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REPORT ON PULLET REARING PERIOD OF THE THIRTY NINETH NORTH CAROLINA LAYER PERFORMANCE AND MANAGEMENT TEST AND ALTERNATIVE MANAGEMENT TEST[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. Joe Hampton is Piedmont Research Station Superintendent; Mr. Aaron Sellers is Poultry Unit Manager of the flock; Dr. Ramon D. Malheiros, Research Associate is 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 http://www.ces.ncsu.edu/depts/poulsci/tech_manuals/layer_reports/39_grow_report.pdf .

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[1]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.

39th NORTH CAROLINA LAYER PERFORMANCE AND MANAGEMENT TEST
Volume 39 No. 2

Report on Pullet Rearing Period

Dates of Importance:

Twenty entries were hatched on July 31, 2013. There were twelve commercial white egg strains, and eight commercial brown egg strains that are participating in the current test. The chicks were all sexed according to their genetics (vent, feather, or color), vaccinated for Marek's disease, and wing banded for identification before being transferred to the brood/grow houses. Tables 1, shows the source of the laying stock, strain which was entered, and participation in the test environments and Table 17, provides the breeder, source of eggs, and entry status of each strain(Cage, Cage Free, or Range Environment).

The rearing phase for the range, cage free, and the cage reared pullets complete the grow phase at 16 weeks, then transitioned to the laying phase during their 17th week of age.

Table 1. 39th North Carolina Layer Performance and Management Test Strain Code Assignments and

Strain No.	Source of Stock	Source Code	Strain	Participation[1]
1	Hendrix-genetics	ISA	Bovans White	C, ECS
2	Hendrix-genetics	ISA	Shaver White	C, ECS
3	Hendrix-genetics	ISA	Dekalb White	C, CF, ECS
4	Hendrix-genetics	ISA	Babcock White	C, ECS
5	Hendrix-genetics	ISA	B-400	C, ECS
6	Hy-Line Int.	HL	W-36	C, CF, ECS
7	Hy-Line Int.	HL	CV-26	C, CF
8	Hy-Line Int.	HL	CV-24	C, CF, ECS
9	Hy-Line Int.	HL	CV-22	C, CF, R
10	Lohmann	L	LSL Lite	C, CF, ECS
11	H&N International	L	H&N Nick Chick	C, CF, ECS
12	Novogen	N	White	C, CF, ECS
13	Tetra Americana	TA	TETRA Amber	C, CF, ECS
14	Tetra Americana	TA	TETRA Brown	C, CF, ECS
15	Novogen	N	Brown	C, CF, ECS
16	Lohmann	L	LB-Lite	C, CF, ECS
17	Hy-Line Int.	HL	Silver Brown	C, CF, ECS, R
18	Hy-Line Int.	HL	Brown	C, CF, ECS, R
19	Hendrix-genetics	ISA	ISA Brown	C, CF, ECS
20	Hendrix-genetics	ISA	Bovans Brown	C, CF, ECS

[1] Participation for each strain in the different components of the tests are indicated by the following codes, a strain may have more than one code: Cage=C; Enriched Colony Housing System=ECS; Cage Free = CF; Range = R

Experimental Design:

The rearing portion of the test was a factorial arrangement of rearing environments and strain were the main effects. The analyses were done by each rearing environment. The pullet rearing facilities consisted of a Quad-deck cage system in a light tight house; slat-litter floor pen house, environmentally controlled, and range houses with paddocks [See **Pullet Housing**]. The breeders selectively entered strains for participation in the various production environments so pullets could be reared in accordance with range standards as practiced by specialty egg producers.

Strain--Samples of fertile eggs were provided from the breeders according to the rules, which govern the conductance of the test. All eggs were set and hatched concurrently (Hatch/Serology Report Vol. 39, No. 1) as described in the hatch report additional chicks had to be acquired and delivered to the station. A total of twelve commercial white egg strains, and eight commercial brown egg strains are participating in the current test. At hatch the chicks were sexed to remove the males. All strains were sexed according to breeder recommendations, (*i.e.* feather, color, or vent sexing).

For the layer test, a maximum of approximately 830 and minimum of 300 white and brown egg pullets/strain were wanted for placement at the initiation of the layer portion of the test depending on which portion of the test the strain was entered into. If the number of pullets hatched were below the prescribed numbers, the chicks were divided as equally as possible between the levels and replicates within the grow house and placement into the layer test would be adjusted appropriately.

PULLET HOUSING AND MANAGEMENT:

Housing: The chicks were weighed then randomly assigned to the growing replicates with white egg and brown egg replicates being intermingled throughout the rooms or pens within the houses. The white egg strains occupied approximately 60 % of the house and brown egg strains occupied the other 40 % of cage replicates, white egg strains occupied approximately 50 % and brown egg strains occupied the other 50 % of floor replicates, and white egg strains occupied approximately 66 % and brown egg strains occupied the other 33 % of range replicates. Individual hens were identified by strain assignment codes that indicate the cage/pen arrangement, replicate identification numbers, and the strain assignments for brood-grow House 8, 4, and range. 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; indicate room, row, level and replicate within room-row-level-replicate, for the four digits, respectively they also indicate the rearing environment. The replicate number identifies individuals from the strain to the unit manager and PI.

