

**REPORT ON PULLET REARING PERIOD OF THE FOURTY-FIRST  
NORTH CAROLINA LAYER PERFORMANCE AND MANAGEMENT TEST<sup>1</sup>**Vol. 41, No. 1  
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The North Carolina Layer Performance and Management Tests are conducted under the auspices of the North Carolina Layer Performance and Management Program, Cooperative Extension Service at North Carolina State University and the North Carolina Department of Agriculture and Consumer Services. The flock is maintained at the Piedmont Research Station-Poultry Unit, Salisbury, North Carolina. Mr. Robert B. Graham is Piedmont Research Station Superintendent; Mrs. Lisa Wilson is Poultry Unit Manager of the flock; Dr. Ishab Poudel, Research Scholar is Co-PI coordinator of data compilation and statistical analysis; and Dr. K. E. Anderson is Project Leader. The purpose of this program is to assist poultry management teams in evaluation of commercial layer stocks and management systems.

Copies of current and past reports are maintained for public access at  
<https://poultry.ces.ncsu.edu/layer-performance/>

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<sup>1</sup>The use of trade names in this publication does not imply endorsement by the North Carolina Cooperative Extension Service of the products named nor criticism of similar ones not mentioned.

**41<sup>st</sup> NORTH CAROLINA LAYER PERFORMANCE AND  
MANAGEMENT TEST  
Volume 41 No. 1**

**Report on Pullet Rearing Period**

**Current Layer Test Format:**

This layer test protocol was developed such that the chicks were received directly from the breeder’s or egg industry hatcheries at the onset of the grow period. Therefore, the chicks arrived the week of August 22, 2023 and were 16 weeks of age the week of December 12, 2023. For each strain, the final body weights and feed weigh backs collected were at the close of their 16<sup>th</sup> week.

**Dates of Importance:**

Nine entries were accepted or acquired in accordance with the rules and regulations of the test. Six commercial white egg strains and three commercial brown egg strains entered and participated in the current test. Table 1 shows the laying stock (Breeder), the strain entered, and the test environments the breeders selected for each strain (Cage and/or Cage Free).

**Table 1. 41st North Carolina Layer Performance and Management Test Strain Code Assignments**

<b>Strain No.</b>	<b>Breeder</b>	<b>Source Code<sup>1</sup></b>	<b>Strain</b>	<b>Participation<sup>2</sup></b>
1	Hendrix-genetics	BRDR	Shaver	Cage/Cage-free
2	Hendrix-genetics	BRDR	Dekalb	Cage/Cage-free
3	Hendrix-genetics	BRDR	Babcock	Cage/Cage-free
4	Hy-Line Int	IND	W-36	Cage/Cage-free
5	Lohmann	IND	LSL-Lite	Cage/Cage-free
6	TETRA Americana	BRDR	White	Cage/Cage-free
7	Hendrix-genetics	BRDR	Bovans Brown	Cage/Cage-free
8	Hy-Line Int	IND	Hy-Line Brown	Cage/Cage-free
9	TETRA Americana	BRDR	Brown	Cage/Cage-free

<sup>1</sup>Source code indicates that the chicks had extensive distribution in United States and were provided by Egg Industry=IND; or a Breeder Company=BRDR

<sup>2</sup>Participation for each strain in the different components of the tests are indicated as Cage or Cage-free

The chicks were sexed according to their genetics, IR beak trimmed and vaccinated at the hatchery. Upon Arrival (week of August 22, 2023) chicks were wing banded for identification and spray vaccinated for ST before being transferred into House 4 and 8, the brood/grow houses. The rearing phase for the cage reared, and cage-free pullets was complete when the pullets reached 16 weeks of age. They were transitioned into the laying phase during their 17th week of age.

### **Experimental Design:**

The rearing portion of the test was a factorial arrangement where the rearing environments and strain were the main effects. The analyses were conducted were dependent upon the rearing environment (Quad-deck cage system or slat-litter floor pen). Both houses were light and environmentally controlled. The pullets were reared in the same environment they would experience during lay period of production.

**Strain**--Chicks were obtained directly from the breeder company or egg industry hatcheries in accordance with the NCLP&MT rules, which govern the conductance of the test. All chicks were hatched within the week of Aug. 22, 2023, time window.

For the layer test, a maximum of 8,658 chicks were placed in the two rearing environments. White and brown egg pullets/strain were placed at the initiation of the test depending on which rearing environment of the test the strain was in. The chicks were divided as equally as possible between the levels and replicates within the grow house and placement into the layer test was adjusted appropriately.

### **Pullet Housing and Management:**

**Housing:** The chicks were weighed then randomly assigned to the growing replicates with the white egg and brown egg replicates being intermingled throughout the cages in the rooms or pens within the houses. The white egg strains occupied approximately 2/3 of the house and brown egg strains occupied the other 1/3 of rearing cages and floor pen replicates. Individual chicks were identified by strain assignment codes that indicate the cage/pen arrangement, replicate identification numbers, and the strain assignments for each brood-grow Houses 4 and 8. Strain codes are maintained by the PI and Unit Manager for identification of birds and record keeping. Individual birds are identified by a permanent identification tag, which identifies the replicate number, room, row, level, and cage within each house, respectively.

