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SINGLE PRODUCTION CYCLE REPORT OF THE THIRTY NINTH NORTH CAROLINA LAYER PERFORMANCE AND MANAGEMENT TEST: ALTERNATIVE PRODUCTION ENVIRONMENTS[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, Prestage Department of Poultry Science, 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.

The data presented herein represents the analysis of the single production cycle of the 39th North Carolina Layer Performance and Management Test. Performance summary tables are available for each strain, and the production systems of Free-range (R), Cage-free (CF), Enrichable Cage (EC), Enriched Environmental Housing (ECS).

Copies of current and past reports are maintained for public access at http://www.ces.ncsu.edu/depts/poulsci/tech_manuals/layer_reports/39_single_cycle 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 ALTERNATIVE PRODUCTION ENVIRONMENTS
Volume 39 No. 4

Report on the Single Laying Cycle

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.

Table 1, shows the source of the laying stock, strain which were entered, and the environments to which they are participating in the test. Table 40, is a list of the breeder, source of eggs, and entry status of each strain. This report will only present the production data from the hens in Houses 4, 5 and range houses 1 and 2 representing the production systems of free-range (R), cage-free (CF), enrichable cages (EC), and the enriched colony housing system (ECS). Figures 1 through 37 provide the bi-weekly HD egg production for each of the strains in the various production systems

Experimental Components of Importance:

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 (39th Hatch/Serology Report Vol. 39, No. 1) as described in the hatch report. However, due to hatch complications, additional chicks had to be acquired and delivered to the station fortunately the added chicks had hatch dates that were within 2 days. 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).

The rearing phase for the systems of the enrichable cage, and enriched colony housing system were grown in cages (39th Grow Report Vol. 39, No.2). The grow phase was completed at 16 wks after which the pullets were moved to the laying phase during their 17th wk of age.

Single production cycle records commenced on November 27, 2013 (17 weeks of age), through 89 weeks of age ending on April 15 when the flock records for this production period ended. This report includes production data summarized from 17 to 89 weeks, for each production system and density. A table showing the changes in body weights from 17 to 89 wk of age is included period information.

For the layer tests, a maximum of approximately 830 and minimum of 300 white and brown egg pullets/strain were placed at the initiation of the layer portion of the test depending on which of the test environments the strain was entered into.

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

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

Pullet Housing and Management:

Housing: The pullets were reared in the environment to which they would be in during the laying phase (39th NCLP&MT Grow Report, Vol.39, No. 2). White egg strains and brown egg strains occupied the approximately proportion of the replicates in the rearing system to which they were entered. Individual hens were identified by strain assignment codes that indicate the cage, replicate identification numbers, and the strain assignments for brood-grow House 8. Strain codes are maintained by the PI and Unit Manager for identification of birds and record keeping. Individual birds were identified by a permanent identification tag which at the time they were transferred to the laying house each hen was retagged with the laying house replicate number; indicate room, row, level and replicate. The replicate number identifies individuals from the strain to the unit manager and PI. All aspects of the laying phase were kept the same.

House 8 – This was the Brood/Grow system used to rear the pullets for the conventional battery cage, enrichable cage, and the enriched environmental housing system. In brief House 8, is an environmentally controlled windowless brood-grow facility with 4 rooms each containing 72 replicates within a Big Dutchman quad-deck cage layout. This allows for a total of 3,744 pullets per room. This study utilized all 4 rooms for a total of 11,062 pullets. The white and brown egg strains were randomly 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 in the grow report (39th NCLP&MT Grow Report, Vol.39, No. 2). Thirteen white-egg or brown-egg chicks were in the same cage (13 per 24" x 26" cage) during the entire 16 wk rearing period. Rearing density was 310 cm^2 (48 in^2) for both 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 (378 in) were included in the rearing pen to allow the pullets to learn to utilize vertical space. There were 9 nipples and 2 tube feeders in each pen.

Range housing -- There were 65 chicks housed at approximately 1143 cm^2 for the range birds (177 in^2) started in each pen (12.15 ft x 6.6 ft), with the laying protocol being identical to the CF, EC and ECS hens. They had access to feed (2 tube feeders one on inside one on outside), nipple waterers (8 inside-8 outside), and roosts (384 in) in order to facilitate nest box usage. The range houses 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 house 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 Paddock density was based upon research a 721 bird/acre static equivalency 5.56 m^2/pullet (60 ft^2/hen). The range paddocks were 18.3 m x 18.3 m (60' x 60') and were enclosed by a fence 1.8 m (6 ft). 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 entire paddock area was covered with 2" x 2" nylon net to prevent areal predation. 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.

Layer Housing and Cage Layout Description:

The pullets were moved to the laying facilities, House 5 in accordance with NCSU IACUC approved methods. The strains of pullets were randomly assigned to the replicate cages with white egg strains occupying approximately 60% and brown egg strains the other 40% of the replicates being intermingled throughout the houses. House 5 contains a feeder system that allows feed consumption to be determined by replicate. The replicates are equipped with feed hoppers to supply and monitor feed consumption for each individual replicate and the feed is distributed by an automatic feeding system. 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. In House 4 and in Range Houses 1 and 2 the pullets were caught, weighed and the laying phase hen population was set. Laying Hen Facilities reported in this test consist of 4 houses shown in Table 2.

House 5 is a standard height windowless forced ventilated laying house with battery style Enriched Environmental Housing Systems (ECS) and Enrichable Cages (EC) using a belt manure handling system with the laying protocol being identical to the CF, and R hens. It has 5 banks of FDI triple deck cages, three of which are ECS and two banks with EC. As with the other houses, each side of a bank has been designated as a row and each row is divided into 9 8-foot replicates/level. The replicates contain either four 24" cages or a single 96" cage. The 96 in cages were equipped with a nesting area 24w x 12d x 19h in (288 in^2) and 2 roost ¾ x 2 x 48 in positioned 3 in off the floor, the total length of 96 in, scratch area is 24w x 12d in (288 in^2). The cages in both houses are 26" deep therefore; when the bird population is held constant at 9 hens per cage, in the 24" and 36 or 18 hens per cage, in the 96" cages, the densities are 69, 69, and 139 in^2, respectively. House 5 population is 8,262 hens.

Table 2. Replicate numbers and Hen populations in the Enrichable Cage, Enriched Environmental Housing, and Conventional Battery Style Cage System

House	Cage/Pen Style[1]	Number of Replicates	Hens per replicate	Hen No.	Total Hens
4	CF	36	60	2160	2160
5	EC	104	36	3,744	
5	ECS	79	36	2,844	
5	ECS	76	18	1,368	7,956
Range 1	R	4	60	240	
Range 2	R	4	60	240	480

[1]Cage-free=CF; Enrichable Cage=EC; Enriched Colony Housing System=ECS; Free-range=R

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 with the laying protocol being identical to the R, EC and ECS hens. 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 60 hens at approximately 1238 cm^2 for the cage free birds (192 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 (378 in) were included in the rearing pen to allow the pullets to learn to utilize vertical space. There were 9 nipples and 2 tube feeders in each pen and nest boxes (5 hens/nest).

Range housing -- There were 60 hens housed at approximately 1238 cm^2/hen (192 in2) in the range pen 12.15 ft x 6.6 ft, started in each pen with the laying protocol being identical to the CF, EC and ECS hens. They had access to feed (2 tube feeders one on inside one on outside), nipple waterers (8 inside-8 outside), and roosts (384 in) and nest boxes (5 hens/nest). The range houses 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 hens had access to the outdoors throughout the day and night hours and 95% of the hens return to the range houses 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 Paddock density was based upon research a 721 bird/acre static equivalency 5.56 m^2/pullet (60 ft^2/hen). The range paddocks are 18.3 m x 18.3 m (60' x 60') and were enclosed by a chain link fence 1.8 m (6 ft) high. In order to facilitate range forage replenishment, each of the paddocks were 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 entire paddock area was covered with 2" x 2" nylon net to prevent areal predation. The veranda area was a 3.04 m x 4.6 m (10'x15') shaded area which was bare dirt. Tube feeders were in each pen 1 inside and a covered feeder outside providing 6.4 cm of feeder space /pullet.

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 hen environments were tested between the ages of 40 and 44 weeks for the presence of *Salmonella enteritidis*. All of the environments were found to be negative for *Salmonella enteritidis.*

Lighting Schedule

The lighting schedule for the hens in controlled environment facilities are outlined in Table 3.

Table 3. Layer House and Free-Range House Lighting[2] Schedules

		Houses	
		4 and Range	5
Age	Date	Photo Period[1]	
		(Daylight Hours)	(Daylight Hours)
16-17 weeks	Nov 19, 2013	10.0	10.0
17 Weeks[1]	Nov. 27, 2013	11.0	11.0
18 Weeks	Dec. 4, 2013	11.5	11.5
19 Weeks	Dec. 11, 2013	12.0	12.0
20 Weeks	Dec. 18, 2013	12.5	12.5
21 Weeks	Dec. 24, 2013	13.0	13.0
22 Weeks	Jan. 1, 2014	13.5	13.5
23 Weeks	Jan. 8, 2014	14.0	14.0
24 Weeks	Jan. 15, 2014	14.25	14.25
25 Weeks	Jan. 22, 2014	14.5	14.5
26 Weeks	Jan. 29, 2014	14.75	14.75
27 Weeks	Feb. 5, 2014	15.0	15.0
28 Weeks	Feb. 12, 2014	15.25	15.25
29 Weeks	Feb. 19, 2014	15.5	15.5
30 Weeks	Feb. 26, 2014	15.75	15.75
31 Weeks	March 5, 2014	16.0	16.0
Through 89 Weeks[3]	Nov. 25, 2014	16.0	16.0

[1]Lighting schedules were the same for all of the birds throughout the study except for the natural light in the range huts.
[2]Light intensity for Houses 5, and 7 was 0.5 to 0.7 ft candle at the second tier
[3] Range house lighting consisted of natural day length with supplemental lighting to match day length same as above for the CF System in House 4

Test Design:

The arrangement for the laying test involved a completely randomized design and the main effects were set up in a factorial arrangement. The main effects within Free-Range Houses, Houses 4 and 5 were strain, density, and production system. Following are general descriptions of the main effects:

Strain - Strains were provided from the breeders according to the rules, which govern the conductance of the test. Fertile eggs were set and hatched concurrently (39th Hatch/Serology Report Vol. 39, No. 1) as described in the hatch report.

Density - House 4 all pens were 8 x 10 ft and density was dictated by the hen population in the pen of 60 hens/cage. In Houses 5, all individual replicates within each block contained one strain of layers. The cage density in House 5 was dictated by the cage size 243.8 or 60.9 cm and populations of 36, 18, or 9 hens/cage (Table 4). The Range houses all pens were 12.15 x 6.6 ft and density was dictated by the hen population in the pen of 60 hens/cage.

Table 4. Population and Density Allocations in Enrichable Cage, Enriched Environmental Housing, and Battery Style Conventional Cage System

House	Hens per Cage	Cage/Pen Size Width Depth	Floor Space per Bird	Feeder Space per Bird	Water Nipples per Cage/pen
5	36[1]	243.8 cm x 66.0 cm	447 cm^2 (69 in^2)	6.8 cm (2.7 in)	6
5	18[2]	243.8 cm x 66.0 cm	894 cm^2 (138 in^2)	13.5 cm (5.3 in)	6
5	9	60.9 cm x 66.0 cm	447 cm^2 (69 in^2)	6.8 cm (2.7 in)	2
4	60	243.8 cm x 304.8 cm	1238 cm^2 (192 in^2)	6.4 cm (2.5 in)	9
Range	60	270.3 cm x 201.2 cm	1238 cm^2 (120 in^2)	6.4 cm (2.5 in)	8 inside/outside

[1]Nest area was 51.6 cm^2/hen, Scratch area 51.6 cm^2/hen and the roost space was 6.8 cm/hen
[2]Nest area was 103.2 cm^2/hen, Scratch area 103.2 cm^2/hen and the roost space was 13.5 cm/hen

Layer Nutrition:

Laying hen diets are identified as Diets D, E, F, G, H, I, M, N, and O which consist of a pre-lay diet and a series of layer diets formulated to assure a daily protein, mineral and amino acid intake as shown in Table 5. Feed was offered ad libitum in accordance with the guidelines that all birds should receive acceptable nutrient intake at all times depending on the bird's age and production rate as shown in the Laying House Feeding Program Table 6.

The diets provided during the molt, consisted of a low protein/energy diet and a Resting Diet described in the Molt Diets Table which follow. The molt diets were formulated to provide nutrition for body maintenance. The Resting Diet provides layer with the nutrients needed to maintain a static body weight with no egg production.

Table 5. Minimum Daily Intake of Nutrients per Bird at Various Stages of Production in the 39th NCLP&MT

Production Stage	Pre-Peak > 87%	87-80%	80-70%	<70%
White Egg Layers				
Protein[1](g/day)	19	18	17	16
Calcium (g/day)	4.0	4.1	4.2	4.3
Lysine (mg/day	820	780	730	690
TSAA (mg)day)	700	670	630	590
Brown Egg Layers				
Protein[1](g/day)	20	19	18	17
Calcium (g/day)	4.0	4.0	4.1	4.2
Lysine (mg/day	830	820	780	730
TSAA (mg)day)	710	700	670	630

[1] If the egg production is higher than predicted values protein intake should be increased by 1%
Note: House temperatures dictate the body maintenance demand of the hen if the house temperature is 75 to 80°F feed protein content should be increased accordingly to compensate for metabolic heat needed to maintain a homeostatic body temperature. If the house temperature is at or above 85°F no adjustment is needed.

Table 6 : NCLP&MT Laying House Feeding Program

Rate of Production	Consumption Per (kg/100 Birds/Day)	Diet Fed	
		White Egg Strains	Brown Egg Strains
Weeks 15-17	< 9.52	D	D
Pre-Peak and > 90%	< 9.52 - 10.43	D	E
	10.43 - 12.20	E	F
	12.25 ->13.11	F	G
90-80%	10.43 - 11.29	F	G
	11.34 - 12.20	G	H
	12.25 ->13.11	H	I
70-80%	10.43 - 11.29	H	I
	11.34 - 12.20	I	M
	12.25 ->13.11	M	N
< 70%	10.43 - 11.29	M	N
	11.34 - 12.20	N	O
	12.25 ->13.11	O	O

Note: Low house temperatures and egg production higher than breeder guides for any given hen age will require an adjustment to the dietary phase feeding program to ensure the hens are in a positive nutrient status.

Table 7. 39th NCLP&MT Laying Periods Feed Formulations[1] D through H

Ingredients	D	E	F	G	H
Corn	879.44	1166.03	1202.7	1240.88	1285.39
Soybean meal	636.39	564.55	533.71	506.44	473.06
Fat (Lard)	10.00	10.00			15.68
D.L. Methionine	3.41	2.92	2.31	2.04	1.80
Soybean oil	45.85	25.90	36.29	25.06	
Ground Limestone	124.15	122.36	121.69	110.55	111.82
Coarse Limestone	70.00	70.00	70.00	75.00	75.00
Bi-Carbonate	2.00	2.00	2.00	3.00	2.00
Phosphate Mono/D	21.93	21.50	17.93	26.03	23.89
Salt	6.96	6.41	5.88	5.00	5.48
Vit. premix	1.00	1.00	1.00	1.00	1.00
Min. premix	1.00	1.00	1.00	1.00	1.00
HyD_3 Broiler (62.5 mg/lb)			0.50		
Prop Acid 50% Dry	1.00	1.00	1.00	1.00	1.00
T-Premix	1.00	1.00	1.00	1.00	1.00
.06% Selenium Premix	1.00	1.00	1.00	1.00	1.00
Choline Cl 60%	1.62	1.94	1.59	1.00	0.87
Avizyme	1.00	1.00			
Ronozyme P-CT 540%	0.40	0.40	0.40		
Total	2000.00	2000.00	2000.00	2000.00	2000.00
Calculated Analysis					
Protein %	19.43	18.10	17.50	17.00	16.37
ME kcal/kg	2926.0	2904.0	2882	2860.0	2843.0
Calcium %	4.10	4.05	4.00	3.95	3.95
A. Phos. %	0.45	0.44	0.40	0.38	0.35
Lysine %	1.10	1.00	0.96	0.91	0.87
TSAA %	0.80	0.74	0.69	0.66	0.63

[1]Feeds were manufactured by Southern States

Table 8. 39th NCLP&MT Laying Periods Feed Formulations I through O

Ingredients	I	M	N	O
Corn	1330.70	1315.29	1303.73	1290.76
Soybean meal	440.37	417.79	378.54	337.65
Wheat Midds		39.27	89.80	145.56
D.L. Methionine	1.56	1.24	1.14	0.78
Lysine 78.8%	2.23	0.10		
Ground Limestone	115.69	119.22	123.59	124.94
Coarse Limestone	75.00	75.00	75.00	75.00
Bi-Carbonate	2.00	2.00	2.00	2.00
Phosphate Mono/D	21.74	19.89	16.49	14.00
Salt	5.20	5.10	4.71	4.31
Vit. premix	1.00	1.00	1.00	1.00
Min. premix	1.00	1.00	1.00	1.00
Prop Acid 50% Dry	1.00	1.00	1.00	1.00
T-Premix	1.00	1.00	1.00	1.00
.06% Selenium Premix	1.00	1.00	1.00	1.00
Choline Cl 60%	0.52	0.10		
Total	2000.00	2000.00	2000.00	2000.00
Calculated Analysis				
Protein %	15.87	15.49	14.93	14.37
ME kcal/kg	2821.9	2800.0	2777.8	2755.8
Calcium %	4.00	4.05	4.10	4.10
A. Phos. %	0.33	0.31	.28	0.26
Lysine %	0.91	0.80	0.75	0.71
TSAA %	0.60	0.58	0.56	0.53

[1]Feeds were manufactured by Southern States

Data Collection Schedule, Procedures, and Comments:

Age at 50% Production (Maturity)--The first day at which the birds in the individual replicates achieved 50% production.

Egg Production[1]--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-Housed and Hen-Day basis.

There were unexpected behaviors in the enriched cage system and in the free range related to broody behavior and laying of floor eggs, respectively which may have influenced the overall performance of the hens in those replicates. In order to mitigate these behavioral issues the frequency of egg collection was increased to minimize number of eggs the hens could interact with. In both cases there was egg breakage within these replicates which we could not capture the broken egg numbers.

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 and used to calculate egg income.

Egg Quality[2]--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 in the pilot processing facility and handled as they would be in a commercial off-line facility. In period 1, statistical estimates were made for those replicates where quality information was missing due to late onset of maturity from sister replicates.

Broody behavior was displayed in many replicates in all of the housing environments which resulted in hens sitting in the nests longer, and hens attempting to pull eggs back into the nesting areas from egg trays.

Egg Size Distribution--At twenty-eight day intervals, all eggs produced within the previous 24 hours were weighed and sorted according to current USDA standards for egg size. In period 1, statistical estimates were made for those replicates where size distributions were missing due to late onset of maturity from sister replicates.

Egg Income--Egg income was calculated using current production year calendar and applying a 3 year average egg price on egg production and quality evaluation.

Feed Consumption and Conversion[3]--All feed offered for consumption was recorded for each replicate. At twenty-eight day intervals, feed not consumed was weighed back and feed consumption was calculated. Daily feed intake (kg/100 hens/day) was calculated and reported for each strain.

The layer diets were reformulated to meet the flock nutrient needs based upon data from previous test reports. Based on the nutrient analysis conducted on each load of feed the protein and Ca levels were in accordance with the calculated analysis. However, in the extensive environments where the hen activity levels were greater due to the availability of space to move within the environments, there appears to be a change in the partitioning of nutrients. Even though the diets were formulated to meet the nutritional needs of the hens for optimal performance there were pauses in the early stages of the production cycle indicating a need for additional nutrients in the diet. This was more pronounced in this test with the reduced daily feed consumption rates and increased bird floor space allowances for the environments to meet recommended density standards.

Feed Costs--Feed costs were based on the actual current feed prices for each feed delivery which were calculated and summarized for the complete production cycle.

Body weights--Birds were weighed and weights recorded at housing (17 wk), end of the single cycle (89 wks). Body weight gain for the production cycle were calculated and reported for each strain.

Mortality--All mortalities were recorded daily, and obvious accidents were not included in reported mortalities.

Statistical Analyses and Separation of Means:

All data were subjected to ANOVA utilizing the GLM procedure of JMP11 (SAS, 2014), with main effects of strain, density, and production system used herein. Period was accounted for in the model within each of the production systems. Separate analyses were conducted for white and brown egg strains, the densities within production systems and between the enrichable and enriched colony housing system. Within each production system the Strain and Strain x Density/Housing System interactions were tested for significance. The LSMeans differences from the GLM Procedure were separated via the Tukey HSD option. Comparisons of overall production systems of Density or Housing System were tested for significance and their LS Means from the GLM Procedure were separated via the Student's t option. Significant differences ($P < 0.01$) within white and brown egg strains are noted by differing letters among columns of means.

DESCRIPTION OF DATA TABLE STATISTICS

Single cycle performance of white and brown egg strains in the four production systems are reported from 119-623 days of age for comparative purposes. The Free-range, Cage-free, Enrichable cage and Enriched Colony Housing System and densities from 119-623 days of age and the body weights.

Breeder (Strain): Short identification codes developed for strain and breeder of the stock are shown in Tables 1 and 40.

Hen Housed Eggs per Bird: The total number of eggs produced divided by the number of birds housed at 119 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 between 119 through 623 days of age (Single Cycle). The hens in the Free-range, Cage-free, Enrichable cage and Enriched Colony Housing System are reported separately.

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 (g) for each period sampled. Weight of all eggs collected from previous 24 hours divided by the number of eggs collected.

Egg Income: The calculated income per hen housed at 119 days, from egg production using current production year calendar then calculating the regional average egg prices 11/27/2011 to 12/25/2014. Using the regional weighted average prices for small lots, USDA Grade A and Grade A, white eggs in cartons, from nearby retail outlets of eggs based in North Carolina (USDA-AMS, RA_PY001).

Table 9. Three Year Regional Average Egg Prices

Grade	Size	$$/Dozen 1st Cycle
A	Extra Large	1.4445
A	Large	1.4179
A	Medium	1.1385
A	Small	0.9408
A[1]	Pee Wee	0.4612
B[2]	All	0.7367
Checks[2]	All	0.7367

[1]Prices are estimates based upon the formula provided by D.D. Bell (Small x 0.5)
[2]Prices are estimates based upon the formula provided by D.D. Bell (Large x 0.53)

Grade Information:

The average grade of all eggs sampled according to USDA grading standards over all sampling periods. Grades are established by personnel trained in USDA grading standards.

Egg Size Distribution:

Following are the size classifications used for establishing the USDA egg size grading. There has been blending of egg size in this test with the weight cutoff between medium and large being 23.5. This maximizes the number of USDA large eggs just as would occur in a commercial plant. The proportion of the eggs falling into the following size categories are reported in the tables.

Table 10. USDA Egg Weights Used To Establish The Egg Size Distribution Weighted for Large Eggs.

Size Category	Ounces/Dozen	Minimum grams/egg
Pee Wee	< 18	35
Small	18 – 21	42.5
Medium	21 - 23.5	49.6
Large	23.5 – 27	56.7
Extra Large	> 27	63.8

Feed Cost:

The calculated feed cost per hen housed at 119 days, using the kilogram/diet consumed and the average price of each diet per ton.

Table 11. The Average Contract Feed Price For Feed Purchases During The First Cycle.

Diets	Price Per Ton
D	380.40
E	380.34
F	363.29
G	342.90
H	326.60
I	

Metric Conversions:

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

TABLE 12. EFFECT OF WHITE EGG STRAIN AND PRODUCTION SYSTEM ON PERFORMANCE OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN ENRICHABLE AND ENRICHED COLONY HOUSING SYSTEMS

Breeder	Production System	Feed Consumption[3]	Feed Conversion[3]	Eggs Per Bird Housed	Egg Production[1]	Egg Mass	Mortality	Age at 50% Production
(Strain)		(kg/100/hen/d)	(g egg/g feed)		(HD%)	(g/HD)	(%)	(Days)
Bovans White	69 EC	10.26^{f}	0.475^{defg}	430.20	80.56^{bcde}	48.73^{ef}	15.56^{abc}	144.90^{abc}
	69 ECS	10.50^{def}	0.471^{defg}	423.50	79.83^{de}	48.52^{ef}	25.70^{abc}	146.14^{a}
	Average	10.38^{BC}	0.473^{CD}	426.85^{AB}	80.19^{CD}	48.63^{DE}	20.63^{ABC}	145.52^{A}
Shaver White	69 EC	10.55^{cdef}	0.512^{abc}	415.33	81.49^{bcde}	50.40^{cdef}	28.70^{abc}	142.00^{bcd}
	69 ECS	11.16^{abcd}	0.509^{abcde}	431.50	84.32^{abcd}	52.11^{abcd}	41.67^{a}	140.50^{d}
	Average	10.85^{AB}	0.510^{AB}	423.42^{ABC}	82.91^{BC}	51.26^{C}	35.19^{A}	141.25^{C}
Dekalb White	69 EC	10.97^{bcdef}	0.488^{bcdefg}	427.80	84.55^{ab}	51.84^{abcd}	13.33^{abc}	144.40^{abcd}
	69 ECS	10.79^{bcdef}	0.496^{abcdefg}	424.50	84.10^{abcde}	51.48^{abcde}	16.66^{abc}	144.25^{abcd}
	Average	10.88^{A}	0.492^{ABC}	426.15^{AB}	84.32^{AB}	51.66^{BC}	15.00^{BC}	144.32^{AB}
Babcock White	69 EC	10.68^{bcdef}	0.538^{a}	434.67	86.22^{a}	53.49^{ab}	11.11^{abc}	141.50^{cd}
	69 ECS	11.90^{a}	0.494^{bcdegf}	438.00	86.43^{a}	53.32^{abc}	25.00^{abc}	140.50^{d}
	Average	11.29^{A}	0.516^{A}	436.33^{AB}	86.33^{A}	53.40^{AB}	18.05^{ABC}	140.00^{C}
ISA B-400	69 EC	10.90^{bcdef}	0.509^{abcd}	435.20	86.16^{a}	53.92^{ab}	10.45^{abc}	144.40^{abcd}
	69 ECS	10.97^{bcdef}	0.529^{ab}	443.00	87.18^{a}	54.59^{a}	25.20^{abc}	141.00^{d}
	Average	10.93^{A}	0.519^{A}	439.10^{A}	86.67^{A}	54.26^{A}	17.83^{ABC}	142.70^{BC}
Hy-Line W-36	69 EC	10.20^{f}	0.471^{defg}	399.67	79.15^{e}	48.39^{ef}	5.96^{c}	146.17^{a}
	69 ECS	10.13^{f}	0.478^{cdefg}	396.33	79.74^{e}	47.33^{f}	7.41^{bc}	145.33^{abcd}
	Average	10.17^{C}	0.475^{CD}	398.00^{C}	78.94^{D}	47.86^{E}	6.68^{C}	145.75^{A}
Hy-Line CV-24	69 EC	10.86^{bcdef}	0.462^{fg}	425.40	83.08^{abcde}	51.07^{bcdef}	16.67^{abc}	144.60^{abcd}
	69 ECS	11.30^{abcd}	0.452^{g}	401.50	79.34^{de}	49.36^{def}	14.58^{abc}	145.75^{abc}
	Average	11.08^{A}	0.457^{D}	413.45^{BC}	81.21^{CD}	50.22^{CD}	15.63^{ABC}	145.18^{AB}
Lohmann LSL Lite	69 EC	11.08^{abcde}	0.478^{cdefg}	424.75	83.84^{abcde}	52.20^{abcd}	24.08^{abc}	146.00^{ab}
	69 ECS	11.34^{abc}	0.464^{efg}	413.00	80.82^{bcde}	50.13^{cdef}	21.53^{abc}	144.75^{abcd}
	Average	11.21^{A}	0.471^{CD}	418.87^{ABC}	82.33^{BCD}	51.17^{C}	22.80^{ABC}	145.38^{AB}
H&N Nick Chick	69 EC	10.97^{bcde}	0.489^{bcdefg}	419.83	83.26^{abcde}	52.04^{abcd}	15.28^{abc}	145.33^{ab}
	69 ECS	11.33^{abc}	0.475^{defg}	419.75	82.95^{abcde}	51.65^{abcde}	20.14^{abc}	145.75^{abc}
	Average	11.15^{A}	0.482^{CD}	419.79^{ABC}	83.10^{B}	51.84^{BC}	17.71^{ABC}	145.54^{A}
Novogen White	69 EC	10.91^{bcdef}	0.505^{abcdef}	426.60	84.40abc	53.06^{abc}	20.00^{abc}	144.60^{abcd}
	69 ECS	11.45^{ab}	0.464^{efg}	415.40	81.31^{bcde}	50.96^{bcdef}	32.78^{ab}	145.00^{abcd}
	Average	11.18^{A}	0.485^{BCD}	421.00^{ABC}	82.86^{BC}	52.01^{BC}	26.39^{AB}	144.80^{AB}
All Strains	69 EC	10.74^{Y}	0.493^{Z}	423.94	83.27	51.52	16.11^{Y}	144.39
	69 ECS	11.09^{Z}	0.483^{Y}	420.65	82.50	50.95	23.07^{Z}	143.90