House 8 - is an environmentally controlled windowless brood-grow facility with 3 banks of quad-deck cages in each room. Each room has been assigned a number and each bank has been assigned a row number, and each cage section within each row and level/row has been assigned a

replicate number, for statistical analysis pairs of rows have been designated as blocks. Thus, each block consists of two rows containing 24 Replicates on all levels. This allows for a total of 3,744 pullets per room resulting in a total pullet count. For this study 4 rooms were utilized in House 8 for a total of 11,062 pullets. The white and brown egg strains were randomly assigned to the replicates within 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 rooms, rows, and levels, as described earlier under the experimental design. All chicks will be brooded in the same cage during the entire 16 wk rearing period. Paper will be placed on the cage floor for the first 7 days within each of the replicate series within each row. Each cage within the replicate will be filled with 13 white-egg or brown-egg (13 per 24" x 26" cage) pullets on the day of hatch for a rearing allowance of 310 cm^2 (48 in^2) for the white and brown-egg layers.

House 4 – is a remodeled high rise house converted to a slat-litter facility which contains 36 pens (8' x 10') for a total of 80 sq ft/pen. The house is set up to include whole house heat capabilities so the birds reared in the facility will also spend the lying phase in that pen. There were 65 chicks at approximately 1143 cm^2 for the cage free birds (177 in^2) started in each pen cage free birds with the rearing protocol being identical to the cage reared hens. Feeder and waterer space designed to meet UEP Guidelines for cage free facilities. Roosts were included in the rearing pen to allow the pullets to learn to utilize vertical space. This improves the use of nests as a hen.

Range housing --The pullets for the range facilities were reared on litter in the range huts designed for whole house heat capabilities so the birds reared in the facility will also spend the lying phase in that pen. There were 65 chicks started at approximately 1143 cm^2 for the range birds (177 in^2) started in each pen with the rearing protocol being identical to the cage reared hens. They had access to feed, nipple waterers, and roosts in order to make them familiar with that behavior and facilitate nest box usage. The range huts had a timer, supplemental light and a propane heater for winter conditions to maintain an interior temperature above 7.2° C (45 F) which is the lower level of the chickens Effective Thermal Neutral Zone (eTNZ) where body temperature will be maintained via a feed intake increase. The pullets had access to the outdoors beginning at 12 wks of age, throughout the day and night hours and learned to return to the range hut during the dark for roosting and protection. Husbandry, lighting and supplemental feed were allocated on the same basis as flock mates in cages in order to minimize the variables between flock mates as much as possible. Range density was based upon research a 721 bird/acre static equivalency 5.56 m^2/pullet (60 ft^2/hen). The range pens are 18.3 m x 18.3 m (60' x 60') and were enclosed by a fence 1.8 m (6 ft) with the lower chain link section being 1.2 m (4 ft) high. In order to facilitate range forage replenishment each of the paddocks was divided in half with a diagonal fence providing 2.78 m^2/hen (30 ft^2/hen) and rotated every 4 wks. One week prior to rotation the paddocks were mowed to an approximate height of 15 cm (6 in.). Pullet movement was controlled by an access a gate that allowed access to one half of the paddock at any point in time. The veranda area was a 3.04 m x 4.6 m (10'x15') shaded area which was bare dirt. Each range hut had 8 nipple drinkers inside each pen and 8 nipple drinkers outside. Tube feeders were in each pen 1 inside and a covered feeder outside providing 6.4 cm of feeder space /pullet.

Pullet Management and Nutrition: Pullets were fed *ad libitum* by hand daily. Feed consumption and body weights were monitored bi-weekly beginning at 2 weeks of age. All mortality was recorded daily, but mortality attributed to the removal of males (sex slips) and accidental deaths from a replicate have been excluded from the 39th NCLP&MT Grow Report.

Table 2. Diet Formulations for the Brood-Grow Periods

	Diet[1] Identification				
Ingredient	Starter	Grower	Developer	Developer2	Pre-Lay[2]
Corn	1123.7	1183.2	1183.4	1165.1	1054.0
Fat (Lard)	32.3	10.0	10.0	10.0	71.8
Soybean meal	564.1	429.1	310.4	295.4	637.6
Soybean Hulls	---	---	---	29.4	---
Wheat Midds	100.0	150.1	249.7	400.0	---
Gluten Meal 60%	100.0	150	150.0	---	---
D.L. Methionine	4.0	2.7	2.4	2.3	3.5
Lysine 78.8%	2.3	2.4	2.3	1.9	---
Coarse Limestone	---	---	---	---	70.0
Limestone	33.7	34.8	57.7	62.4	124.1
Bi-Carbonate	2.0	2.1	2.0	2.0	2.0
Phosphate Mono/D	21.2	20.9	17.9	17.7	
Salt	5.7	5.7	5.5	4.8	6.9
Vit. Premix	1.0	1.0	1.0	1.0	1.0
Min. premix 434	1.0	1.0	1.0	1.0	1.0
HyD3 (62.5 mg/lb)	1.0	0.5	---	---	---
Prop Acid 50% Dry	2.0	2.0	2.0	2.0	2.0
T-Premix	2.1	2.0	2.0	2.0	1.0
.06% Sel. Premix	1.0	1.0	1.0	1.0	1.0
Choline Cl 60%	1.4	1.1	1.4	1.6	1.6
Ronozyme P-CT 540%	0.5	0.4	0.4	0.4	0.4
Amprol 25 25%	1.0	---	---	---	---
Avizyme 1502	---	---	---	---	1.0
Total	2000	2000	2000	2000	2000
Protein %	20.0	18.0	16.0	15.4	19.4
ME kcal/kg	2926	2860	2805	2772	2926
Calcium %	1.00	1.0	1.4	1.5	4.1
T. Phos. %	0.61	0.62	0.59	0.58	0.55
Lysine %	1.15	0.98	0.83	0.80	1.10
TSAA %	0.86	0.74	0.67	0.64	0.80

[1]Diets were acquired from Southern States Cooperative in mash form and Lance Minear, Nutritionist for Southern States, provided assistance in formulation.
[2]This Prelay diet was fed through 23 weeks.

