) | 81 | 94.6 | 2.5 | 2.9 | 0.0 | 13.97 | 5.47 |
| All Strains | 61 | 95.3 | 2.2 | 2.5 | 0.0 | 12.62[B] | 5.10[B] |
| | 81 | 95.6 | 2.0 | 2.3 | 0.1 | 13.53[A] | 5.40[A] |

[1]All cages are 35.5 cm deep with length being either 61 or 81 cm.

TABLE 10. DENSITY EFFECTS ON PERFORMANCE OF WHITE-EGG STRAINS, DUE TO THE ADDITIVE EFFECTS OF CAGE SIZE AND POPULATION 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Density ($cm^2$/hen) | Cage Length /Pop[1] | Feed Cons. (kg/100 hens/d) | Feed Conv. (g egg/ g feed) | Eggs Per Bird Housed | Egg Production (HD%) | Egg Mass (g/HD) | Mortality (%) | Age at 50% Production (Days) |
|---|---|---|---|---|---|---|---|---|---|
| Hy-Line | 310 | 61/7 | 10.1 | .41 | 216.3 | 71.5 | 42.3 | 4.9 | 157 |
| (W-36) | 361 | 61/6 | 10.3 | .43 | 227.1 | 74.5 | 44.6 | 1.7 | 156 |
| | 413 | 81/7 | 10.6 | .43 | 234.6 | 77.0 | 46.3 | 2.4 | 152 |
| | 482 | 81/6 | 10.7 | .43 | 236.9 | 78.3 | 47.0 | 4.1 | 156 |
| Hy-Line | 310 | 61/7 | 11.1 | .41 | 225.7 | 75.1 | 45.6 | 5.4 | 143 |
| (W-77) | 361 | 61/6 | 11.0 | .41 | 234.3 | 77.1 | 46.4 | 4.3 | 142 |
| | 413 | 81/7 | 11.3 | .42 | 243.0 | 79.5 | 47.9 | 1.6 | 144 |
| | 482 | 81/6 | 11.5 | .41 | 236.1 | 77.1 | 47.4 | 1.5 | 145 |
| H & N | 310 | 61/7 | 11.3 | .40 | 221.8 | 75.7 | 46.5 | 9.9 | 157 |
| (Nick Chick) | 361 | 61/6 | 11.5 | .41 | 226.8 | 77.4 | 47.9 | 10.2 | 154 |
| | 413 | 81/7 | 11.6 | .41 | 230.6 | 78.0 | 47.8 | 10.7 | 153 |
| | 482 | 81/6 | 11.8 | .41 | 243.8 | 80.8 | 49.5 | 5.8 | 152 |
| Bovans | 310 | 61/7 | 10.4 | .42 | 220.3 | 75.2 | 43.9 | 7.3 | 153 |
| (White) | 361 | 61/6 | 10.7 | .43 | 233.3 | 77.9 | 46.4 | 6.1 | 149 |
| | 413 | 81/7 | 10.8 | .42 | 231.0 | 77.4 | 45.9 | 4.1 | 155 |
| | 482 | 81/6 | 11.1 | .42 | 238.6 | 79.2 | 47.2 | 4.0 | 151 |
| ISA | 310 | 61/7 | 10.4 | .42 | 205.2 | 71.4 | 44.8 | 14.7 | 156 |
| (Experimental) | 361 | 61/6 | 10.7 | .44 | 224.4 | 75.1 | 47.3 | 9.3 | 151 |
| | 413 | 81/7 | 10.9 | .44 | 231.7 | 76.6 | 47.8 | 5.9 | 153 |
| | 482 | 81/6 | 11.0 | .45 | 239.8 | 79.2 | 49.6 | 5.6 | 152 |
| ISA | 310 | 61/7 | 10.8 | .42 | 224.9 | 75.9 | 45.8 | 11.8 | 144 |
| (Babcock B-300) | 361 | 61/6 | 11.0 | .42 | 227.4 | 77.4 | 46.7 | 12.7 | 143 |
| | 413 | 81/7 | 11.2 | .43 | 237.1 | 80.0 | 48.3 | 9.8 | 141 |
| | 482 | 81/6 | 11.6 | .43 | 241.1 | 82.7 | 50.1 | 13.1 | 142 |
| Shaver | 310 | 61/7 | 11.1 | .39 | 210.8 | 72.5 | 44.3 | 12.3 | 156 |
| (White) | 361 | 61/6 | 11.0 | .40 | 219.6 | 73.4 | 44.4 | 7.2 | 155 |
| | 413 | 81/7 | 11.2 | .41 | 237.2 | 76.8 | 46.8 | 9.4 | 157 |
| | 482 | 81/6 | 11.5 | .42 | 238.7 | 79.8 | 48.6 | 6.9 | 156 |
| Shaver | 310 | 61/7 | 11.2 | .40 | 210.7 | 72.5 | 45.3 | 11.9 | 157 |
| (2000) | 361 | 61/6 | 11.4 | .40 | 216.8 | 72.8 | 45.7 | 8.7 | 154 |
| | 413 | 81/7 | 11.7 | .41 | 233.9 | 77.2 | 48.5 | 7.0 | 155 |
| | 482 | 81/6 | 12.0 | .41 | 242.7 | 80.0 | 50.2 | 5.2 | 152 |
| Dekalb | 310 | 61/7 | 11.0 | .43 | 229.0 | 76.0 | 47.4 | 4.4 | 153 |
| (Delta) | 361 | 61/6 | 10.9 | .43 | 232.8 | 77.1 | 47.8 | 5.0 | 152 |
| | 413 | 81/7 | 11.2 | .43 | 239.5 | 78.5 | 48.8 | 3.7 | 155 |
| | 482 | 81/6 | 11.4 | .44 | 251.2 | 82.2 | 51.2 | 2.2 | 151 |
| All Strains | 310 | 61/7 | 10.8 | .41 | 218.3 | 74.0 | 45.1 | 9.2 | 153 |
| | 361 | 61/6 | 11.0 | .42 | 226.9 | 75.9 | 46.3 | 7.3 | 151 |
| | 413 | 81/7 | 11.1 | .42 | 235.4 | 77.9 | 47.6 | 6.0 | 152 |
| | 482 | 81/6 | 11.4 | .42 | 241.0 | 79.9 | 49.0 | 5.4 | 151 |

*There are no significant differences among these means.
[1]Density was represented by a combination of cage size designated by lengths of 61 or 81 cm and hen population of either 6 or 7.

TABLE 11. DENSITY EFFECTS ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF WHITE-EGG STRAINS, DUE TO THE ADDITIVE EFFECTS OF CAGE SIZE AND POPULATION 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Density[1] ($cm^2$) | Cage Length /Pop[1] | Egg Weight (g/egg) | Pee Wee (%) | Small (%) | Medium (%) | Large (%) | Extra Large (%) |
|---|---|---|---|---|---|---|---|---|
| Hy-Line | 310 | 61/7 | 58.3 | 2.7 | 4.2 | 17.8 | 45.9 | 29.5 |
| (W-36) | 361 | 61/6 | 58.9 | 1.9 | 6.5 | 19.1 | 41.7 | 32.2 |
| | 413 | 81/7 | 59.2 | 2.4 | 5.7 | 14.9 | 44.2 | 33.6 |
| | 482 | 81/6 | 58.7 | 2.5 | 5.0 | 17.2 | 45.0 | 30.3 |
| Hy-Line | 310 | 61/7 | 60.2 | 1.5 | 3.5 | 16.0 | 39.4 | 38.8 |
| (W-77) | 361 | 61/6 | 59.9 | 1.3 | 4.9 | 16.2 | 42.2 | 35.3 |
| | 413 | 81/7 | 59.8 | 0.8 | 2.6 | 18.7 | 40.8 | 36.7 |
| | 482 | 81/6 | 61.0 | 1.7 | 4.0 | 15.1 | 40.1 | 39.4 |
| H & N | 310 | 61/7 | 60.4 | 2.2 | 4.0 | 13.0 | 38.8 | 41.8 |
| (Nick Chick) | 361 | 61/6 | 60.9 | 1.4 | 3.8 | 13.8 | 42.4 | 39.3 |
| | 413 | 81/7 | 60.2 | 1.5 | 4.7 | 13.3 | 41.6 | 39.0 |
| | 482 | 81/6 | 60.4 | 2.4 | 4.3 | 13.4 | 43.0 | 37.8 |
| Bovans | 310 | 61/7 | 57.8 | 2.8 | 4.9 | 19.8 | 48.7 | 23.9 |
| (White) | 361 | 61/6 | 58.8 | 2.5 | 4.9 | 19.3 | 47.1 | 26.4 |
| | 413 | 81/7 | 58.7 | 1.9 | 4.5 | 19.3 | 44.3 | 30.2 |
| | 482 | 81/6 | 58.7 | 2.1 | 6.2 | 16.2 | 46.6 | 29.1 |
| ISA | 310 | 61/7 | 61.9 | 2.2 | 3.4 | 9.1 | 38.9 | 46.2 |
| (Experimental) | 361 | 61/6 | 62.2 | 1.3 | 2.9 | 11.1 | 38.1 | 46.8 |
| | 413 | 81/7 | 61.8 | 1.8 | 3.7 | 12.2 | 37.8 | 45.0 |
| | 482 | 81/6 | 61.8 | 1.6 | 2.9 | 11.0 | 36.4 | 47.9 |
| ISA | 310 | 61/7 | 59.9 | 1.0 | 4.0 | 13.1 | 42.5 | 38.2 |
| (Babcock B-300) | 361 | 61/6 | 60.0 | 2.0 | 3.9 | 15.7 | 43.5 | 34.7 |
| | 413 | 81/7 | 60.1 | 0.8 | 3.5 | 15.5 | 44.1 | 34.9 |
| | 482 | 81/6 | 60.3 | 1.0 | 4.0 | 12.8 | 44.7 | 37.0 |
| Shaver | 310 | 61/7 | 60.0 | 2.7 | 4.4 | 12.6 | 42.7 | 37.6 |
| (White) | 361 | 61/6 | 59.6 | 2.1 | 4.8 | 13.3 | 46.1 | 34.8 |
| | 413 | 81/7 | 59.8 | 2.8 | 4.7 | 13.7 | 44.2 | 35.1 |
| | 482 | 81/6 | 59.9 | 3.2 | 2.8 | 13.1 | 47.1 | 33.6 |
| Shaver | 310 | 61/7 | 61.6 | 2.2 | 4.0 | 9.4 | 37.5 | 46.9 |
| (2000) | 361 | 61/6 | 62.0 | 1.8 | 3.3 | 10.6 | 37.0 | 46.9 |
| | 413 | 81/7 | 61.9 | 2.5 | 3.6 | 11.2 | 35.0 | 47.4 |
| | 482 | 81/6 | 61.9 | 1.5 | 3.4 | 11.5 | 35.8 | 47.7 |
| Dekalb | 310 | 61/7 | 61.7 | 1.4 | 3.3 | 10.6 | 40.4 | 44.3 |
| (Delta) | 361 | 61/6 | 61.3 | 1.0 | 4.0 | 11.0 | 41.6 | 42.5 |
| | 413 | 81/7 | 61.3 | 1.4 | 2.7 | 12.4 | 37.9 | 45.3 |
| | 482 | 81/6 | 61.5 | 1.3 | 3.4 | 11.0 | 41.6 | 42.6 |
| All Strains | 310 | 61/7 | 60.2 | 2.1 | 4.0 | 13.5 | 41.6 | 38.6 |
| | 361 | 61/6 | 60.4 | 1.7 | 4.3 | 14.4 | 42.2 | 37.7 |
| | 413 | 81/7 | 60.3 | 1.8 | 4.0 | 14.6 | 41.1 | 38.6 |
| | 482 | 81/6 | 60.4 | 1.9 | 4.0 | 13.5 | 42.3 | 38.3 |