Enrichable Cage=EC; Enriched Colony Housing System=ECS.
ABCD - Different letters denote significant differences (P<.01), comparisons made among strain average values.
abcdefg - Different letters denote significant differences (P<.01) in the strain*housing system interactions
YZ - Different letters denote significant differences (P<.01), comparisons made among production system average values.
Mortality percentage prior to analyzes was transformed in Square Root Asin
[1]See Egg Production section on Page 12
[3]See Feed Consumption and Conversion section on Page 12

TABLE 13. **EFFECT OF WHITE EGG STRAIN AND PRODUCTION SYSTEM ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN ENRICHABLE AND ENRICHED COLONY HOUSING SYSTEMS**

Breeder	Production System	Egg Weight	Pee Wee	Small	Medium	Large	Extra Large
(Strain)		(g/egg)	(%)	(%)	(%)	(%)	(%)
Bovans White	69 EC	59.40^{f}	0.00	5.63	10.28	26.73^{a}	55.70^{d}
	69 ECS	59.68^{ef}	0.00	5.58	10.56	25.41^{abc}	56.76^{cd}
	Average	59.54^{F}	0.00	5.60^{A}	10.42^{AB}	20.07^{A}	56.23^{D}
Shaver White	69 EC	61.18^{abcd}	0.03	4.52	7.57	22.27^{abc}	63.91^{ab}
	69 ECS	61.21^{abcd}	0.00	3.49	8.58	21.46^{abc}	62.97^{abc}
	Average	61.20^{BC}	0.02	4.00^{AB}	8.07^{ABC}	21.86^{B}	63.44^{ABC}
Dekalb White	69 EC	60.59^{cde}	0.00	4.57	8.26	23.15^{abc}	62.56^{abc}
	69 ECS	60.32^{def}	0.00	4.91	7.60	25.46^{abc}	59.93^{bcd}
	Average	60.45^{DE}	0.00	4.74^{AB}	7.93^{ABC}	24.31^{AB}	61.25^{BC}
Babcock White	69 EC	61.41^{abcd}	0.00	3.86	7.98	21.54^{abc}	64.31^{ab}
	69 ECS	61.09^{abcd}	0.36	3.68	8.60	22.10^{abc}	62.60^{abc}
	Average	61.25^{BC}	0.18	3.78^{AB}	8.29^{ABC}	21.84^{B}	63.46^{ABC}
ISA B-400	69 EC	61.90^{a}	0.04	3.92	6.52	19.54^{bc}	68.15^{a}
	69 ECS	61.97^{a}	0.00	3.19	6.72	19.98^{bc}	66.60^{ab}
	Average	61.93^{AB}	0.02	3.56^{B}	6.62^{C}	19.74^{B}	67.37^{A}
Hy-Line W-36	69 EC	60.63^{cde}	0.00	5.64	10.53	19.92^{bc}	62.51^{abc}
	69 ECS	59.60^{ef}	0.00	5.89	12.08	24.16^{abc}	55.68^{d}
	Average	60.11^{EF}	0.00	5.73^{A}	11.31^{A}	22.04^{AB}	59.10^{CD}
Hy-Line CV-24	69 EC	60.63^{bcde}	0.00	4.20	10.29	21.63^{abc}	62.28^{abc}
	69 ECS	61.75^{abc}	0.00	5.86	7.95	20.63^{abc}	63.71^{ab}
	Average	61.19^{BCD}	0.00	5.03^{AB}	9.12^{ABC}	21.13^{B}	63.00^{ABC}
Lohmann LSL Lite	69 EC	61.61^{abc}	0.00	4.50	8.55	18.54^{c}	66.44^{ab}
	69 ECS	61.33^{abcd}	0.00	3.64	7.79	23.77^{abc}	62.73^{abc}
	Average	61.47^{ABC}	0.00	4.07^{AB}	8.17^{ABC}	21.16^{B}	64.58^{AB}
H&N Nick Chick	69 EC	61.68^{abc}	0.00	4.40	7.13	20.62^{bc}	67.17^{a}
	69 ECS	61.60^{abc}	0.00	3.87	8.00	20.55^{bc}	65.09^{ab}
	Average	61.64^{ABC}	0.00	4.13^{AB}	7.57^{BC}	20.58^{B}	66.13^{A}
Novogen White	69 EC	61.96^{a}	0.00	3.80	7.13	20.87^{abc}	67.15^{a}
	69 ECS	62.08^{a}	0.00	3.83	7.83	19.67^{bc}	67.04^{a}
	Average	62.01^{A}	0.00	3.81^{AB}	7.48^{BC}	20.27^{B}	67.08^{A}
All Strains	69 EC	61.10	0.00	4.50	8.42	21.48	64.02^{Z}
	69 ECS	61.06	0.04	4.39	8.57	22.32	62.31^{Y}

Enrichable Cage=EC; Enriched Colony Housing System=ECS.
ABCDEF - Different letters denote significant differences (P<.01), comparisons made among strain average values.
abcdef - Different letters denote significant differences (P<.01) in the strain*production system interactions.

TABLE 14. **EFFECT OF WHITE EGG STRAIN AND PRODUCTION SYSTEM ON EGG QUALITY[2], INCOME AND FEED COSTS OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN ENRICHABLE AND ENRICHED COLONY HOUSING SYSTEMS**

Breeder	Production System	Grade A	Grade B	Cracks	Loss	Egg Income	Feed Costs
(Strain)		(%)	(%)	(%)	(%)	($/hen)	($/hen)
Bovans	69 EC	92.48	0.20	6.64	0.86	48.78^{abc}	21.94^{abcd}
White	69 ECS	90.25	0.08	9.08	0.58	46.40^{abc}	22.21^{abcd}
	Average	91.36	0.14	7.76	0.72	47.59^{ABC}	22.10^{A}
Shaver	69 EC	92.93	0.15	6.70	0.17	47.46^{abc}	21.48^{bcd}
White	69 ECS	84.82	0.18	13.20	1.80	48.11^{abc}	22.62^{abcd}
	Average	88.88	0.16	9.95	0.98	47.78^{AB}	22.05^{AB}
Dekalb	69 EC	94.92	0.70	3.92	0.46	49.27^{ab}	22.32^{abcd}
White	69 ECS	90.45	0.28	8.48	0.82	48.87^{abc}	21.96^{abcd}
	Average	92.68	0.49	6.20	0.64	49.07^{AB}	22.14^{A}
Babcock	69 EC	92.40	0.10	6.78	0.68	49.80^{a}	21.76^{bcd}
White	69 ECS	88.40	0.15	9.58	1.90	49.13^{abc}	24.11^{a}
	Average	90.40	0.12	8.18	1.29	49.46^{AB}	22.94^{A}
ISA	69 EC	94.48	0.32	4.88	0.34	50.23^{a}	22.23^{abcd}
B-400	69 ECS	86.98	0.42	11.02	1.60	49.86^{a}	22.35^{abcd}
	Average	90.73	0.37	7.95	0.97	50.04^{A}	22.29^{A}
Hy-Line	69 EC	94.56	0.10	4.88	0.50	45.43^{bc}	20.65^{d}
W-36	69 ECS	89.03	0.03	9.97	0.90	43.94^{c}	20.68^{cd}
	Average	91.80	0.07	7.42	0.70	44.68^{C}	20.67^{B}
Hy-Line	69 EC	94.76	0.28	4.40	0.54	48.76^{abc}	22.83^{abc}
CV-24	69 ECS	91.02	0.30	7.58	1.08	45.17^{bc}	22.95^{abc}
	Average	92.89	0.29	5.99	0.81	46.96^{BC}	22.89^{A}
Lohmann	69 EC	91.80	0.55	6.58	1.05	48.78^{abc}	22.45^{abcd}
LSL Lite	69 ECS	89.80	0.18	9.22	0.78	46.76^{abc}	23.07^{abc}
	Average	90.80	0.36	7.90	0.91	47.77^{ABC}	22.76^{A}
H&N	69 EC	95.20	0.55	3.90	0.38	48.46^{abc}	22.31^{abcd}
Nick Chick	69 ECS	88.85	0.10	9.22	1.80	47.34^{abc}	22.98^{abc}
	Average	92.02	0.32	6.56	1.09	47.90^{AB}	22.64^{A}
Novogen	69 EC	93.84	0.16	5.26	0.74	49.21^{ab}	22.17^{abcd}
White	69 ECS	90.70	0.68	7.88	0.80	47.24^{abc}	23.34^{ab}
	Average	92.27	0.42	6.57	0.77	48.22^{AB}	22.75^{A}
All	69 EC	93.74^{Y}	0.31	5.37^{Y}	0.57^{Y}	48.62^{Y}	22.02^{Y}
Strains	69 ECS	89.03^{Z}	0.24	9.52^{Z}	1.20^{Z}	47.28^{Z}	22.63^{Z}

Enrichable Cage=EC; Enriched Colony Housing System=ECS.
ABC - Different letters denote significant differences (P<.01), comparisons made among strain average values.
abc - Different letters denote significant differences (P<.01) in the strain*production system interactions
YZ - Different letters denote significant differences (P<.01), comparisons made among production system average values.
[2]See Egg Quality section on Page 12

TABLE 15. EFFECT OF BROWN EGG STRAIN AND PRODUCTION SYSTEM ON PERFORMANCE OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN ENRICHABLE AND ENRICHED COLONY HOUSING SYSTEMS

Breeder	Production System	Feed Consumption[3]	Feed Conversion[3]	Eggs Per Bird Housed	Egg Production[1]	Egg Mass	Mortality	Age at 50% Production
(Strain)		(kg/100/hen/d)	(g egg/g feed)		(HD%)	(g/HD)	(%)	(Days)
TETRA	69 EC	10.78^{bc}	0.440^{bc}	400.14	95.21^{abcd}	46.49	12.30^{ab}	145.00^{abc}
Amber	69 ECS	11.20^{abc}	0.410^{c}	377.50	91.75^{abcde}	43.71	10.42^{ab}	145.50^{abc}
	Average	10.99^{ABC}	0.425^{C}	388.82^{AB}	93.48	45.10^{B}	11.36^{AB}	145.25^{AB}
TETRA	69 EC	10.70^{bc}	0.447^{abc}	377.67	95.87^{abcd}	45.06	28.70^{a}	143.67^{abc}
Brown	69 ECS	11.03^{abc}	0.429^{bc}	377.33	91.27^{abcde}	45.00	12.04^{ab}	145.00^{abc}
	Average	10.88^{ABC}	0.438^{BC}	377.50^{B}	93.57	45.03^{B}	20.37^{A}	144.33^{ABC}
Novogen	69 EC	10.60^{c}	0.489^{a}	400.00	96.46^{ab}	48.74	11.67^{ab}	144.00^{abc}
Brown	69 ECS	11.08^{abc}	0.475^{ab}	400.80	89.48^{de}	49.29	11.11^{ab}	144.00^{abc}
	Average	10.84^{ABC}	0.482^{A}	400.40^{AB}	92.97	49.01^{AB}	11.39^{AB}	144.00^{ABC}
Lohmann	69 EC	10.61^{c}	0.482^{ab}	411.67	96.37^{abc}	49.75	9.10^{ab}	145.00^{abc}
LB-Lite	69 ECS	11.93^{abc}	0.458^{abc}	398.75	88.62^{e}	48.39	11.80^{ab}	145.75^{abc}
	Average	10.77^{BC}	0.470^{AB}	405.21^{AB}	92.49	49.07^{AB}	10.45^{AB}	145.38^{AB}
Hy-Line	69 EC	11.04^{abc}	0.459^{abc}	409.00	96.45^{abc}	47.43	8.10^{ab}	143.50^{abc}
Silver Brown	69 ECS	11.40^{ab}	0.452^{abc}	409.25	92.32^{abcde}	47.37	15.28^{ab}	141.50^{bc}
	Average	11.22^{AB}	0.455^{ABC}	409.12^{A}	94.39	47.40^{AB}	11.69^{AB}	142.50^{BC}
Hy-Line	69 EC	10.61^{c}	0.485^{ab}	386.00	95.38^{abcd}	46.57	3.70^{b}	141.17^{c}
Brown	69 ECS	11.15^{abc}	0.456^{abc}	385.20	89.96^{cde}	46.69	7.22^{ab}	142.20^{abc}
	Average	10.88^{ABC}	0.470^{AB}	385.60^{AB}	92.67	46.63^{AB}	5.46^{B}	141.68^{C}
ISA	69 EC	10.54^{c}	0.475^{ab}	400.83	94.27^{abcde}	48.77	15.74^{ab}	147.33^{a}
Brown	69 ECS	10.80^{abc}	0.468^{ab}	407.60	91.04^{abcde}	49.03	10.49^{ab}	146.00^{abc}
	Average	10.67^{C}	0.471^{AB}	404.22^{AB}	92.65	48.90^{AB}	13.12^{AB}	146.67^{A}
Bovans	69 EC	11.06^{abc}	0.457^{abc}	406.28	94.03^{abcde}	49.30	8.99^{ab}	146.43^{ab}
Brown	69 ECS	11.49^{a}	0.450^{abc}	410.20	90.12^{bcde}	50.16	8.89^{ab}	146.00^{abc}
	Average	11.27^{A}	0.454^{ABC}	408.24^{A}	92.07	49.73^{A}	8.94^{AB}	146.21^{A}
All	69 EC	10.74^{Y}	0.467^{Z}	398.95	95.50^{Y}	47.76	12.29	144.51
Strains	69ECS	11.14^{Z}	0.450^{Y}	395.83	90.57^{Z}	47.46	10.91	144.49

Enrichable Cage=EC; Enriched Colony Housing System=ECS.
ABCD - Different letters denote significant differences (P<.01), comparisons made among strain average values.
abcdefgh - Different letters denote significant differences (P<.01) in the strain*production system interactions
YZ - Different letters denote significant differences (P<.01), comparisons made among production system average values.
Mortality percentage prior to analyzes was transformed in Square Root Asin
[1]See Egg Production section on Page 12
[3]See Feed Consumption and Conversion section on Page 12

TABLE 16. **EFFECT OF BROWN EGG STRAIN AND PRODUCTION SYSTEM ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF HENS IN THE 39th NCLP&MT (119-483 DAYS) IN ENRICHABLE AND ENRICHED COLONY HOUSING SYSTEMS**

Breeder	Production System	Egg Weight	Pee Wee	Small	Medium	Large	Extra Large
(Strain)		(g/egg)	(%)	(%)	(%)	(%)	(%)
TETRA	69 EC	58.42^{d}	0.02	5.12	15.86	29.51	48.09
Amber	69 ECS	58.36^{d}	0.35	5.70	16.21	26.32	49.45
	Average	58.39C	0.18	5.41	16.04^{A}	27.91^{AB}	48.77^{C}
TETRA	69 EC	60.71^{abcd}	0.00	3.46	11.40	24.73	59.71
Brown	69 ECS	60.21^{abcd}	0.00	3.22	11.63	26.04	57.42
	Average	60.46^{AB}	0.00	3.34	11.53^{AB}	25.38^{AB}	58.56^{ABC}
Novogen	69 EC	61.38^{a}	0.00	2.64	8.59	23.62	63.94
Brown	69 ECS	61.99^{a}	0.00	2.34	9.86	21.22	63.92
	Average	61.69^{A}	0.00	2.49	9.23^{B}	22.42^{B}	63.93^{A}
Lohmann	69 EC	60.57^{abcd}	0.00	4.21	9.36	22.92	62.52
LB-Lite	69 ECS	60.96^{abc}	0.00	3.38	9.55	20.06	63.65
	Average	60.76^{A}	0.00	3.79	9.45^{B}	21.49^{B}	63.09^{A}
Hy-Line	69 EC	58.43^{bcd}	0.09	3.35	14.61	30.54	50.39
Silver Brown	69 ECS	58.44^{bcd}	0.00	3.27	18.25	29.56	46.88
	Average	58.44^{ABC}	0.04	3.31	16.43^{A}	30.06^{A}	48.63^{C}
Hy-Line	69 EC	60.87^{abc}	0.12	1.68	10.11	26.81	60.01
Brown	69 ECS	61.28^{ab}	0.00	1.17	9.02	25.81	61.17
	Average	61.08^{A}	0.06	1.42	9.56^{B}	26.31^{AB}	60.59^{A}
ISA	69 EC	61.27^{ab}	0.00	3.29	8.42	24.63	61.95
Brown	69 ECS	60.48^{abcd}	0.37	2.03	10.44	26.10	58.77
	Average	60.87^{A}	0.18	2.66	9.43^{B}	25.36^{AB}	60.36^{AB}
Bovans	69 EC	61.03^{abc}	0.02	2.74	11.49	22.55	61.28
Brown	69 ECS	61.81^{a}	0.00	2.60	10.02	23.34	61.50
	Average	61.42^{A}	0.01	2.67	10.76^{AB}	22.94^{AB}	61.39^{A}
All	69 EC	60.33	0.03	3.31	11.23	25.66	58.49
Strains	69 ECS	60.44	0.09	2.96	11.88	24.81	57.84

Enrichable Cage=EC; Enriched Colony Housing System=ECS.
ABC - Different letters denote significant differences (P<.01), comparisons made among strain average values.
abcde - Different letters denote significant differences (P<.01) in the strain*production system interactions.

TABLE 17. **EFFECT OF BROWN EGG STRAIN AND PRODUCTION SYSTEM ON EGG QUALITY[2], INCOME AND FEED COSTS OF HENS IN THE 39th NCLP&MT (119-483 DAYS) IN ENRICHABLE AND ENRICHED COLONY HOUSING SYSTEMS**

Breeder	Production System	Grade A	Grade B	Cracks	Loss	Egg Income	Feed Costs
(Strain)		(%)	(%)	(%)	(%)	($/hen)	($/hen)
TETRA	69 EC	95.21^{abcd}	0.21	4.04^{ab}	0.53	44.83^{ab}	21.61
Amber	69 ECS	91.75^{abcde}	0.08	7.60^{ab}	0.52	41.37^{b}	22.40
	Average	93.48	0.14	5.82	0.53	43.10^{B}	22.00^{AB}
TETRA	69 EC	95.87^{abcd}	0.27	3.73^{ab}	0.10	42.94^{ab}	21.43
Brown	69 ECS	91.27^{abcde}	0.37	7.70^{ab}	0.37	42.32^{ab}	22.14
	Average	93.57	0.32	5.72	0.38	42.63^{B}	21.79^{AB}
Novogen	69 EC	96.46^{ab}	0.16	2.76^{b}	0.64	46.14^{ab}	21.25
Brown	69 ECS	89.48^{de}	0.66	9.36^{a}	0.50	45.08^{ab}	22.21
	Average	92.97	0.41	6.06	0.57	46.61^{AB}	21.73^{AB}
Lohmann	69 EC	96.37^{abc}	0.20	2.93^{b}	0.50	47.39^{a}	21.30
LB-Lite	69 ECS	88.62^{e}	0.22	10.22^{a}	0.92	44.24^{ab}	21.89
	Average	92.50	0.21	6.58	0.71	45.82^{AB}	21.59^{AB}
Hy-Line	69 EC	96.45^{abc}	0.00	5.52^{ab}	0.05	46.97^{ab}	21.13
Silver Brown	69 ECS	92.32^{abcde}	0.02	6.85^{ab}	0.80	45.48^{ab}	22.81
	Average	94.39	0.01	5.19	0.42	46.27^{AB}	22.47^{AB}
Hy-Line	69 EC	95.38^{abcd}	0.05	3.28^{b}	1.28	44.08^{ab}	21.28
Brown	69 ECS	89.96^{cde}	0.22	9.46^{a}	0.36	43.65^{ab}	22.30
	Average	92.67	0.14	6.37	0.82	43.87^{AB}	21.79^{AB}
ISA	69 EC	94.27^{abcde}	0.77	3.98^{ab}	0.97	46.12^{ab}	21.09
Brown	69 ECS	91.04^{abcde}	0.02	8.50^{ab}	0.40	46.21^{ab}	21.66
	Average	92.65	0.39	6.24	0.68	46.17^{AB}	21.37^{B}
Bovans	69 EC	94.03^{abcde}	0.14	5.34^{ab}	0.50	46.26^{ab}	21.17
Brown	69 ECS	90.12^{bcde}	0.02	8.52^{ab}	1.30	46.38^{ab}	22.98
	Average	92.07	0.08	6.93	0.90	46.32^{A}	22.58^{A}
All	69 EC	95.50^{Y}	0.22	3.70^{Y}	0.57	45.59^{Y}	21.53
Strains	69 ECS	90.57^{Z}	0.20	8.53^{Z}	0.68	44.35^{Z}	22.30

Enrichable Cage=EC; Enriched Colony Housing System=ECS.
AB - Different letters denote significant differences (P<.01), comparisons made among strain average values.
abcde - Different letters denote significant differences (P<.01) in the strain*production system interactions.
YZ - Different letters denote significant differences (P<.01), comparisons made among production system average values.
[2]See Egg Quality section on Page 12

TABLE 18. **EFFECT OF WHITE EGG STRAIN AND PRODUCTION SYSTEM ON BODY WEIGHT OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN ENRICHABLE AND ENRICHED COLONY HOUSING SYSTEM: NON-MOLTED PROGRAM**

Breeder	Production System	17 Wk* Body Wt	89 Wk** Body Wt	1st Cycle Wt Gain
(Strain)		(kg)	(kg)	(%)
Bovans	69 EC	1.22	1.70	28.34
White	69 ECS	1.22	1.74	30.00
	Average	1.22[AB]	1.72	29.18
Shaver	69 EC	1.35	1.80	29.30
White	69 ECS	1.28	1.76	26.90
	Average	1.32[A]	1.78	28.10
Dekalb	69 EC	1.20	1.72	27.89
White	69 ECS	1.20	1.68	30.82
	Average	1.20[AB]	1.70	29.36
Babcock	69 EC	1.28	1.85	27.93
White	69 ECS	1.31	1.76	27.48
	Average	1.30[AB]	1.81	27.70
ISA	69 EC	1.22	1.76	30.71
B-400	69 ECS	1.18	1.65	27.45
	Average	1.20[AB]	1.71	29.08
Hy-Line	69 EC	1.22	1.72	28.81
W-36	69 ECS	1.20	1.72	30.09
	Average	1.21[AB]	1.72	29.45
Hy-Line	69 EC	1.22	1.66	39.88
CV-26	69 ECS	1.12	1.87	26.38
	Average	1.17[B]	1.76	33.13
Hy-Line	69 EC	1.22	1.67	25.88
CV-24	69 ECS	1.22	1.72	29.57
	Average	1.22[AB]	1.70	27.72
Lohmann	69 EC	1.27	1.73	28.12
LSL Lite	69 ECS	1.22	1.74	27.38
	Average	1.24[AB]	1.74	27.76
H&N	69 EC	1.21	1.78	30.93
Nick Chick	69 ECS	1.24	1.68	25.30
	Average	1.23[AB]	1.72	28.11
Novogen	69 EC	1.24	1.82	29.36
White	69 ECS	1.22	1.78	31.35
	Average	1.23[AB]	1.80	30.36
All	69 EC	1.24	1.74	28.51
Strains	69 ECS	1.22	1.74	29.66

Enrichable Cage=EC; Enriched Colony Housing System=ECS.
AB - Different letters denote significant differences (P<.01), comparisons made among strain average values.
(*) All replicates in all strains were weight at 17 wks,
(**) Only a sample of replicates (2 per strain treatment) in each strain were weighted at 89wks.

TABLE 19. **EFFECT OF BROWN EGG STRAIN AND PRODUCTION SYSTEM ON BODY WEIGHT OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN ENRICHABLE AND ENRICHED COLONY HOUSING SYSTEM: NON-MOLTED PROGRAM**

Breeder	Production System	17 Wk* Body Wt	89 Wk** Body Wt	1st Cycle Wt Gain
(Strain)		(kg)	(kg)	(%)
TETRA	69 EC	1.50	2.06	25.00
Amber	69 ECS	1.50	1.79	13.24
	Average	1.50	1.92	19.12
TETRA	69 EC	1.64	2.03	19.28
Brown	69 ECS	1.54	1.97	21.96
	Average	1.58	2.00	20.62
Novogen	69 EC	1.60	1.88	18.44
Brown	69 ECS	1.55	1.78	12.18
	Average	1.58	1.83	15.30
Lohmann	69 EC	1.44	1.84	22.21
LB-Lite	69 ECS	1.52	1.91	20.59
	Average	1.48	1.88	21.40
Hy-Line	69 EC	1.64	2.14	24.74
Silver Brown	69 ECS	1.42	1.88	24.02
	Average	1.53	2.01	24.38
Hy-Line	69 EC	1.62	1.94	17.16
Brown	69 ECS	1.53	1.86	22.95
	Average	1.58	1.90	20.06
ISA	69 EC	1.47	1.84	20.78
Brown	69 ECS	1.45	1.80	19.66
	Average	1.46	1.82	20.22
Bovans	69 EC	1.52	1.94	23.22
Brown	69 ECS	1.60	1.79	10.28
	Average	1.56	1.86	16.75
All	69 EC	1.55	1.96^{Y}	21.35
Strains	69 ECS	1.51	1.85^{Z}	18.11

Enrichable Cage=EC; Enriched Colony Housing System=ECS.
YZ - Different letters denote significant differences (P<.01), comparisons made among density average values.
(*) All replicates in all strains were weight at 17 wks,
(**) Only a sample of replicates (2 per strain treatment) in each strain were weighted at 69 and 73 wks.