Each pullet placed was provided with Starter feed containing Amprol during the initial brooding period, followed by Grower, Developer, and Developer 2 diets that are shown in the diet formulation section Table 2. Thus, the white-egg and brown-egg replicates in brood-grow House 8 and

House 4 were given the starter feed to achieve the breeder recommended body weights at each weigh interval. Pullets in each house were moved independently on to the next tier 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 9 weeks; developer, 9 to 11 weeks; Developer 2, 11 to16 weeks; Pre-lay diet 16 to 17 weeks. The strains were grown to the breeder recommended body weights. Generally, in this flock, the birds grew to heavier weights with the guidelines meaning that the dietary regimens was administered as discussed previously with the inclusion of the Developer 2 diet. The Starter, Grower, and Developer, diets were administered in order to maintain a growth pattern and target weights as closely as possible to the breeder recommendations. The pre-lay diet was provided no later than the last week in the rearing facility through the 23rd week of age.

Pullet Vaccination, and Beak Trimming:

Pullet vaccination and beak trimming schedules are outlined in Table 3. Pullets were not re-trimmed at any point in the rearing period.

Table 3. Pullet Vaccination and Beak Trimming Schedule

Age	Date	Event
Hatch	July 31, 2013	MVT Marek's vaccination by injection in neck
Day 6-8	Aug 5 - 7, 2013	Precision Beak Trim[1] all replicates throughout the flock
Day 10	Aug 9, 2013	1st Newcastle (B1) and Bronchitis (Mass.) vaccination Via aerosol spray (Triple Vac)
Day 35	Sept 3, 2013	2nd Newcastle (LaSota) and Bronchitis (Mass.) vaccination via aerosol spray (ComboVac)
Day 63	Oct 1, 2013	3rd Newcastle (LaSota) and Bronchitis (Mass.) vaccination via aerosol spray (ComboVac)
Day 70	Oct 8, 2013	Fowl Pox and Avian Encephalomyelitis vaccination via the wing web
Day 105	Nov 11, 2013	4th Newcastle (Lasota) and Bronchitis (Mass.) vaccination via aerosol spray (ComboVac)
Week 70	Dec 2, 2014	5th Newcastle (LaSota) and Bronchitis (Mass.) vaccination via aerosol spray (ComboVac)

Beak trimming was begun at 6 days of age using a Lyons Precision beak trimmer, with a 7/64" guide hole. The trim was a block cut with an approximate blade temp of 1100° F (dull red). Beak trimming was completed in less than 3 days.

Lighting Schedule

The lighting schedule for the pullet controlled environment facility, floor, and range rearing are outlined in Table 4. Then the pullets were moved from the floor house to the range they were on natural light with matching supplemental light in the range hut matching the program used in

house 8. The curtains were uncovered in the floor house 4 at 14 weeks of age with supplemental light being the same as in house 8.

Table 4. Pullet House Lighting Schedules[1]

Age	Date	Light Intensity	Photoperiod (hr)
Days 1-2	July 31 and Aug 1,2013	10 ftc. (100 lux)	24
Day 3	Aug 2, 2013	1 ftc. (10 lux)	23
Week 1	Aug 6, 2013	1 to 0.5 flc. (10 to 5 lux)	22
Week 2	Aug 13, 2013	1 to 0.5 flc. (10 to 5 lux)	20
Week 3	Aug. 20, 2013	1 to 0.5 flc. (10 to 5 lux)	18
Week 4	Aug. 27, 2013	1 to 0.5 flc. (10 to 5 lux)	16
Week 5	Sept 3, 2013	1 to 0.5 flc. (10 to 5 lux)	14
Week 6	Sept 10, 2013	1 to 0.5 flc. (10 to 5 lux)	12
Week 7 through	Sept. 17, 2013	1 to 0.5 flc. (10 to 5 lux)	10
Week 9	Oct. 9, 2013	1 to 0.5 flc. (10 to 5 lux)	9
Week 10	Oct. 16, 2013	1 to 0.5 flc. (10 to 5 lux)	8
Week 13 – 16 (House 4 & 8)	Oct. 29 to Nov 19, 2013	1 to 0.5 flc. (10 to 5 lux)	8
Week 13 – 16 (Range)	Oct. 29 to Nov 19, 2013	Natural Day length with supplement same as above	
Housing of Pullets commences	Nov 19, 2013	Working Intensity	10

[1]Lighting schedules were the same for all of the birds through12 weeks of age.

FDA EGG SAFETY PLAN TESTING

In accordance with the Egg Safety Rule and the NCLP&MT Egg Safety Plan the cage, cage-free and range 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 and brown egg strains are shown in Tables 5-7 and 8-10, respectively for House 8. The House 4, floor rearing data, is shown in Tables 11-13. The Hy-Line W-98 birds which were grown in the floor environment are shown at the bottom of Tables 11-13 (Not included in statistical analysis). The Range Huts 1 and 2, rearing data, is shown in Tables 14-16. 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 is shown Table 1, with more complete details in Table 17 following the data tables.

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 trough 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. Using average contract feed prices for the rearing period.

Starter	$445.20 /Ton
Grower	$400.87 /Ton
Developer	$356.60 /Ton
Developer 2	$313.15 /Ton
Pre-Lay Diet	$370.57 /Ton

Livability 1-112 Days:

The percentage of the birds housed which survived during days 1-112. Males and accidental deaths, which were removed, are excluded from the analysis of livability. There were a significant proportion of weak chicks saved as a result of a late hatch resulting in low chick numbers.