**House 8** - is an environmentally controlled windowless brood/grow facility with 3 banks of quad-deck cages in each of 4 rooms. Each room was assigned a number, each bank assigned a row number, and each cage section within each row and level per row assigned a replicate number. For statistical analysis the room has been designated as a block. This test utilized Rooms 2-4 block consists of six rows using 54 replicates on 3 levels, allowing for a total of 2,808 pullets per room utilized in House 8 for a total of 8,424 pullets. The white and brown egg strains were randomly assigned to the replicates within rooms in the house in a restricted randomized manner so that all strains are approximately equally represented in all rooms, rows, and levels, as described earlier under the experimental design. All chicks were brooded in the same cage during the entire 16 week rearing period. Paper was placed on the cage floor for the first 7 days within each of the replicate series within each row. Each cage within the replicate was filled with 13 white-egg or brown-egg (13 per 24 in x 26 in cage) pullets on the day of hatch for a rearing allowance of 310 cm<sup>2</sup> (48 in<sup>2</sup>) for the white and brown-egg layers.

**House 4** – is an environmentally controlled windowless house modified to accommodate 36 replicates for cage free egg production. The house is set up to include whole house heat capabilities

serving a dual purpose for brood/grow and egg lay production. The house is divided into 36 pens which are 2.43 m x 3.05 m (8.0 ft x 10 ft). Sixty-five chicks were placed in each replicate pen, that provided a minimum of 929 cm<sup>2</sup>, (144 in<sup>2</sup>) per pullet. Pullets were started in each cage free replicate pen with the rearing protocol being as like the cage reared pullets as possible. Feeder and drinker space were designed to meet UEP Guidelines for cage-free facilities. For the cage-free pullets, they were brooded and grown within the same production environment they would experience during the laying phase. They were housed such that all the chicks from one brooding replicate will remain in the pen to minimize social disruption.

### **Pullet Nutrition:**

Pullets were fed *ad libitum* by hand daily throughout the brood grow period. Feed consumption and body weights were monitored bi-weekly beginning at 2 weeks of age. The chicks for each strain were provided Starter feed containing Amprol during the initial brooding period, followed by Grower, Developer diets that are shown in the diet formulation section (Table 2). Thus, the replicates for each strain in brood-grow Houses 4 and 8 were provided feed to achieve the breeder recommended body weights at each weigh interval. Pullets of each strain in each house were transitioned independently to the next rearing diet at the point of achieving target body weight goals or after a prescribed time interval. Expected feed transition intervals were: starter, 0 to 6 weeks; grower 6 to 12 weeks; developer, 12 to 16 weeks; and Pre-lay diet 16 to 17 weeks. The goal for each strain was to meet breeder recommended body weights which dictated rearing diet changes. Generally, in this flock, the birds in the caged rearing environment (House 8) were consistently heavier than the guidelines meaning that the dietary regimens were administered follows. The Starter, Grower, and Developer diets were administered to maintain a growth pattern and target weights as close as possible to the breeder recommendations. The pre-lay diet was provided no later than the last week in the rearing facility.

All mortality were recorded daily, but mortality attributed to the chick quality, removal of males (sex slips) and accidental deaths from a replicate have been excluded from the 41<sup>st</sup> NCLP&MT Grow Report.

### **Pullet Vaccination, and Beak Trimming:**

The chicks arrived at the Piedmont Research Station between August 21 to August 24 from the hatchery. All chicks were beak trimmed at hatch and vaccinated for Mareks and IBD prior to delivery. At the time of arrival after body weights and tagging the chicks were spray vaccinated Live ST – Zoetis Poulvac ST spray. The remaining vaccinations were provided at the Piedmont Research Station at the days post arrival according to schedules that are outlined in Table 3.

**Table 2. Diet Formulations for the Brood-Grow Periods**

Ingredient	Diet <sup>1</sup> Identification			
	Starter	Grower	Developer	Pre-Lay <sup>2</sup>
Corn	1304.2	1363.6	1413.77	822.6
Fat (Lard)	40.0	---	---	154.0
Soybean meal	577.5	554.1	462.82	723.7
D.L. Methionine	3.9	3.02	3.07	7.66
Lysine 78.8%	0.8	---	---	---
Coarse Limestone	---	---	---	135.5
Fine Limestone	22.3	27.88	73.01	90.4
Di-calcium Phosphate	36.8	37.34	32.90	53.20
Salt	5.0	5.0	5.0	5.00
L-Vit. Premix	1.0	1.0	1.0	1.00
Min. premix	4.0	4.0	1.0	4.00
.06% Sel. Premix	1.0	1.0	1.0	1.00
Choline Cl 60%	2.47	2.99	1.5	1.00
Amprol 25 25%	1.0	---	---	---
Santoquin	---	---	---	1.00
Total	2000	2000	2000	2000
Protein %	20.0	18.00	16.00	20.50
ME kcal/kg	2926	2926	2882	2899
Calcium %	1.00	0.95	1.70	5.00
A. Phos. %	0.48	0.45	0.40	0.60
Lysine %	1.10	0.92	0.85	1.11
TSAA %	0.80	0.75	0.70	1.00

<sup>1</sup>Diets were mixed by the NCSU Feed Mill, Raleigh, NC in mash form. Formulated to meet Breeder guidelines by Drs. Poudel and Anderson