TABLE 20. EFFECT OF WHITE EGG STRAIN AND DENSITY ON PERFORMANCE OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN THE ENRICHED COLONY HOUSING SYSTEMS

Breeder	Density[1]	Feed Consumption[3]	Feed Conversion[3]	Eggs Per Bird Housed	Egg Production[1]	Egg Mass	Mortality	Age at 50% Production
(Strain)	(in^2/hen)	(kg/100/hen/d)	(g egg/g feed)		(HD%)	(g/HD)	(%)	(Days)
Bovans	69 ECS	10.63^{cde}	0.471^{bcde}	423.50	81.22^{def}	49.56^{hij}	25.70^{ab}	146.14^{a}
White	138 ECS	10.84^{bcd}	0.491^{abcd}	436.00	85.02^{abc}	52.80^{bcdefg}	16.67^{ab}	143.14^{abcd}
	Average	10.74^{B}	0.481^{D}	429.75^{AB}	83.12^{DE}	51.18^{C}	21.18	144.64^{A}
Shaver	69 ECS	11.11^{abc}	0.503^{abc}	431.50	83.59^{bcde}	51.72^{cdefgh}	41.67^{a}	140.50^{cd}
White	138 ECS	10.74^{bcde}	0.519^{a}	441.25	86.99^{ab}	54.14^{abcd}	5.55^{b}	142.00^{abcd}
	Average	10.93^{AB}	0.511^{AB}	436.38^{AB}	85.29^{ABCD}	52.93^{AB}	23.61	141.25^{B}
Dekalb	69 ECS	10.77^{bcde}	0.489^{abcde}	424.50	83.38^{bcde}	51.15^{efghi}	16.67^{ab}	144.25^{abcd}
White	138 ECS	10.78^{bcde}	0.500^{abcd}	445.75	87.88^{a}	53.72^{abcde}	8.33^{ab}	142.25^{abcd}
	Average	10.77^{B}	0.494^{ABCD}	435.12^{AB}	85.63^{ABC}	52.43^{BC}	12.50	143.25^{AB}
Babcock	69 ECS	11.85^{a}	0.491^{abcde}	438.00	86.07^{abc}	53.18^{bcdef}	25.00^{ab}	140.50^{cd}
White	138 ECS	10.88^{bcd}	0.528^{a}	447.40	88.33^{a}	55.90^{a}	4.45^{b}	141.20^{bcd}
	Average	11.36^{A}	0.510^{ABC}	442.70^{A}	87.20^{A}	54.54^{A}	14.72	140.85^{B}
ISA	69 ECS	10.96^{bcd}	0.525^{a}	443.00	86.70^{ab}	54.34^{abc}	25.20^{ab}	141.00^{bcd}
B-400	138 ECS	11.01^{abcd}	0.508^{ab}	436.75	86.14^{abc}	54.62^{ab}	9.72^{ab}	139.75^{d}
	Average	10.99^{AB}	0.517^{A}	439.88^{AB}	86.41^{AB}	54.48^{A}	17.46	140.38^{B}
Hy-Line	69 ECS	10.13^{de}	0.470^{bcde}	396.33	78.24^{f}	47.11^{j}	7.40^{ab}	145.33^{abc}
W-36	138 ECS	9.87^{e}	0.495^{abcd}	403.00	79.60^{ef}	48.63^{ij}	3.70^{b}	145.67^{abc}
	Average	10.00^{C}	0.483^{BCD}	399.67^{C}	78.92^{F}	47.87^{D}	5.55	145.50^{A}
Hy-Line	69 ECS	11.26^{abc}	0.446^{e}	401.50	78.85^{f}	49.11^{hij}	14.58^{ab}	145.75^{ab}
CV-24	138 ECS	10.81^{bcd}	0.487^{abcde}	429.75	84.81^{abcd}	52.64^{bcdefg}	11.11^{ab}	145.25^{abc}
	Average	11.04^{AB}	0.466^{D}	415.62^{BC}	81.83^{E}	50.87^{C}	12.85	145.50^{A}
Lohmann	69 ECS	11.32^{abc}	0.461^{cde}	413.00	80.93^{def}	50.35^{ghi}	21.53^{ab}	144.75^{abc}
LSL Lite	138 ECS	10.95^{bcd}	0.498^{abcd}	439.25	86.17^{abc}	54.39^{abc}	16.67^{ab}	144.25^{abcd}
	Average	11.14^{AB}	0.480^{D}	426.12^{ABC}	83.55^{CDE}	52.37BC	19.10	144.50^{A}
H&N	69 ECS	11.29^{abc}	0.468^{bcde}	419.75	82.27^{cdef}	51.31^{defghi}	20.14^{ab}	145.75^{ab}
Nick Chick	138 ECS	10.02^{abcd}	0.499^{abcd}	440.00	86.71^{ab}	54.96^{ab}	13.89^{ab}	144.25^{abcd}
	Average	11.16^{AB}	0.483^{BCD}	429.88^{AB}	84.49^{BCDE}	53.13^{AB}	17.01	145.00^{A}
Novogen	69 ECS	11.45^{ab}	0.458^{de}	415.40	80.98^{def}	50.87^{fghi}	32.78^{ab}	145.00^{abc}
White	138 ECS	10.96^{bcd}	0.508^{ab}	439.80	86.52^{ab}	55.11^{ab}	8.89^{ab}	143.67^{abcd}
	Average	11.21^{AB}	0.483^{BCD}	427.60^{AB}	83.75^{CDE}	52.99^{AB}	20.84	144.33^{A}
All	69 ECS	11.08^{Z}	0.503^{Z}	420.65^{Z}	82.22^{Z}	50.87^{Z}	23.07^{Z}	143.90
Strains	138 ECS	10.79^{Y}	0.478^{Y}	435.89^{Y}	85.82^{Y}	53.69^{Y}	9.90^{Y}	143.14

[1]All strains were housed such that each strain is equally represented in each density.
Enriched Colony Housing System=ECS
ABCDEF - Different letters denote significant differences (P<.01), comparisons made among strain average values.
abcdefghjj - Different letters denote significant differences (P<.01) in the strain*density interactions.
YZ - Different letters denote significant differences (P<.01), comparisons made among density average values.
Mortality percentage prior to analyzes was transformed in Square Root Asin
[1]See Egg Production section on Page 12
[3]See Feed Consumption and Conversion section on Page 12

TABLE 21. EFFECT OF WHITE EGG STRAIN AND DENSITY ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN THE ENRICHED COLONY HOUSING SYSTEMS

Breeder	Density[1]	Egg Weight	Pee Wee	Small	Medium	Large	Extra Large
(Strain)	(in^2/hen)	(g/egg)	(%)	(%)	(%)	(%)	(%)
Bovans White	69 ECS	60.06^{gh}	0.00	6.05	9.70^{abcd}	22.64^{abcd}	59.05^{f}
	138 ECS	61.19^{cdefg}	2.70	2.43	5.71^{a}	23.14^{a}	62.89^{ef}
	Average	60.63^{C}	1.32	4.24	7.71A	22.89^{A}	60.97^{A}
Shaver White	69 ECS	61.32^{cdef}	0.00	3.43	8.57^{abcde}	20.20^{abcde}	63.61^{def}
	138 ECS	61.53^{bcdef}	0.69	3.10	6.86^{abcde}	19.18^{abcde}	66.87^{abcde}
	Average	61.42^{B}	0.35	3.27	7.72^{ABCD}	19.69^{ABCD}	65.24^{ABC}
Dekalb White	69 ECS	59.86^{h}	0.00	4.97	7.58^{ab}	23.01^{ab}	61.69^{ef}
	138 ECS	60.48^{fgh}	1.39	2.18	9.87^{abcd}	22.75^{abcd}	61.22^{ef}
	Average	60.17^{C}	0.69	3.57	8.73^{AB}	22.88^{AB}	61.46^{CD}
Babcock White	69 ECS	61.25^{cdefg}	0.37	3.67	8.64^{abcde}	20.12^{abcde}	63.94^{cdef}
	138 ECS	62.61^{ab}	0.11	3.29	5.07^{bcde}	16.34^{bcde}	73.18^{a}
	Average	61.93^{AB}	0.24	3.48	6.85^{BCD}	18.23^{BCD}	68.56^{A}
ISA B-400	69 ECS	62.03^{abcde}	0.00	3.14	6.69^{abcde}	19.28^{abcde}	67.07^{abcde}
	138 ECS	62.73^{ab}	1.04	2.18	5.80^{abcd}	15.71^{bcde}	71.56^{abc}
	Average	62.38^{A}	0.52	2.66	6.24^{B}	17.49^{CD}	69.31^{A}
Hy-Line W-36	69 ECS	59.73^{h}	0.00	6.00	12.35^{a}	22.54^{abcd}	56.18^{f}
	138 ECS	60.70^{efgh}	1.85	1.02	11.65^{ab}	21.63^{abcde}	61.01^{ef}
	Average	60.22^{C}	0.92	3.51	12.00^{A}	22.08^{ABC}	58.60^{D}
Hy-Line CV-24	69 ECS	61.84^{abcde}	0.00	5.96	7.80^{abcd}	19.08^{abcde}	64.47^{bcdef}
	138 ECS	60.96^{defgh}	1.04	2.60	10.15^{abcd}	19.11^{abcde}	62.94^{def}
	Average	61.40^{B}	0.51	4.28	9.08^{AB}	19.10^{ABCD}	63.70^{BCD}
Lohmann LSL Lite	69 ECS	61.55^{bcdef}	0.00	3.65	7.84^{abcd}	21.56^{abcde}	64.27^{cdef}
	138 ECS	62.19^{abcd}	1.61	2.52	6.87^{abcd}	16.33^{bcde}	70.05^{abcd}
	Average	61.87^{AB}	0.80	3.09	7.35^{B}	18.94^{ABCD}	67.16^{AB}
H&N Nick Chick	69 ECS	61.74^{abcdef}	0.00	3.86	8.01^{abcd}	18.83^{abcde}	66.11^{abcde}
	138 ECS	62.34^{abc}	2.78	1.68	7.74^{abcd}	15.53^{cde}	69.87^{abcd}
	Average	62.04^{AB}	1.39	2.77	7.88^{AB}	17.18^{CD}	67.99^{AB}
Novogen White	69 ECS	62.24^{abc}	0.00	3.86	7.82^{abcd}	17.97^{abcde}	68.12^{abcde}
	138 ECS	62.82^{a}	1.10	4.26	4.46^{d}	14.55^{e}	71.62^{ab}
	Average	62.53^{A}	0.54	4.06	6.14^{B}	16.26^{D}	69.87^{A}
All Strains	69 ECS	61.22^{Z}	0.00^{Y}	4.46^{Z}	8.52	20.52^{Y}	63.45^{Z}
	138 ECS	61.69^{Y}	1.43^{Z}	2.53^{Y}	7.42	18.43^{Z}	67.12^{Y}

[1]All strains were housed such that each strain is equally represented in each density.
Enriched Colony Housing System=ECS.
ABCD - Different letters denote significant differences (P<.01), comparisons made among strain average values.
abcdefgh - Different letters denote significant differences (P<.01) in the strain*density interactions.
YZ - Different letters denote significant differences (P<.01), comparisons made among density average values.

TABLE 22. **EFFECT OF WHITE EGG STRAIN AND DENSITY ON EGG QUALITY[2], INCOME AND FEED COSTS OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN THE ENRICHED COLONY HOUSING SYSTEMS**

Breeder	Density[1]	Grade A	Grade B	Cracks	Loss	Egg Income	Feed Costs
(Strain)	(in^2/hen)	(%)	(%)	(%)	(%)	($/hen)	($/hen)
Bovans	69 ECS	90.25	0.08	9.08	0.58	46.40[abc]	22.21
White	138 ECS	87.10	0.38	11.68	0.90	49.40[abc]	22.38
	Average	88.68	0.22	10.38	0.74	47.90[ABC]	22.30[A]
Shaver	69 ECS	84.82	0.18	13.20	1.80	48.11[abc]	22.61
White	138 ECS	85.05	0.12	13.98	0.88	48.88[abc]	21.96
	Average	84.94	0.15	13.59	1.34	48.50[AB]	22.29[A]
Dekalb	69 ECS	90.45	0.28	8.48	0.82	48.87[abc]	21.96
White	138 ECS	90.42	0.00	9.48	0.12	49.61[abc]	22.00
	Average	90.44	0.14	8.98	0.48	49.24[AB]	21.98[AB]
Babcock	69 ECS	88.40	0.15	9.58	1.90	49.13[abc]	24.11
White	138 ECS	89.12	0.08	10.42	0.38	50.60[a]	22.22
	Average	88.76	0.12	10.00	1.14	49.86[A]	23.16[A]
ISA	69 ECS	86.98	0.42	11.02	1.60	49.86[ab]	22.35
B-400	138 ECS	83.60	0.05	15.72	0.62	48.28[abc]	22.48
	Average	85.29	0.24	13.38	1.11	49.07[AB]	22.42[A]
Hy-Line	69 ECS	89.03	0.03	9.97	0.90	43.94[c]	20.68
W-36	138 ECS	89.30	0.00	9.23	1.47	44.99[bc]	20.16
	Average	89.17	0.02	9.60	1.18	44.47[C]	20.42[B]
Hy-Line	69 ECS	91.02	0.30	7.58	1.08	45.17[bc]	22.96
CV-24	138 ECS	83.62	1.22	14.30	0.82	47.88[abc]	22.04
	Average	87.32	0.76	10.94	0.95	46.52[BC]	22.50[A]
Lohmann	69 ECS	89.80	0.18	9.22	0.78	46.76[abc]	23.07
LSL Lite	138 ECS	89.62	0.75	9.60	0.05	49.83[ab]	22.30
	Average	89.71	0.46	9.41	0.41	48.30[AB]	22.69[A]
H&N	69 ECS	88.85	0.10	9.22	1.80	47.34[abc]	22.98
Nick Chick	138 ECS	89.12	0.08	10.75	0.02	49.87[ab]	22.51
	Average	88.99	0.09	9.99	0.91	48.60AB	22.74[A]
Novogen	69 ECS	90.70	0.68	7.88	0.80	47.24[abc]	23.34
White	138 ECS	84.04	0.12	14.90	0.96	48.86[abc]	22.33
	Average	87.37	0.40	11.39	0.88	48.05[AB]	22.84[A]
All	69 ECS	87.10	0.24	9.52	1.20	47.28[Z]	22.63[Y]
Strains	138 ECS	89.03	0.28	12.00	0.62	48.82[Y]	22.04[Z]

[1]All strains were housed such that each strain is equally represented in each density.
Enriched Colony Housing System=ECS.
ABC - Different letters denote significant differences (P<.01), comparisons made among strain average values.
abc - Different letters denote significant differences (P<.01) in the strain*density interactions
YZ - Different letters denote significant differences (P<.01), comparisons made among density average values.
[2]See Egg Quality section on Page 12

TABLE 23. EFFECT OF BROWN EGG STRAIN AND DENSITY ON PERFORMANCE OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN THE ENRICHED COLONY HOUSING SYSTEMS

Breeder	Density[1]	Feed Consumption[3]	Feed Conversion[3]	Eggs Per Bird Housed	Egg Production[1]	Egg Mass	Mortality	Age at 50% Production
(Strain)	(in^2/hen)	(kg/100/hen/d)	(g egg/g feed)		(HD%)	(g/HD)	(%)	(Days)
TETRA	69 ECS	11.20^{ab}	0.410^{d}	377.50	74.40^{def}	43.71^{g}	10.42	145.50^{ab}
Amber	138 ECS	11.02^{ab}	0.426cd	393.25	77.53^{bcdef}	46.10^{efg}	6.94	143.00^{ab}
	Average	11.11^{ABC}	0.418^{D}	385.38^{AB}	75.97^{C}	44.91^{C}	8.68	144.25^{ABC}
TETRA	69 ECS	11.06^{ab}	0.429^{bcd}	377.33	74.30^{def}	45.04^{fg}	12.04	145.00^{ab}
Brown	138 ECS	11.06^{ab}	0.425^{cd}	376.33	74.20^{ef}	45.03^{fg}	5.56	140.33^{ab}
	Average	11.06^{ABC}	0.427^{CD}	376.83^{B}	74.25^{C}	45.04^{C}	8.80	142.67^{ABC}
Novogen	69 ECS	11.08^{ab}	0.439^{bcd}	400.80	79.02^{abcdef}	49.29^{abcde}	11.11	144.00^{ab}
Brown	138 ECS	11.12^{ab}	0.475^{ab}	384.60	75.69^{cdef}	47.29^{cdefg}	16.38	141.80^{ab}
	Average	11.10^{ABC}	0.457^{ABC}	392.70^{AB}	77.36B^{C}	48.29^{AB}	13.74	142.90^{ABC}
Lohmann	69 ECS	10.93^{ab}	0.458^{bcd}	398.75	78.62^{abcdef}	48.39^{bcdef}	11.80	145.75^{ab}
LB-Lite	138 ECS	10.56^{b}	0.508^{a}	427.75	84.41^{a}	52.34^{a}	2.78	142.25_{ab}
	Average	10.75^{C}	0.483^{A}	413.25^{A}	81.52^{A}	50.36^{A}	7.29	144.00_{ABC}
Hy-Line	69 ECS	11.39^{a}	0.452^{bcd}	409.25	80.70^{abcd}	47.37^{cdefg}	15.28	141.50_{ab}
Silver Brown	138 ECS	11.18^{ab}	0.448^{bcd}	414.50	81.82^{ab}	48.38^{bcdef}	4.17	140.00^{ab}
	Average	11.29^{AB}	0.450^{BC}	411.88^{AB}	81.26^{A}	47.87^{AB}	9.72	140.75^{BC}
Hy-Line	69 ECS	11.14^{ab}	0.455^{bcd}	385.20	76.86^{cdef}	46.64^{defg}	7.22	142.20^{ab}
Brown	138 ECS	11.13^{ab}	0.442^{bcd}	382.20	75.68^{cdef}	46.96^{cdefg}	3.34	139.40^{b}
	Average	11.14^{ABC}	0.449^{BC}	383.70^{AB}	75.77^{C}	46.80^{BC}	5.28	140.80^{C}
ISA	69 ECS	10.80^{ab}	0.468^{abc}	407.60	80.36^{abcde}	49.03^{abcdef}	10.49	146.00^{a}
Brown	138 ECS	10.98^{ab}	0.475^{ab}	410.60	80.88^{abc}	51.42^{ab}	6.67	144.60^{ab}
	Average	10.89^{BC}	0.471^{AB}	409.10^{AB}	80.62^{AB}	50.23^{A}	8.58	145.30^{A}
Bovans	69 ECS	11.49^{a}	0.451^{bcd}	410.20	80.90^{abc}	50.16^{abc}	8.89	146.00^{a}
Brown	138 ECS	11.54^{a}	0.443^{bcd}	398.75	78.58^{abcdef}	50.06^{abcd}	11.11	144.00^{ab}
	Average	11.52^{A}	0.447^{BCD}	404.48^{AB}	79.74^{AB}	50.13^{A}	10.00	145.00^{AB}
All	69 ECS	11.14	0.450	395.83	78.02	47.45^{Z}	10.91^{Z}	144.49^{Y}
Strains	138 ECS	11.08	0.450	398.50	78.60	48.45^{Y}	7.12^{Y}	141.92^{Z}

[1]All strains were housed such that each strain is equally represented in each density.
Enrichable Cage=EC; Enriched Colony Housing System=ECS.
ABC - Different letters denote significant differences (P<.01), comparisons made among strain average values
abcdefg - Different letters denote significant differences (P<.01) in the strain*density interactions.
YZ - Different letters denote significant differences (P<.01), comparisons made among density average values.
Mortality percentage prior to analyzes was transformed in Square Root Asin
[1]See Egg Production section on Page 12
[3]See Feed Consumption and Conversion section on Page 12

TABLE 24. EFFECT OF BROWN EGG STRAIN AND DENSITY ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN THE ENRICHED COLONY HOUSING SYSTEMS

Breeder	Density[1]	Egg Weight	Pee Wee	Small	Medium	Large	Extra Large
(Strain)	(in^2/hen)	(g/egg)	(%)	(%)	(%)	(%)	(%)
TETRA	69 ECS	58.36^{f}	0.35	5.70^{a}	16.21^{ab}	26.32^{abcd}	49.45^{ef}
Amber	138 ECS	58.79^{ef}	1.39	3.52^{ab}	11.80^{bcd}	28.21^{abc}	51.21^{def}
	Average	58.58^{D}	0.87	4.61^{A}	14.00^{A}	27.26^{AB}	50.33^{C}
TETRA	69 ECS	60.26^{de}	0.00	3.16^{ab}	11.46^{bcde}	26.26^{abcd}	57.45^{cde}
Brown	138 ECS	60.42^{d}	2.43	2.56^{ab}	7.01^{cde}	26.19^{abcd}	60.14^{cd}
	Average	60.33^{C}	1.21	2.86^{AB}	9.23^{B}	26.22^{ABC}	58.80^{B}
Novogen	69 ECS	61.99^{ab}	0.00	2.34^{ab}	9.86^{cde}	21.22^{cdef}	63.92^{bc}
Brown	138 ECS	61.85^{abc}	0.49	1.91^{b}	5.36^{e}	19.00^{def}	70.79^{ab}
	Average	61.92^{AB}	0.25	2.13^{B}	7.61^{B}	20.11^{E}	67.36^{A}
Lohmann	69 ECS	60.96^{bcd}	0.00	3.38^{ab}	9.55^{cde}	20.06^{cdef}	63.65^{bc}
LB-Lite	138 ECS	61.49^{bcd}	0.40	2.98^{ab}	6.49^{de}	20.61^{cdef}	66.60^{abc}
	Average	61.22^{BC}	0.20	3.18^{AB}	8.02^{B}	20.33^{DE}	65.13A
Hy-Line	69 ECS	58.43^{f}	0.00	3.21^{ab}	18.31^{a}	29.56^{ab}	46.88^{f}
Silver Brown	138 ECS	58.70^{ef}	0.78	3.59^{ab}	13.14^{abc}	31.26^{a}	50.14^{ef}
	Average	58.56^{D}	0.39	3.40^{AB}	15.73^{A}	30.41^{A}	48.51^{C}
Hy-Line	69 ECS	61.28^{bcd}	0.00	1.18^{b}	9.02^{cde}	25.76^{abcd}	61.21^{c}
Brown	138 ECS	61.64^{bcd}	0.80	2.40^{ab}	5.52^{e}	24.83^{abcde}	65.03^{bc}
	Average	61.46^{B}	0.40	1.79^{B}	7.27^{B}	25.29^{BCD}	63.12^{AB}
ISA	69 ECS	60.47^{d}	0.37	2.03^{ab}	10.44^{bcde}	26.10^{abcd}	58.77^{cd}
Brown	138 ECS	63.08^{a}	0.00	3.35^{ab}	5.18^{e}	15.87^{f}	73.68^{a}
	Average	61.78^{AB}	0.18	2.69^{AB}	7.81^{B}	20.99^{CDE}	66.22^{A}
Bovans	69 ECS	61.81^{abc}	0.00	2.60^{ab}	10.02^{cde}	23.34^{bcde}	61.50^{c}
Brown	138 ECS	63.08^{a}	0.00	0.93^{ab}	5.88^{de}	17.62^{ef}	71.39^{ab}
	Average	62.44^{A}	0.00	2.77^{AB}	7.95^{B}	20.48^{DE}	66.44^{A}
All	69 ECS	60.44^{Z}	0.09^{Y}	2.95	11.86^{Y}	24.83	57.85^{Z}
Strains	138 ECS	61.13^{Y}	0.79^{Z}	2.91	7.55^{Z}	22.95	63.62^{Y}

[1]All strains were housed such that each strain is equally represented in each density.
Enriched Colony Housing System=ECS.
ABCD - Different letters denote significant differences (P<.01), comparisons made among strain average values.
abcdef - Different letters denote significant differences (P<.01) in the strain*density interactions.
YZ - Different letters denote significant differences (P<.01), comparisons made among density average values.

TABLE 25. **EFFECT OF BROWN EGG STRAIN AND DENSITY ON EGG QUALITY[2], INCOME AND FEED COSTS OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN THE ENRICHED COLONY HOUSING SYSTEMS**

Breeder	Density[1]	Grade A	Grade B	Cracks	Loss	Egg Income	Feed Costs
(Strain)	(in^2/hen)	(%)	(%)	(%)	(%)	($/hen)	($/hen)
TETRA	69 ECS	91.75	0.08	7.60	0.52	41.37	22.40
Amber	138 ECS	86.02	0.50	12.70	0.78	43.30	22.18
	Average	88.89	0.29	10.15	0.65	42.33	22.29[AB]
TETRA	69 ECS	91.27	0.37	7.70	0.67	42.32	22.14
Brown	138 ECS	93.97	0.03	4.93	1.13	42.55	22.25
	Average	92.62	0.20	6.32	0.90	42.44	22.20[AB]
Novogen	69 ECS	89.48	0.66	9.36	0.50	45.08	22.21
Brown	138 ECS	90.00	0.34	9.34	0.32	43.67	22.39
	Average	89.74	0.50	9.35	0.41	44.38	22.30[AB]
Lohmann	69 ECS	88.62	0.22	10.22	0.92	44.24	21.89
LB-Lite	138 ECS	86.52	0.10	13.32	0.05	47.66	21.26
	Average	87.58	0.16	11.78	0.49	45.95	21.57[B]
Hy-Line	69 ECS	92.32	0.02	6.85	0.80	45.58	22.81
Silver Brown	138 ECS	92.12	0.42	7.32	0.12	46.32	22.45
	Average	92.22	0.22	7.09	0.46	45.95	22.63[AB]
Hy-Line	69 ECS	89.96	0.22	9.46	0.36	43.65	22.30
Brown	138 ECS	93.22	0.10	5.86	0.86	43.17	22.40
	Average	91.59	0.16	7.66	0.61	43.41	22.35[AB]
ISA	69 ECS	91.04	0.02	8.50	0.40	46.21	21.66
Brown	138 ECS	89.74	0.02	9.72	0.54	46.61	22.05
	Average	90.39	0.02	9.11	0.47	46.41	21.86[B]
Bovans	69 ECS	90.12	0.02	8.52	1.30	46.38	22.98
Brown	138 ECS	91.50	0.05	8.05	0.45	45.50	23.21
	Average	90.81	0.04	8.28	0.88	45.94	23.10
All	69 ECS	90.39	0.20	8.53	0.68	44.36	22.30
Strains	138 ECS	90.57	0.20	8.90	0.53	44.85	22.27

[1]All strains were housed such that each strain is equally represented in each density.
Enriched Colony Housing System=ECS.
AB - Different letters denote significant differences ($P<.01$), comparisons made among strain average values.
YZ - Different letters denote significant differences ($P<.01$), comparisons made among density average values.
[2]See Egg Quality section on Page 12

TABLE 26. EFFECT OF WHITE EGG STRAIN AND DENSITY ON BODY WEIGHT OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN THE ENRICHED COLONY HOUSING SYSTEM: NON-MOLTED PROGRAM

Breeder	Density[1]	17 Wk* Body Wt	89 Wk** Body Wt	Cycle Wt Gain
(Strain)	(in^2/hen)	(kg)	(kg)	(%)
Bovans	69 ECS	1.22	1.74	30.00
White	138 ECS	1.32	1.72	26.76
	Average	1.27	1.73	28.38
Shaver	69 ECS	1.28	1.76	26.90
White	138 ECS	1.34	1.80	25.27
26.09	Average	1.32	1.78	26.09
Dekalb	69 ECS	1.20	1.68	30.82
White	138 ECS	1.20	1.71	26.62
	Average	1.20	1.70	28.72
Babcock	69 ECS	1.31	1.76	27.48
White	138 ECS	1.36	1.88	31.81
	Average	1.34	1.82	29.64
ISA	69 ECS	1.18	1.66	27.46
B-400	138 ECS	1.23	1.70	27.44
	Average	1.20	1.68	27.45
Hy-Line	69 ECS	1.20	1.72	30.09
W-36	138 ECS	1.22	1.69	31.32
	Average	1.21	1.70	30.70
Hy-Line	69 ECS	1.12	1.87	39.88
CV-26	138 ECS	1.19	1.82	34.76
	Average	1.16	1.84	37.32
Hy-Line	69 ECS	1.22	1.72	29.56
CV-24	138 ECS	1.24	1.73	26.00
	Average	1.23	1.73	27.78
Lohmann	69 ECS	1.22	1.74	27.38
LSL Lite	138 ECS	1.24	1.68	25.92
	Average	1.23	1.71	26.65
H&N	69 ECS	1.24	1.68	26.30
Nick Chick	138 ECS	1.24	1.76	27.96
	Average	1.24	1.72	26.62
Novogen	69 ECS	1.22	1.78	31.35
White	138 ECS	1.26	1.76	28.84
	Average	1.24	1.77	30.10
All	69 ECS	1.22	1.74	29.66
Strains	138 ECS	1.26	1.75	28.43

[1]All strains were housed such that each strain is equally represented in each density. Enriched Colony Housing System=ECS.
(*) All replicates in all strains were weight at 17 wks,
(**) Only a sample of replicates (2 per strain treatment) in each strain were weighted at 69 and 73 wks.

TABLE 27. **EFFECT OF BROWN EGG STRAIN AND DENSITY ON BODY WEIGHT OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN THE ENRICHED COLONY HOUSING SYSTEM: NON-MOLTED PROGRAM**

Breeder	Density[1]	17 Wk* Body Wt	89 Wk** Body Wt	1st Cycle Wt Gain
(Strain)	(in^2/hen)	(kg)	(kg)	(%)
TETRA	69 ECS	1.50	1.79^{b}	13.24
Amber	138 ECS	1.55	2.08^{a}	23.44
	Average	1.52	1.94	18.34
TETRA	69 ECS	1.54	1.97^{ab}	21.96
Brown	138 ECS	1.58	1.94^{ab}	18.08
	Average	1.56	1.95	20.02
Novogen	69 ECS	1.55	1.78^{b}	12.18
Brown	138 ECS	1.58	1.84^{ab}	12.66
	Average	1.56	1.81	12.42
Lohmann	69 ECS	1.52	1.91^{ab}	20.59
LB-Lite	138 ECS	1.57	1.86^{ab}	14.97
	Average	1.54	1.88	17.78
Hy-Line	69 ECS	1.42	1.88^{ab}	24.01
Silver Brown	138 ECS	1.70	1.99^{ab}	14.83
	Average	1.56	1.93	19.42
Hy-Line	69 ECS	1.53	1.86^{ab}	22.95
Brown	138 ECS	1.64	2.04^{ab}	19.68
	Average	1.58	1.95	21.32
ISA	69 ECS	1.45	1.80^{b}	19.66
Brown	138 ECS	1.48	1.82^{ab}	19.18
	Average	1.46	1.81	19.42
Bovans	69 ECS	1.60	1.79^{b}	10.28
Brown	138 ECS	1.60	1.95^{ab}	17.94
	Average	1.60	1.87	14.11
All	69 ECS	1.51	1.94^{Y}	18.11
Strains	138 ECS	1.58	1.85^{Z}	17.60

Enriched Colony Housing System=ECS.
ab - Different letters denote significant differences (P<.01) in the strain*density interactions
YZ - Different letters denote significant differences (P<.01), comparisons made among density average values.
(*) All replicates in all strains were weighed at 17 wks,
(**) Only a sample of replicates (2 per strain treatment) in each strain were weighed at 69 and 73 wks.