Flock Uniformity at 112 Days:

The percentage of the pullets with body weights falling within ±10% of the mean body weight at 112 days of age. This is based on the individual body weight from a sample of 100 pullets from 9 replicates representing each strain and environment.

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

Initial body weights were taken at time of placement in the brood/grow houses 8, 4, and range huts 1 & 2. 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 in houses 8, 4, and range huts 1 & 2 and after 12 weeks of age the time the range pullets were allowed access to the range hut and a final feed weight was taken at 16 weeks. In this study there was no attempt to measure the feed wasted in the cage system or the forage disappearance on the paddocks.

The forage used was a mixture of pasture grasses to provide both cool and warm season forage. The paddocks were well established having been maintained as forage for more than 6 years. Prior to the construction of the range paddock fences for this trial clover was no-till drilled into the paddocks.

Statistical Analyses and Separation of Means:

Analyses of variance were performed on all data using the GLM procedure of JMP analysis package SAS Institute (2009)[2]. Separate analyses were conducted for white and brown egg strains in each environment. Significant differences ($P<.01$) within white and brown egg strains are noted by different letters among columns of means.

Metric Conversions

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^2 = 6.45 cm^2	

[2]SAS Institute Inc. 2009. SAS 9.1.3 Help and Documentation, Cary, NC: SAS Institute Inc., 2000-2004. Web page http://www.sas.com/presscenter/guidelines.html

Table 5. Bi-weekly Body Weights of White-Egg Entries, 39th NCLP&MT, Cage-reared

Breeder	(Weeks of Age) 0	2	4	6	8	10	12	14	16
	(kg)								
Bovans White	.041^{A}	0.121^{AB}	0.296^{ABC}	0.457^{ABC}	0.643^{ABCD}	0.845	1.024^{ABC}	1.123	1.173^{BC}
Shaver White	.040^{AB}	0.112^{CDEF}	0.277^{AB}	0.463^{ABC}	0.651^{ABCD}	0.858	1.010^{ABC}	1.144	1.183^{BC}
Dekalb White	.039^{CD}	0.112^{CDEF}	0.265^{BC}	0.444^{BCD}	0.634^{BCD}	1.193	0.994^{ABC}	1.141	1.166^{BC}
Babcock White	.038^{D}	0.119^{ABC}	0.277^{AB}	0.472^{AB}	0.667^{AB}	0.886	1.064^{A}	1.179	1.243^{A}
ISA B-400	.038^{D}	0.111^{DEFG}	0.241^{D}	0.420^{D}	0.611^{D}	0.815	0.990^{BC}	1.099	1.136^{C}
Hy-Line W-36	.041^{A}	0.104^{FG}	0.245^{D}	0.433^{CD}	0.614^{CD}	0.837	0.998^{ABC}	1.108	1.156^{BC}
Hy-Line CV-26	.040^{AB}	0.102^{G}	0.252^{CD}	0.421^{D}	0.614^{CD}	0.805	0.954^{C}	1.091	1.142^{BC}
Hy-Line CV-24	.038^{D}	0.102^{G}	0.251^{CD}	0.450^{BCD}	0.657^{ABC}	0.872	1.008^{ABC}	1.132	1.198^{AB}
Hy-Line CV-22	.038^{D}	0.103^{EFG}	0.251^{BCD}	0.440^{BCD}	0.642^{ABCD}	0.851	1.048^{AB}	1.117	1.186^{ABC}
Lohmann LSL-Lite	.039^{CD}	0.115^{BCDE}	0.278^{AB}	0.461^{ABC}	0.668^{AB}	0.898	1.037^{AB}	1.143	1.197^{AB}
H&N Nick Chick	0.38^{D}	0.118^{ABCD}	0.282^{AB}	0.470^{AB}	0.673^{AB}	0.883	1.037^{AB}	1.136	1.194^{AB}
Novogen White	.038^{D}	0.124^{A}	0.287^{A}	0.483^{A}	0.680^{A}	0.893	1.029^{ABC}	1.134	1.186^{BC}
Average	.039	0.112	0.266	0.451	0.646	0.886	1.016	1.129	1.180

^{ABCDE} Denotes significant differences between strains (P<0.01)

Table 6. Bi-weekly Feed Consumption of White-Egg Entries, 39th 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
	(kg per bird)								
Bovans White	0.205^{B}	0.429^{AB}	0.517^{B}	0.684^{D}	1.073^{D}	1.243^{C}	1.271^{B}	1.081^{C}	6.591^{C}
Shaver White	0.204^{B}	0.432^{AB}	0.537^{AB}	0.689^{D}	1.095^{D}	1.225^{C}	1.307^{B}	1.136^{BC}	6.694^{C}
Dekalb White	0.205^{B}	0.419^{AB}	0.534^{AB}	0.714^{D}	1.145^{BCD}	1.215^{C}	1.292^{B}	1.098^{C}	6.634^{C}
Babcock White	0.213^{B}	0.396^{B}	0.532^{AB}	0.714^{D}	1.083^{D}	1.224^{C}	1.309^{B}	1.105^{C}	6.628^{C}
ISA B-400	0.202^{B}	0.402^{B}	0.511^{B}	0.689^{D}	1.099^{D}	1.188^{C}	1.264^{B}	1.094^{C}	6.498^{C}
Hy-Line W-36	0.227^{AB}	0.487^{A}	0.567^{AB}	0.836^{AB}	1.248^{ABC}	1.375^{AB}	1.555^{A}	1.306^{A}	7.289^{AB}
Hy-Line CV-26	0.261^{A}	0.486^{A}	0.553^{AB}	0.956^{A}	1.335^{A}	1.489^{A}	1.552^{A}	1.408^{A}	7.638^{A}
Hy-Line CV-24	0.221^{AB}	0.461^{AB}	0.588^{A}	0.836^{AB}	1.274^{AB}	1.376^{AB}	1.520^{A}	1.267^{AB}	7.344^{AB}
Hy-Line CV-22	0.181^{B}	0.432^{AB}	0.495^{AB}	0.787^{ABC}	1.140^{ABCD}	1.213^{C}	1.404^{AB}	1.066^{C}	6.804^{BC}
Lohmann LSL-Lite	0.194^{B}	0.438^{AB}	0.546^{AB}	0.725^{CD}	1.063^{D}	1.219^{C}	1.288^{B}	1.088^{C}	6.676^{C}
H&N Nick Chick	0.207^{B}	0.431^{AB}	0.573^{AB}	0.739^{BCD}	1.135^{CD}	1.273^{BC}	1.334^{B}	1.109^{C}	6.852^{BC}
Novogen White	0.213^{B}	0.436^{AB}	0.553^{AB}	0.722^{D}	1.097^{D}	1.253^{BC}	1.300^{B}	1.110^{C}	6.691^{C}
Average	0.211	0.437	0.542	0.757	1.149	1.274	1.366	1.156	6.836