<sup>2</sup>This pre-lay diet was fed from 16-17 weeks

**Table 3. Pullet Vaccination and Beak Trimming Schedule for the 41<sup>st</sup> NCLP&MT**

Age	Location	Event
Hatch	Hatchery	Marek's Rispens in combo with IBD-HVT vaccination sub Q by injection in neck
Hatch	Hatchery	Precision Beak Trim <sup>1</sup> all replicates throughout the flock
Delivery	PRS <sup>2</sup>	Live ST – Zoetis Poulvac ST spray
Day 10	PRS <sup>2</sup>	1 <sup>st</sup> Newcastle (B1) and Bronchitis (Mass.) vaccination Via aerosol spray (Triple Vac)
Day 15	PRS <sup>2</sup>	Live ST – LAH Megan Egg spray
Day 35	PRS <sup>2</sup>	2nd Newcastle (LaSota) and Bronchitis (Mass.) vaccination via aerosol spray (ComboVac) Ark
Day 70	PRS <sup>2</sup>	3th Newcastle (LaSota) and Bronchitis (Mass. Ark)) vaccination via aerosol spray (ComboVac)
Day 90	PRS <sup>2</sup>	Fowl Pox and Avian Encephalomyelitis vaccination via the wig web
Day 90	PRS <sup>2</sup>	LAH Killed ND-IB-SE Breast Muscle
Day 105	PRS <sup>2</sup>	4th Newcastle (Lasota) and Bronchitis (Mass. Ark) vaccination via aerosol spray (ComboVac)

<sup>1</sup> Beak trimming was performed using the Infrared (IR) method at the Hatcheries.

<sup>2</sup> PRS - Piedmont Research Station-Poultry Unit

### **Lighting Schedule**

The pullet lighting schedule for the controlled environment facilities, cage and cage-free are outlined in Table 4.

**Table 4. Pullet lighting schedule for the controlled environment facilities, cage, and cage free in Houses 4 & 8**

Age <sup>1</sup>	Light Intensity <sup>2</sup>	Photoperiod (hr)
Days 1-2	10 ftc. (100 lux)	24
Day 3	1 ftc. (10 lux)	23
Day 7	1 to 0.5 flc. (10 to 5 lux)	22
Day 14	1 to 0.5 flc. (10 to 5 lux)	20
Day 17	1 to 0.5 flc. (10 to 5 lux)	18
Day 20	1 to 0.5 flc. (10 to 5 lux)	16
Day 23	1 to 0.5 flc. (10 to 5 lux)	14
Day 26	1 to 0.5 flc. (10 to 5 lux)	12
Week 4 through	1 to 0.5 flc. (10 to 5 lux)	10
Week 12	1 to 0.5 flc. (10 to 5 lux)	10
Week 13 – 16	1 to 0.5 flc. (10 to 5 lux)	10
Housing of Pullets	Working Intensity	10

<sup>1</sup> Lighting program was initiated when all chicks had arrived and were housed

**FDA Egg Safety Plan Testing:**

In accordance with the California Compliance and Egg Safety Rule and the NCLP&MT Egg Safety Plan the chick delivery papers and the cage, and cage-free pullet environments were tested between the ages of 14 and 16 weeks for the presence of *Salmonella* Enteritidis. All of the environments were found to be negative for *Salmonella* Enteritidis.

**Description of Data Table Statistics:**

Rearing period performance of white egg strains grown in cage (Houses 8) and cage-free (House 4) systems are shown in Tables 5-7 and 8-10, respectively. Data for the Brown egg strains grown in cage (Houses 8) and cage-free (House 4) systems are shown in Tables 11-13 and 14-16, respectively. Following are the descriptions of the observations taken throughout the rearing period. Data presented in this report will be in metric.

**Breeder (Strain):**

Short identification of the breeder and strain of the stock and the donors for each strain are shown Table 1.

**Protein per Bird to 112 Days:**

Cumulative protein intake per bird through 112 days was based on calculated values.

**Metabolizable Energy per Bird to 112 Days:**

Cumulative metabolizable energy intake per bird through 112 days was based upon calculated values.

**Lysine intake per Bird to 112 Days:**

Cumulative Lysine intake per bird through 112 days was based on calculated values.

**Total Sulfur Amino Acids (TSAA) intake per Bird to 112 Days:**

Cumulative TSAA intake per bird through 112 days was based on calculated values.

**Feed Cost per Bird to 112 Days:**

Calculated feed cost per bird to 112 days. To calculate the feed cost per pullet the average feed prices on a per ton basis for the rearing period were used.

Starter	\$569.80 /Ton
Grower	\$476.92 /Ton
Developer	\$411.82 /Ton

### **Livability 1-112 Days:**

The percentage of the birds housed which survived during days 1-112. At delivery and during housing all chicks were inspected, and weak chicks were removed. Males and accidental deaths were removed and are excluded from the analysis of livability in the first days post-housing.

### **Flock Uniformity at 112 Days:**

The percentage of the pullets with body weights falling within  $\pm 10\%$  of the mean body weight at 112 days of age. This was based on the individual body weight from a sample of 100 pullets from replicates representing each strain and environment. In the cage-free house 25 pullets from each of the 4 pens representing each strain composed the 100 individual weights.

### **Body Weights (0, 2, 4, 6, 8....16 Weeks):**

Initial body weights were taken at time of placement in the brood/grow houses 4 and 4. Thereafter, bi-weekly average body weights of all birds within representative cages and pens were collected. Sample sizes for these were approximately 60 birds/strain/brood-grow house. Cages and pens selected were, as much as possible, a representative sample from all house locations and strains.

### **Feed Consumption (1-2, 3-4, 5-6....16, 1-16 Weeks):**

Feed consumption per bird within the time periods indicated. The last column in the table is the cumulative feed intake per bird throughout the growing period. Estimated feed consumed is calculated using pullet days which compensates for males removed from the flock at any time. Feed consumption weights were tabulated on a bi-weekly basis after remaining feed was weighed back at the end of each period in houses 4 and 8. The final feed weight was taken at the 16th week based on the strains hatch date provided at the time of delivery.