*There are no significant differences among these means.
[1]Density was represented by a combination of cage size designated by lengths of 61 or 81 cm and hen population of either 6 or 7.

TABLE 12. DENSITY EFFECTS ON EGG QUALITY, INCOME AND FEED COSTS OF WHITE-EGG STRAINS, DUE TO THE ADDITIVE EFFECTS OF CAGE SIZE AND POPULATION 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Density[1] ($cm^2$) | Cage Length /Pop[1] | Grade A (%) | Grade B (%) | Cracks (%) | Loss (%) | Egg Income ($/hen) | Feed Costs ($/hen) |
|---|---|---|---|---|---|---|---|---|
| Hy-Line | 310 | 61/7 | 94.8 | 1.6 | 3.6 | 0.0 | 12.14 | 4.84 |
| (W-36) | 361 | 61/6 | 96.7 | 1.6 | 1.7 | 0.0 | 12.99 | 5.05 |
| | 413 | 81/7 | 94.4 | 2.9 | 2.5 | 0.2 | 13.18 | 5.18 |
| | 482 | 81/6 | 95.6 | 2.4 | 1.9 | 0.1 | 13.29 | 5.23 |
| Hy-Line | 310 | 61/7 | 95.3 | 1.4 | 3.3 | 0.0 | 12.72 | 5.36 |
| (W-77) | 361 | 61/6 | 94.2 | 2.8 | 2.9 | 0.0 | 13.18 | 5.41 |
| | 413 | 81/7 | 96.1 | 1.5 | 2.5 | 0.0 | 13.85 | 5.58 |
| | 482 | 81/6 | 95.9 | 1.5 | 2.5 | 0.1 | 13.48 | 5.71 |
| H & N | 310 | 61/7 | 94.1 | 2.6 | 3.3 | 0.0 | 12.47 | 5.06 |
| (Nick Chick) | 361 | 61/6 | 95.3 | 2.0 | 2.6 | 0.0 | 13.01 | 5.41 |
| | 413 | 81/7 | 96.5 | 1.8 | 1.8 | 0.0 | 13.20 | 5.43 |
| | 482 | 81/6 | 96.6 | 1.9 | 1.6 | 0.0 | 13.98 | 5.67 |
| Bovans | 310 | 61/7 | 96.0 | 1.5 | 2.5 | 0.0 | 12.35 | 4.87 |
| (White) | 361 | 61/6 | 96.0 | 1.7 | 2.3 | 0.0 | 13.12 | 5.10 |
| | 413 | 81/7 | 95.7 | 1.7 | 2.5 | 0.1 | 13.05 | 5.15 |
| | 482 | 81/6 | 95.3 | 2.2 | 2.4 | 0.0 | 13.43 | 5.40 |
| ISA | 310 | 61/7 | 94.5 | 3.4 | 2.2 | 0.0 | 11.63 | 4.60 |
| (Experimental) | 361 | 61/6 | 96.3 | 2.1 | 1.5 | 0.2 | 12.93 | 4.99 |
| | 413 | 81/7 | 95.1 | 2.1 | 2.7 | 0.1 | 13.24 | 5.15 |
| | 482 | 81/6 | 95.9 | 1.9 | 2.0 | 0.1 | 13.73 | 5.26 |
| ISA | 310 | 61/7 | 96.2 | 1.9 | 1.9 | 0.0 | 12.73 | 5.05 |
| (Babcock B-300) | 361 | 61/6 | 92.7 | 4.9 | 2.3 | 0.1 | 12.61 | 5.03 |
| | 413 | 81/7 | 95.6 | 1.7 | 2.6 | 0.1 | 13.38 | 5.33 |
| | 482 | 81/6 | 95.6 | 2.3 | 2.1 | 0.0 | 13.70 | 5.40 |
| Shaver | 310 | 61/7 | 96.1 | 2.2 | 1.7 | 0.0 | 11.94 | 5.00 |
| (White) | 361 | 61/6 | 96.0 | 2.1 | 1.9 | 0.0 | 12.58 | 5.13 |
| | 413 | 81/7 | 96.1 | 1.8 | 2.0 | 0.1 | 13.48 | 5.22 |
| | 482 | 81/6 | 96.5 | 2.0 | 1.5 | 0.1 | 13.53 | 5.39 |
| Shaver | 310 | 61/7 | 96.3 | 1.9 | 1.8 | 0.0 | 12.04 | 5.08 |
| (2000) | 361 | 61/6 | 94.1 | 2.4 | 3.4 | 0.1 | 12.26 | 5.31 |
| | 413 | 81/7 | 96.7 | 1.7 | 1.6 | 0.0 | 13.33 | 5.41 |
| | 482 | 81/6 | 94.7 | 2.1 | 3.1 | 0.0 | 13.80 | 5.78 |
| Dekalb | 310 | 61/7 | 94.4 | 2.2 | 3.5 | 0.0 | 13.06 | 5.19 |
| (Delta) | 361 | 61/6 | 95.6 | 1.2 | 3.1 | 0.1 | 13.38 | 5.27 |
| | 413 | 81/7 | 94.0 | 2.9 | 3.1 | 0.0 | 13.57 | 5.37 |
| | 482 | 81/6 | 95.2 | 2.0 | 2.8 | 0.0 | 14.36 | 5.58 |
| All Strains | 310 | 61/7 | 95.3 | 2.1 | 2.6 | 0.0 | 12.34 | 5.00 |
| | 361 | 61/6 | 95.2 | 2.3 | 2.4 | 0.1 | 12.89 | 5.19 |
| | 413 | 81/7 | 95.6 | 2.0 | 2.4 | 0.1 | 13.36 | 5.31 |
| | 482 | 81/6 | 95.7 | 2.0 | 2.2 | 0.1 | 13.70 | 5.49 |

*There are no significant differences among these means.
[1]Density was represented by a combination of cage size designated by lengths of 61 or 81 cm and hen population of either 6 or 7.

TABLE 13. EFFECT OF LAYING HOUSE ON PERFORMANCE OF BROWN-EGG STRAINS, 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Laying House | Feed Cons. (kg/100 hens/d) | Feed Conver. (g egg/ g feed) | Eggs Per Bird Housed | Egg Production (HD%) | Egg Mass (g/HD) | Mortality (%) | Age at 50% Production (Days) |
|---|---|---|---|---|---|---|---|---|
| Bovans | Closed | 12.2 | .41 | 243.2 | 80.3 | 49.9 | 5.6 | 150 |
| (Brown) | Open | 12.2 | .41 | 238.0 | 80.0 | 49.8 | 9.2 | 148 |
| | Average | 12.2$^{A}$ | .41$^{B}$ | 240.6$^{A}$ | 80.2$^{A}$ | 49.9 | 7.4 | 149$^{B}$ |
| ISA | Closed | 11.7 | .42 | 232.8 | 78.7 | 50.2 | 10.6 | 153 |
| (Brown) | Open | 11.9 | .42 | 237.5 | 79.0 | 49.9 | 8.4 | 150 |
| | Average | 11.8$^{BC}$ | .42$^{A}$ | 235.2$^{A}$ | 78.9$^{AB}$ | 50.1 | 9.5 | 151$^{AB}$ |
| H & N | Closed | 11.5 | .42 | 224.9 | 75.9 | 49.3 | 10.0 | 154 |
| (Brown Nick) | Open | 11.7 | .42 | 226.7 | 76.9 | 49.6 | 10.5 | 151 |
| | Average | 11.6$^{C}$ | .42$^{A}$ | 225.8$^{B}$ | 76.4$^{C}$ | 49.5 | 10.3 | 152$^{A}$ |
| Hy-Line | Closed | 11.9 | .40 | 235.9 | 78.0 | 48.3 | 5.5 | 150 |
| (Brown) | Open | 11.9 | .39 | 231.9 | 77.4 | 47.0 | 5.7 | 147 |
| | Average | 11.9$^{AB}$ | .40$^{B}$ | 233.9$^{A}$ | 77.7$^{BC}$ | 47.7 | 5.6 | 149$^{B}$ |
| All Strains | Closed | 11.8 | .41 | 234.2 | 78.2 | 49.4 | 7.9 | 152 |
| | Open | 11.9 | .41 | 233.5 | 78.4 | 49.1 | 8.4 | 149 |
| | Average | 11.9 | .41 | 233.9 | 78.3 | 49.3 | 8.2 | 150 |

A,B,C - Different letters denote significant differences (P<.01), comparisons made among strain average values. Differences among individual laying house and strain averages are not significant.