^{ABC} Denotes significant differences between strains (P<0.01)

Table 7. Total Nutrient Intake, Feed Cost, Livability, and Flock Uniformity of White-Egg Entries, 39th NCLP&MT, Cage-reared

Breeder	Protein	Met. Energy	Lysine	TSAA	Feed Cost	Livability (1-112 d)	Flock Uniformity (% of pullets within ±10% of *x*)
	----------(per bird to 112 days)----------						
	(kg)	(kcal)	(g)	(g)	($)	(%)	
Bovans White	0.968^{C}	15,931^{C}	57.91^{C}	40.49^{C}	2.27^{C}	98.4^{AB}	88.7
Shaver White	1.000^{C}	16,464^{C}	59.90^{C}	41.87^{C}	2.35^{C}	97.0^{AB}	90.0
Dekalb White	0.994^{C}	16,358^{C}	59.46^{C}	41.61^{C}	2.34^{C}	96.5^{AB}	95.0
Babcock White	0.987^{C}	16,241^{C}	59.08^{C}	41.29^{C}	2.32^{C}	99.1^{A}	90.0
ISA B-400	0.973^{C}	16,022^{C}	58.22^{C}	40.70^{C}	2.28^{C}	98.7^{AB}	91.2
Hy-Line W-36	1.138^{AB}	18,744^{AB}	68.05^{AB}	47.60^{AB}	2.67^{AB}	87.4^{C}	91.2
Hy-Line CV-26	1.201^{A}	19,765^{A}	71.60^{A}	50.20^{A}	2.82^{A}	89.7^{BC}	92.8
Hy-Line CV-24	1.130^{AB}	18,592^{AB}	67.46^{AB}	47.27^{AB}	2.65^{AB}	91.1^{ABC}	87.5
Hy-Line CV-22	1.009^{C}	16,651^{C}	60.34^{C}	42.19^{C}	2.37^{C}	82.7^{C}	93.3
Lohmann LSL-Lite	0.983^{C}	16,170^{C}	58.81^{C}	41.14^{C}	2.31^{C}	96.6^{AB}	93.3
H&N Nick Chick	1.019^{C}	16,755^{C}	60.92^{C}	42.64^{C}	2.39^{C}	98.3^{AB}	83.7
Novogen White	1.006^{C}	16,548^{C}	60.17^{C}	42.10^{C}	2.36^{C}	98.3^{AB}	93.7
Average	1.034	17,020	61.82	43.26	2.42	94.5	90.8

^{ABC} Denotes significant differences between strains (P<0.01)

Table 8. Bi-weekly Body Weights of White-Egg Entries, 39th NCLP&MT, Cage-free reared

Breeder	(Weeks of Age) 0	2	4	6	8	10	12	14	16
	(kg)								
Dekalb White	.035^{A}	0.107^{B}	0.256^{ABC}	0.431^{BC}	0.623^{BC}	0.831	0.960^{A}	1.076	1.152^{AB}
Hy-Line W-36	.040^{AB}	0.100^{C}	0.231^{D}	0.396^{D}	0.576^{E}	0.763	0.890^{B}	0.988	1.076^{C}
Hy-Line CV-26	.041^{A}	0.100^{C}	0.236^{CD}	0.400^{D}	0.583^{DE}	0.830	0.943^{AB}	1.046	1.116^{BC}
Hy-Line CV-24	.037^{CD}	0.100^{C}	0.243^{BCD}	0.423^{BCD}	0.616^{CD}	0.803	0.936^{AB}	1.073	1.155^{AB}
Hy-Line CV-22	.038^{BC}	0.100^{C}	0.247^{BCD}	0.410^{CD}	0.613^{CD}	0.800	0.993^{A}	1.060	1.124^{BC}
Lohmann LSL-Lite	.040^{ABC}	0.107^{B}	0.250^{BCD}	0.433^{AB}	0.640^{ABC}	0.847	0.986^{A}	1.083	1.192^{A}
H&N Nick Chick	.037^{CD}	0.120^{A}	0.270^{AB}	0.446^{AB}	0.653^{AB}	0.850	0.986^{A}	1.110	1.176^{AB}
Novogen White	.038^{BC}	0.123^{A}	0.280^{A}	0.463^{A}	0.670^{A}	0.860	0.967^{AB}	1.090	1.177^{AB}
Average	.038	0.107	0.251	0.425	0.621	0.823	0.957	1.065	1.146