### **Flock Mortality:**

Livability and flock uniformity was calculated at 16 weeks of age. Significant differences ( $P < 0.01$ ) within white and brown egg strains are noted by different letters among column of means. Mortalities for cage and cage-free production were transported to the lab for necropsy to potentially identify potential cause of death. Necropsy results are shown in Figure 1.

### **Statistical Analyses and Separation of Means:**

Data was analyzed using the GLM procedure of SAS 9.4 Institute (2013)<sup>2</sup>. Separate analyses were conducted for white and brown egg strains in each environment. Body weight and feed intake were analyzed bi-weekly. The cumulative sums of feed intake, protein consumption, lysine, methionine, total sulfur amino acid and feed cost were done for the entire 16 week period.

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<sup>2</sup>SAS Institute Inc. 2013. SAS 9.4, Cary, NC: SAS Institute Inc., 2013. Web page <http://www.sas.com/presscenter/guidelines.html>



### Metric Conversions

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English to Metric	Metric to English
1 lb = 453.6 g	1 g = .03527 oz
1 lb = .4536 kg	1 kg = 2.204 lb
1 oz = 28.35 g	1 g = 1000 mg
	1 kg = 1000 g
1 in = 2.54 cm	1 m = 39.4 in = 3.28 ft
1 in <sup>2</sup> = 6.45 cm <sup>2</sup>	

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**Table 5. Bi-weekly Body Weights of White-Egg Entries, 41<sup>st</sup> NCLP&MT, Cage-reared**

Breed Strain	------(Weeks of Age)-----								
	0	2	4	6	8	10	12	14	16
	------(kg)-----								
Babcock	0.03	0.12 <sup>A</sup>	0.27 <sup>A</sup>	0.47 <sup>A</sup>	0.71 <sup>A</sup>	0.90 <sup>A</sup>	1.10 <sup>A</sup>	1.17 <sup>A</sup>	1.29 <sup>A</sup>
Dekalb	0.03	0.11 <sup>B</sup>	0.25 <sup>B</sup>	0.44 <sup>B</sup>	0.67 <sup>BC</sup>	0.85 <sup>B</sup>	1.03 <sup>B</sup>	1.13 <sup>B</sup>	1.23 <sup>B</sup>
LSL-Lite	0.03	0.11 <sup>B</sup>	0.25 <sup>B</sup>	0.45 <sup>B</sup>	0.66 <sup>C</sup>	0.84 <sup>C</sup>	1.02 <sup>BC</sup>	1.12 <sup>B</sup>	1.21 <sup>B</sup>
Shaver	0.04	0.11 <sup>AB</sup>	0.26 <sup>B</sup>	0.46 <sup>AB</sup>	0.69 <sup>AB</sup>	0.87 <sup>AB</sup>	1.05 <sup>B</sup>	1.12 <sup>B</sup>	1.23 <sup>B</sup>
Tetra-White	0.03	0.12 <sup>A</sup>	0.27 <sup>A</sup>	0.45 <sup>B</sup>	0.68 <sup>BC</sup>	0.86 <sup>BC</sup>	1.02 <sup>B</sup>	1.12 <sup>B</sup>	1.21 <sup>B</sup>
Hy-Line W-36	0.04	0.10 <sup>C</sup>	0.22 <sup>C</sup>	0.40 <sup>C</sup>	0.61 <sup>D</sup>	0.79 <sup>C</sup>	0.99 <sup>C</sup>	1.09 <sup>C</sup>	1.22 <sup>B</sup>
Average	0.03	0.11	0.25	0.44	0.67	0.85	1.04	1.12	1.23

<sup>ABCD</sup> Denotes significant differences between strains (P<0.01)

**Table 6. Bi-weekly Feed Consumption of White-Egg Entries, 41<sup>st</sup> NCLP&MT, Cage-reared**

Breed Strain	------(Weeks of Age)-----								Total Cons. g
	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	
	------(g/bird per day)-----								
Babcock	11.35 <sup>B</sup>	22.47 <sup>A</sup>	38.11 <sup>A</sup>	51.61 <sup>A</sup>	53.27 <sup>A</sup>	59.18 <sup>A</sup>	64.06 <sup>A</sup>	63.78 <sup>B</sup>	5046 <sup>A</sup>
Dekalb	10.53 <sup>CD</sup>	19.85 <sup>C</sup>	36.58 <sup>B</sup>	50.05 <sup>BC</sup>	53.72 <sup>AB</sup>	57.51 <sup>ABC</sup>	62.52 <sup>ABC</sup>	62.02 <sup>BC</sup>	4939 <sup>AB</sup>
LSL-Lite	10.11 <sup>D</sup>	20.37 <sup>BC</sup>	36.27 <sup>B</sup>	49.21 <sup>C</sup>	52.85 <sup>AB</sup>	57.22 <sup>BC</sup>	61.02 <sup>BC</sup>	61.06 <sup>C</sup>	4878 <sup>B</sup>
Shaver	10.88 <sup>BC</sup>	20.97 <sup>ABC</sup>	36.88 <sup>B</sup>	50.59 <sup>AB</sup>	49.96 <sup>AB</sup>	58.99 <sup>AB</sup>	62.93 <sup>AB</sup>	64.02 <sup>B</sup>	4965 <sup>AB</sup>
Tetra-White	14.31 <sup>A</sup>	21.87 <sup>AB</sup>	37.31 <sup>AB</sup>	50.73 <sup>AB</sup>	52.39 <sup>B</sup>	57.21 <sup>BC</sup>	61.24 <sup>BC</sup>	57.82 <sup>D</sup>	4940 <sup>AB</sup>
Hy-Line W-36	9.27 <sup>E</sup>	19.31 <sup>C</sup>	33.30 <sup>C</sup>	47.46 <sup>D</sup>	51.23 <sup>C</sup>	54.15 <sup>C</sup>	60.55 <sup>C</sup>	71.28 <sup>A</sup>	4836 <sup>B</sup>
Average	11.10	20.81	36.39	49.88	52.28	57.38	62.05	63.32	4934