TABLE 14. EFFECT OF LAYING HOUSE ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF BROWN-EGG STRAINS, 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Laying House | Egg Weight (g/egg) | Pee Wee (%) | Small (%) | Medium (%) | Large (%) | Extra Large (%) |
|---|---|---|---|---|---|---|---|
| Bovans | Closed | 61.5 | 1.0 | 3.7 | 11.1 | 40.6 | 43.1 |
| (Brown) | Open | 61.5 | 0.9 | 2.7 | 11.2 | 41.7 | 43.7 |
| | Average | 61.5[C] | 0.9 | 3.2 | 11.2 | 41.2[A] | 43.4[C] |
| ISA | Closed | 63.0 | 1.3 | 2.8 | 11.5 | 33.6 | 50.4 |
| (Brown) | Open | 62.5 | 0.9 | 2.9 | 10.0 | 34.3 | 51.4 |
| | Average | 62.8[B] | 1.1 | 2.8 | 10.8 | 34.0[B] | 50.9[B] |
| H & N | Closed | 64.0 | 0.6 | 3.8 | 10.2 | 30.5 | 56.4 |
| (Brown Nick) | Open | 63.7 | 0.7 | 2.5 | 9.8 | 30.8 | 56.2 |
| | Average | 63.9[A] | 0.6 | 3.2 | 10.0 | 30.6[B] | 56.3[A] |
| Hy-Line | Closed | 61.3 | 1.3 | 3.7 | 12.1 | 41.8 | 40.9 |
| (Brown) | Open | 60.4 | 0.6 | 3.1 | 13.0 | 44.2 | 39.0 |
| | Average | 60.8[C] | 0.9 | 3.4 | 12.5 | 43.0[A] | 40.0[C] |
| All Strains | Closed | 62.5 | 1.1 | 3.5 | 11.2 | 36.6 | 47.7 |
| | Open | 62.0 | 0.8 | 2.8 | 11.0 | 37.8 | 47.6 |
| | Average | 62.2 | 0.9 | 3.1 | 11.1 | 37.1 | 47.7 |

A,B,C - Different letters denote significant differences (P<.01), comparisons made among strain average values. Differences among individual laying house and strain averages are not significant.

TABLE 15. EFFECT OF LAYING HOUSE ON EGG QUALITY, INCOME AND FEED COSTS OF BROWN-EGG STRAINS, 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Laying House | Grade A (%) | Grade B (%) | Cracks (%) | Loss (%) | Egg Income ($/hen) | Feed Costs ($/hen) |
|---|---|---|---|---|---|---|---|
| Bovans | Closed | 95.0 | 2.2 | 2.8 | 0.0 | 13.86 | 6.01 |
| (Brown) | Open | 95.8 | 1.2 | 3.0 | 0.0 | 13.78 | 5.89 |
| | Average | 95.4 | 1.7 | 2.9 | 0.0 | 13.82[A] | 5.95[A] |
| ISA | Closed | 94.6 | 3.3 | 2.1 | 0.0 | 13.24 | 5.65 |
| (Brown) | Open | 95.9 | 1.7 | 2.4 | 0.0 | 13.65 | 5.78 |
| | Average | 95.2 | 2.5 | 2.3 | 0.0 | 13.44[AB] | 5.72[BC] |
| H & N | Closed | 94.8 | 2.6 | 2.6 | 0.0 | 13.08 | 5.55 |
| (Brown Nick) | Open | 95.1 | 2.2 | 2.7 | 0.0 | 13.06 | 5.59 |
| | Average | 95.0 | 2.4 | 2.6 | 0.0 | 13.07[B] | 5.57[C] |
| Hy-Line | Closed | 94.4 | 2.4 | 3.1 | 0.1 | 13.38 | 5.84 |
| (Brown) | Open | 94.9 | 1.5 | 3.6 | 0.0 | 13.28 | 5.87 |
| | Average | 94.7 | 1.9 | 3.4 | 0.1 | 13.33[B] | 5.86[AB] |
| All Strains | Closed | 94.7 | 2.6 | 2.7 | 0.0 | 13.39 | 5.76 |
| | Open | 95.4 | 1.7 | 2.9 | 0.0 | 13.44 | 5.78 |
| | Average | 95.1 | 2.1 | 2.8 | 0.0 | 13.42 | 5.77 |

A,B,C - Different letters denote significant differences (P<.01), comparisons made among strain average values. Differences among individual laying house and strain averages are not significant.

TABLE 16. EFFECT OF POPULATION ON PERFORMANCE OF BROWN-EGG STRAINS, 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Hens/ Cage | Feed Cons. (kg/100 hens/d) | Feed Conver. (g egg/ g feed) | Eggs Per Bird Housed | Egg Production (HD%) | Egg Mass (g/HD) | Mortality (%) | Age at 50% Production (Days) |
|---|---|---|---|---|---|---|---|---|
| Bovans | 6 | 12.2 | .41 | 246.2 | 81.5 | 50.7 | 6.8 | 148 |
| (Brown) | 7 | 12.1 | .40 | 234.9 | 78.9 | 49.1 | 8.0 | 150 |
| ISA | 6 | 12.0 | .42 | 241.0 | 80.2 | 51.0 | 7.2 | 151 |
| (Brown) | 7 | 11.6 | .42 | 229.3 | 77.6 | 49.1 | 11.8 | 152 |
| H & N | 6 | 11.8 | .42 | 231.0 | 77.9 | 50.7 | 10.1 | 153 |
| (Brown Nick) | 7 | 11.4 | .42 | 220.6 | 74.9 | 48.2 | 10.5 | 152 |
| Hy-Line | 6 | 11.9 | .41 | 239.8 | 79.5 | 48.9 | 5.2 | 147 |
| (Brown) | 7 | 11.9 | .39 | 228.0 | 75.9 | 46.5 | 6.1 | 150 |
| All Strains | 6 | 12.0[A] | .42[A] | 239.5[A] | 79.8[A] | 50.3 | 7.3 | 150 |
| | 7 | 11.8[B] | .41[B] | 228.2[B] | 76.8[B] | 48.2 | 9.1 | 151 |

A,B - Different letters denote significant differences (P<.01).

TABLE 17. EFFECT OF POPULATION ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF BROWN-EGG STRAINS, 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Hens/ Cage | Egg Weight (g/egg) | Pee Wee (%) | Small (%) | Medium (%) | Large (%) | Extra Large (%) |
|---|---|---|---|---|---|---|---|
| Bovans | 6 | 61.5 | 0.8 | 2.9 | 11.0 | 41.7 | 43.7 |
| (Brown) | 7 | 61.5 | 1.0 | 3.5 | 11.3 | 40.6 | 43.2 |
| ISA | 6 | 63.0 | 0.8 | 2.9 | 9.4 | 33.7 | 52.8 |
| (Brown) | 7 | 62.6 | 1.5 | 2.8 | 12.1 | 34.2 | 49.0 |
| H & N | 6 | 64.2 | 0.6 | 3.4 | 9.1 | 29.4 | 57.8 |
| (Brown Nick) | 7 | 63.6 | 0.7 | 2.9 | 10.8 | 31.8 | 54.8 |
| Hy-Line | 6 | 60.9 | 0.7 | 3.3 | 13.5 | 43.1 | 39.2 |
| (Brown) | 7 | 60.8 | 1.2 | 3.4 | 11.6 | 42.9 | 40.8 |
| All Strains | 6 | 62.4 | 0.7 | 3.1 | 10.7 | 37.0 | 48.4 |
| | 7 | 62.1 | 1.1 | 3.2 | 11.5 | 37.4 | 46.9 |

*There are no significant differences among these means.

TABLE 18. EFFECT OF POPULATION ON EGG QUALITY, INCOME AND FEED COSTS OF BROWN-EGG STRAINS, 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Hens/ Cage | Grade A (%) | Grade B (%) | Cracks (%) | Loss (%) | Egg Income ($/hen) | Feed Costs ($/hen) |
|---|---|---|---|---|---|---|---|
| Bovans | 6 | 96.1 | 1.5 | 2.3 | 0.0 | 14.25 | 6.01 |
| (Brown) | 7 | 94.7 | 1.8 | 3.4 | 0.0 | 13.39 | 5.90 |
| ISA | 6 | 95.0 | 2.6 | 2.4 | 0.0 | 13.82 | 5.87 |
| (Brown) | 7 | 95.5 | 2.4 | 2.1 | 0.0 | 13.07 | 5.56 |
| H & N | 6 | 95.4 | 2.2 | 2.4 | 0.0 | 13.36 | 5.69 |
| (Brown Nick) | 7 | 94.5 | 2.6 | 2.9 | 0.0 | 12.78 | 5.45 |
| Hy-Line | 6 | 94.8 | 2.1 | 2.9 | 0.1 | 13.68 | 5.88 |
| (Brown) | 7 | 94.5 | 1.7 | 3.8 | 0.0 | 12.98 | 5.83 |
| All Strains | 6 | 95.4 | 2.1 | 2.5 | 0.1 | 13.78[A] | 5.86[A] |
| | 7 | 94.8 | 2.1 | 3.1 | 0.0 | 13.05[B] | 5.69[B] |

A,B - Different letters denote significant differences (P<.01).

TABLE 19. EFFECT OF CAGE SIZE ON PERFORMANCE OF BROWN-EGG STRAINS, 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Cage Length (cm)[1] | Feed Cons. (kg/100 hens/d) | Feed Conver. (g egg/ g feed) | Eggs Per Bird Housed | Egg Production (HD%) | Egg Mass (g/HD) | Mortality (%) | Age at 50% Production (Days) |
|---|---|---|---|---|---|---|---|---|
| Bovans | 61 | 11.9 | .39 | 230.0 | 76.8 | 47.5 | 7.5 | 148 |
| (Brown) | 81 | 12.4 | .42 | 251.2 | 83.6 | 52.2 | 7.4 | 149 |
| ISA | 61 | 11.5 | .41 | 223.7 | 75.6 | 48.0 | 11.4 | 153 |
| (Brown) | 81 | 12.1 | .43 | 246.6 | 82.1 | 52.1 | 7.6 | 150 |
| H & N | 61 | 11.5 | .41 | 219.2 | 74.5 | 48.2 | 11.4 | 152 |
| (Brown Nick) | 81 | 11.8 | .43 | 232.5 | 78.3 | 50.7 | 9.2 | 153 |
| Hy-Line | 61 | 11.7 | .40 | 226.9 | 76.0 | 46.7 | 6.1 | 148 |
| (Brown) | 81 | 12.1 | .40 | 240.9 | 79.3 | 48.7 | 5.1 | 149 |
| All Strains | 61 | $11.7^{B}$ | $.40^{B}$ | $224.9^{B}$ | $75.7^{B}$ | $47.6^{B}$ | 9.1 | 150 |
| | 81 | $12.1^{A}$ | $.42^{A}$ | $242.8^{A}$ | $80.8^{A}$ | $50.9^{A}$ | 7.3 | 150 |

[1]Density was represented by a combination of cage size designated by lengths of 61 or 81 cm and hen population of either 6 or 7.
A,B - Different letters denote significant differences (P<.01).