TABLE 28. EFFECT OF WHITE EGG STRAIN ON PERFORMANCE OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN THE CAGE-FREE HOUSING SYSTEMS

Breeder	Feed Consumption[3]	Feed Conversion[3]	Eggs Per Bird Housed	Egg Production[1]	Egg Mass	Mortality*	Age at 50% Production*
(Strain)	(kg/100/hen/d)	(g egg/g feed)		(HD%)	(g/HD)	(%)	(Days)
Dekalb White	12.12^{A}	0.44^{ABC}	433.65	84.7^{A}	53.7^{AB}	11.3^{B}	144^{AB}
Hy-Line W-36	11.44^{B}	0.41^{CD}	374.20	77.0^{B}	47.0^{D}	13.0^{AB}	145^{A}
Hy-Line CV-26	11.46^{AB}	0.44^{ABC}	416.30	82.3^{A}	50.7^{C}	12.2^{AB}	145^{A}
Hy-Line CV-24	11.55^{AB}	0.43^{CD}	425.20	84.0^{A}	52.0^{BC}	15.6^{AB}	144^{AB}
Hy-Line CV-22	11.30^{B}	0.43^{CD}	389.00	77.0^{B}	48.1^{D}	9.7^{B}	142^{B}
Lohmann LSL Lite	11.26^{AB}	0.46^{AB}	423.45	83.5^{A}	53.6^{AB}	22.2^{A}	145^{A}
H&N Nick Chick	11.55^{AB}	0.47^{A}	425.25	84.0^{A}	54.9^{A}	13.0^{AB}	146^{A}
Novogen White	12.26^{A}	0.44^{AB}	421.95	83.3^{A}	53.5^{AB}	17.2^{AB}	144^{AB}
All Strains	11.62	0.44	413.62	82.0	51.7	14.3	144

ABCD - Different letters denote significant differences (P<.01), comparisons made among strain average values.
Mortality percentage prior to analyzes was transformed in Square Root Asin (*) Student test
[1]See Egg Production section on Page 12
[3]See Feed Consumption and Conversion section on Page 12

TABLE 29. EFFECT OF WHITE EGG STRAIN ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN THE CAGE-FREE HOUSING SYSTEMS

Breeder	Egg Weight	Pee Wee	Small	Medium	Large	Extra Large
(Strain)	(g/egg)	(%)	(%)	(%)	(%)	(%)
Dekalb White	62.6^{CD}	0.13	4.30	3.16^{B}	13.62^{BC}	74.52^{AB}
Hy-Line W-36	60.7^{E}	0	4.47	9.04^{A}	19.49^{A}	63.45^{D}
Hy-Line CV-26	61.0^{E}	0	4.81	6.66^{AB}	22.12^{A}	63.14^{D}
Hy-Line CV-24	61.2^{DE}	0.20	3.52	7.20^{AB}	17.61^{AB}	67.74^{CD}
Hy-Line CV-22	62.1^{CD}	0	2.72	5.86^{AB}	16.30^{AB}	70.83^{BC}
Lohmann LSL Lite	63.4^{AB}	0	3.33	5.19^{AB}	11.48^{BC}	76.00^{AB}
H&N Nick Chick	64.3^{A}	0	4.51	3.45^{B}	8.58^{C}	79.00^{A}
Novogen White	63.5^{A}	0	3.70	4.71^{B}	11.96^{BC}	76.92^{AB}
All Strains	62.4	0.04	3.92	5.66	15.14	71.45

ABCD - Different letters denote significant differences (P<.01), comparisons made among strain average values.

TABLE 30. **EFFECT OF WHITE EGG STRAIN ON EGG QUALITY[2], INCOME AND FEED COSTS OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN THE CAGE-FREE HOUSING SYSTEMS**

Breeder	Grade A	Grade B	Cracks	Loss	Egg Income	Feed Costs
(Strain)	(%)	(%)	(%)	(%)	($/hen)	($/hen)
Dekalb White	95.7	0.42	2.80	1.05	50.31	24.7
Hy-Line W-36	96.4	0.03	3.29	0.20	43.15	23.3
Hy-Line CV-26	96.8	0.28	2.12	0.83	48.16	23.6
Hy-Line CV-24	96.2	0.20	3.43	0.19	49.33	23.8
Hy-Line CV-22	95.8	0.37	3.26	0.55	45.16	23.3
Lohmann LSL Lite	96.0	0.65	3.07	0.28	49.49	23.2
H&N Nick Chick	95.5	0.41	3.47	0.56	49.60	23.8
Novogen White	97.3	0.18	2.16	0.37	49.45	25.3
All Strains	96.2	0.32	2.95	0.50	48.08	24.20

[2]See Egg Quality section on Page 12

TABLE 31. EFFECT OF WHITE EGG STRAIN ON BODY WEIGHT OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN THE CAGE-FREE HOUSING SYSTEMS

Breeder	17 Wk* Body Wt	89 Wk** Body Wt	1st Cycle Wt Gain
(Strain)	(kg)	(kg)	(%)
Dekalb White	1.17^{A}	1.92	39.37
Hy-Line W-36	1.08^{B}	1.93	44.11
Hy-Line CV-26	1.12^{AB}	1.78	37.28
Hy-Line CV-24	1.15^{AB}	1.83	36.68
Hy-Line CV-22	1.12^{AB}	1.85	39.22
Lohmann LSL Lite	1.19^{A}	1.94	38.44
H&N Nick Chick	1.17^{A}	1.92	38.73
Novogen White	1.18^{A}	1.91	38.19
All Strains	1.15	1.88	39.00

ABC - Different letters denote significant differences (P<.01), comparisons made among strain average values.

TABLE 32. EFFECT OF BROWN EGG STRAIN ON PERFORMANCE OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN THE CAGE-FREE HOUSING SYSTEMS

Breeder	Feed Consumption[3]	Feed Conversion[3]	Eggs Per Bird Housed	Egg Production[1]	Egg Mass	Mortality	Age at 50% Production
(Strain)	(kg/100/hen/d)	(g egg/g feed)		(HD%)	(g/HD)	(%)	(Days)
TETRA Amber	12.03^{ABC}	0.42	410.50	81.1^{ABC}	49.5^{CD}	12.14	145
TETRA Brown	12.14^{ABC}	0.42	410.65	80.9^{ABC}	50.6^{BCD}	22.28	146
Novogen Brown	11.91^{ABC}	0.45	427.40	84.5^{A}	54.4^{A}	18.84	145
Lohmann LB-Lite	12.23^{AB}	0.44	431.15	85.2^{A}	53.5^{AB}	18.01	146
Hy-Line Silver Brown	11.63^{ABC}	0.42	395.85	78.2^{C}	48.0^{CD}	14.74	146
Hy-Line Brown	11.53^{BC}	0.44	407.95	80.7^{ABC}	52.0^{ABC}	10.51	146
ISA Brown	11.34^{BC}	0.44	400.00	79.0^{BC}	50.7^{BCD}	16.35	146
Bovans Brown	12.40^{A}	0.44	424.15	83.9^{AB}	54.0^{A}	12.16	146
All Strains	11.90	0.43	413.46	81.7	51.6	15.63	146

ABC - Different letters denote significant differences (P<.01), comparisons made among strain average values
Mortality percentage prior to analyzes was transformed in Square Root Asin
[1]See Egg Production section on Page 12
[3]See Feed Consumption and Conversion section on Page 12

TABLE 33. **EFFECT OF BROWN EGG STRAIN ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN THE CAGE-FREE HOUSING SYSTEMS**

Breeder (Strain)	Egg Weight (g/egg)	Pee Wee (%)	Small (%)	Medium (%)	Large (%)	Extra Large (%)
TETRA Amber	60.2^{C}	0	3.8	7.8	23.2^{A}	63.6^{E}
TETRA Brown	61.7^{B}	0	4.0	4.7	19.2^{AB}	69.5^{CDE}
Novogen Brown	63.5^{A}	0	2.4	4.8	13.2^{B}	76.9^{AB}
Lohmann LB-Lite	61.9^{B}	0	2.4	5.4	19.0^{AB}	72.0^{BCD}
Hy-Line Silver Brown	60.3^{C}	0	5.0	3.9	23.0^{A}	65.6^{DE}
Hy-Line Brown	63.6^{A}	0	1.0	4.4	11.8^{B}	80.6^{A}
ISA Brown	63.4^{A}	0	3.2	3.8	16.1^{AB}	75.4^{ABC}
Bovans Brown	63.5^{A}	0	3.3	3.1	12.6^{B}	78.2^{AB}
All Strains	62.26	0	3.1	4.7	17.3	72.7

ABCDE - Different letters denote significant differences (P<.01), comparisons made among strain average values.

TABLE 34. EFFECT OF BROWN EGG STRAIN ON EGG QUALITY[2], INCOME AND FEED COSTS OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN THE CAGE-FREE HOUSING SYSTEMS

Breeder	Grade A	Grade B	Cracks	Loss	Egg Income	Feed Costs
(Strain)	(%)	(%)	(%)	(%)	($/hen)	($/hen)
TETRA Amber	98.5	0.0	1.30	0.18	48.00	23.84
TETRA Brown	97.4	0.4	1.70	0.48	48.31	23.99
Novogen Brown	97.3	0.5	1.45	0.74	50.29	23.58
Lohmann LB-Lite	98.8	0.1	0.83	0.27	50.97	24.17
Hy-Line Silver Brown	97.7	0.2	2.05	0.01	46.59	23.03
Hy-Line Brown	98.0	0.1	1.60	0.40	48.27	22.87
ISA Brown	98.4	0.1	1.29	0.18	47.32	22.47
Bovans Brown	97.4	0.4	1.47	0.74	49.98	24.57
All Strains	97.94	0.2	1.46	0.38	48.71	23.56

[2]See Egg Quality section on Page 12

TABLE 35. **EFFECT OF BROWN EGG STRAIN ON BODY WEIGHT OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN THE CAGE-FREE HOUSING SYSTEMS**

Breeder	17 Wk* Body Wt	89 Wk** Body Wt	1st Cycle Wt Gain
(Strain)	(kg)	(kg)	(%)
TETRA Amber	1.30	2.21	41.00
TETRA Brown	1.31	1.90	30.96
Novogen Brown	1.34	2.07	35.48
Lohmann LB-Lite	1.30	2.08	37.50
Hy-Line Silver Brown	1.32	2.32	43.19
Hy-Line Brown	1.25	2.17	42.27
ISA Brown	1.32	2.07	36.18
Bovans Brown	1.31	2.12	38.44
All Strains	1.31	2.12	38.13

TABLE 36. **EFFECT OF BROWN AND WHITE EGG STRAIN ON PERFORMANCE OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN THE FREE-RANGE HOUSING SYSTEMS**

Breeder	Feed Consumption[3]	Feed Conversion[3]	Eggs Per Bird Housed	Egg Production[1]	Egg Mass	Mortality	Age at 50% Production
(Strain)	(kg/100/hen/d)	(g egg/g feed)		(HD%)	(g/HD)	(%)	(Days)
Hy-Line Silver Brown	11.90[A]	0.42	409.22	80.81	50.7	4.16[B]	143
Hy-Line Brown	11.63[AB]	0.43	408.02	76.02	50.1	3.33[B]	149
Hyline CV-22	10.92[B]	0.47	384.68	80.33	51.5	13.30[A]	145
All Strains	11.48	0.44	400.64	79.05	50.77	6.93	146

AB - Different letters denote significant differences (P<.01), comparisons made among strain average values
Mortality percentage prior to analyzes was transformed in Square Root Asin
[1]See Egg Production section on Page 12
[3]See Feed Consumption and Conversion section on Page 12

TABLE 37. **EFFECT OF BROWN AND WHITE EGG STRAIN ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN THE FREE-RANGE HOUSING SYSTEMS**

Breeder	Egg Weight	Pee Wee	Small	Medium	Large	Extra Large
(Strain)	(g/egg)	(%)	(%)	(%)	(%)	(%)
Hy-Line Silver Brown	61.97	0	1.94	6.85	19.30	71.71
Hy-Line Brown	64.87	0	3.08	1.57	13.90	80.79
Hy-Line CV-22	63.88	0	2.06	6.05	15.30	75.74
All Strains	63.57	0	2.36	4.82	16.17	76.08

TABLE 38. **EFFECT OF BROWN EGG STRAIN ON EGG QUALITY[2], INCOME AND FEED COSTS HENS IN THE 39th NCLP&MT (119-623 DAYS) IN THE FREE-RANGE HOUSING SYSTEMS**

Breeder	Grade A	Grade B	Cracks	Loss	Egg Income	Feed Costs
(Strain)	(%)	(%)	(%)	(%)	($/hen)	($/hen)
Hy-Line Silver Brown	99.17^{A}	0.09	1.02^{AB}	0.27	34.56	23.55
Hy-Line Brown	98.33^{A}	0.27	0.55^{B}	0.19	35.03	22.94
Hy-Line CV-22	97.74^{B}	0.09	1.89^{A}	0.52	33.38	22.40
All Strains	98.41	0.15	1.15	0.33	34.32	22.96

AB - Different letters denote significant differences (P<.01), comparisons made among strain average values.
[2]See Egg Quality section on Page 12

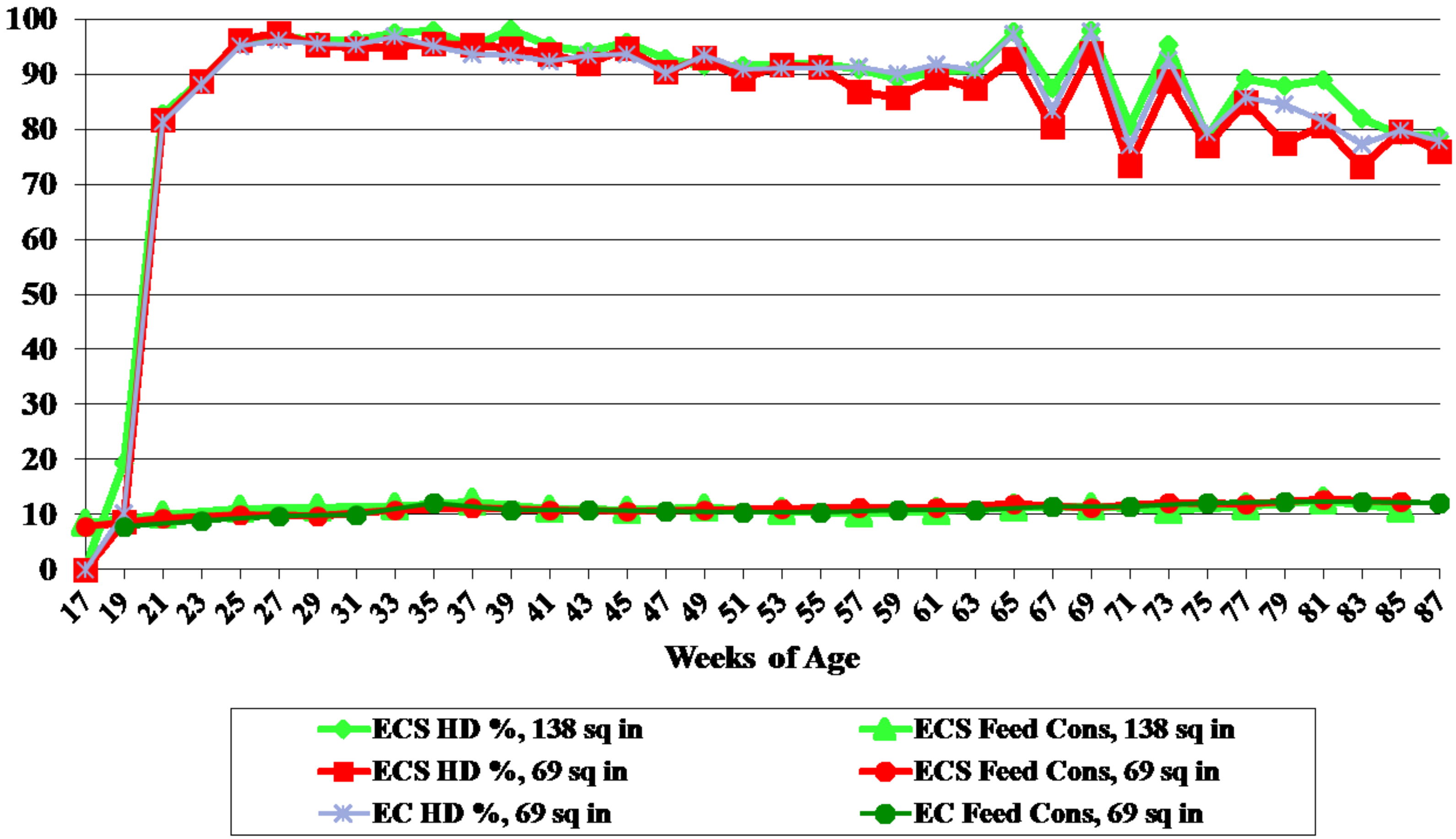
TABLE 39. **EFFECT OF BROWN AND WHITE EGG STRAIN ON BODY WEIGHT OF HENS IN THE 39th NCLP&MT (119-623 DAYS) IN THE FREE-RANGE HOUSING SYSTEMS**

Breeder	17 Wk* Body Wt	89 Wk** Body Wt	1st Cycle Wt Gain
(Strain)	(kg)	(kg)	(%)
Hy-Line Silver Brown	1.38^{A}	2.88^{A}	39.82
Hy-Line Brown	1.26^{B}	2.12^{A}	40.80
Hy-Line CV-22	1.16^{B}	1.80^{B}	35.36
All Strains	1.27	2.27	38.66

AB - Different letters denote significant differences (P<.01), comparisons made among strain average values.

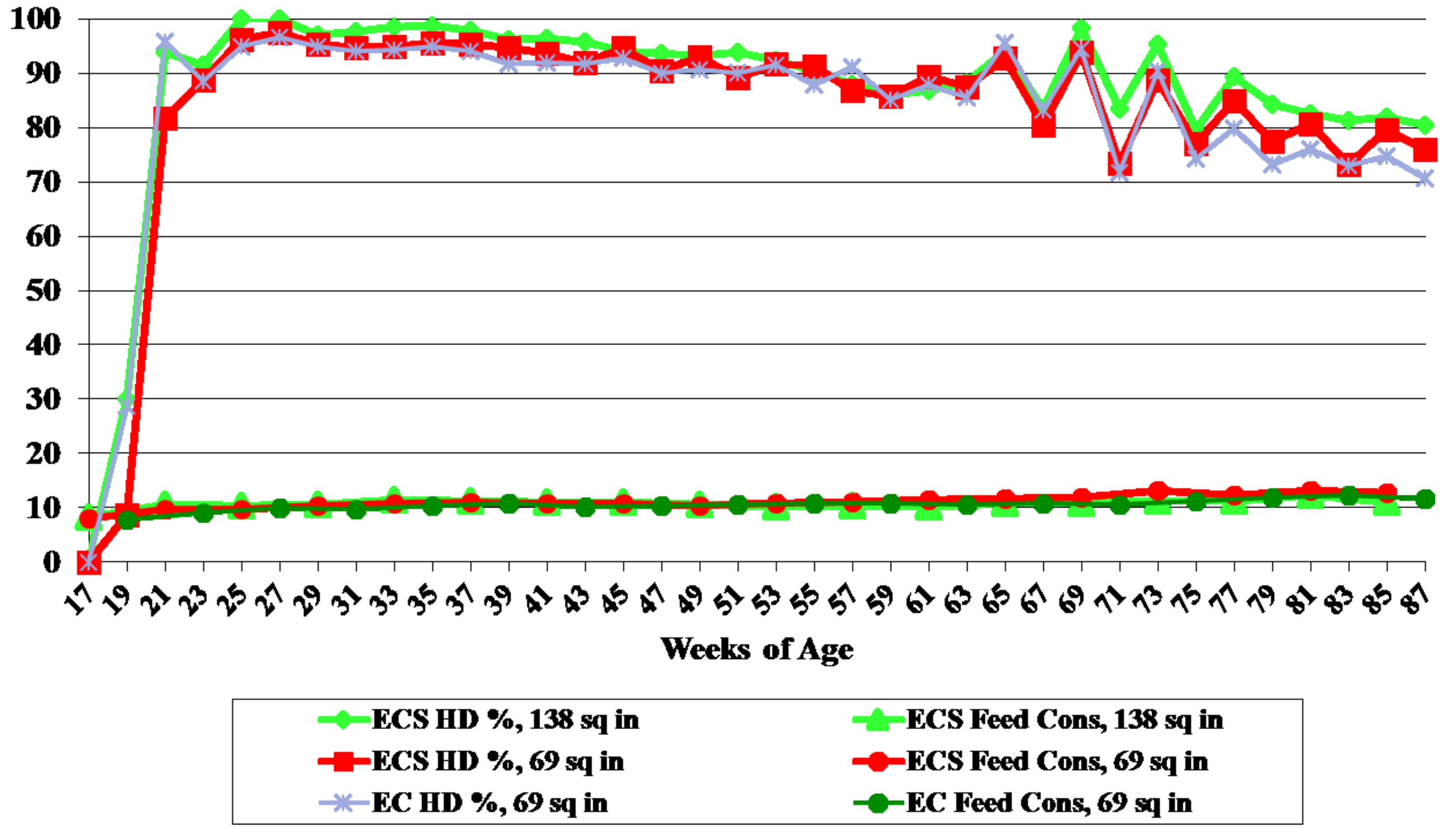
Production Graphs for Laying Hens in Enrichable Cages at 69 sq. in. and the Enriched Colony Housing System Densities of 69 and 138 sq. in.

Figure 1. Bovans White, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (69 and 138 in^2) in Enriched Colony Housing System(ECS) and the Enrichable Cage (EC) at 69 in^2



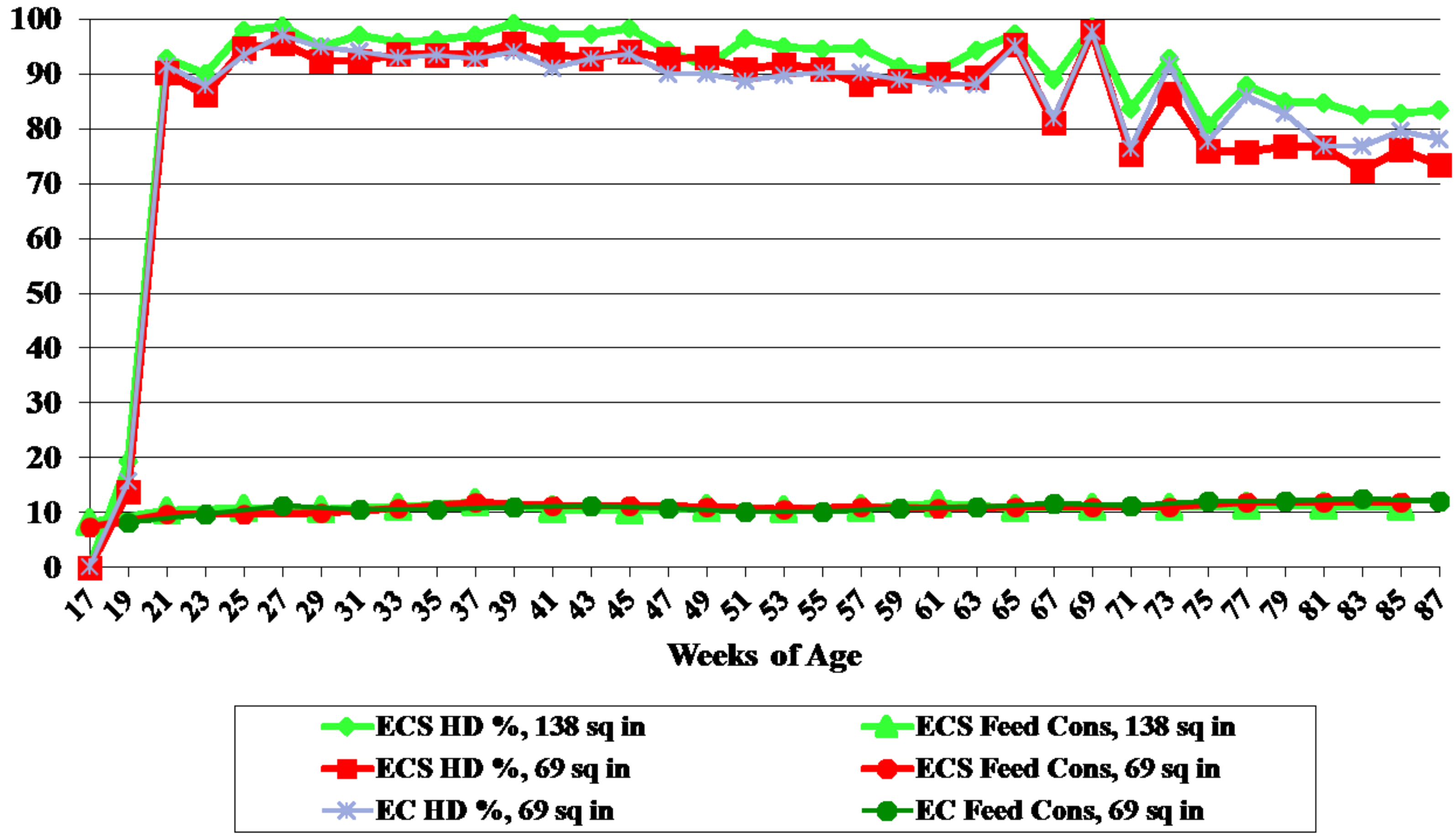
[1] kg per 100 Hens

Figure 2. Shaver, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (69 and 138 in^2) in Enriched Colony Housing System(ECS) and the Enrichable Cage (EC) at 69 in^2



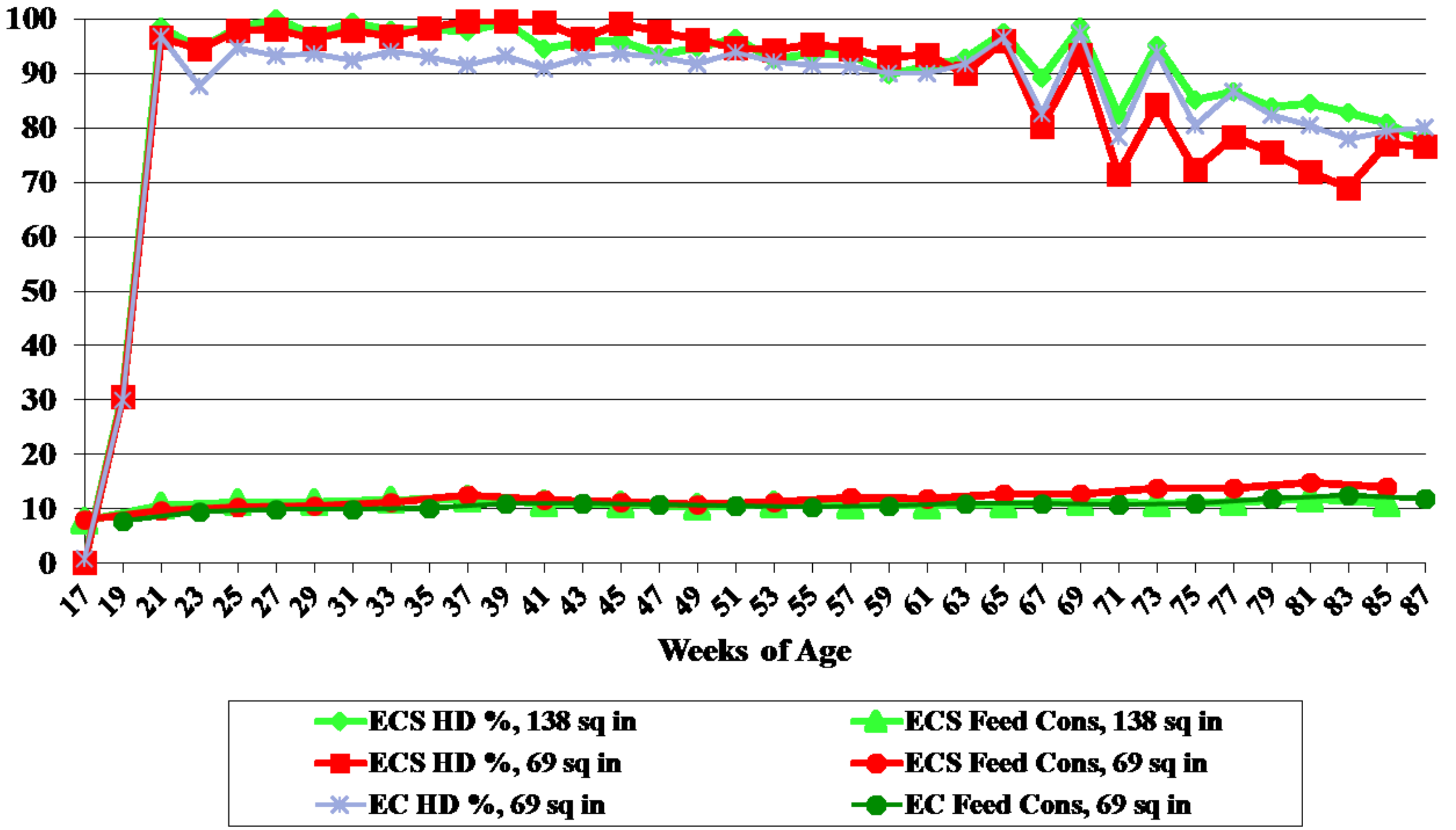
[1] kg per 100 Hens

Figure 3. Dekalb, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (69 and 138 in^2) in Enriched Colony Housing System(ECS) and the Enrichable Cage (EC) at 69 in^2