^{ABCDE} Denotes significant differences between strains (P<0.01)

Table 9. Bi-weekly Feed Consumption of White-Egg Entries, 39th 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
	(kg per bird)								
Dekalb White	0.190	0.353^{BC}	0.488	0.638^{A}	0.802^{A}	0.857	0.915^{AB}	0.910^{AB}	5.153^{A}
Hy-Line W-36	0.166	0.315^{D}	0.613	0.542^{C}	0.718^{B}	0.834	0.833^{C}	0.843^{B}	4.865^{BC}
Hy-Line CV-26	0.165	0.330^{CD}	0.453	0.567^{BC}	0.734^{AB}	0.801	0.849^{C}	0.869^{AB}	4.772^{C}
Hy-Line CV-24	0.189	0.352^{ABC}	0.455	0.609^{AB}	0.761^{AB}	0.830	0.879^{BC}	0.924^{AB}	4.997^{ABC}
Hy-Line CV-22	0.154	0.382^{A}	0.476	0.607^{AB}	0.743^{AB}	0.847	0.927^{AB}	0.918^{AB}	5.056^{ABC}
Lohmann LSL-Lite	0.178	0.330^{CD}	0.399	0.627^{AB}	0.802^{A}	0.844	0.910^{AB}	0.944^{A}	5.035^{ABC}
H&N Nick Chick	0.189	0.374^{AB}	0.505	0.625^{AB}	0.783^{AB}	0.867	0.956^{A}	0.957^{A}	5.257^{A}
Novogen White	0.192	0.373^{AB}	0.439	0.632^{AB}	0.804^{A}	0.847	0.909^{AB}	0.947^{A}	5.145^{AB}
Average	0.178	0.351	0.479	0.606	0.768	0.841	0.897	0.914	5.035

^{ABC} Denotes significant differences between strains ($P<0.01$)

Table 10. Total Nutrient Intake, Feed Cost, Livability, and Flock Uniformity of White-Egg Entries, 39th NCLP&MT, Cage-free reared

Breeder	Protein	Met. Energy	Lysine	TSAA	Feed Cost	Livability (1-112 d)	Flock Uniformity (% of pullets within ±10% of *x*)
	----------(per bird to 112 days)----------						
	(kg)	(kcal)	(g)	(g)	($)	(%)	
Dekalb White	0.913	14,914	49.68	38.39	2.19	98.8	95.0
Hy-Line W-36	0.898	14,638	48.87	37.79	2.16	96.2	93.0
Hy-Line CV-26	0.848	13,893	46.01	35.61	2.03	95.4	96.0
Hy-Line CV-24	0.878	14,369	47.67	36.89	2.10	93.1	94.0
Hy-Line CV-22	0.892	14,615	48.41	37.47	2.14	98.5	88.0
Lohmann LSL-Lite	0.893	14,656	48.42	37.50	2.14	100.0	96.0
H&N Nick Chick	0.924	15,110	50.24	38.85	2.21	100.0	94.0
Novogen White	0.903	14,784	49.01	37.94	2.16	100.0	88.0
Average	0.894	14,622	48.54	35.05	2.14	97.3	93.0

[ABC] Denotes significant differences between strains (P<0.01)

Table 11. Bi-weekly Body Weights of Brown-Egg Entries, 39th NCLP&MT, Cage-reared

Breeder	(Weeks of Age)								
	0	2	4	6	8	10	12	14	16
	(kg)								
TETRA Amber	.036^{C}	0.116^{AB}	0.289^{ABC}	0.503^{AB}	0.753^{AB}	0.983^{AB}	1.172^{BC}	1.334^{AB}	1.400
TETRA Brown	.034^{D}	0.111^{B}	0.274^{C}	0.495^{AB}	0.730^{AB}	0.975^{AB}	1.187^{ABC}	1.336^{AB}	1.398
Novogen Brown	.037^{B}	0.124^{A}	0.296^{A}	0.521^{A}	0.772^{A}	1.028^{AB}	1.239^{A}	1.403^{A}	1.459
Lohmann LB-Lite	.038^{B}	0.116^{AB}	0.276^{BC}	0.474^{B}	0.706^{B}	0.963^{B}	1.169^{BC}	1.338^{AB}	1.415
Hy-Line S. Brown	.040^{A}	0.122^{A}	0.292^{ABC}	0.526^{A}	0.767^{A}	1.016^{AB}	1.177^{ABC}	1.377^{AB}	1.431
Hy-Line Brown	.041^{A}	0.121^{A}	0.293^{AB}	0.520^{A}	0.770^{A}	1.036^{A}	1.224^{AB}	1.367^{AB}	1.415
ISA Brown	.030^{B}	0.119^{AB}	0.290^{ABC}	0.504^{AB}	0.728^{AB}	0.959^{B}	1.153^{C}	1.307^{B}	1.369
Bovans Brown	.037^{B}	0.122^{A}	0.293^{AB}	0.518^{A}	0.758^{AB}	1.014^{AB}	1.208^{ABC}	1.371^{AB}	1.425
Average	.037	0.119	0.288	0.508	0.748	0.997	1.191	1.354	1.414

^{ABCD} Denotes significant differences between strains (P<0.01)

Table 12. Bi-weekly Feed Consumption of Brown-Egg Entries, 39th NCLP&MT, Cage-reared