TABLE 20. EFFECT OF CAGE SIZE ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF BROWN-EGG STRAINS, 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Cage Length (cm)[1] | Egg Weight (g/egg) | Pee Wee (%) | Small (%) | Medium (%) | Large (%) | Extra Large (%) |
|---|---|---|---|---|---|---|---|
| Bovans | 61 | 61.2 | 1.0 | 3.2 | 10.5 | 41.7 | 42.8 |
| (Brown) | 81 | 61.8 | 0.9 | 3.1 | 11.8 | 40.6 | 44.0 |
| ISA | 61 | 62.8 | 1.0 | 3.2 | 10.1 | 33.4 | 51.7 |
| (Brown) | 81 | 62.7 | 1.2 | 2.5 | 11.4 | 34.5 | 50.1 |
| H & N | 61 | 63.9 | 0.5 | 3.4 | 10.2 | 29.5 | 56.8 |
| (Brown Nick) | 81 | 63.9 | 0.7 | 3.0 | 9.8 | 31.8 | 55.8 |
| Hy-Line | 61 | 60.9 | 0.8 | 3.5 | 14.3 | 41.9 | 39.4 |
| (Brown) | 81 | 60.8 | 1.1 | 3.3 | 10.7 | 44.0 | 40.6 |
| All Strains | 61 | 62.2 | 0.8 | 3.3 | 11.3 | 36.6 | 47.7 |
| | 81 | 62.3 | 1.0 | 3.0 | 10.9 | 37.7 | 47.7 |

*There are no significant differences among these means.

TABLE 21. EFFECT OF CAGE SIZE ON EGG QUALITY, INCOME AND FEED COSTS OF BROWN-EGG STRAINS, 31ST NCLP&MT (126-434 DAYS)

| Breeder (Strain) | Cage Length (cm)[1] | Grade A (%) | Grade B (%) | Cracks (%) | Loss (%) | Egg Income ($/hen) | Feed Costs ($/hen) |
|---|---|---|---|---|---|---|---|
| Bovans | 61 | 95.2 | 2.1 | 2.7 | 0.0 | 13.11 | 5.77 |
| (Brown) | 81 | 95.6 | 1.3 | 3.1 | 0.0 | 14.53 | 6.13 |
| ISA | 61 | 95.0 | 2.4 | 2.6 | 0.0 | 12.74 | 5.51 |
| (Brown) | 81 | 95.5 | 2.5 | 1.9 | 0.0 | 14.14 | 5.92 |
| H & N | 61 | 95.2 | 2.2 | 2.6 | 0.0 | 12.65 | 5.49 |
| (Brown Nick) | 81 | 94.8 | 2.6 | 2.6 | 0.0 | 13.49 | 5.65 |
| Hy-Line | 61 | 94.9 | 1.9 | 3.2 | 0.0 | 12.94 | 5.73 |
| (Brown) | 81 | 94.4 | 1.9 | 3.5 | 0.1 | 13.73 | 5.98 |
| All Strains | 61 | 95.0 | 2.2 | 2.8 | 0.0 | 12.86[B] | 5.62[B] |
| | 81 | 95.1 | 2.1 | 2.8 | 0.0 | 13.97[A] | 5.92[A] |

[1]Density was represented by a combination of cage size designated by lengths of 61 or 81 cm and hen population of either 6 or 7.
A,B - Different letters denote significant differences (P<.01).