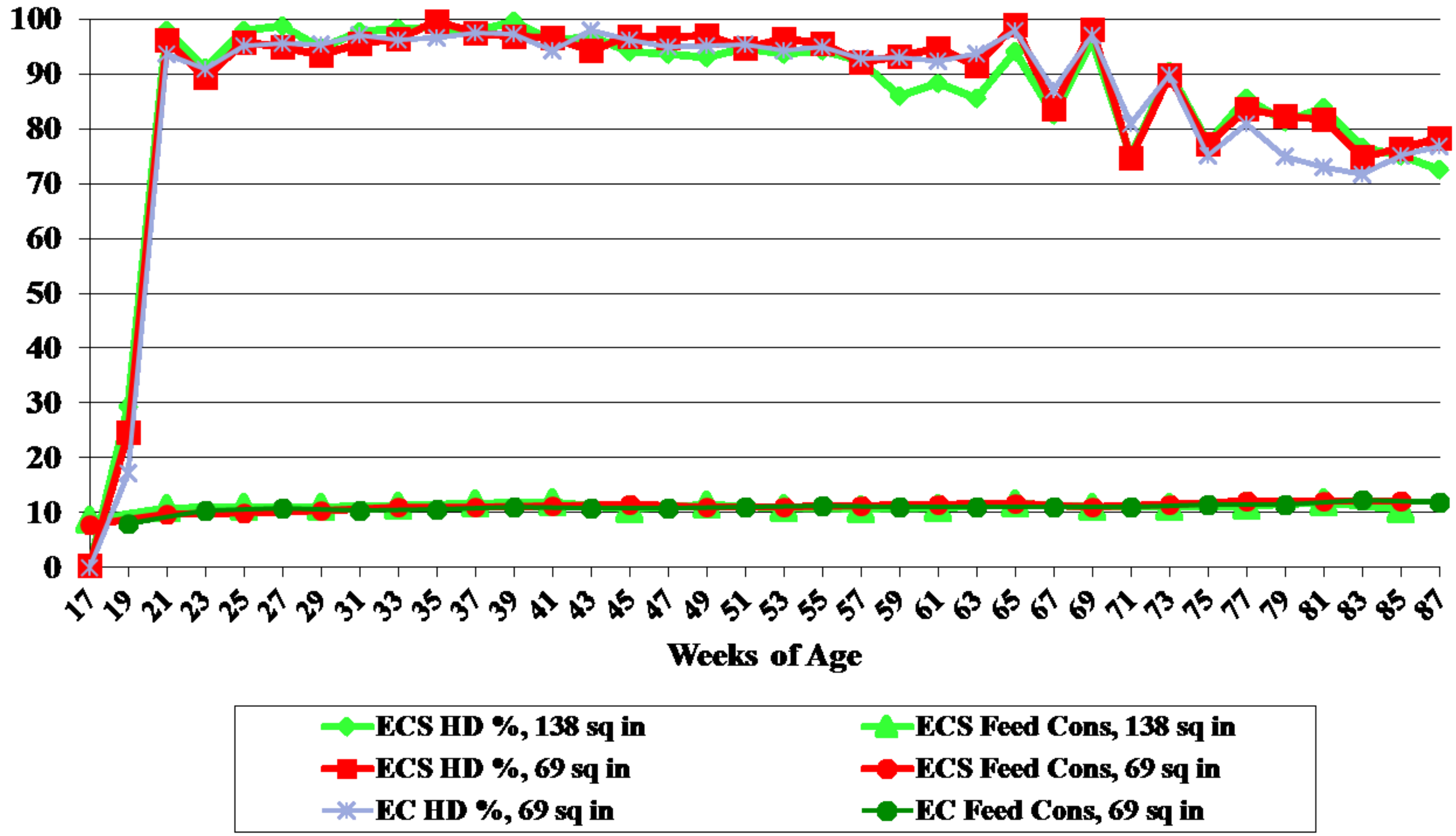
[1] kg per 100 Hens

Figure 4. Babcock, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (69 and 138 in²) in Enriched Colony Housing System(ECS) and the Enrichable Cage (EC) at 69 in²



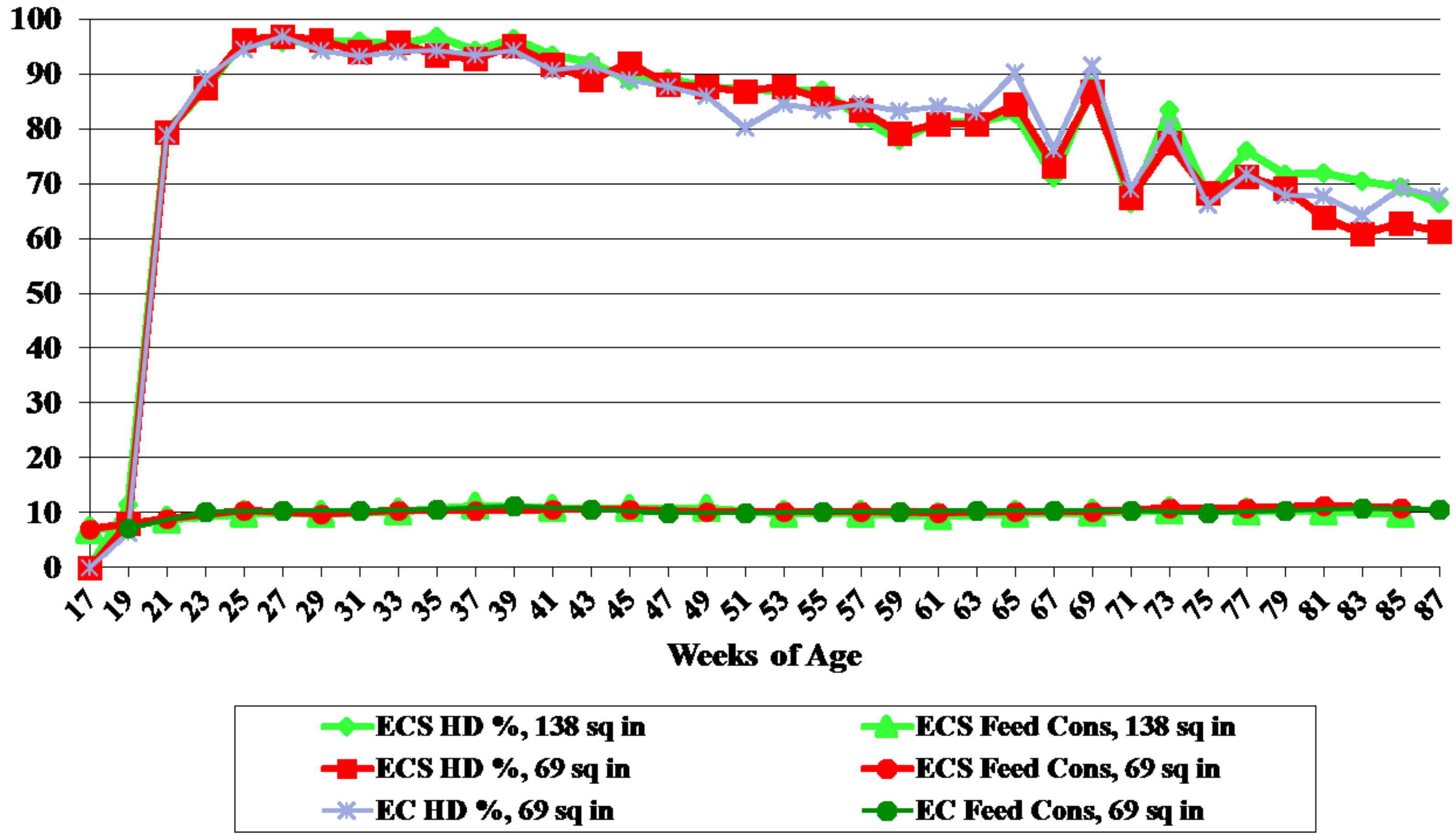
[1] kg per 100 Hens

Figure 5. B-400, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (69 and 138 in²) in Enriched Colony Housing System(ECS) and the Enrichable Cage (EC) at 69 in²



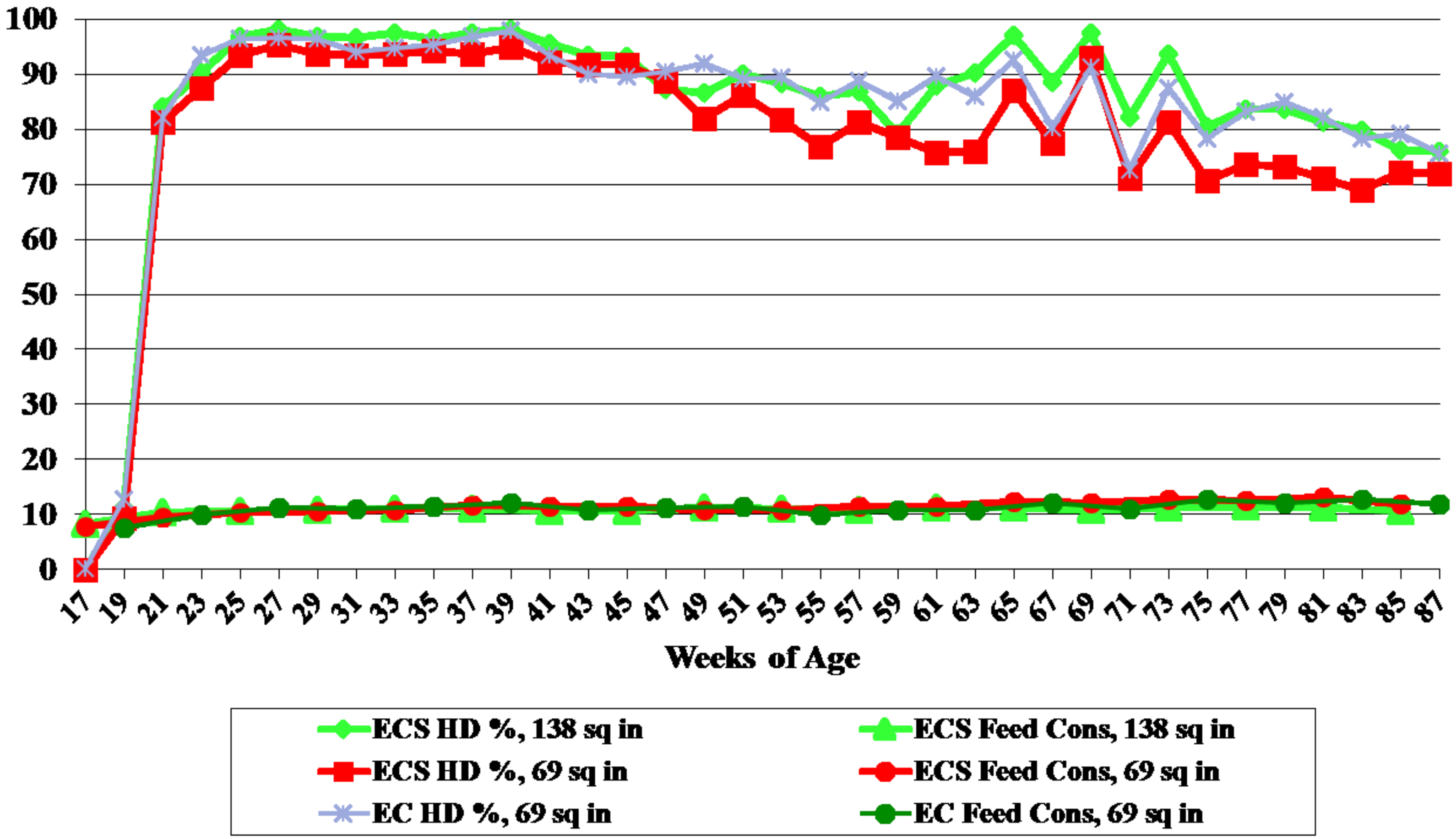
[1] kg per 100 Hens

Figure 6. Hy-Line W-36, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (69 and 138 in^2) in Enriched Colony Housing System(ECS) and the Enrichable Cage (EC) at 69 in^2



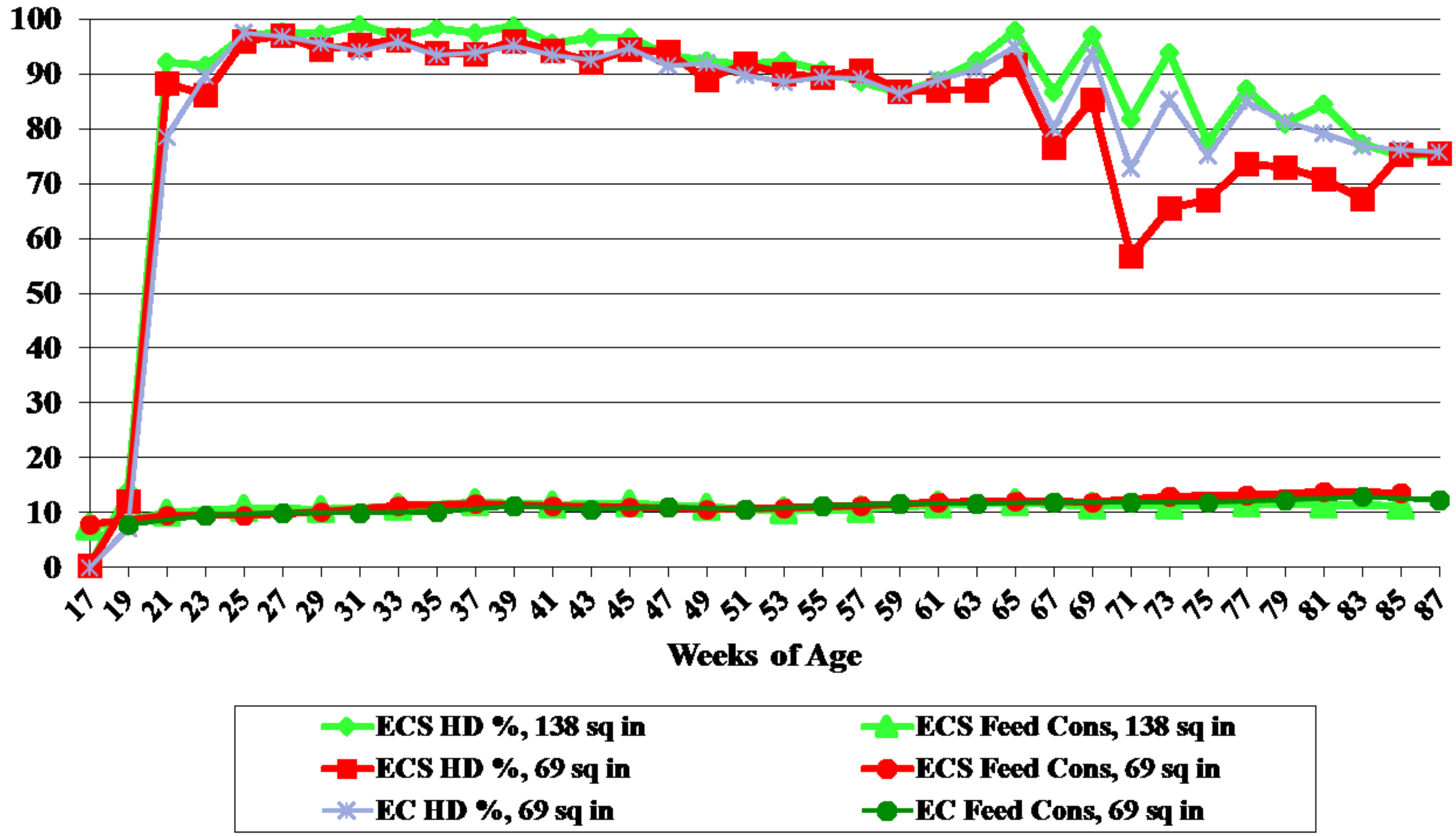
[1] kg per 100 Hens

Figure 7. Hy-Line CV-24, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (69 and 138 in^2) in Enriched Colony Housing System(ECS) and the Enrichable Cage (EC) at 69 in^2



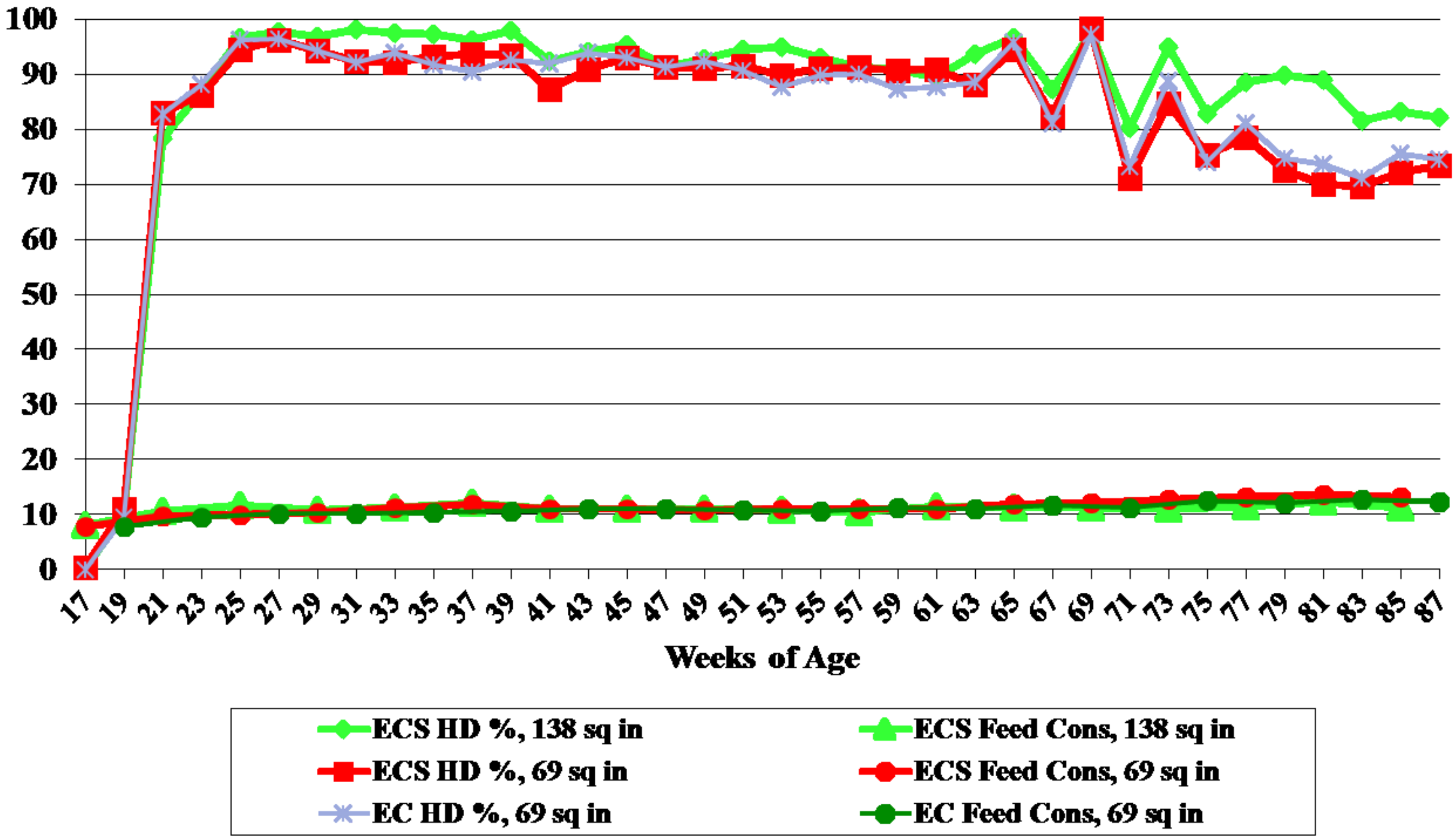
[1] kg per 100 Hens

Figure 8. Lohmann, LSL-Lite, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (69 and 138 in^2) in Enriched Colony Housing System(ECS) and the Enrichable Cage (EC) at 69 in^2



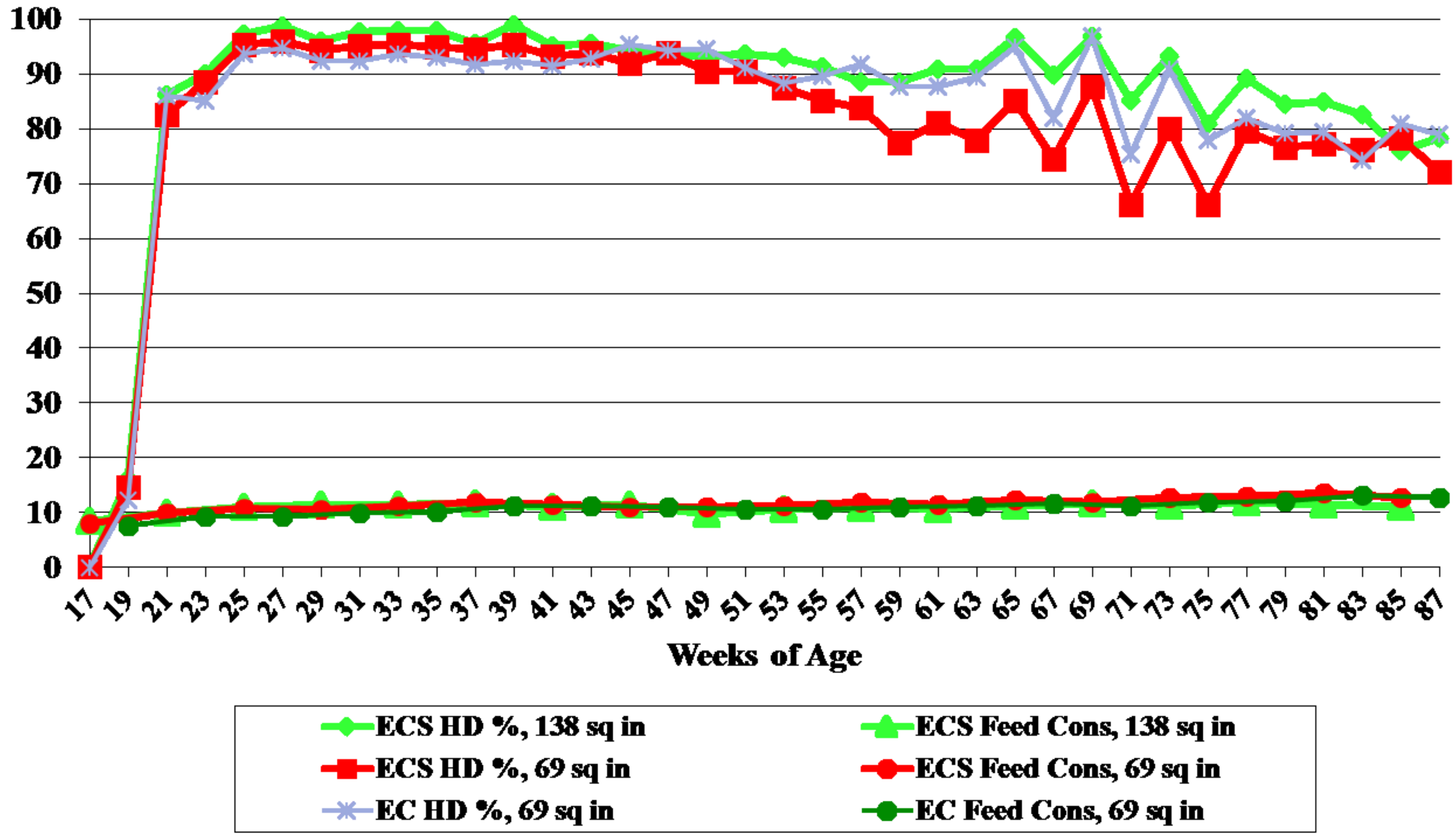
[1] kg per 100 Hens

Figure 9. Lohmann, "Nick Chick", Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (69 and 138 in^2) in Enriched Colony Housing System(ECS) and the Enrichable Cage (EC) at 69 in^2



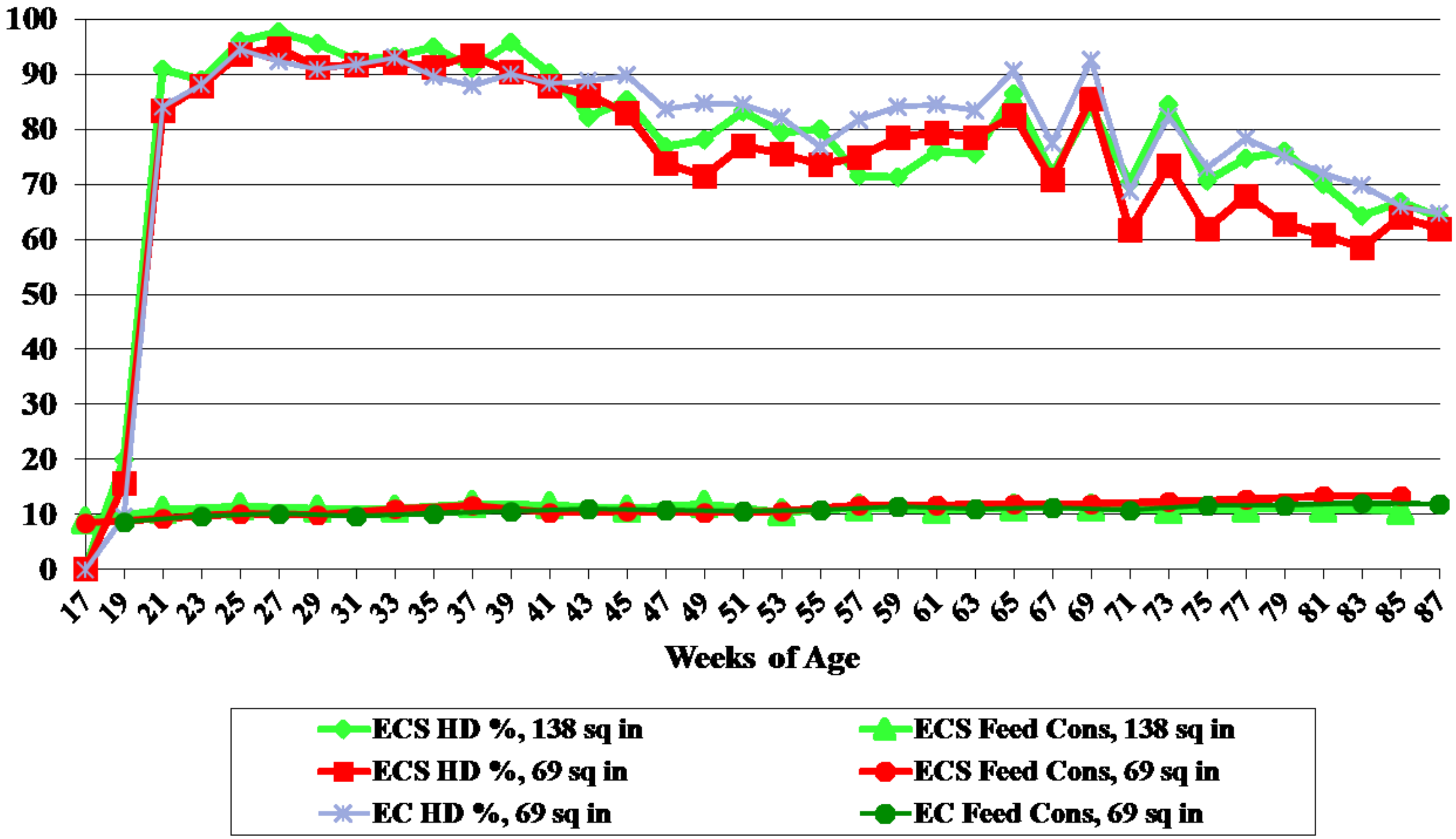
[1] kg per 100 Hens

Figure 10. Novogen White, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (69 and 138 in^2) in Enriched Colony Housing System(ECS) and the Enrichable Cage (EC) at 69 in^2



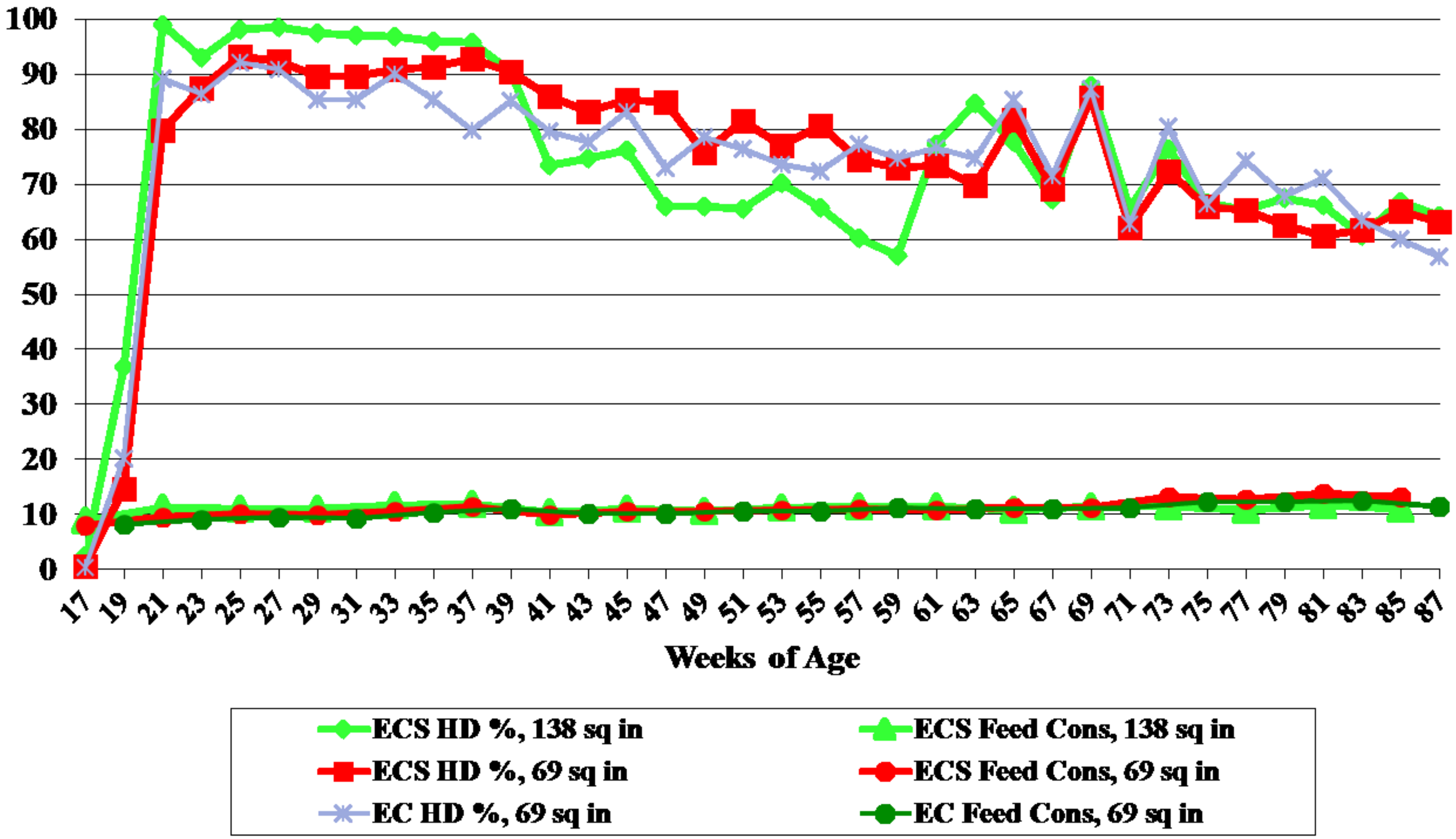
[1] kg per 100 Hens

Figure 11. TETRA Amber, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (69 and 138 in^2) in Enriched Colony Housing System(ECS) and the Enrichable Cage (EC) at 69 in^2