<sup>ABCDE</sup> Denotes significant differences between strains (P<0.01)

<sup>1</sup>Cummulative feed intake from 1 to 16 weeks of age

**Table 7. Total Nutrient Intake, Feed Cost, Livability, and Flock Uniformity of White-Egg Entries, 41<sup>st</sup> NCLP&MT, Cage-reared**

Breed Strain	Protein	Met.	Lysine	TSAA	Feed Cost	Livability (1-112 d)	Flock Uniformity (% of pullets within $\pm 10\%$ of $x$ )
	Energy						
	------(per bird to 112 days)-----						
	(g)	(kcal)	(g)	(g)	(\$)	(%)	
Babcock	873 <sup>A</sup>	14,506 <sup>A</sup>	48.24 <sup>A</sup>	37.10 <sup>A</sup>	2.34 <sup>A</sup>	99.42	92.2 <sup>A</sup>
Dekalb	845 <sup>BC</sup>	14,064 <sup>B</sup>	46.70 <sup>BC</sup>	35.93 <sup>BC</sup>	2.29 <sup>AB</sup>	99.28	92.8 <sup>A</sup>
LSL-Lite	835 <sup>BC</sup>	13,890 <sup>B</sup>	46.13 <sup>BC</sup>	35.49 <sup>BC</sup>	2.26 <sup>B</sup>	98.85	90.0 <sup>A</sup>
Shaver	852 <sup>AB</sup>	14,156 <sup>AB</sup>	47.07 <sup>AB</sup>	36.20 <sup>AB</sup>	2.30 <sup>AB</sup>	98.41	95.0 <sup>A</sup>
Tetra-White	849 <sup>B</sup>	14,078 <sup>B</sup>	46.96 <sup>B</sup>	36.09 <sup>BC</sup>	2.30 <sup>AB</sup>	98.71	76.7 <sup>B</sup>
Hy-Line W-36	826 <sup>C</sup>	13,793 <sup>B</sup>	45.59 <sup>C</sup>	35.14 <sup>C</sup>	2.23 <sup>B</sup>	97.98	88.3 <sup>A</sup>
Average	847	14,081	46.78	35.99	2.29	98.78	89.2

<sup>ABCD</sup> Denotes significant differences between strains (P<0.01)

**Table 8. Bi-weekly Body Weights of White-Egg Entries, 41<sup>st</sup> NCLP&MT, Cage-free reared**

Breed Strain	------(Weeks of Age)-----								
	0	2	4	6	8	10	12	14	16
	------(kg)-----								
Babcock	0.03	0.11 <sup>A</sup>	0.23 <sup>BC</sup>	0.43 <sup>A</sup>	0.67 <sup>A</sup>	0.87 <sup>A</sup>	1.01 <sup>A</sup>	1.12 <sup>A</sup>	1.23 <sup>A</sup>
Dekalb	0.03	0.10 <sup>B</sup>	0.23 <sup>BC</sup>	0.43 <sup>A</sup>	0.63 <sup>A</sup>	0.81 <sup>AB</sup>	0.99 <sup>AB</sup>	1.10 <sup>AB</sup>	1.19 <sup>B</sup>
LSL-Lite	0.03	0.10 <sup>B</sup>	0.23 <sup>BC</sup>	0.43 <sup>A</sup>	0.64 <sup>A</sup>	0.82 <sup>AB</sup>	0.98 <sup>AB</sup>	1.07 <sup>AB</sup>	1.17 <sup>B</sup>
Shaver	0.04	0.10 <sup>B</sup>	0.25 <sup>AB</sup>	0.44 <sup>A</sup>	0.67 <sup>A</sup>	0.82 <sup>AB</sup>	0.99 <sup>AB</sup>	1.09 <sup>AB</sup>	1.18 <sup>B</sup>
Tetra-White	0.03	0.12 <sup>A</sup>	0.26 <sup>A</sup>	0.45 <sup>A</sup>	0.66 <sup>A</sup>	0.84 <sup>A</sup>	0.98 <sup>AB</sup>	1.09 <sup>AB</sup>	1.18 <sup>B</sup>
Hy-Line W-36	0.04	0.10 <sup>B</sup>	0.21 <sup>C</sup>	0.38 <sup>B</sup>	0.57 <sup>B</sup>	0.76 <sup>B</sup>	0.92 <sup>B</sup>	1.06 <sup>B</sup>	1.15 <sup>B</sup>
Average	0.03	0.10	0.23	0.43	0.64	0.82	0.98	1.09	1.18

<sup>ABCD</sup> Denotes significant differences between strains (P<0.01)