**Figure 1. Hy-Line "W-36" Strain Bi-weekly Percent Egg Production and Period Feed Consumption kg per 100 Hens**

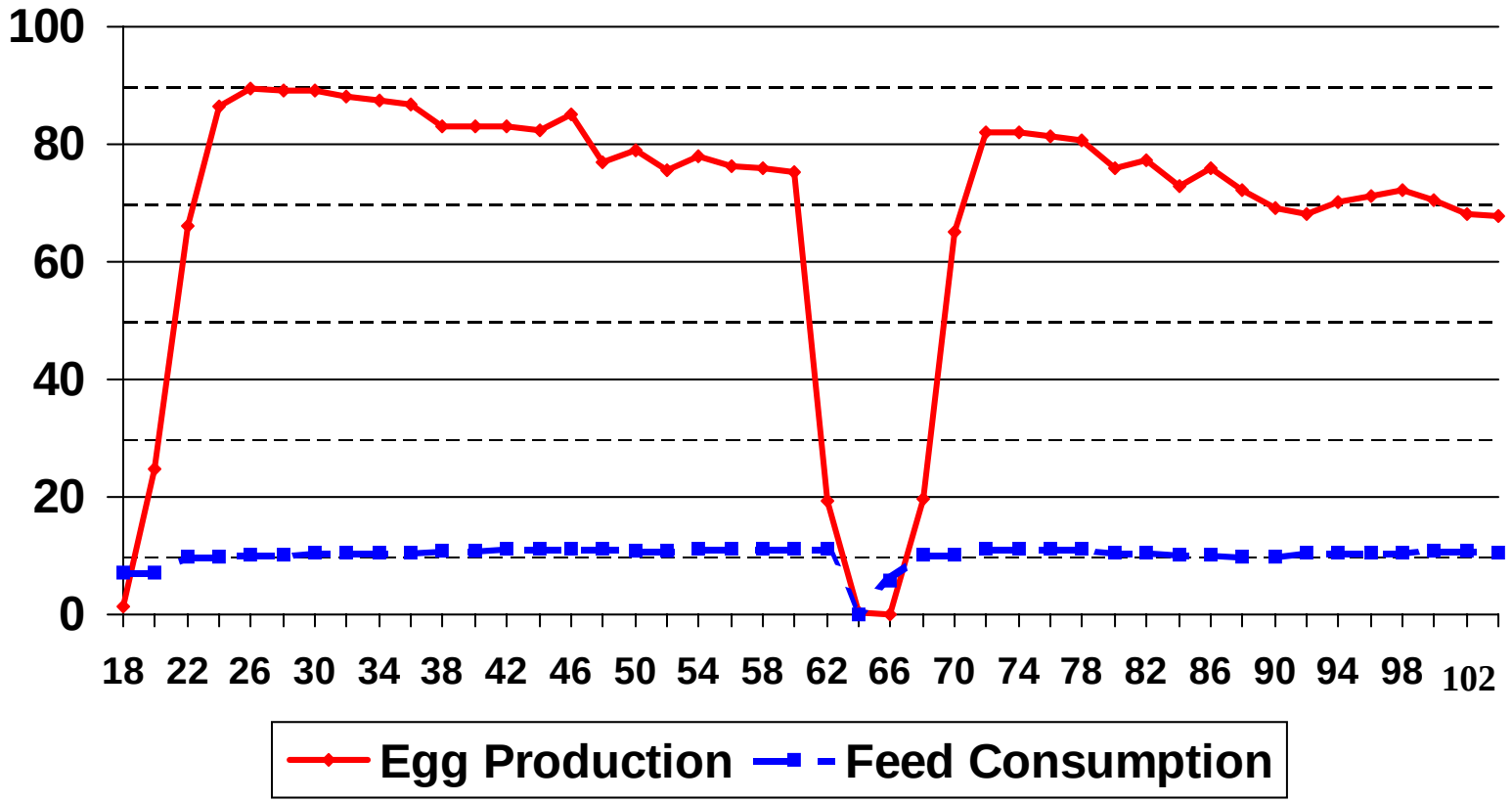


**Figure 2. Hy-Line "W-77" Strain Bi-weekly Percent Egg Production and Period Feed Consumption kg per 100 Hens**

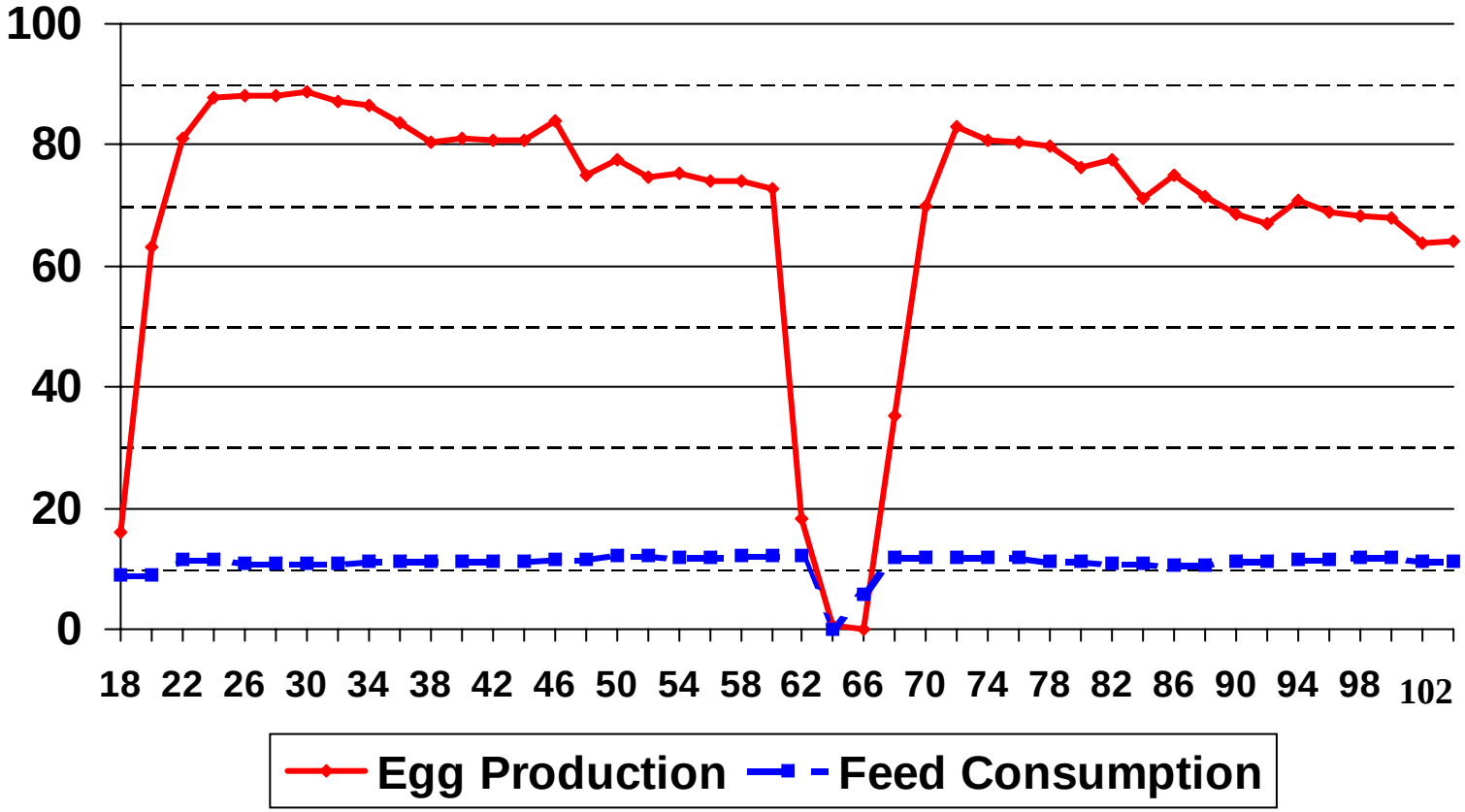


**Figure 3. H & N "Nick Chick" Strain Bi-weekly Percent Egg Production and Period Feed Consumption kg per 100 Hens**

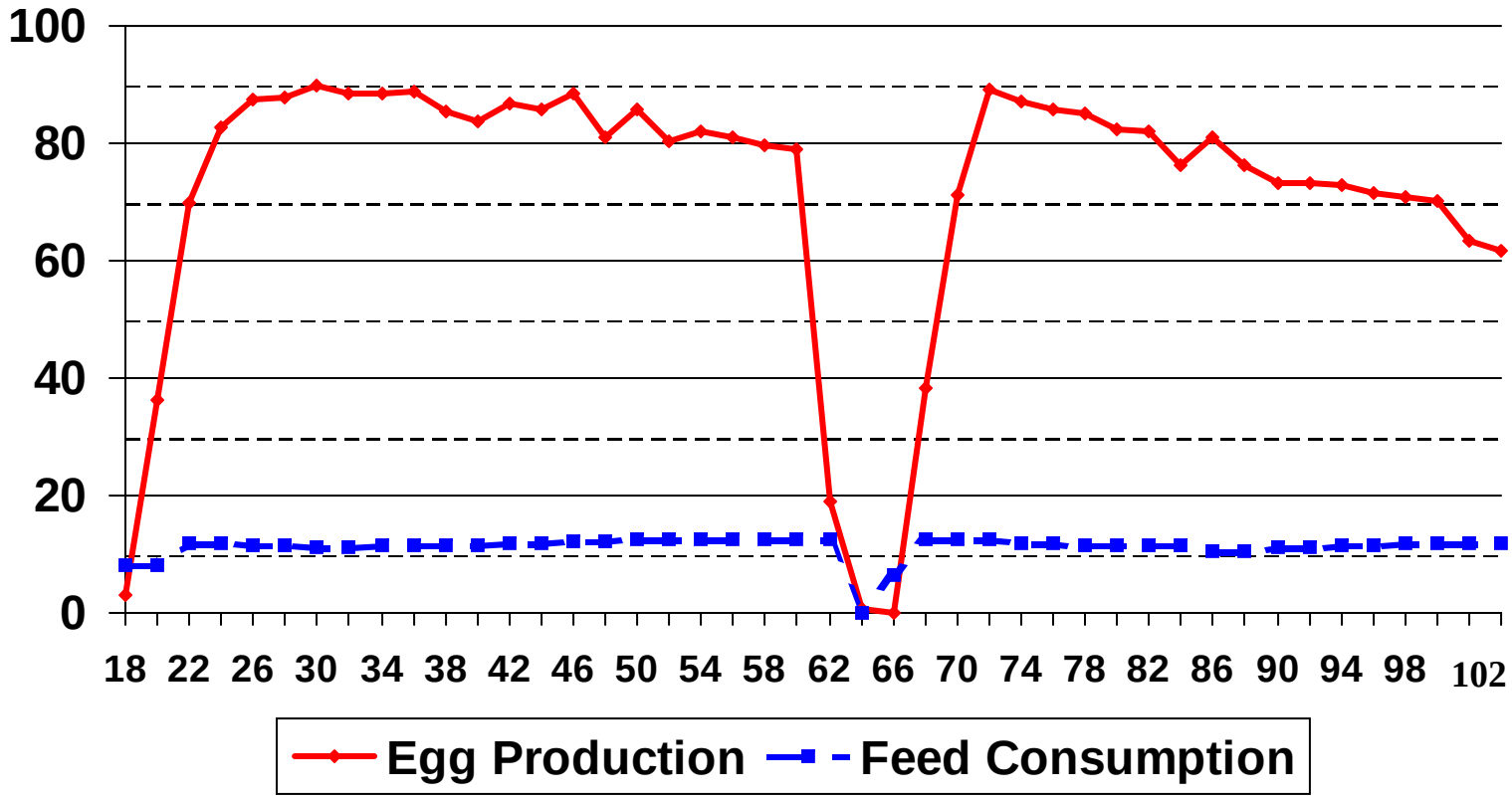