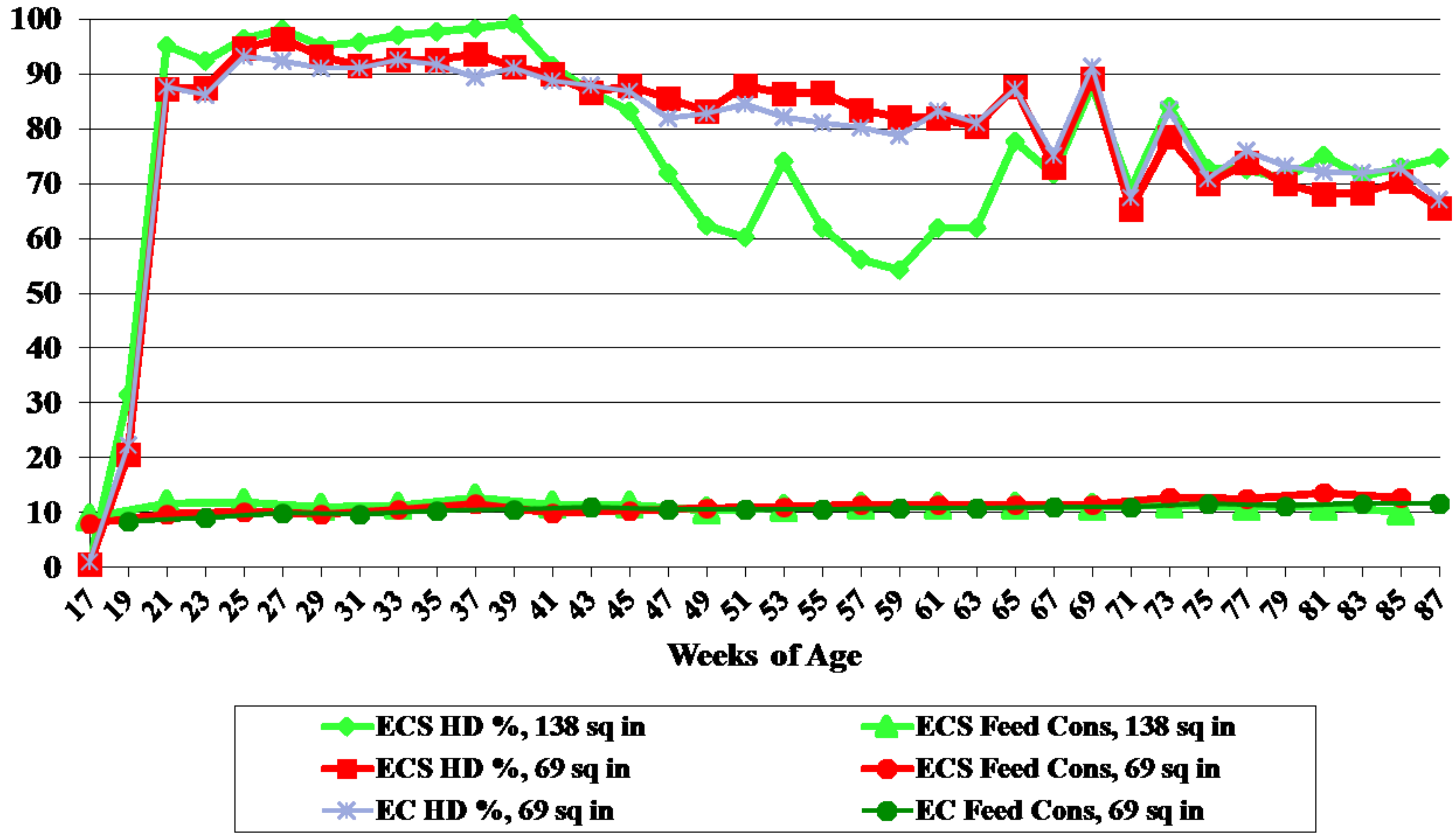
[1] kg per 100 Hens

Figure 12. TETRA Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (69 and 138 in^2) in Enriched Colony Housing System(ECS) and the Enrichable Cage (EC) at 69 in^2



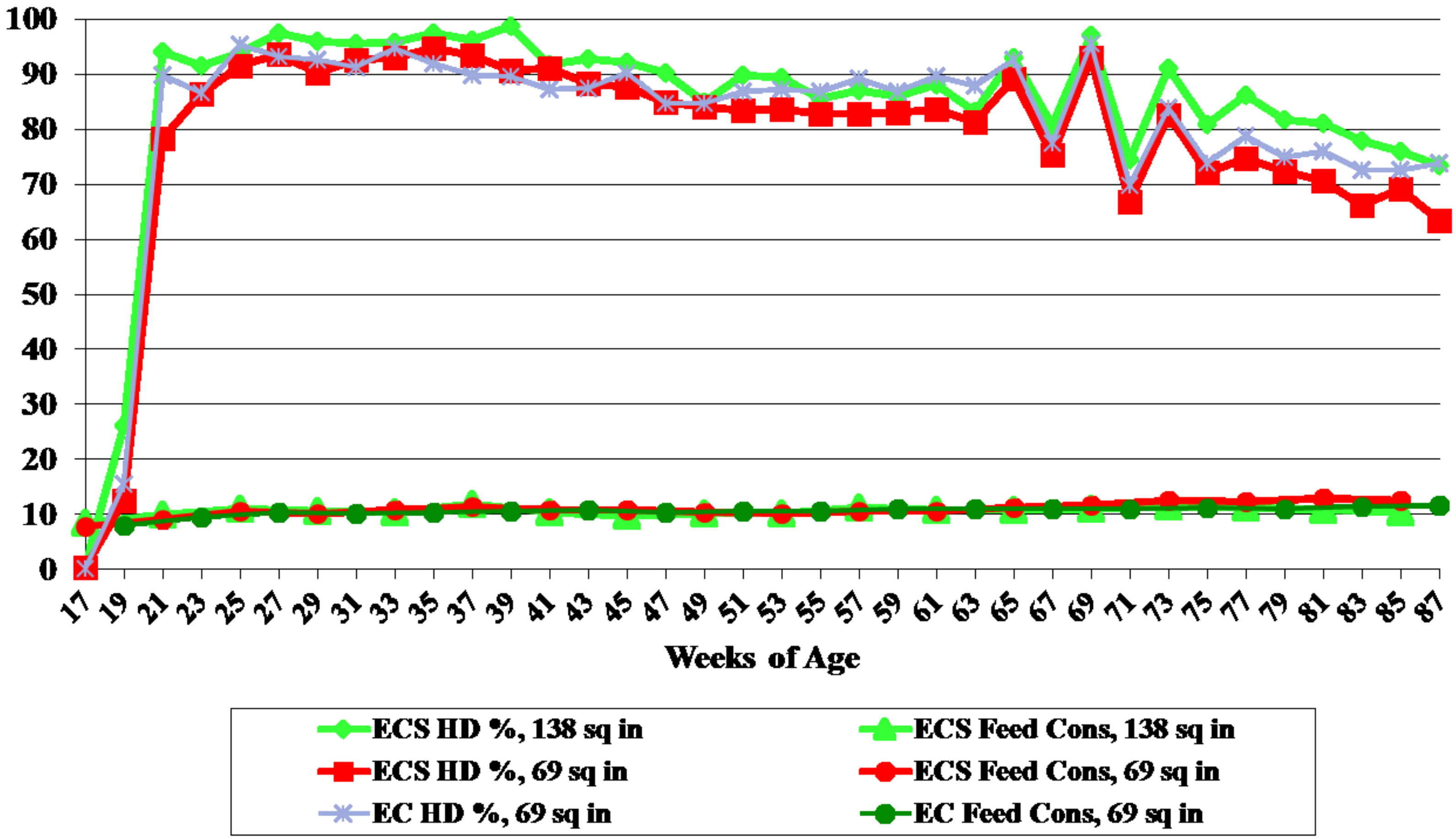
[1] kg per 100 Hens

Figure 13. Novogen Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (69 and 138 in^2) in Enriched Colony Housing System(ECS) and the Enrichable Cage (EC) at 69 in^2



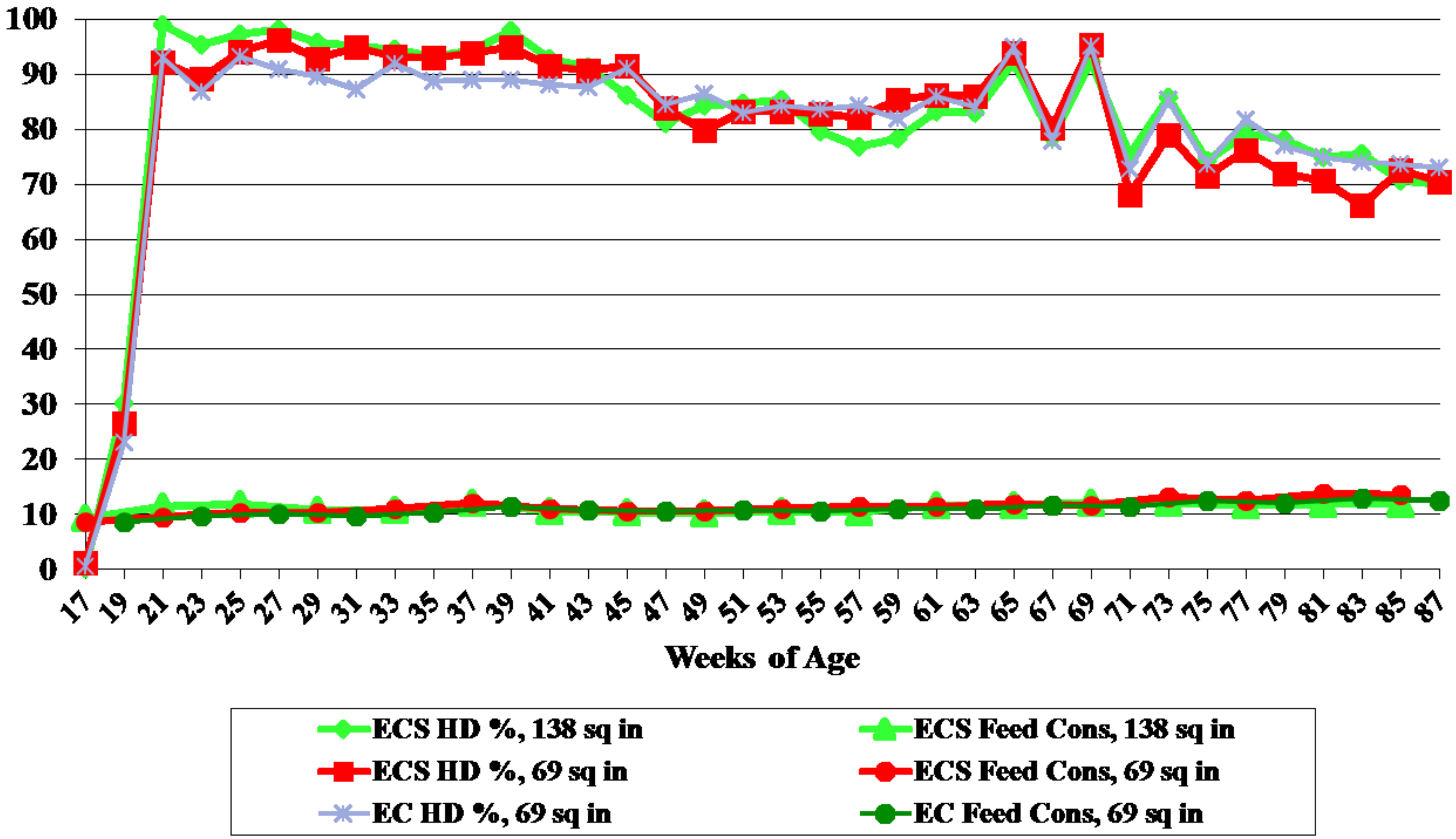
[1] kg per 100 Hens

Figure 14. Lohmann, LB-Lite, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (69 and 138 in^2) in Enriched Colony Housing System(ECS) and the Enrichable Cage (EC) at 69 in^2



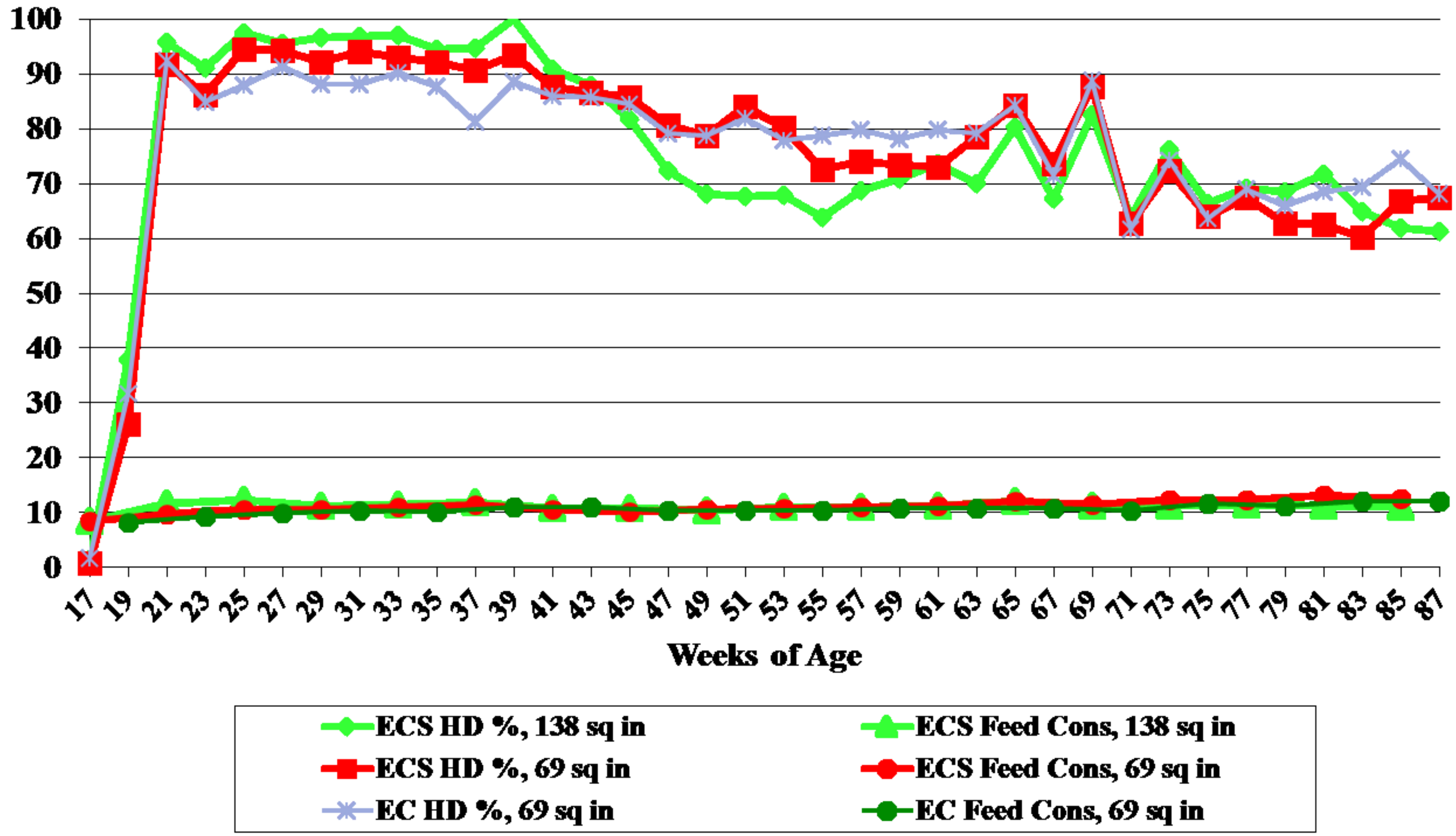
[1] kg per 100 Hens

Figure 15. Hy-Line Silver Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (69 and 138 in²) in Enriched Colony Housing System(ECS) and the Enrichable Cage (EC) at 69 in²



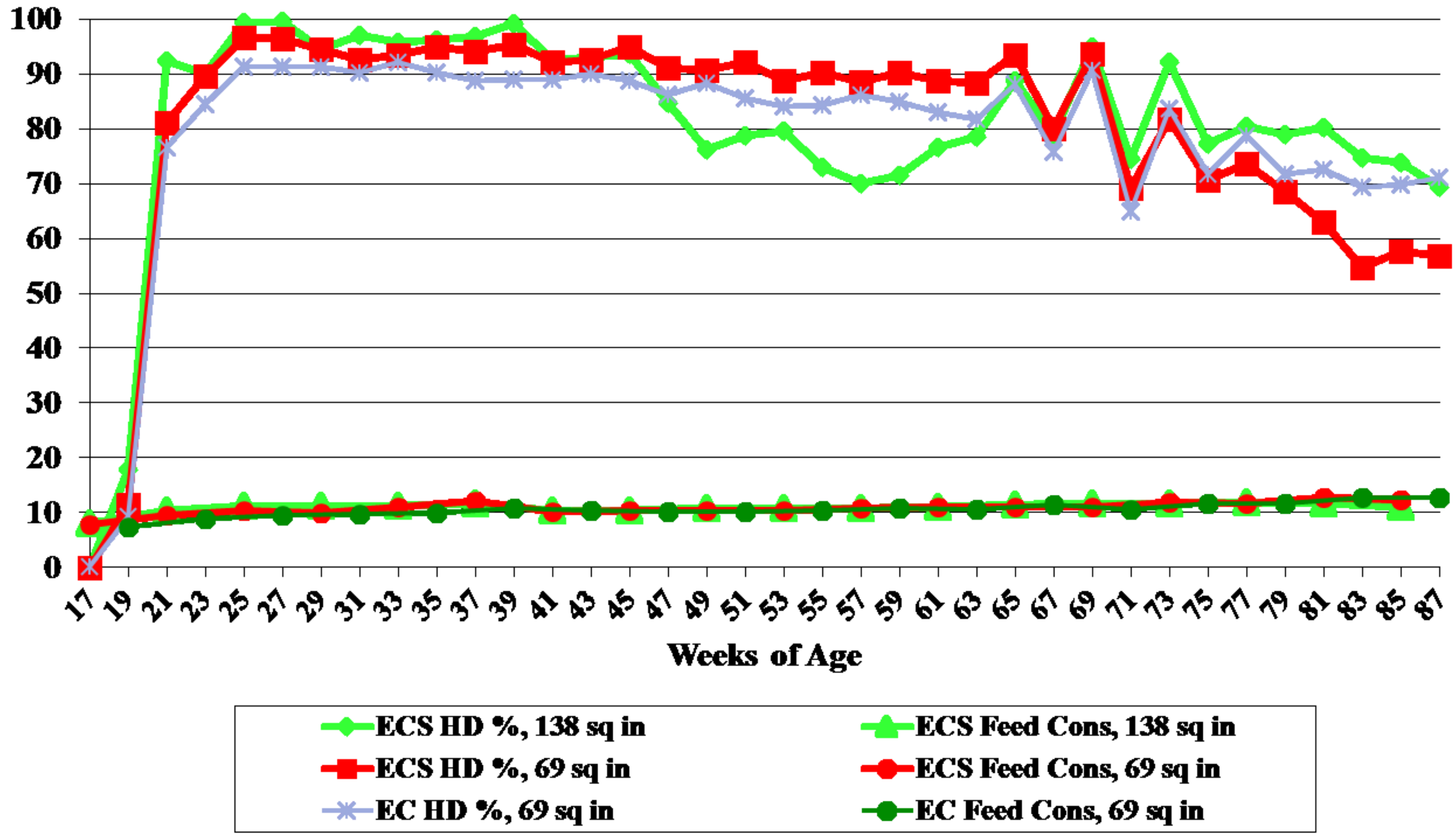
[1] kg per 100 Hens

Figure 16. Hy-Line Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (69 and 138 in^2) in Enriched Colony Housing System(ECS) and the Enrichable Cage (EC) at 69 in^2



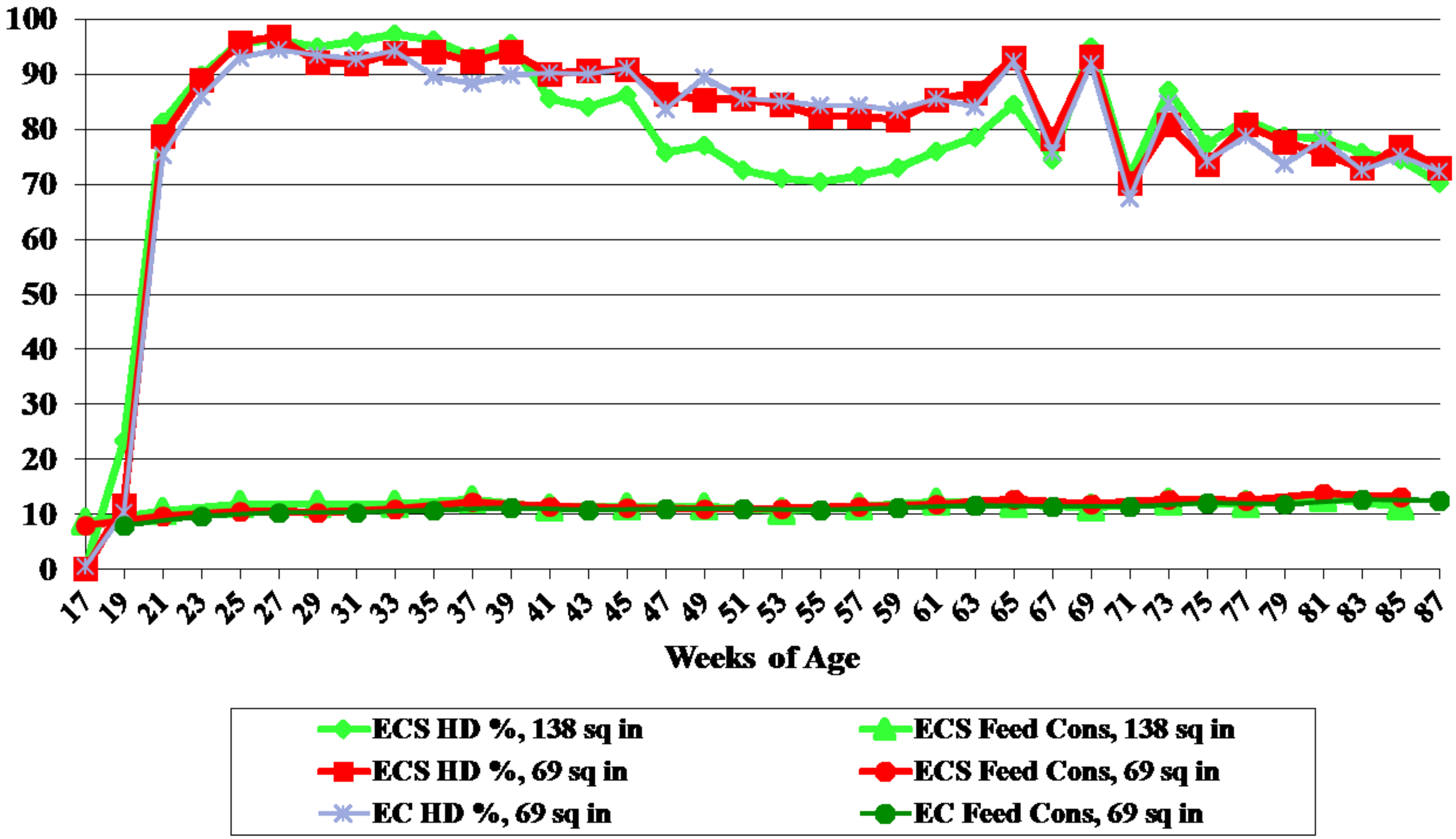
[1] kg per 100 Hens

Figure 17. ISA Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (69 and 138 in^2) in Enriched Colony Housing System(ECS) and the Enrichable Cage (EC) at 69 in^2



[1] kg per 100 Hens

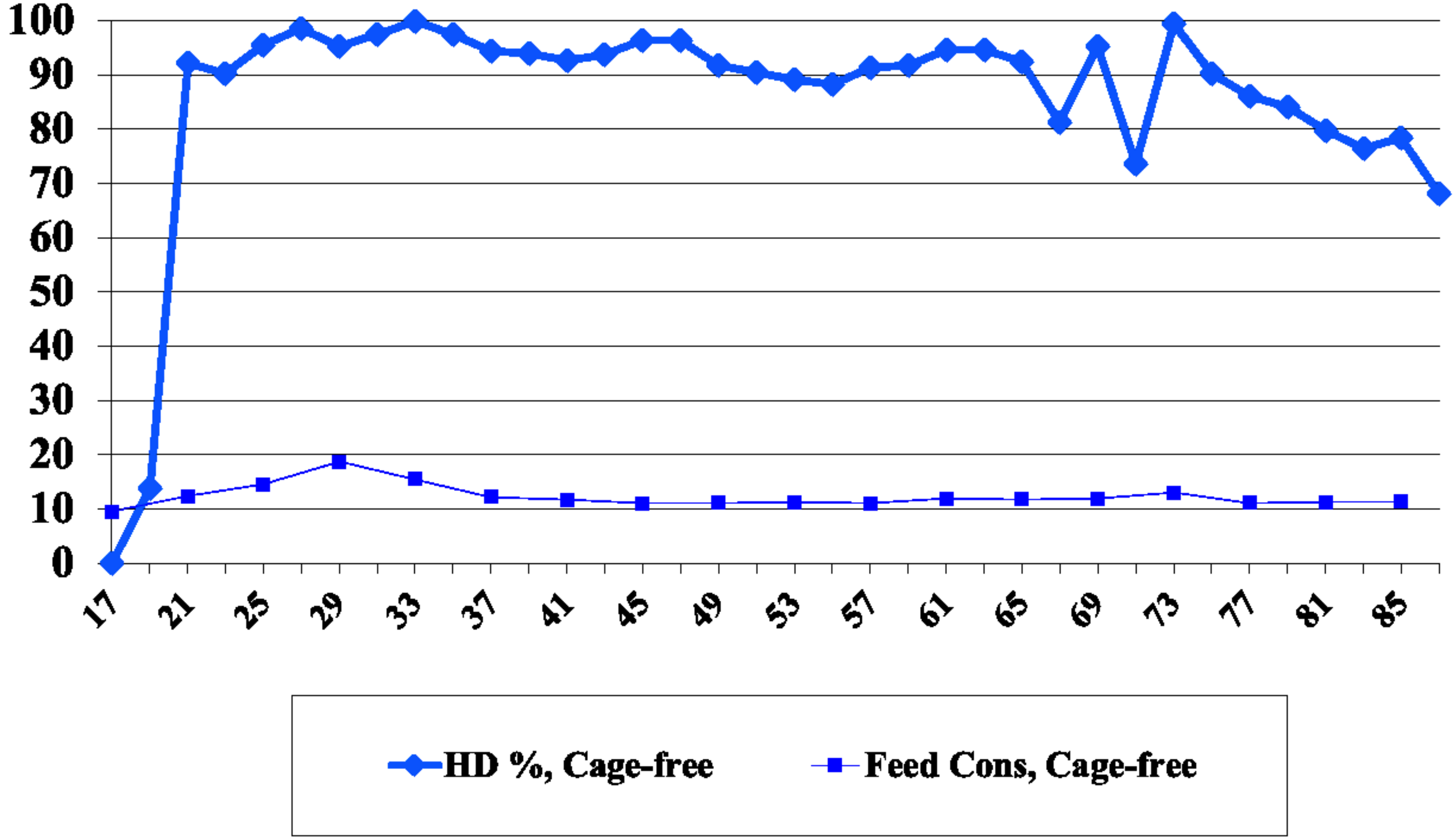
Figure 18. Bovans Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (69 and 138 in^2) in Enriched Colony Housing System(ECS) and the Enrichable Cage (EC) at 69 in^2