**Table 9. Bi-weekly Feed Consumption of White-Egg Entries, 41<sup>st</sup> NCLP&MT, Cage-free reared**

Breed Strain	------(Weeks of Age)-----								Total Cons. g
	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	
	----- (g/bird per day) -----								
Babcock	15.21 <sup>AB</sup>	58.66 <sup>AB</sup>	31.96 <sup>AB</sup>	46.97 <sup>A</sup>	50.49 <sup>A</sup>	61.79	54.93 <sup>AB</sup>	58.35 <sup>B</sup>	5297
Dekalb	14.66 <sup>AB</sup>	49.86 <sup>BC</sup>	33.87 <sup>A</sup>	47.04 <sup>A</sup>	49.99 <sup>A</sup>	61.36	56.68 <sup>A</sup>	56.82 <sup>BC</sup>	5184
LSL-Lite	12.36 <sup>BC</sup>	46.46 <sup>C</sup>	32.97 <sup>A</sup>	46.11 <sup>A</sup>	48.63 <sup>A</sup>	59.00	55.17 <sup>AB</sup>	55.12 <sup>BC</sup>	4981
Shaver	14.15 <sup>AB</sup>	61.54 <sup>A</sup>	35.16 <sup>A</sup>	47.68 <sup>A</sup>	49.82 <sup>AB</sup>	61.86	54.13 <sup>AB</sup>	58.68 <sup>B</sup>	5362
Tetra-White	16.42 <sup>A</sup>	51.28 <sup>BC</sup>	33.87 <sup>A</sup>	47.36 <sup>A</sup>	49.98 <sup>A</sup>	59.87	54.09 <sup>AB</sup>	53.49 <sup>C</sup>	5129
Hy-Line W-36	10.92 <sup>C</sup>	47.20 <sup>C</sup>	28.99 <sup>B</sup>	41.80 <sup>B</sup>	46.50 <sup>B</sup>	58.60	52.38 <sup>B</sup>	64.16 <sup>A</sup>	4908
Average	13.95	52.50	32.80	46.16	49.24	60.41	54.56	57.77	5143

<sup>ABC</sup> Denotes significant differences between strains (P<0.01)

<sup>1</sup>Cummulative feed intake from 1 to 16 weeks of age.

**Table 10. Total Nutrient Intake, Feed Cost, Livability, and Flock Uniformity of White-Egg Entries, 41<sup>st</sup> NCLP&MT, Cage-free reared**

Breed Strain	Protein	Met.	Lysine	TSAA	Feed Cost	Livability (1-112 d)	Flock Uniformity (% of pullets within ±10% of x)
	Energy						
	------(per bird to 112 days)-----						
	(g)	(kcal)	(g)	(g)	(%)	(%)	
Babcock	924 <sup>AB</sup>	15,130 <sup>AB</sup>	52.06 <sup>AB</sup>	39.33 <sup>AB</sup>	2.28 <sup>A</sup>	99.25	91.0 <sup>A</sup>
Dekalb	901 <sup>B</sup>	14,798 <sup>B</sup>	50.77 <sup>B</sup>	38.33 <sup>B</sup>	2.23 <sup>AB</sup>	99.25	94.0 <sup>A</sup>
LSL-Lite	864 <sup>CD</sup>	14,216 <sup>CD</sup>	48.69 <sup>CD</sup>	36.77 <sup>CD</sup>	2.12 <sup>BC</sup>	98.50	93.0 <sup>A</sup>
Shaver	936 <sup>A</sup>	15,319 <sup>A</sup>	52.82 <sup>A</sup>	39.85 <sup>A</sup>	2.32 <sup>A</sup>	100.00	92.0 <sup>A</sup>
Tetra-White	894 <sup>BC</sup>	14,648 <sup>BC</sup>	50.42 <sup>BC</sup>	38.04 <sup>BC</sup>	2.16 <sup>BC</sup>	96.95	70.0 <sup>B</sup>
Hy-Line W-36	849 <sup>D</sup>	14,000 <sup>D</sup>	47.72 <sup>D</sup>	36.16 <sup>D</sup>	2.06 <sup>C</sup>	97.35	90.0 <sup>A</sup>
Average	895	14,685	50.41	38.08	2.19	98.55	88.3

<sup>ABC</sup> Denotes significant differences between strains (P<0.01)

**Table 11. Bi-weekly Body Weights of Brown-Egg Entries, 41<sup>st</sup> NCLP&MT, Cage-reared**

Breeder	-----(Weeks of Age)-----								
	0	2	4	6	8	10	12	14	16
	-----(kg)-----								
Hy-Line-Brown	0.03	0.09 <sup>C</sup>	0.23	0.45 <sup>B</sup>	0.72 <sup>C</sup>	0.96 <sup>B</sup>	1.19	1.31 <sup>A</sup>	1.47 <sup>A</sup>
Tetra-Brown	0.03	0.14 <sup>A</sup>	0.28	0.51 <sup>A</sup>	0.78 <sup>A</sup>	0.99 <sup>A</sup>	1.22	1.33 <sup>A</sup>	1.47 <sup>A</sup>
Bovans-Brown	0.03	0.11 <sup>B</sup>	0.25	0.47 <sup>B</sup>	0.74 <sup>B</sup>	0.97 <sup>AB</sup>	1.19	1.26 <sup>B</sup>	1.44 <sup>A</sup>
Average	0.03	0.11	0.25	0.47	0.747	0.968	1.199	1.301	1.462

<sup>ABC</sup> Denotes significant differences between strains (P<0.01)

**Table 12. Bi-weekly Feed Consumption of Brown-Egg Entries, 41<sup>st</sup> NCLP&MT, Cage-reared**

Breeder	-----(Weeks of Age)-----								
	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	1-16 <sup>1</sup>
	----- (g per bird) -----								
Bovans-Brown	10.24 <sup>B</sup>	20.54 <sup>AB</sup>	39.28 <sup>A</sup>	58.09 <sup>A</sup>	61.25	64.34 <sup>A</sup>	71.94 <sup>A</sup>	70.94	Total Cons. g 5452
Hy-Line-Brown	7.73 <sup>C</sup>	17.49 <sup>C</sup>	36.66 <sup>B</sup>	53.71 <sup>B</sup>	61.17	61.64 <sup>AB</sup>	68.24 <sup>B</sup>	81.40	5436
Tetra-Brown	13.79 <sup>A</sup>	22.36 <sup>A</sup>	39.40 <sup>A</sup>	57.13 <sup>A</sup>	61.57	62.80 <sup>B</sup>	69.92 <sup>AB</sup>	64.30	5495
Average	10.11	19.71	38.18	56.26	61.33	62.75	69.70	61.32	5461

<sup>ABC</sup> Denotes significant differences between strains (P<0.01)

<sup>1</sup>Cummulative feed intake from 1 to 16 weeks of age.