**Figure 4. Bovans "White" Strain Bi-weekly Percent Egg Production and Period Feed Consumption kg per 100 Hens**

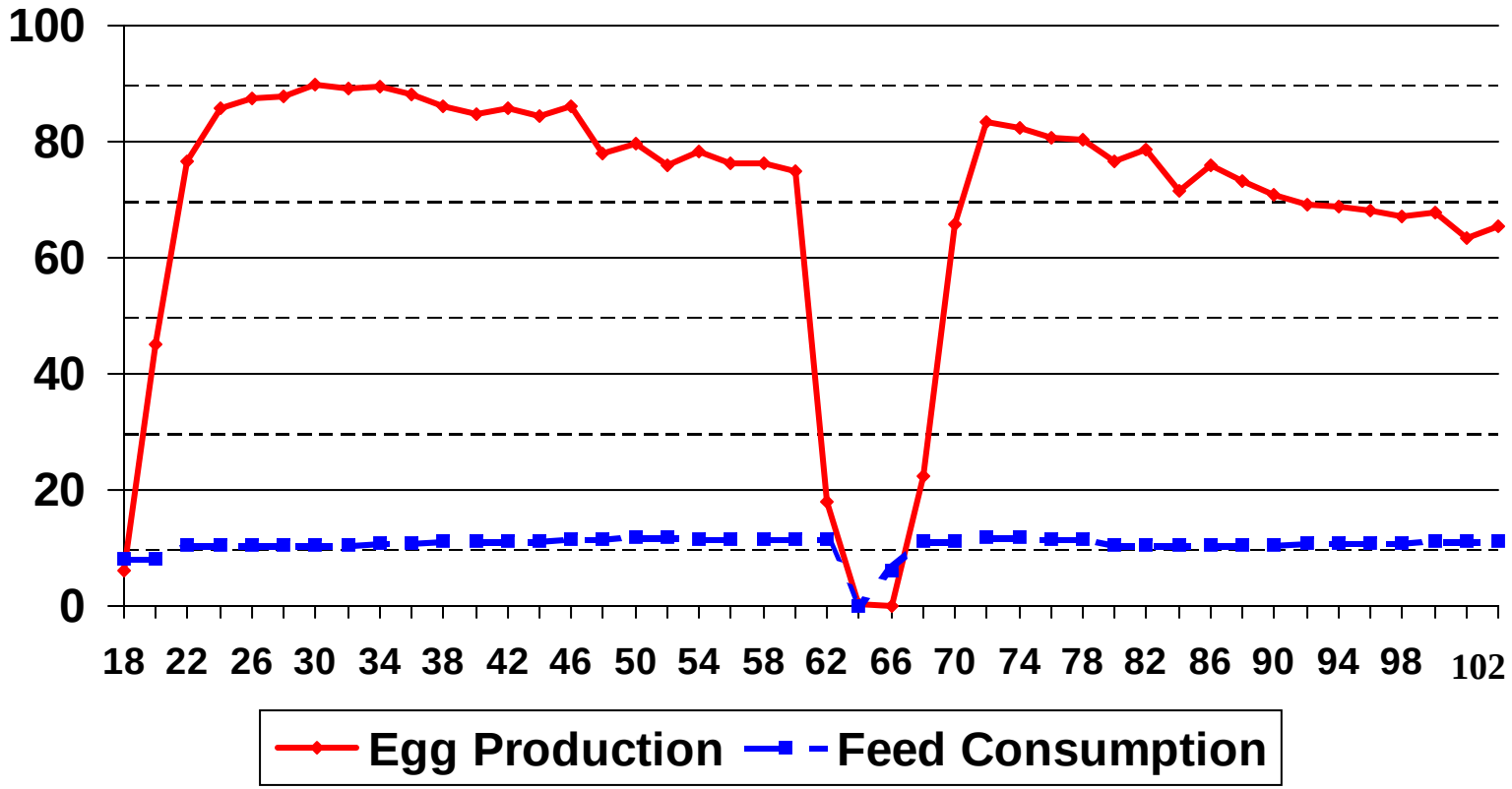


**Figure 5. ISA "Experimental" Strain Bi-weekly Percent Egg Production and Period Feed Consumption kg per 100 Hens**

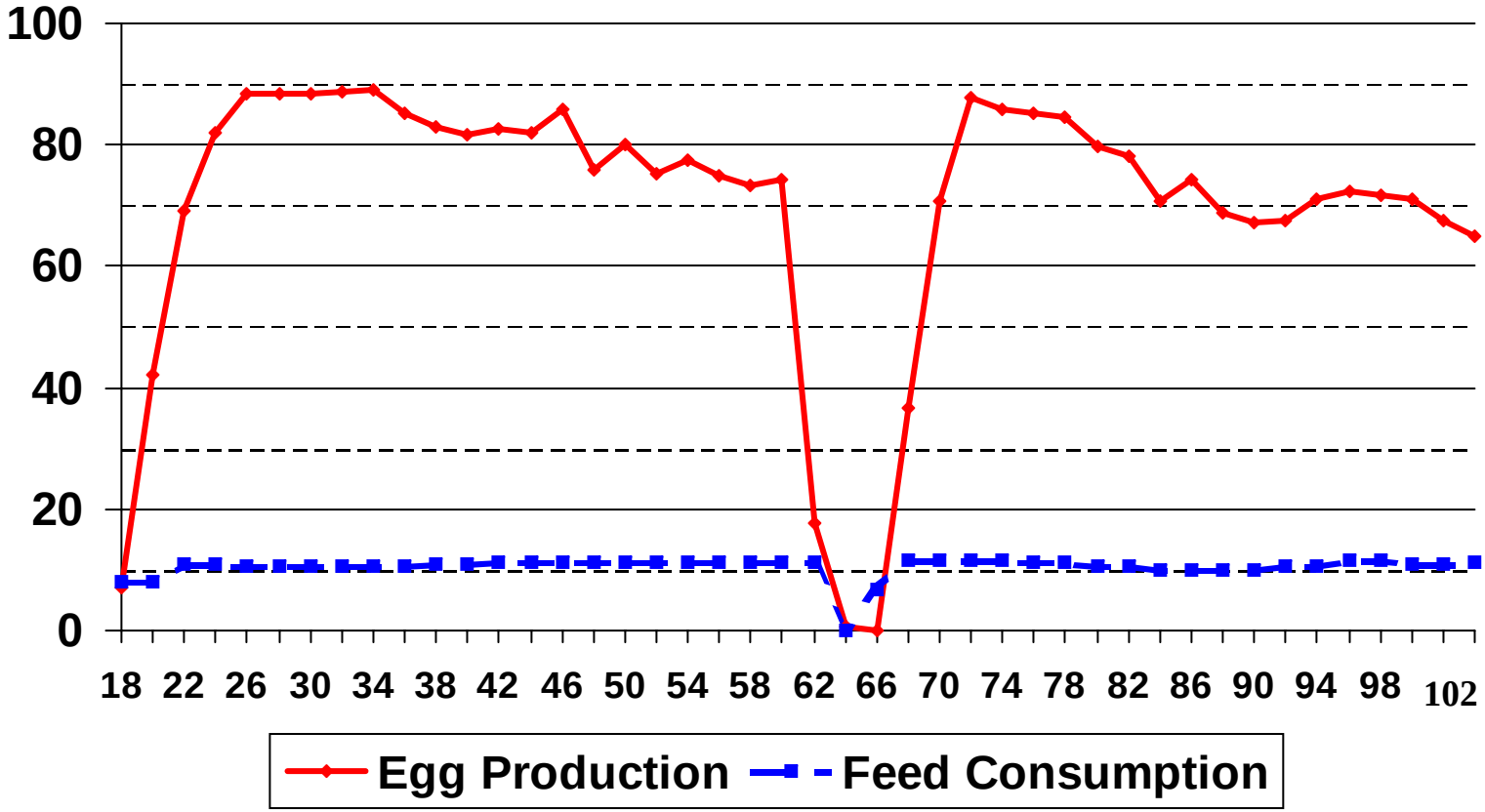


**Figure 6. ISA Babcock "B300" Strain Bi-weekly Percent Egg Production and Period Feed Consumption kg per 100 Hens**

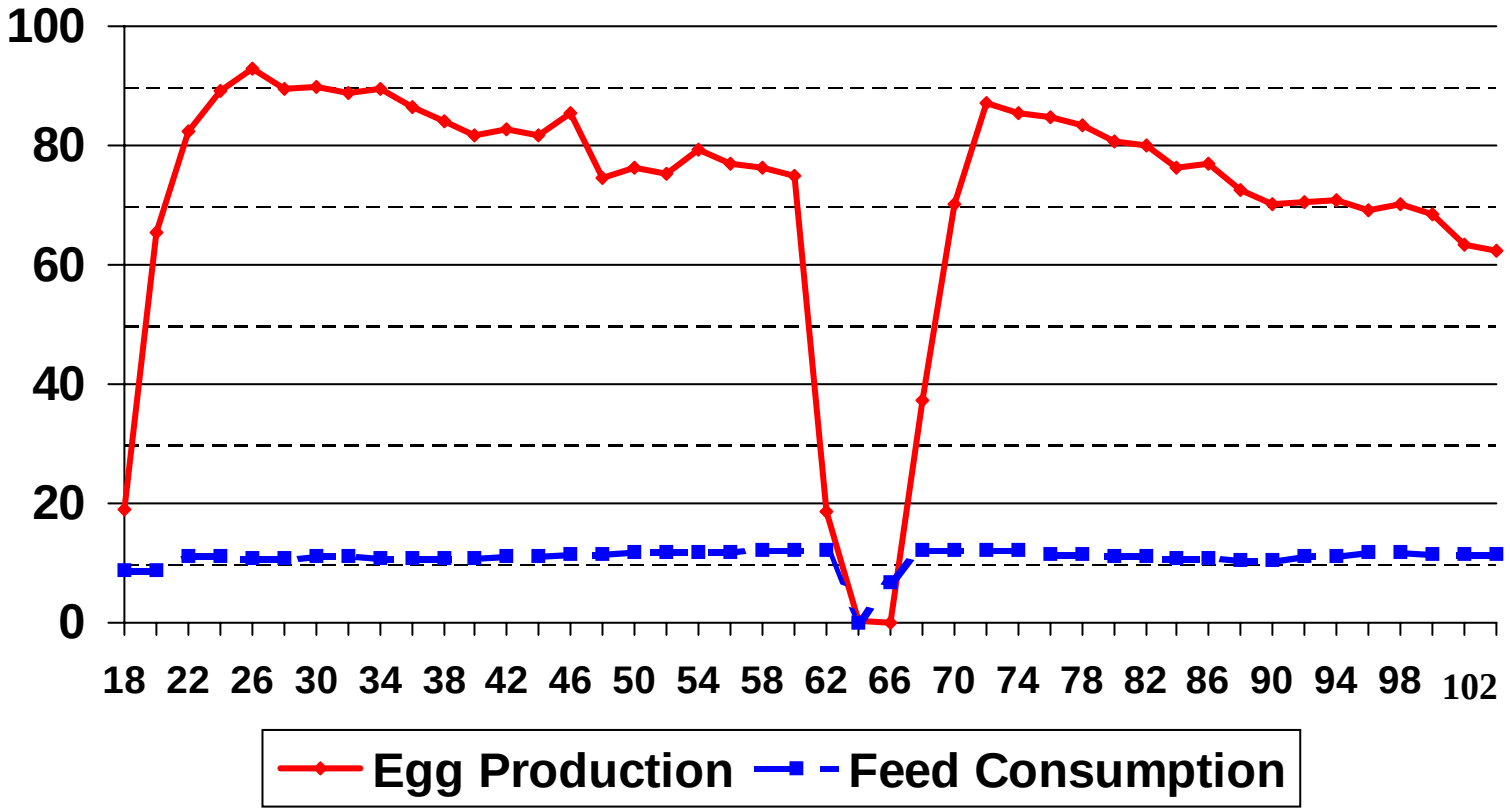