[1] kg per 100 Hens

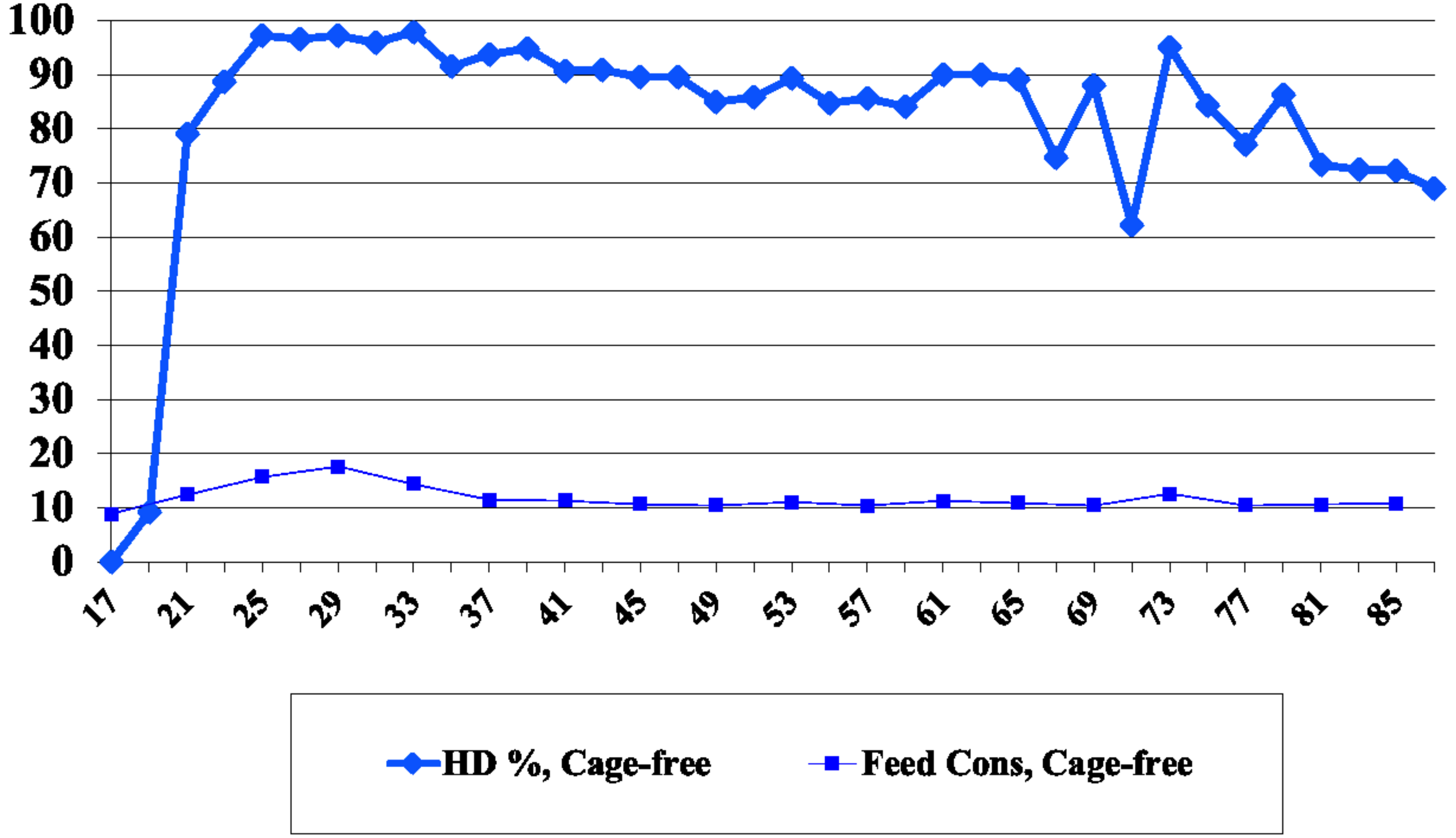
Production Graphs for Laying Hens in the Cage-free Environment which was 1/2 slat and 1/2 litter

Figure 19. Dekalb, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



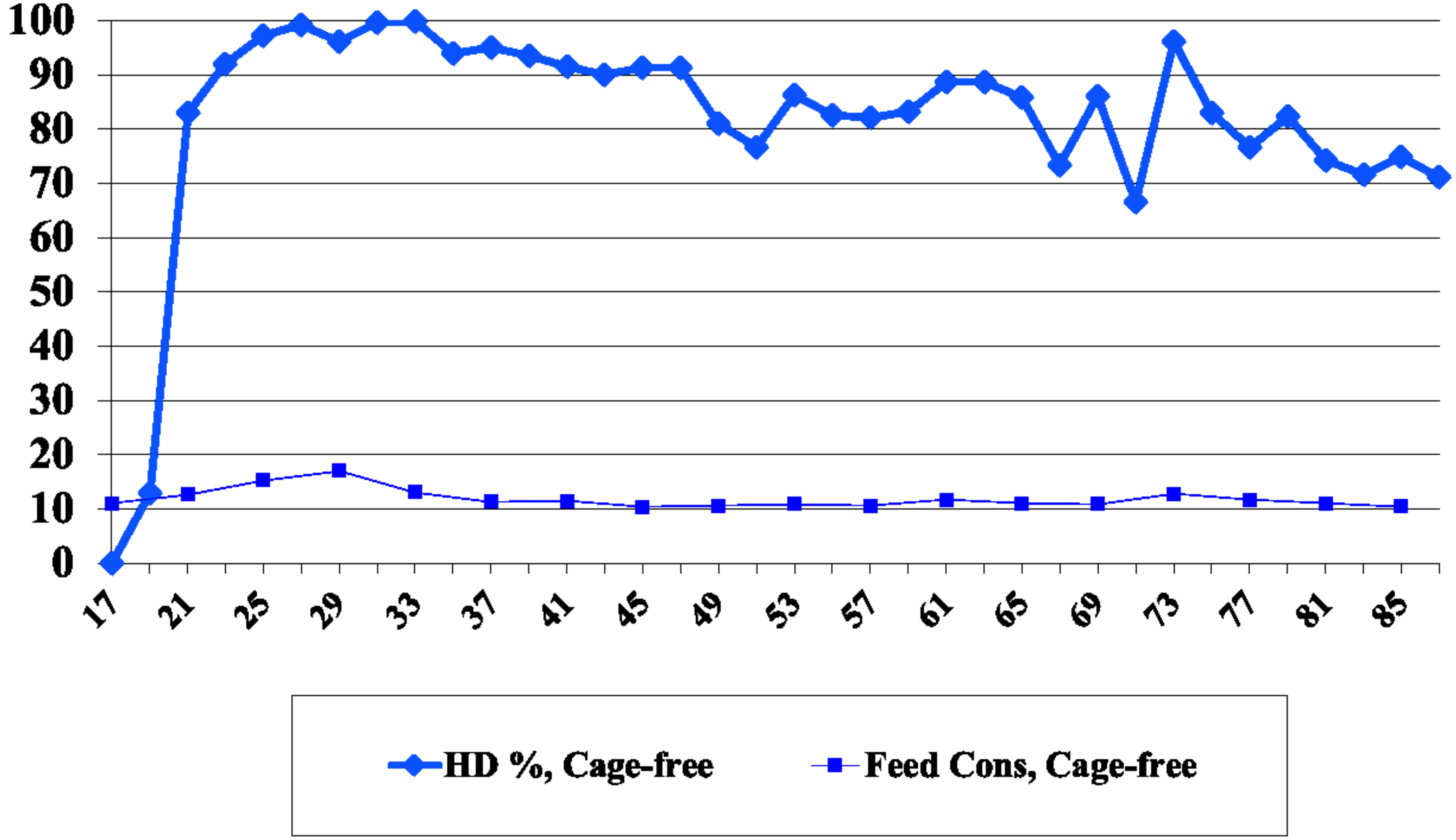
[1] kg per 100 Hens

Figure 20. Hy-Line W-36, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



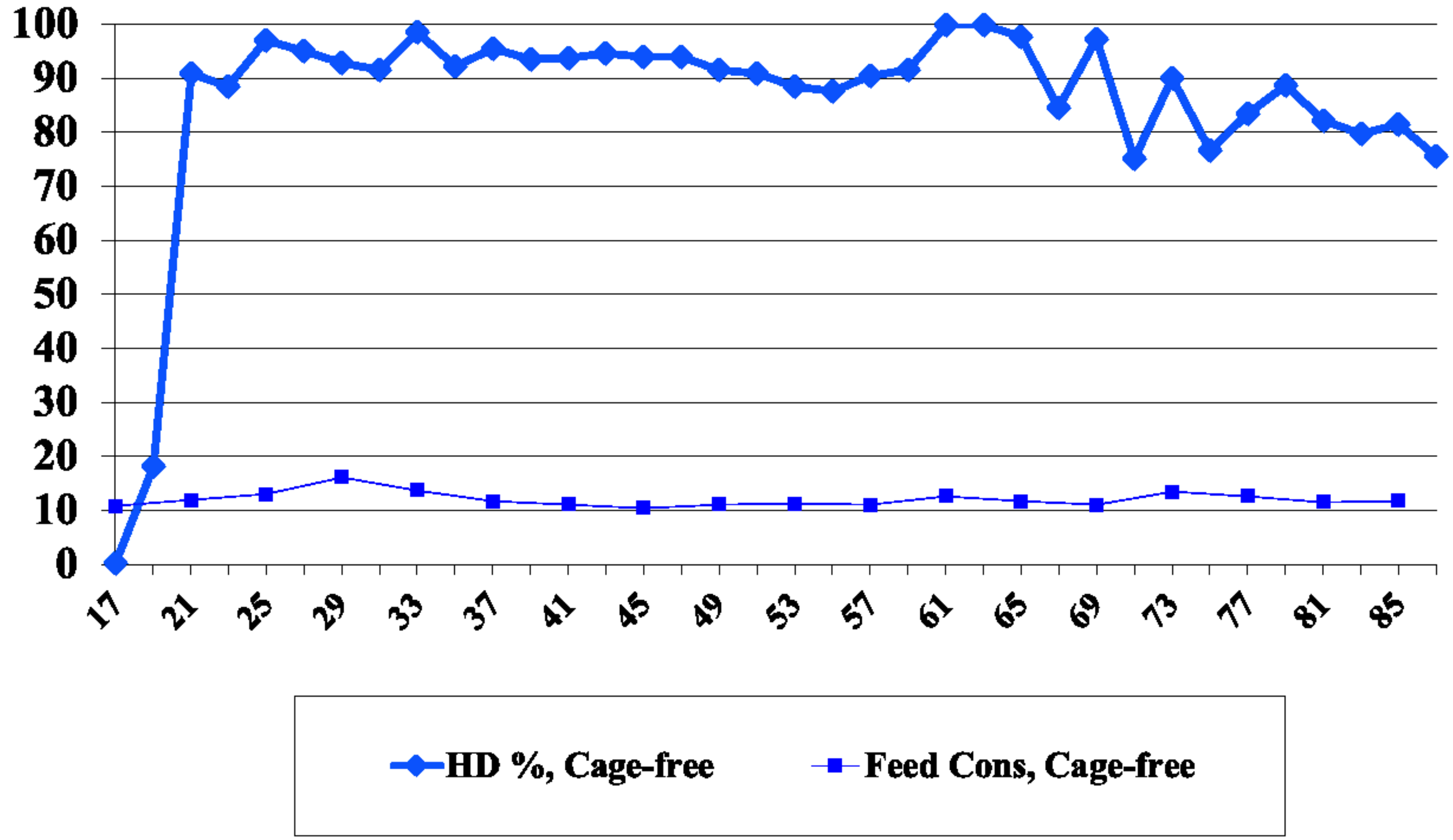
[1] kg per 100 Hens

Figure 21. Hy-Line CV-26, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



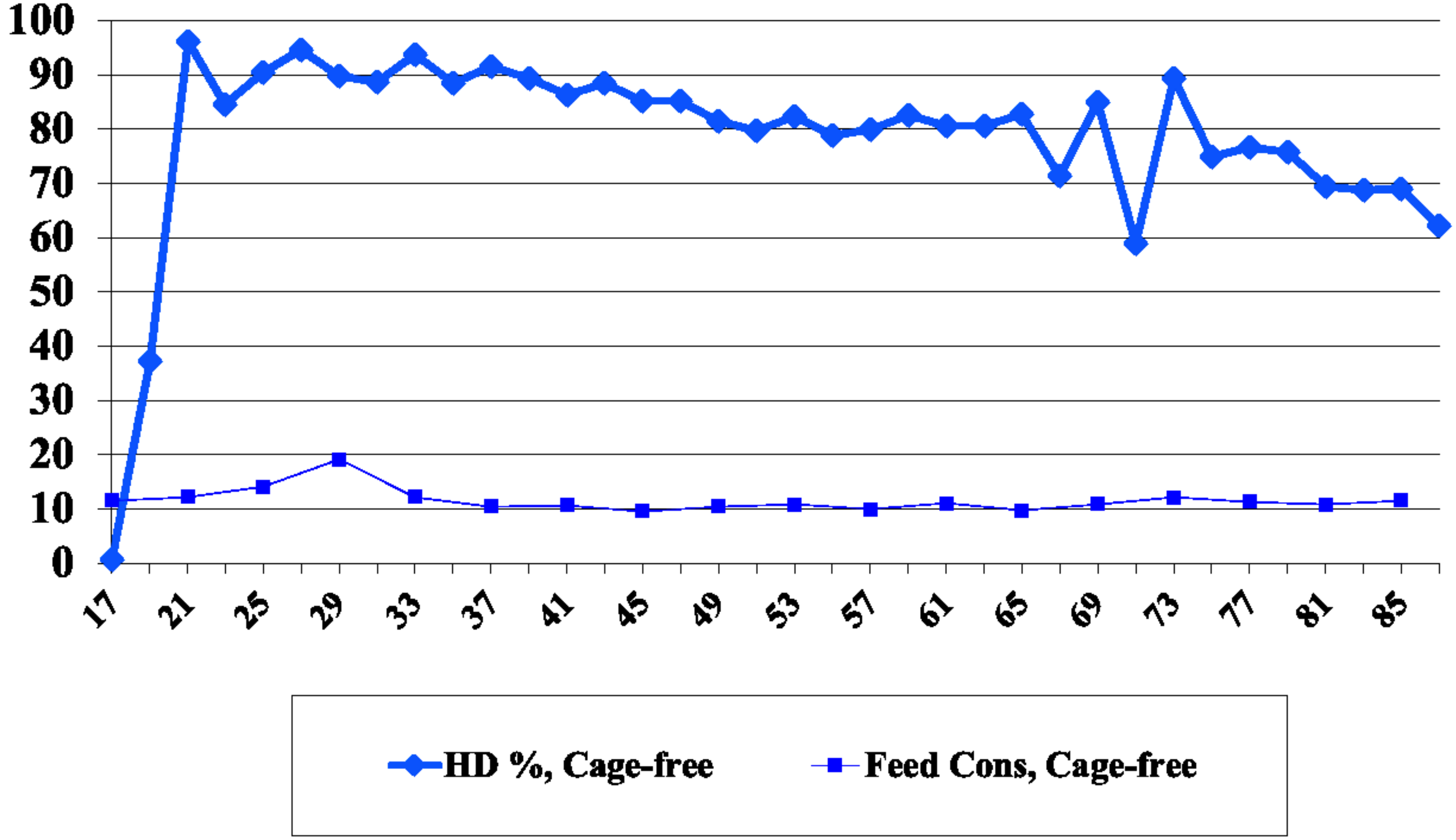
[1] kg per 100 Hens

Figure 22. Hy-Line CV-24, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



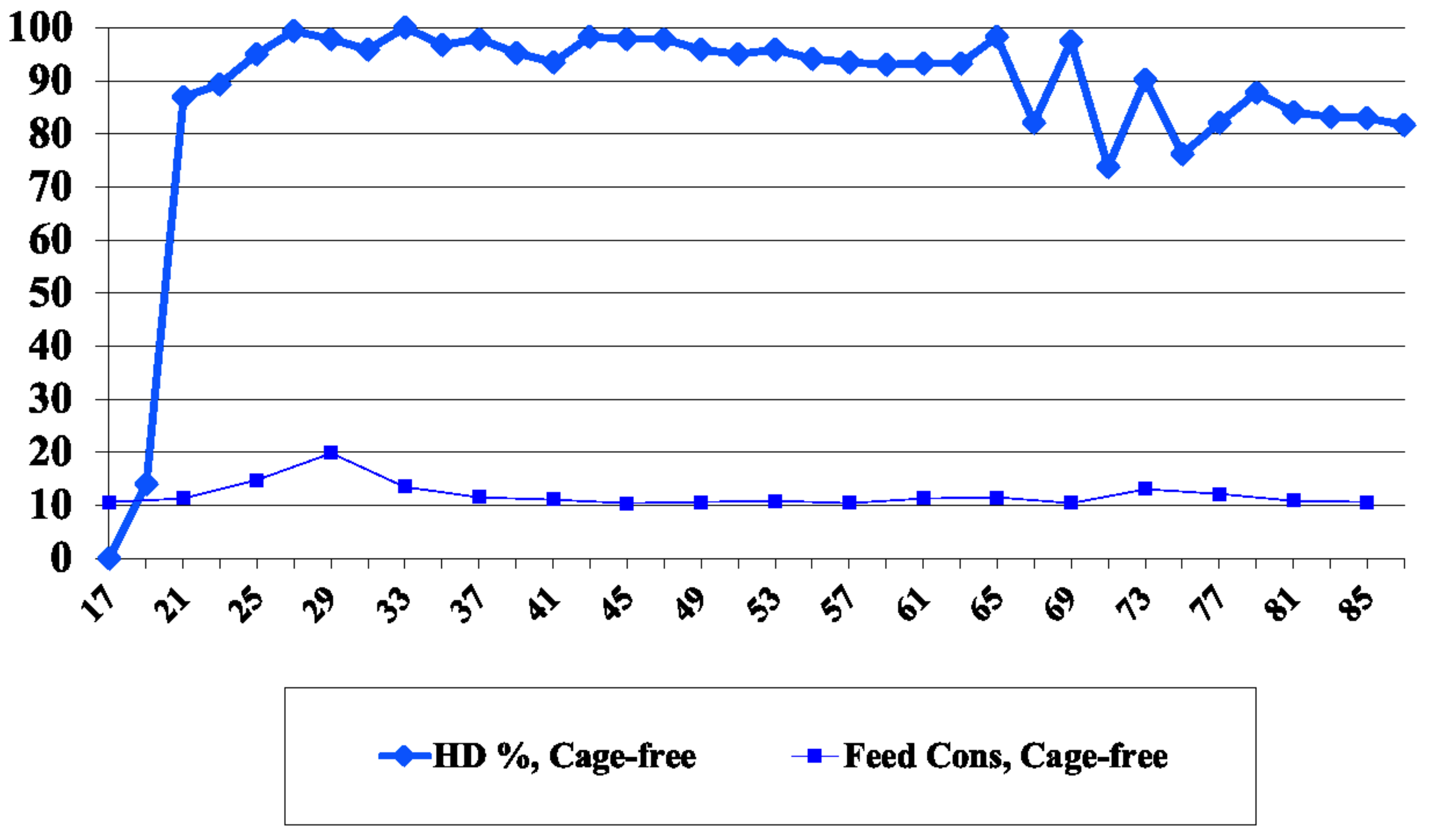
[1] kg per 100 Hens

Figure 23. Hy-Line CV-22, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



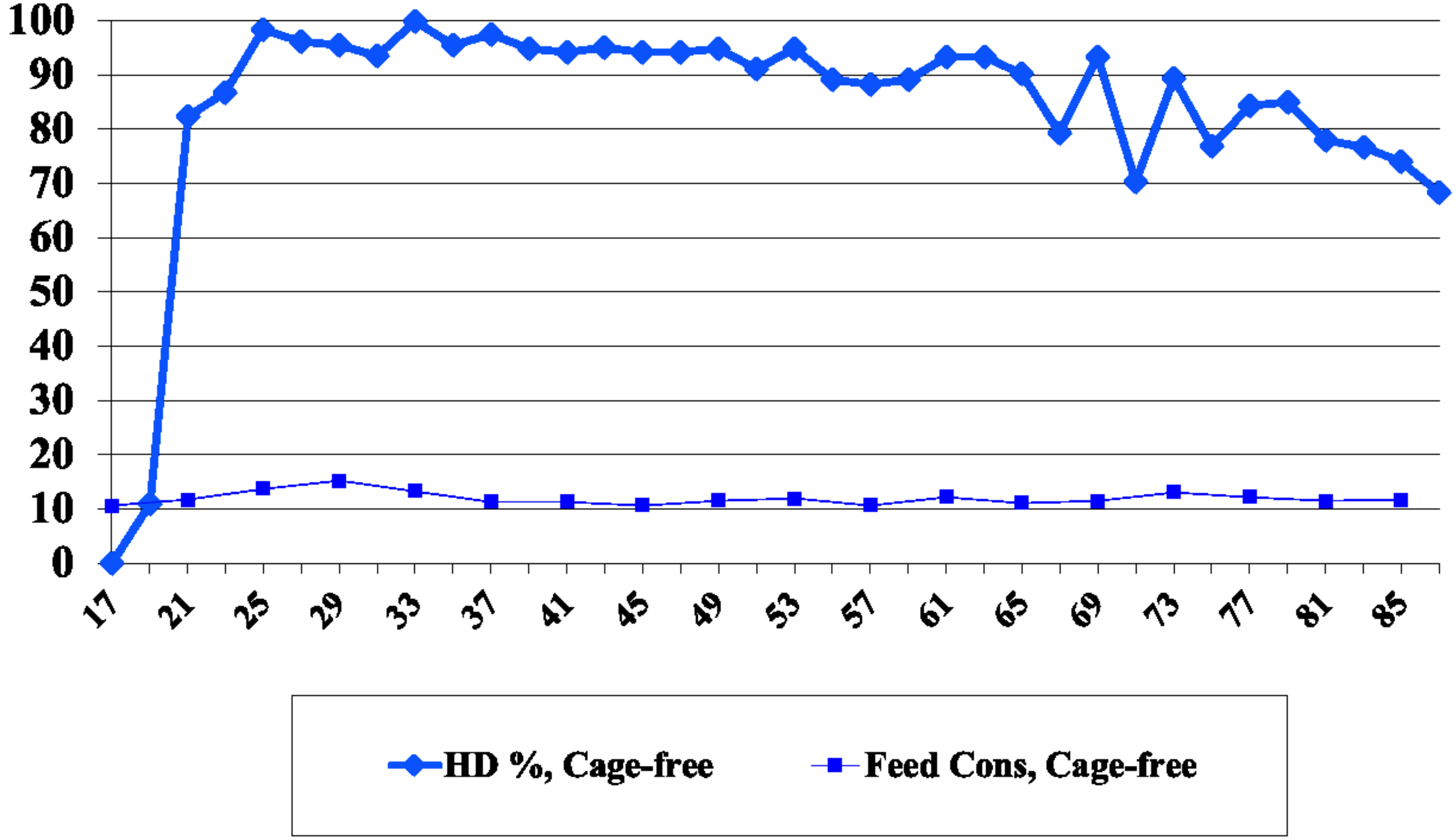
[1] kg per 100 Hens

Figure 24. Lohmann LSL-Lite, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