**Total Nutrient Intake, Feed Cost, Livability, and Flock Uniformity of Brown-Egg Entries, 41<sup>st</sup> NCLP&MT, Cage-reared**

Breeder	Protein	Met. Energy	Lysine	TSAA	Feed Cost	Livability (1-112 d)	Flock Uniformity
	(per bird to 112 days)						(% of pullets within ±10% of x )
	(g)	(kcal)	(g)	(g)	(\$)	(%)	
Bovans-Brown	953 <sup>A</sup>	15,857	52.66 <sup>A</sup>	40.50 <sup>A</sup>	2.52	99.57	91.1
Hy-Line-Brown	923 <sup>B</sup>	15,460	50.88 <sup>B</sup>	39.25 <sup>B</sup>	2.49	98.70	86.1
Tetra-Brown	946 <sup>AB</sup>	157,17	52.30 <sup>AB</sup>	40.21 <sup>AB</sup>	2.55	99.28	91.1
Average	940	15,678	51.94	39.99	2.52	99.18	89.4

<sup>AB</sup> Denotes significant differences between strains (P<0.01)

**Table 14. Bi-weekly Body Weights of Brown-Egg Entries, 41<sup>st</sup> NCLP&MT, Cage-free reared**

Breeder	(Weeks of Age)								
	0	2	4	6	8	10	12	14	16
	(kg per bird)								
Bovans-Brown	0.03	0.11 <sup>B</sup>	0.24	0.45	0.68 <sup>B</sup>	0.88 <sup>B</sup>	1.10	1.22 <sup>B</sup>	1.34 <sup>B</sup>
Hy-Line-Brown	0.03	0.10 <sup>C</sup>	0.22	0.42	0.66 <sup>B</sup>	0.89 <sup>B</sup>	1.08	1.29 <sup>A</sup>	1.45 <sup>A</sup>
Tetra-Brown	0.03	0.13 <sup>A</sup>	0.28	0.47	0.73 <sup>A</sup>	0.92 <sup>A</sup>	1.13	1.26 <sup>A</sup>	1.41 <sup>A</sup>
Average	0.03	0.11	0.25	0.45	0.69	0.89	1.10	1.25	1.40

<sup>ABC</sup> Denotes significant differences between strains (P<0.01)

**Table 15. Bi-weekly Feed Consumption of Brown-Egg Entries, 41<sup>st</sup> NCLP&MT, Cage-free reared**

Breeder	(Weeks of Age)									
	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	1-16	
	(g per bird)									Total Cons. g
Bovans-Brown	14.00 <sup>B</sup>	48.36	30.33	47.37	54.02	64.76	61.06	60.45	5325 <sup>B</sup>	
Hy-Line-Brown	10.19 <sup>C</sup>	43.10	30.29	46.50	53.43	67.39	67.97	77.76	5553 <sup>A</sup>	
Tetra-Brown	16.94 <sup>A</sup>	42.20	33.76	49.15	55.25	66.74	65.13	58.49	5427 <sup>AB</sup>	
Average	13.70	44.55	31.46	47.68	54.23	66.30	64.72	65.57	5435	

<sup>AB</sup> Denotes significant differences between strains (P<0.01)

**Table 16. Total Nutrient Intake, Feed Cost, Livability, and Flock Uniformity of Brown-Egg Entries, 41<sup>st</sup> NCLP&MT, Cage-free reared**

Breeder	Protein	Met. Energy	Lysine	TSAA	Feed Cost	Livability (1-112 d)	Flock Uniformity
	(g)	(kcal)	(g)	(g)	(\$)	(%)	(% of pullets within ±10% of x)
	(per bird to 112 days)						
Bovans-Brown	922	15,192 <sup>B</sup>	51.83	39.26	2.26	98.85	83.0
Hy-Line-Brown	952	15,818 <sup>A</sup>	53.35	40.56	2.33	99.25	89.0
Tetra-Brown	939	15,481 <sup>AB</sup>	52.80	39.94	2.32	100.00	86.0
Average	938	15,497	52.66	39.92	2.31	99.37	86.0

<sup>AB</sup> Denotes significant differences between strains (P<0.01)