**Figure 7. Shaver "White" Strain Bi-weekly Percent Egg Production and Period Feed Consumption kg per 100 Hens**

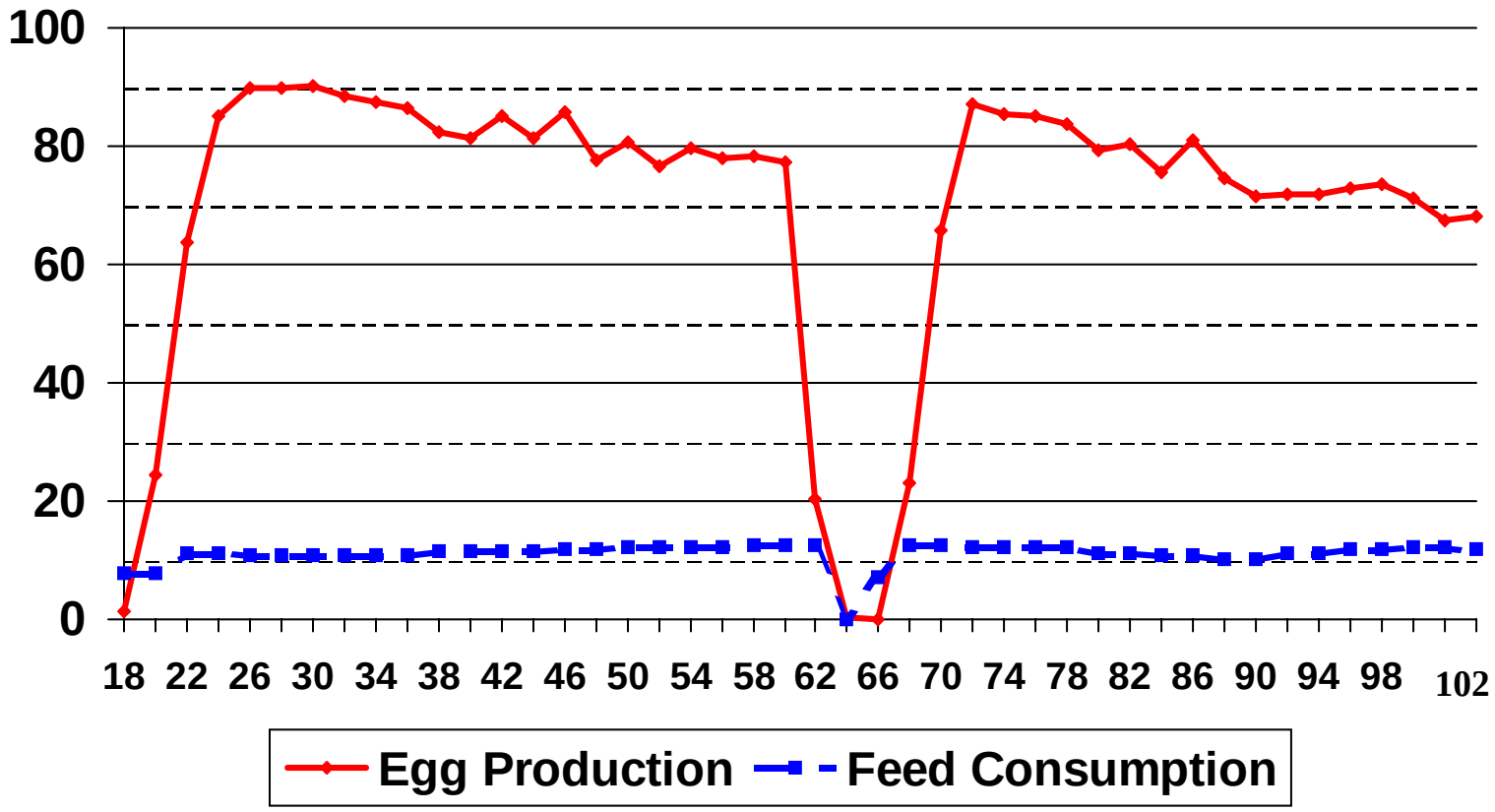


**Figure 8. Shaver "2000" Strain Bi-weekly Percent Egg Production and Period Feed Consumption kg per 100 Hens**

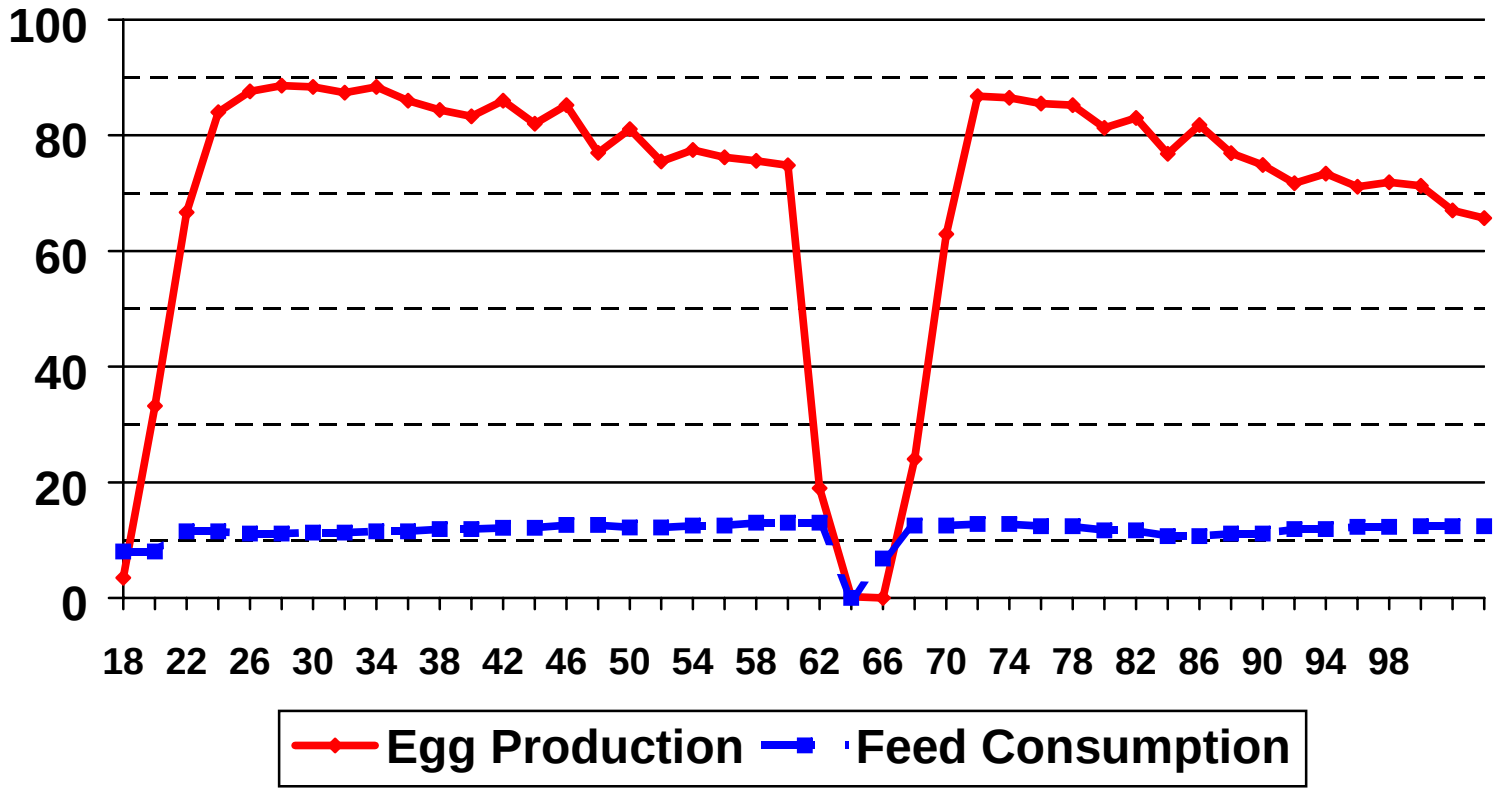


**Figure 9. Dekalb "Delta" Strain Bi-weekly Percent Egg Production and Period Feed Consumption kg per 100 Hens**

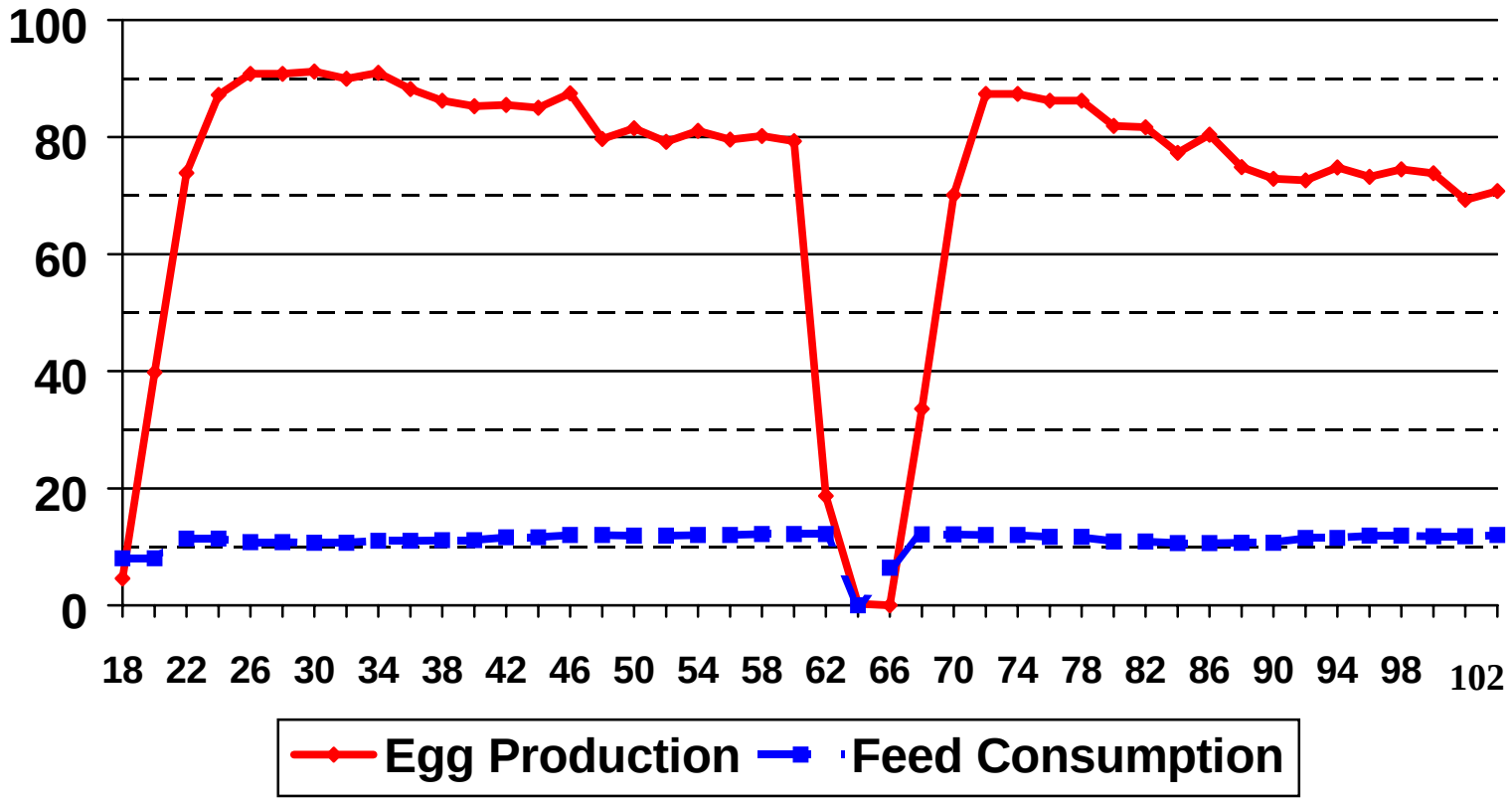


**Figure 10. Hy-Line "Brown" Strain Bi-weekly Percent Egg Production and Period Feed Consumption kg per 100 Hens**

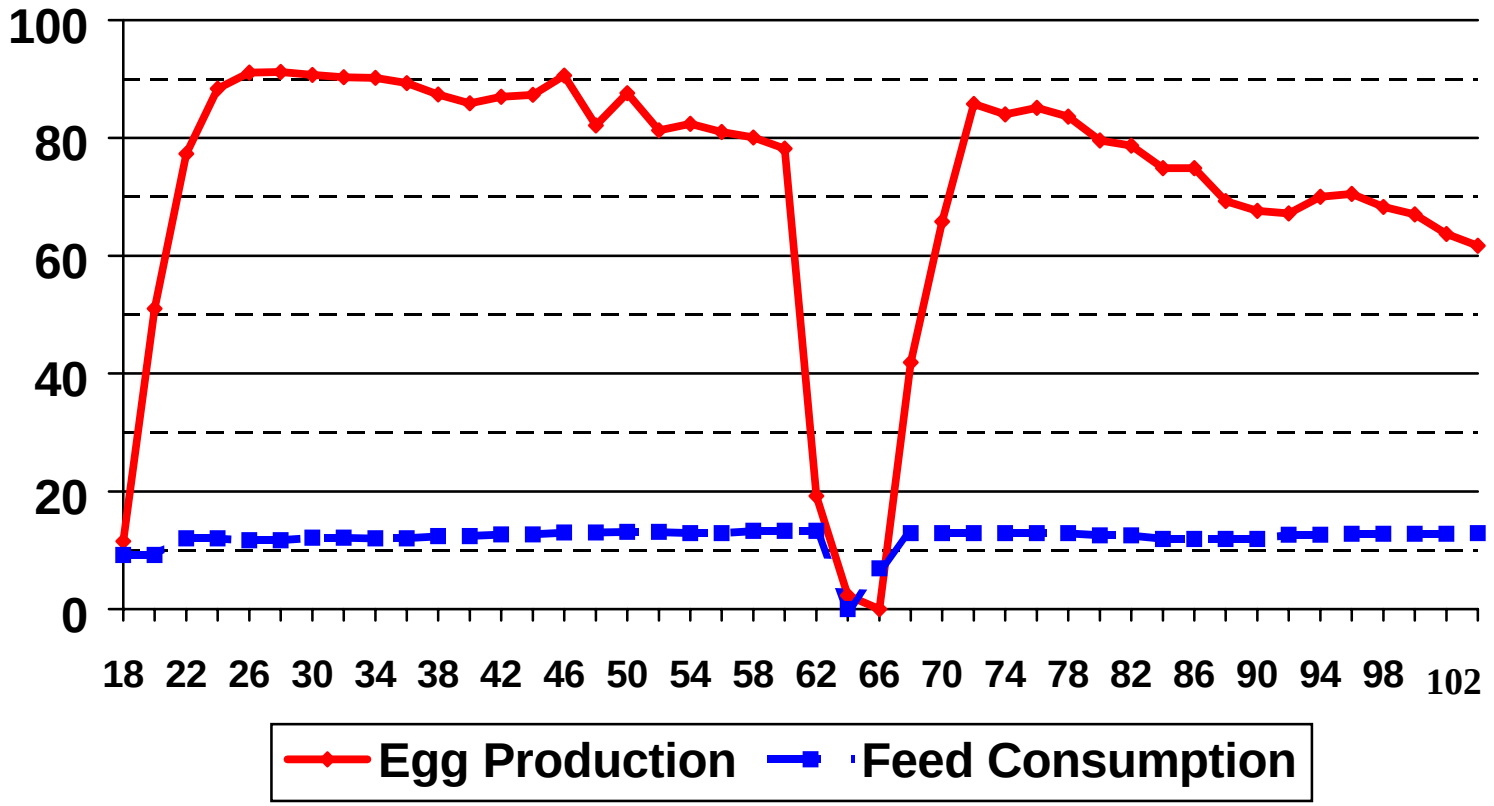