	(Weeks of Age)								
Breeder	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	1-16
	(kg per bird)								
TETRA Amber	0.195^{AB}	0.406	0.558^{B}	0.729^{B}	1.119^{B}	1.146	1.305^{AB}	1.074^{B}	6.634^{B}
TETRA Brown	0.227^{A}	0.408	0.663^{A}	0.986^{A}	1.335^{A}	1.325	1.376^{AB}	1.145^{AB}	7.509^{A}
Novogen Brown	0.194^{AB}	0.422	0.575^{B}	0.750^{B}	1.138^{B}	1.240	1.287^{B}	1.078^{B}	6.736^{B}
Lohmann LB-Lite	0.185^{B}	0.397	0.531^{B}	0.708^{B}	1.105^{B}	1.177	1.271^{B}	1.070^{B}	6.477^{B}
Hy-Line S. Brown	0.195^{AB}	0.429	0.590^{AB}	0.783^{B}	1.161^{AB}	1.365	1.455^{A}	1.194^{A}	7.066^{AB}
Hy-Line Brown	0.212^{AB}	0.416	0.568^{B}	0.757^{B}	1.127^{B}	1.237	1.308^{AB}	1.084^{B}	6.696^{B}
ISA Brown	0.196^{AB}	0.420	0.571^{B}	0.756^{B}	1.116^{B}	1.210	1.258^{B}	1.063^{B}	6.651^{B}
Bovans Brown	0.197^{AB}	0.430	0.581^{B}	0.780^{B}	1.171^{AB}	1.155	1.362^{AB}	1.110^{AB}	6.969^{AB}
Average	0.200	0.416	0.580	0.781	1.159	1.232	1.328	1.102	6.842

^{ABC} Denotes significant differences between strains ($P<0.01$)

Table 13. Total Nutrient Intake, Feed Cost, Livability, and Flock Uniformity of Brown-Egg Entries, 39th 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)
	(kg)	(kcal)	(g)	(g)	($)	(%)	
TETRA Amber	0.996^{B}	16.401^{B}	59.58^{B}	41.67^{B}	2.34^{B}	98.6	85.0
TETRA Brown	1.123^{A}	18.430^{A}	66.64^{A}	46.98^{A}	2.65^{A}	96.7	85.5
Novogen Brown	1.003^{B}	16.494^{B}	59.95^{B}	41.49^{B}	2.36^{B}	97.9	78.7
Lohmann LB-Lite	0.972^{B}	16.002^{B}	58.14^{B}	40.65^{B}	2.28^{B}	97.5	80.0
Hy-Line S. Brown	1.064^{AB}	17.509^{AB}	63.66^{AB}	44.52^{AB}	2.50^{AB}	95.8	82.5
Hy-Line Brown	1.010^{B}	16.617^{B}	60.36^{B}	42.26^{B}	2.37^{B}	97.1	85.0
ISA Brown	0.987^{B}	16.228^{B}	58.96^{B}	41.33^{B}	2.32^{B}	98.1	75.7
Bovans Brown	1.035^{AB}	17.026^{AB}	61.82^{AB}	43.30^{AB}	2.43^{AB}	97.0	95.0
Average	1.024	16,836	61.14	42.77	2.41	97.3	83.4

^{ABC} Denotes significant differences between strains (P<0.01)

Table 14. Bi-weekly Body Weights of Brown-Egg Entries, 39th NCLP&MT, Cage-free reared

	(Weeks of Age)								
Breeder	0	2	4	6	8	10	12	14	16
	(kg per bird)								
TETRA Amber	.036[C]	0.116A[B]	0.280	0.466	0.676	0.903	1.163	1.250	1.304
TETRA Brown	.035[C]	0.110[B]	0.260	0.460	0.687	0.933	1.046	1.207	1.305
Novogen Brown	0.037[BC]	0.123[A]	0.286	0.473	0.683	0.923	1.063	1.207	1.335
Lohmann LB-Lite	.037[BC]	0.107[B]	0.250	0.433	0.647	0.900	1.037	1.220	1.303
Hy-Line S. Brown	.040[AB]	0.127[A]	0.290	0.477	0.703	0.893	1.070	1.176	1.316
Hy-Line Brown	.041[A]	0.107[B]	0.260	0.450	0.637	0.880	1.026	1.156	1.252
ISA Brown	.038[BC]	0.123[A]	0.276	0.480	0.700	0.933	1.073	1.220	1.319
Bovans Brown	.037[C]	0.127[A]	0.283	0.486	0.693	0.934	1.117	1.147	1.308
Average	.037	0.118	0.273	0.467	0.678	0.912	1.074	1.198	1.305

[ABC] Denotes significant differences between strains (P<0.01)

Table 15. Bi-weekly Feed Consumption of Brown-Egg Entries, 39th NCLP&MT, Cage-free reared

	(Weeks of Age)								
Breeder	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	1-16
	(kg per bird)								
TETRA Amber	0.182	0.347	0.484	0.645	0.846	0.927	1.021	0.874	5.327
TETRA Brown	0.177	0.355	0.487	0.654	0.846	0.899	0.976	0.944	5.340
Novogen Brown	0.192	0.348	0.472	0.624	0.806	0.882	0.959	0.933	5.220
Lohmann LB-Lite	0.163	0.336	0.454	0.611	0.811	0.874	0.964	0.936	5.150
Hy-Line S. Brown	0.194	0.349	0.497	0.648	0.832	0.776	0.981	0.962	5.241
Hy-Line Brown	0.165	0.327	0.452	0.602	0.813	0.831	0.993	0.870	5.046
ISA Brown	0.201	0.358	0.493	0.641	0.836	0.905	0.971	0.946	5.374
Bovans Brown	0.201	0.375	0.509	0.612	0.858	0.936	1.022	0.949	5.463
Average	0.184	0.349	0.481	0.630	0.831	0.879	0.986	0.927	5.270