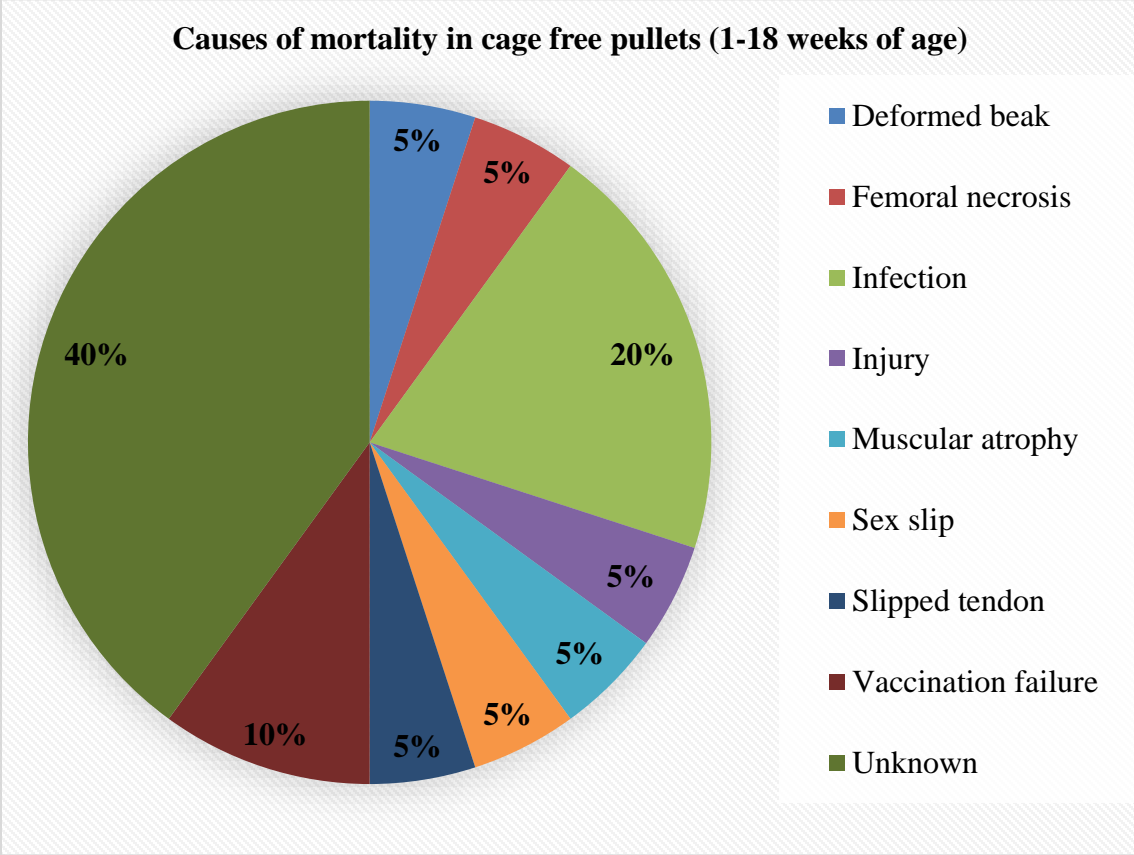
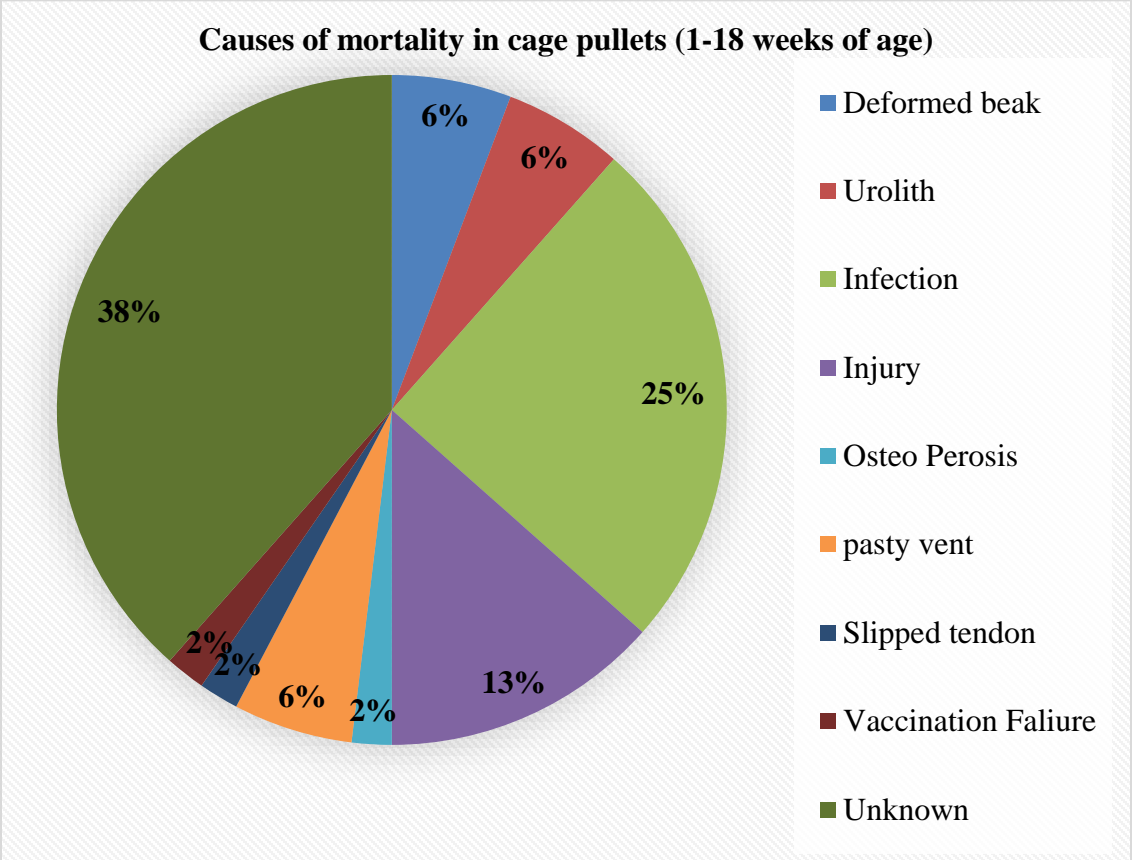


Figure 1. Pie chart showing the cause of mortality in percentage in cage and cage free pullets. 25% of unknown cases had mouth ulceration due to fine feed (feed cake)