**Figure 11. ISA "Brown" Strain Bi-weekly Percent Egg Production and Period Feed Consumption kg per 100 Hens**

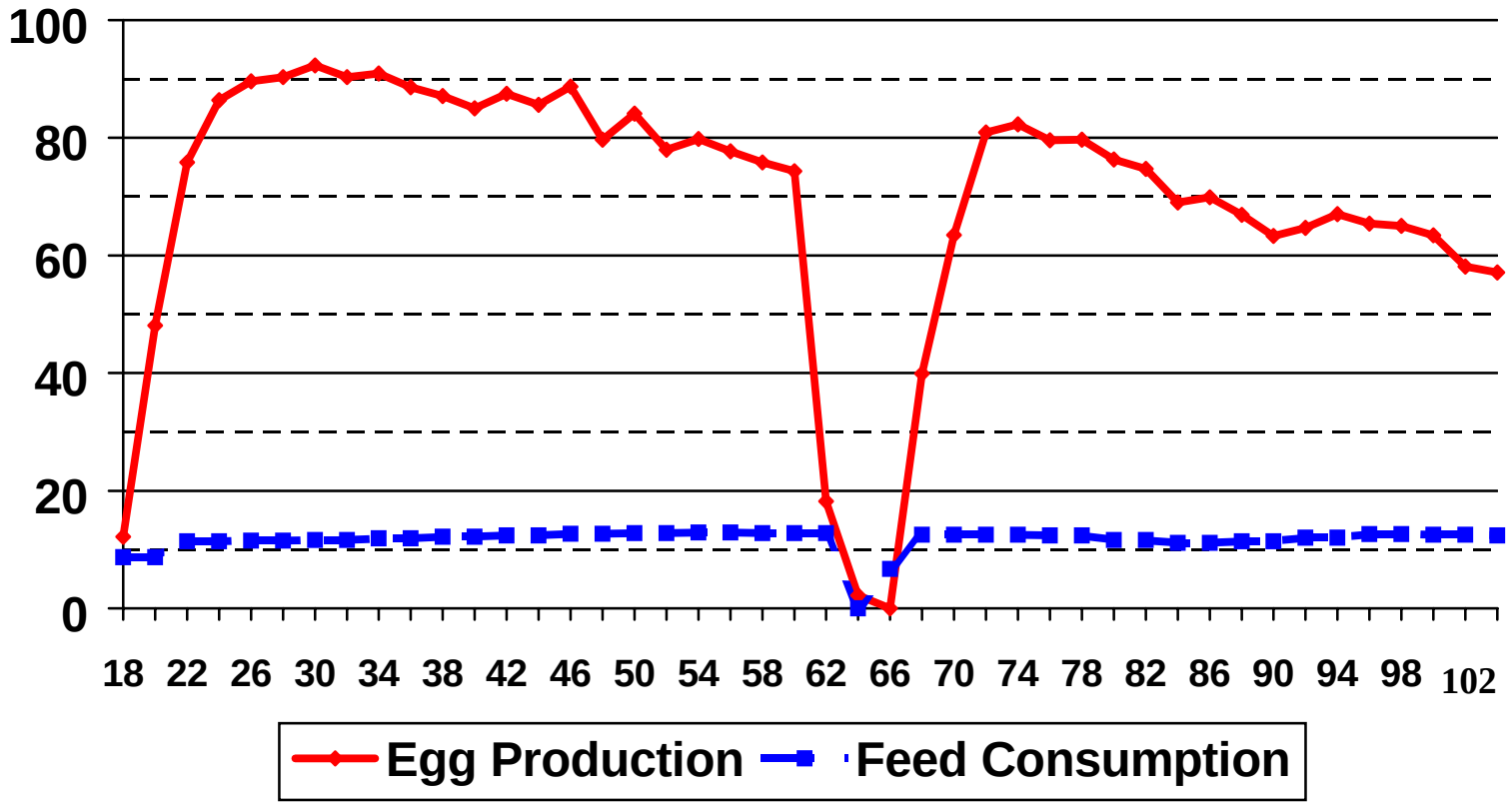


**Figure 12. H & N "Brown Nick" Strain Bi-weekly Percent Egg Production and Period Feed Consumption kg per 100 Hens**

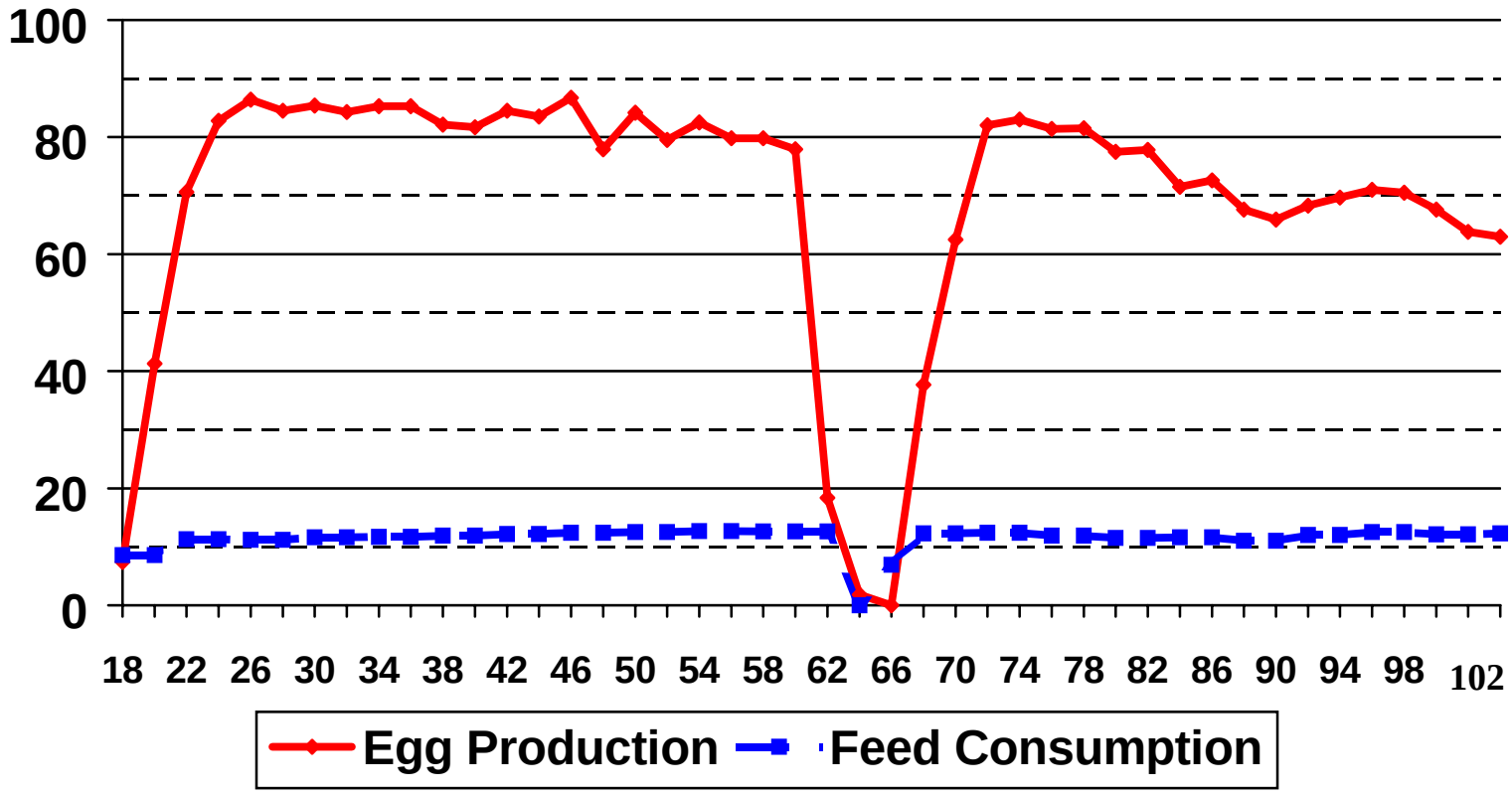


**Figure 13. Bovans "Brown" Strain Bi-weekly Percent Egg Production and Period Feed Consumption kg per 100 Hens**