[AB] Denotes significant differences between strains ($P<0.01$)

Table 16. Total Nutrient Intake, Feed Cost, Livability, and Flock Uniformity of Brown-Egg Entries, 39th NCLP&MT, Cage-free 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*)
	(kg)	(kcal)	(g)	(g)	($)	(%)	
TETRA Amber	0.926	15.201	50.18	38.85	2.21	99.2	80.0
TETRA Brown	0.954	15.601	51.81	40.06	2.28	100.0	82.0
Novogen Brown	0.923	15.126	50.10	38.78	2.21	99.2	78.0
Lohmann LB-Lite	0.906	15.873	49.10	38.04	2.17	100.0	74.0
Hy-Line S. Brown	0.936	15.274	50.93	39.25	2.24	98.5	94.0
Hy-Line Brown	0.885	15.542	48.00	37.19	2.12	98.5	86.0
ISA Brown	0.944	15.467	51.24	39.67	2.26	100.0	86.0
Bovans Brown	0.957	15.696	51.97	40.23	2.29	99.2	100.0
Average	0.929	15,473	50,41	39.09	2.22	99.3	85.0

[ABC] Denotes significant differences between strains (P<0.01)

Table 17. Bi-weekly Body Weights of Brown-Egg Entries, 39th NCLP&MT on Range

Breeder	(Weeks of Age) 0	2	4	6	8	10	12	14	16
	(kg)								
Hy-Line S. Brown	.041	0.115	0.278[A]	0.448	0.690	0.909	1.108	1.300	1.377
Hy-Line Brown	.041	0.100	0.231[B]	0.413	0.607	0.852	1.009	1.129	1.260
Hy-Line * CV-22 White	.038	0.092	0.235	0.408	0.617	0.814	0.882	1.077	1.163

(*) no replicate

Table 18. Bi-weekly Feed Consumption of Brown-Egg Entries, 39th NCLP&MT on Range

Breeder	(Weeks of Age) 1-2	3-4	5-6	7-8	9-10	11-12	13-14	14-16	1-16
	(kg per bird)								
Hy-Line S. Brown	0.167	0.289	0.442	0.645	0.775	0.943	0.947	0.798	5.008
Hy-Line Brown	0.142	0.248	0.383	0.567	0.706	0.838	0.746	0.698	4.329
Hy-Line * CV-22 white	0.137	0.260	0.402	0.571	0.690	0.757	0.764	0.764	4.345

(*) no replicate

Table 19. Total Nutrient Intake, Feed Cost, Livability, and Flock Uniformity of Brown-Egg Entries, 39th NCLP&MT on Range

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*)
	(kg)	(kcal)	(g)	(g)	($)	(%)	
Hy-Line S. Brown	1.647	13.531	43.99	34.28	1.98	100.0	88
Hy-Line Brown	1.416	11.131	36.06	28.16	1.62	100.0	82
Hy-Line * CV-22 White	1.470	11.092	36.08	28.16	1.62	98.5	92

(*) No replicate

Table 20. Entries in the 39th NCLP&MT by Breeder, Stock Suppliers, and Categories			
Breeder	Stock	Category[1]	Source
Hy-Line International 2583 240th Street Dallas Center, IA 50063	W-36	I-A	Hy-Line North America 4432 Highway 213, Box 309 Mansfield, GA 30255
	Hy-Line Brown	I-A	(Same)
	Hy-Line Silver Brown	III-A	(Same)
	CV22	II-A	(Same)
	CV24	II-A	(Same)
	CV26	II-A	(Same)
Lohmann Tierzucht Gmbh Am Seedeich 9-11 . P.O.Box 460 D-27454 Cuxhaven, Germany	Lohmann LSL-Lite	I-A	Hy-Line North America Elizabeth-town 79 Industrial Rd Elizabethtown, PA 17022
	Lohmann LB-Lite	I-A	(Same)
H&N International 321 Burnett Ave South, Suite 300 Renton, Washington 98055	H&N "Nick Chick"	I-A	Feather Land Farms 32832 E. Peral Road Coberg, OR 97408
Instiut de Selection Animale (A Hendrix Genetic Company) ISA North America 650 Riverbend Drive, Suite C Kitchener, Ontario N2K 3S2 Canada	Bovans White	I-A	CPI-South Central Hatchery 5087 County Road 35 Bremen, AL 35033
	Dekalb White	I-A	(Same)
	Bovans Brown	I-A	(Same)
	Babcock White	II-A	Institute de Sélection Animale 650 Riverbend Dr. Suite C Kitchener, Ontario N2K 3S2 Canada
	B 400	II-A	(Same)
	Shaver White	I-A	Midwest Farms, LLC. 135 S. Epes St. Blackstone, VA 23824
	ISA Brown	I-A	(Same)
Tetra Americana, LLC 1105 Washington Road Lexington, GA 30648	TETRA Brown	I-A	CPI-MidAmerica Hatchery Lexington, GA 30648 (Same)
	TETRA Amber	I-A	
NOVOGEN S.A.S. Mauguérand – Le Foeil BP 265 22 800 QUINTIN - FRANCE	NOVOgen BROWN	I-A	Morris Hatchery 18370 SW 232 Street, Goulds, FL 33170-5399
	NOVOgen WHITE	I-A	Pennovo Hatchery 621 Stevens Road Ephrata, PA 17522

[1] I = Extensive distribution in southeast United States A = Entry requested
II = Little or no distribution in southeast United States
III = Unavailable for commercial distribution in United States