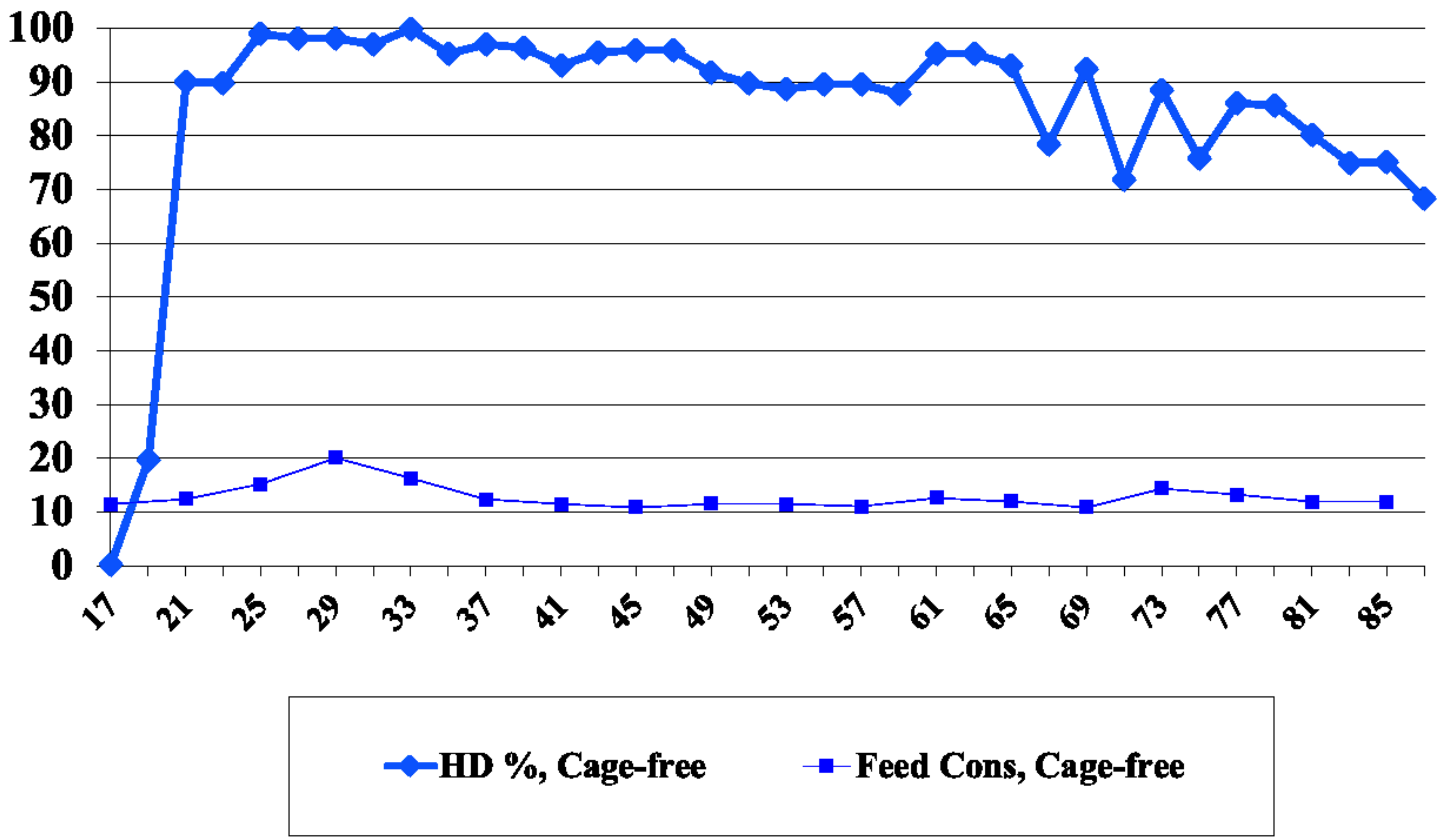
[1] kg per 100 Hens

Figure 25. H&N Nick Chick, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



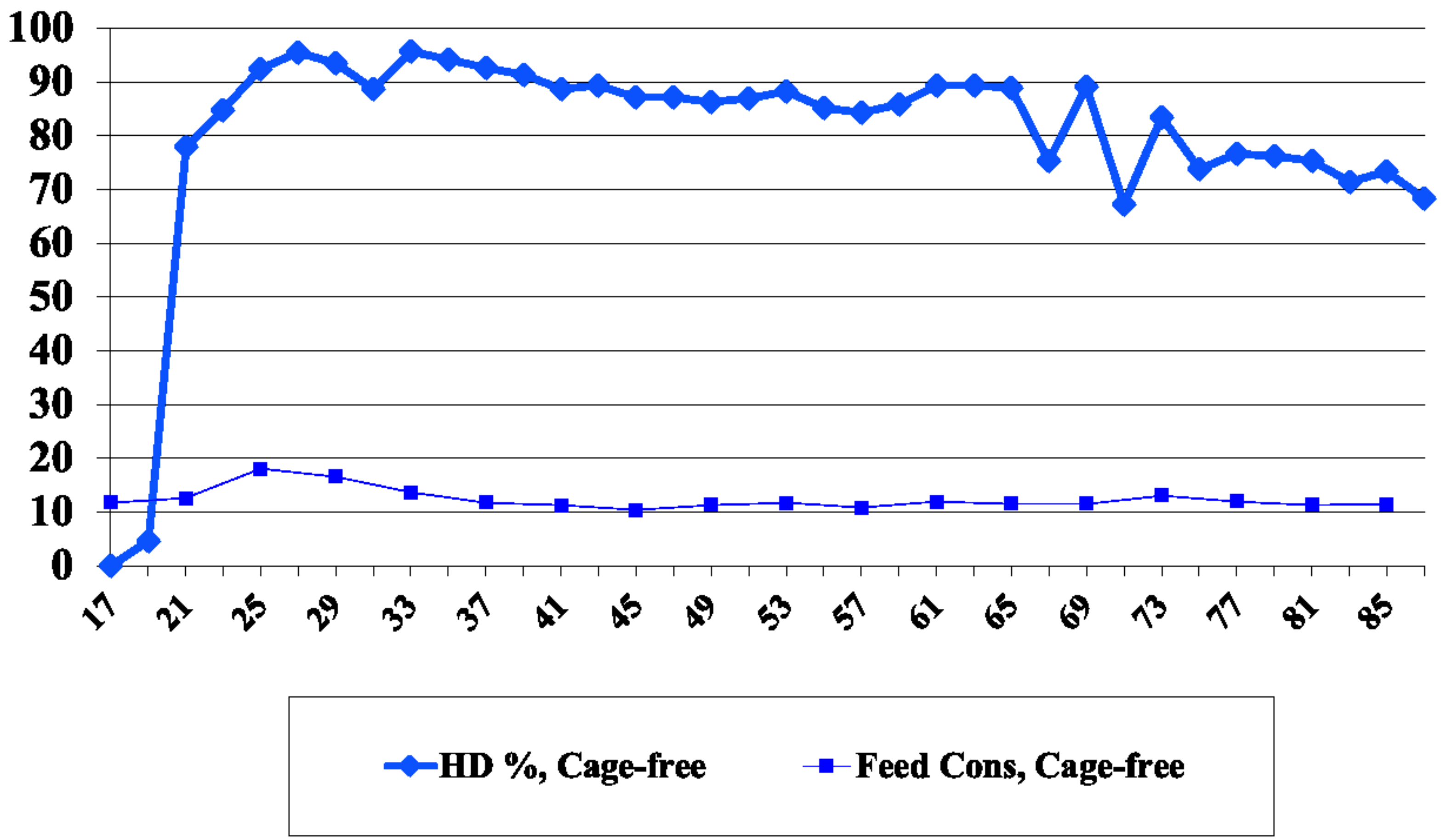
[1] kg per 100 Hens

Figure 26. Novogen White, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



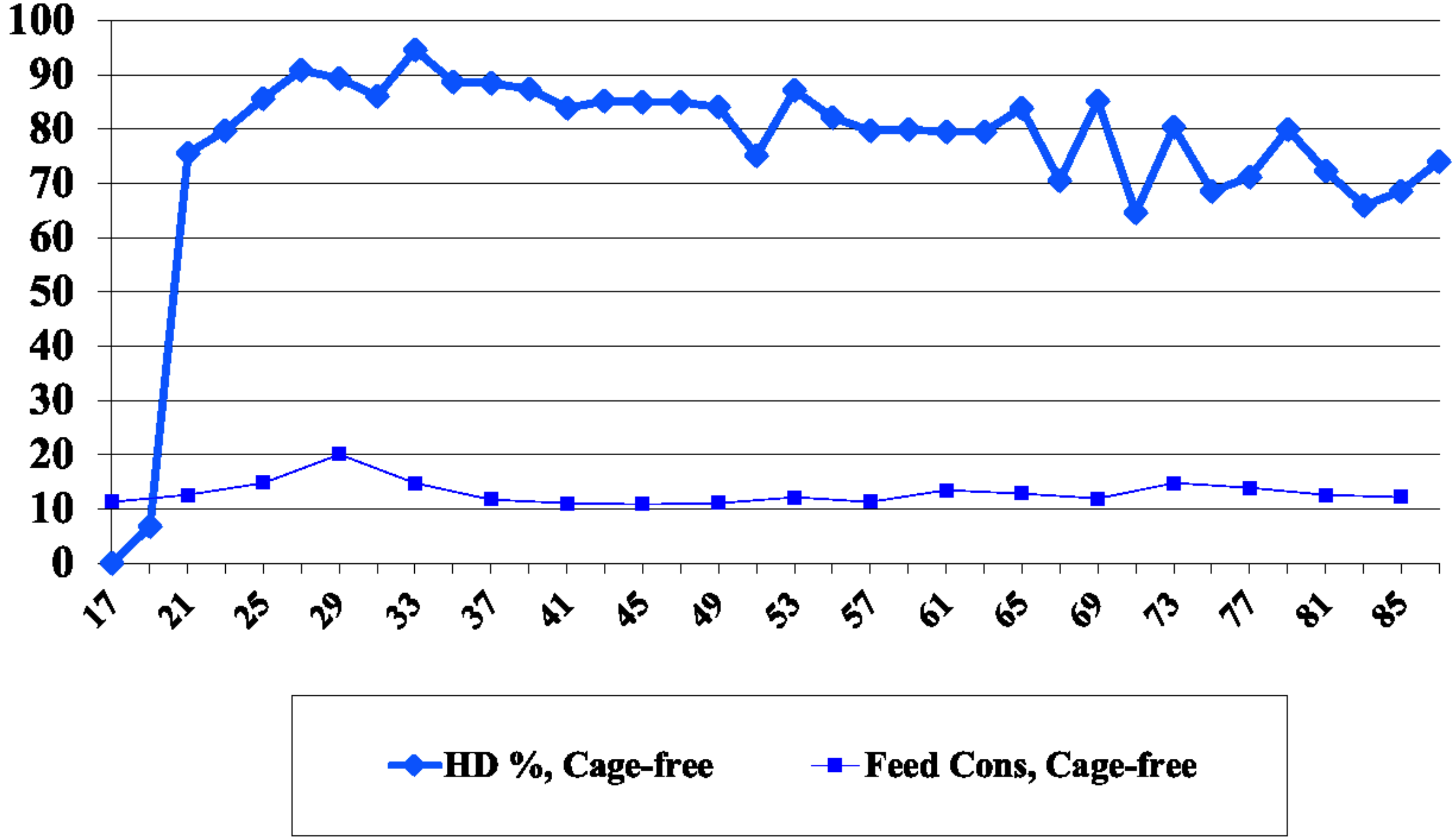
[1] kg per 100 Hens

Figure 27. TETRA Amber, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



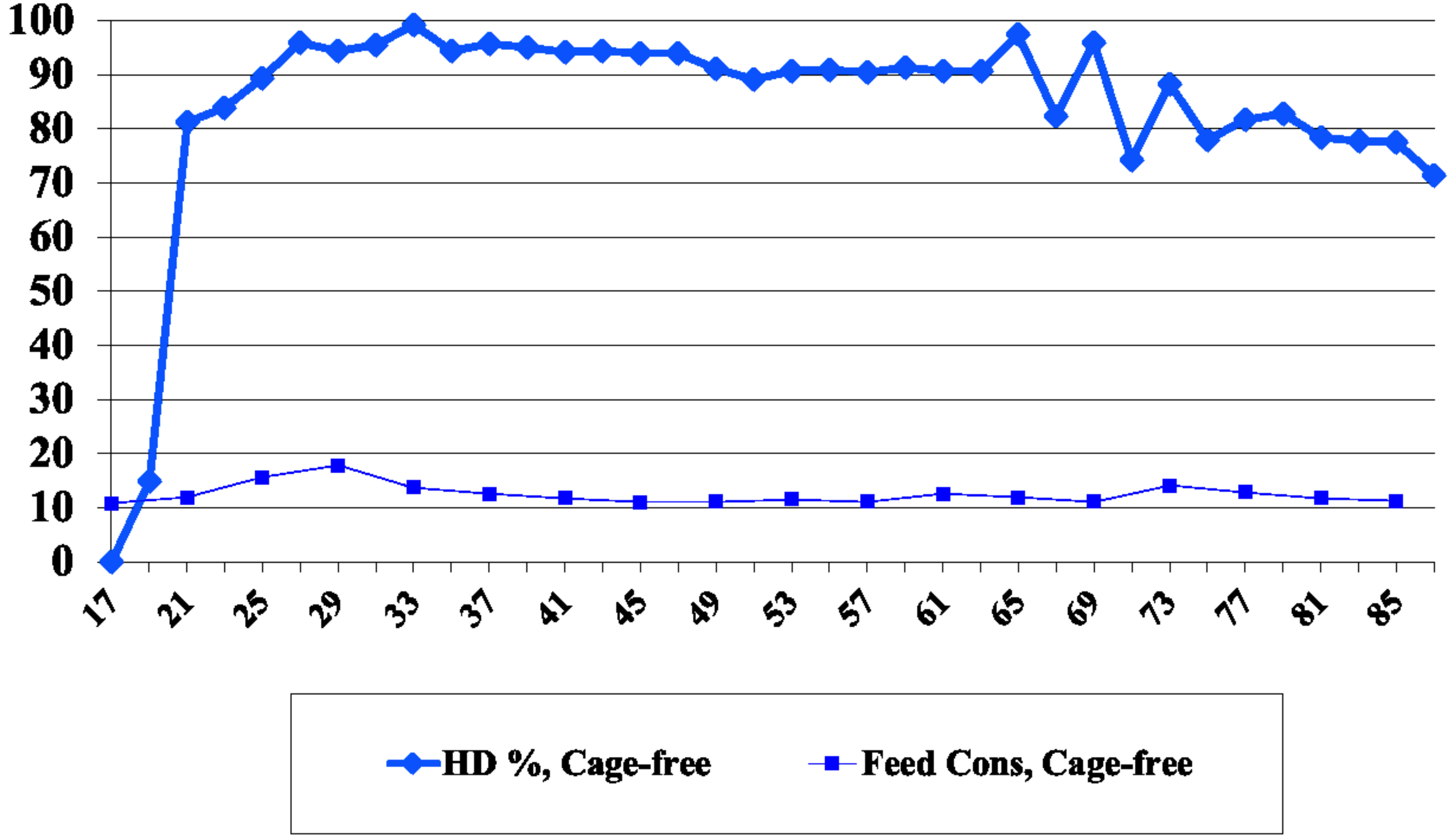
[1] kg per 100 Hens

Figure 28. TETRA Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



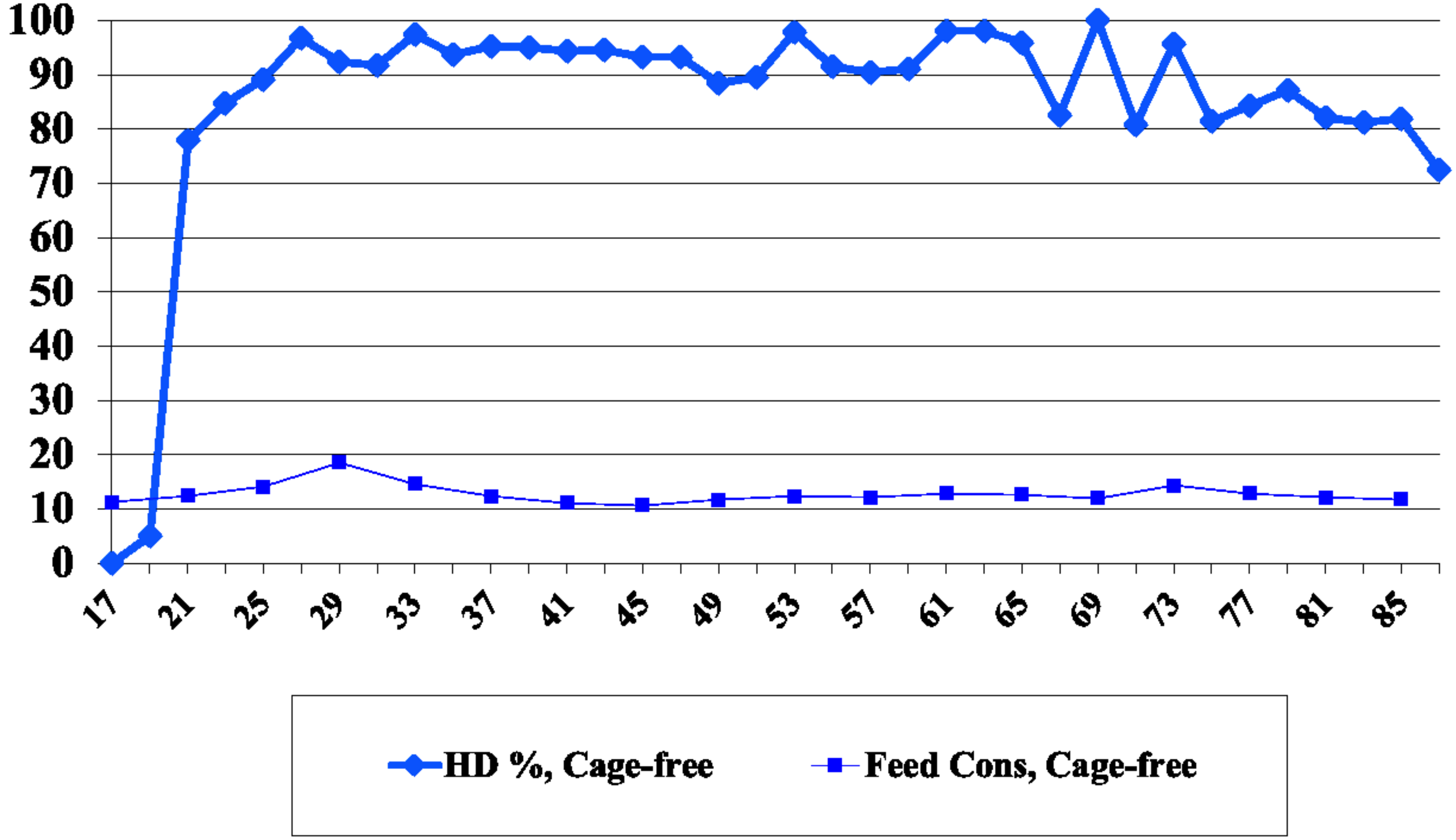
[1] kg per 100 Hens

Figure 29. Novogen Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



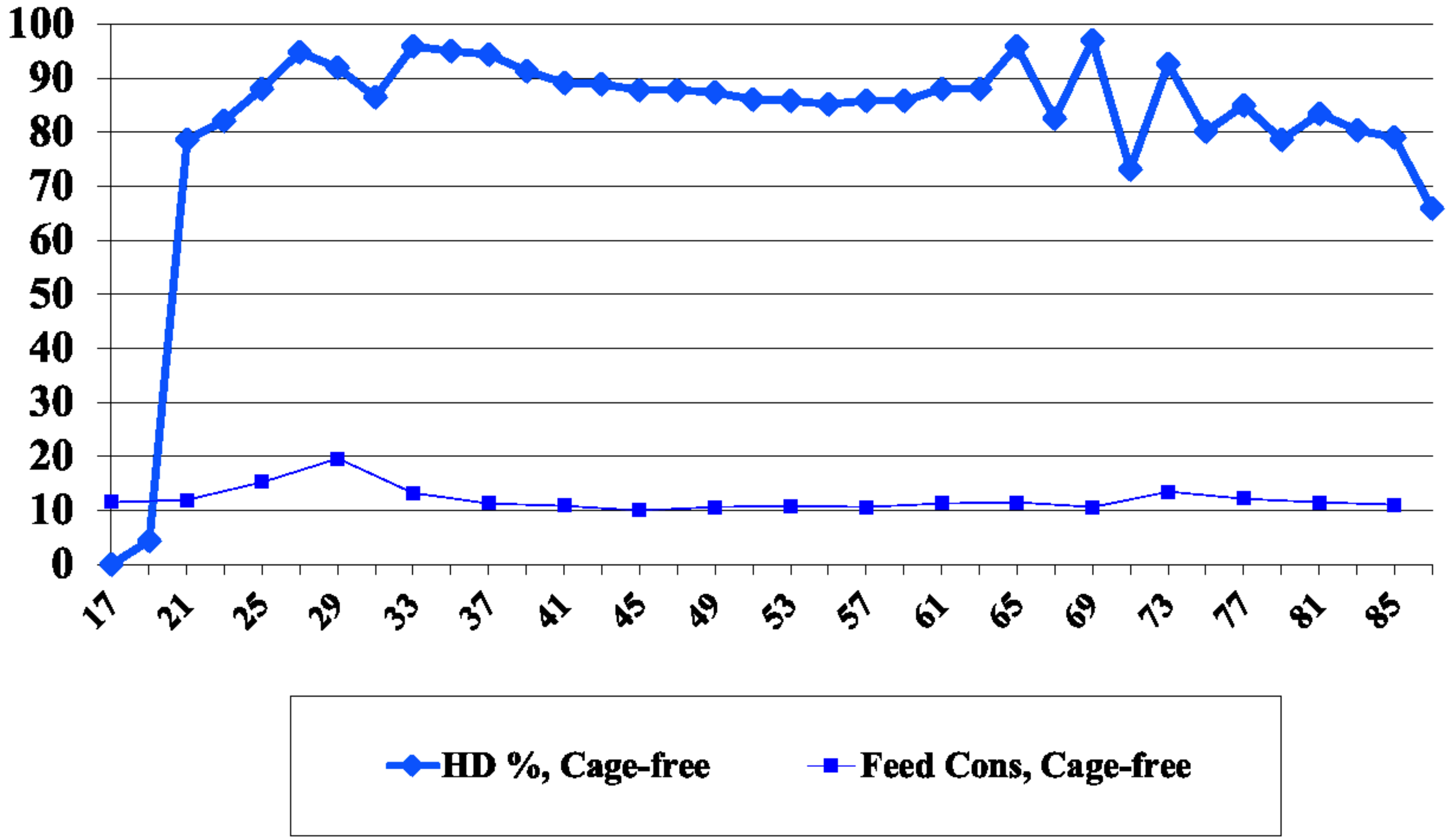
[1] kg per 100 Hens

Figure 30. Lohmann, LB-Lite, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



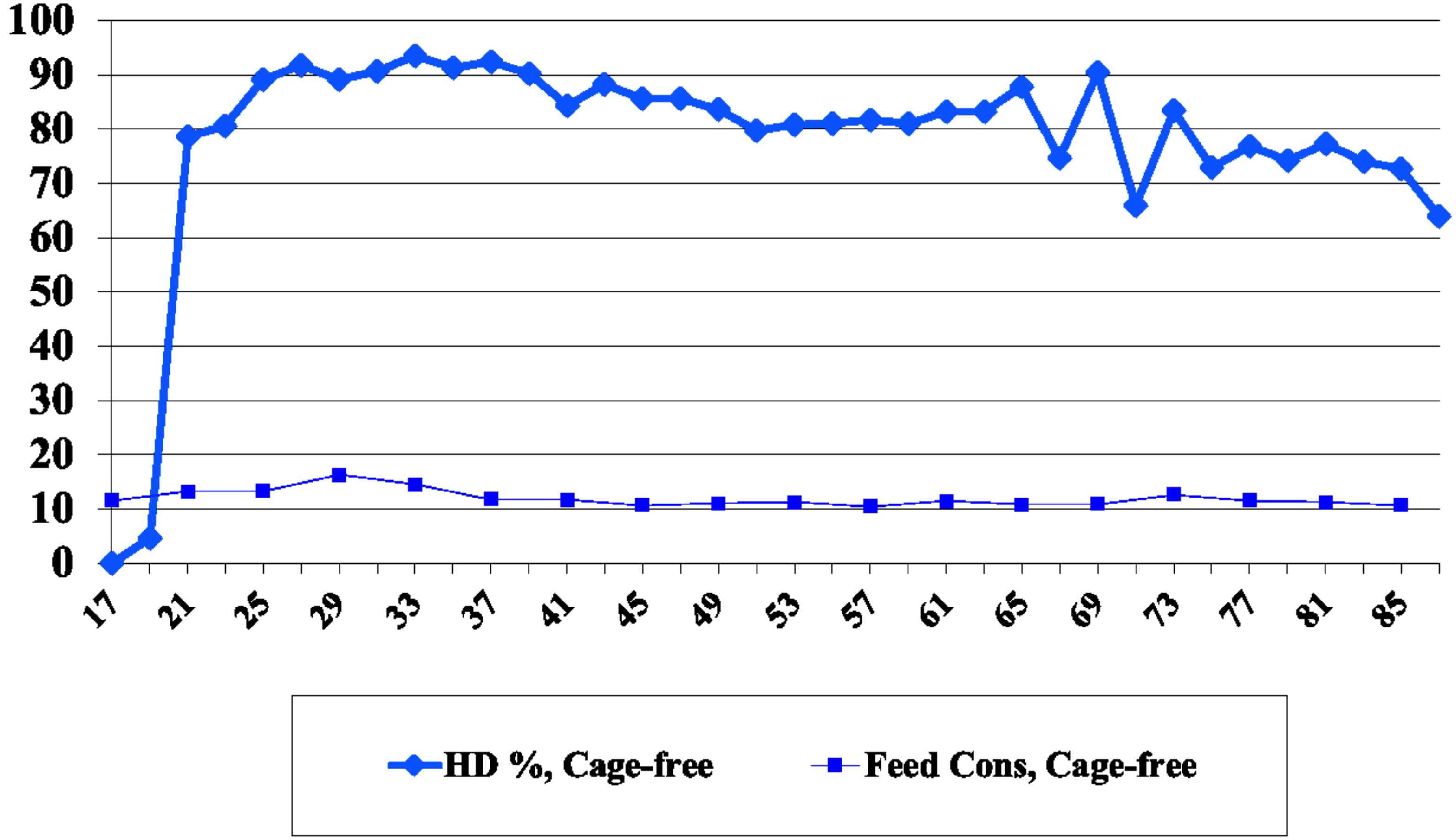
[1] kg per 100 Hens

Figure 31. Hy-Line Silver Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



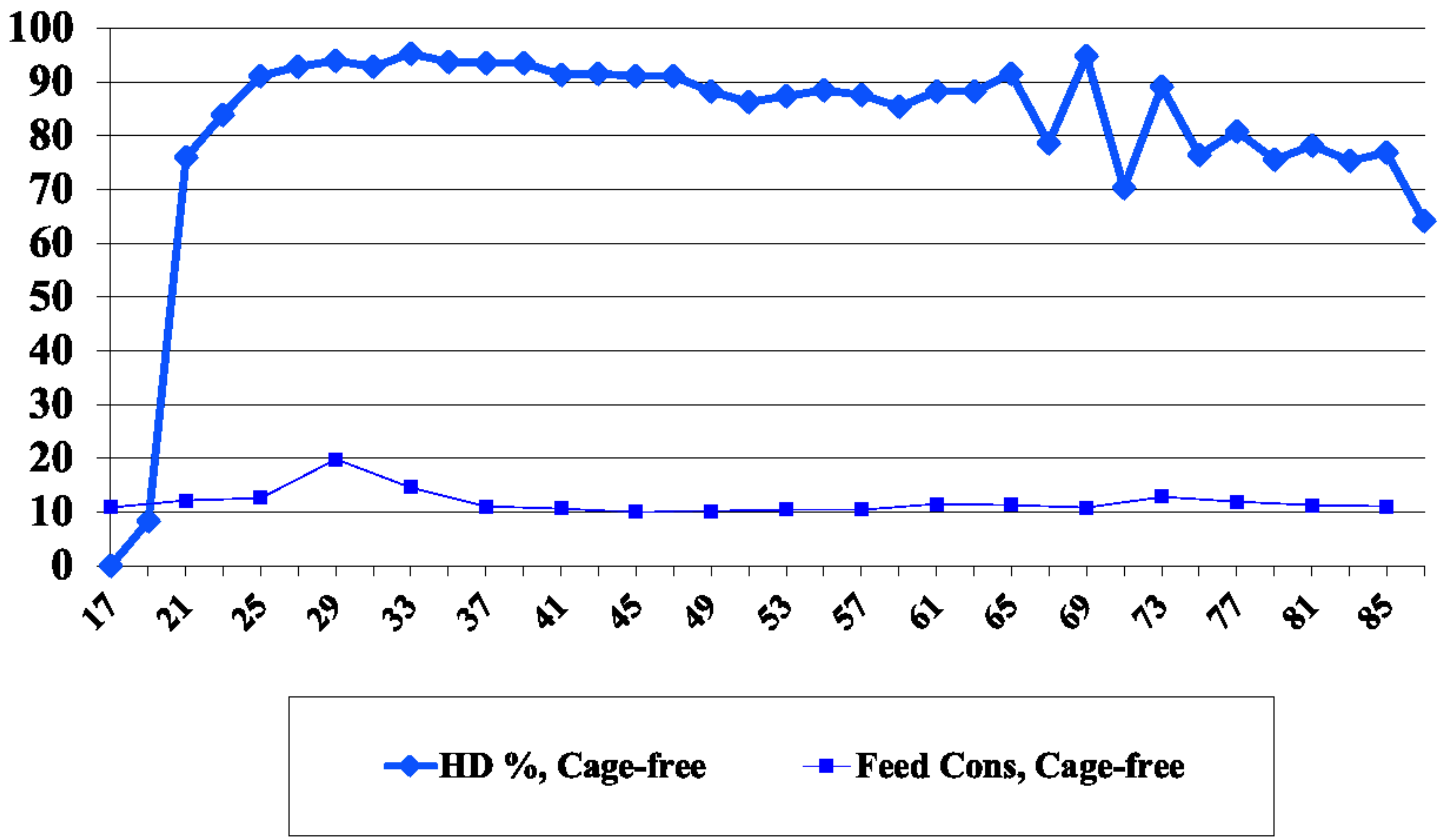
[1] kg per 100 Hens

Figure 32. Hy-Line Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



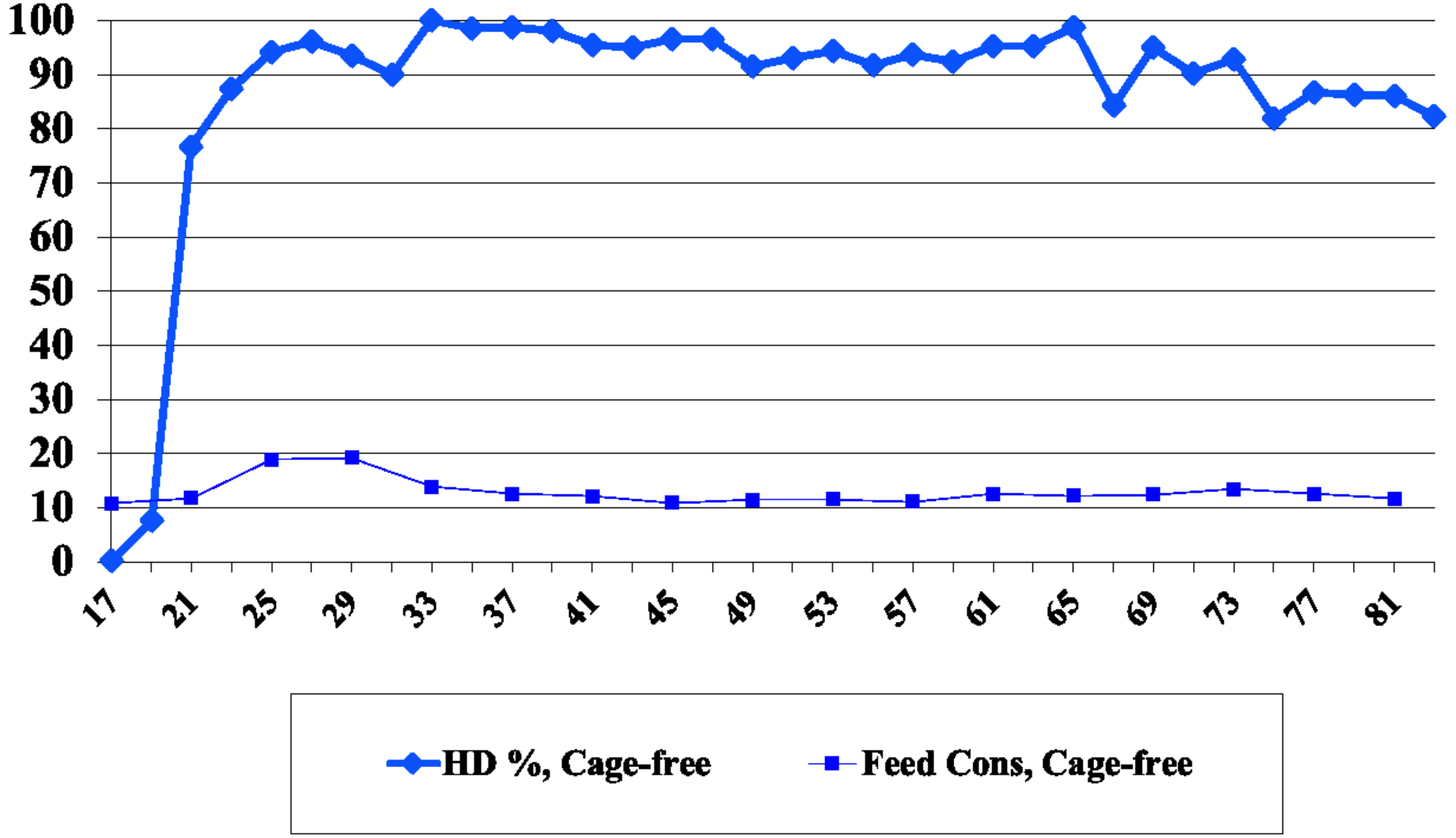
[1] kg per 100 Hens

Figure 33. ISA Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



[1] kg per 100 Hens

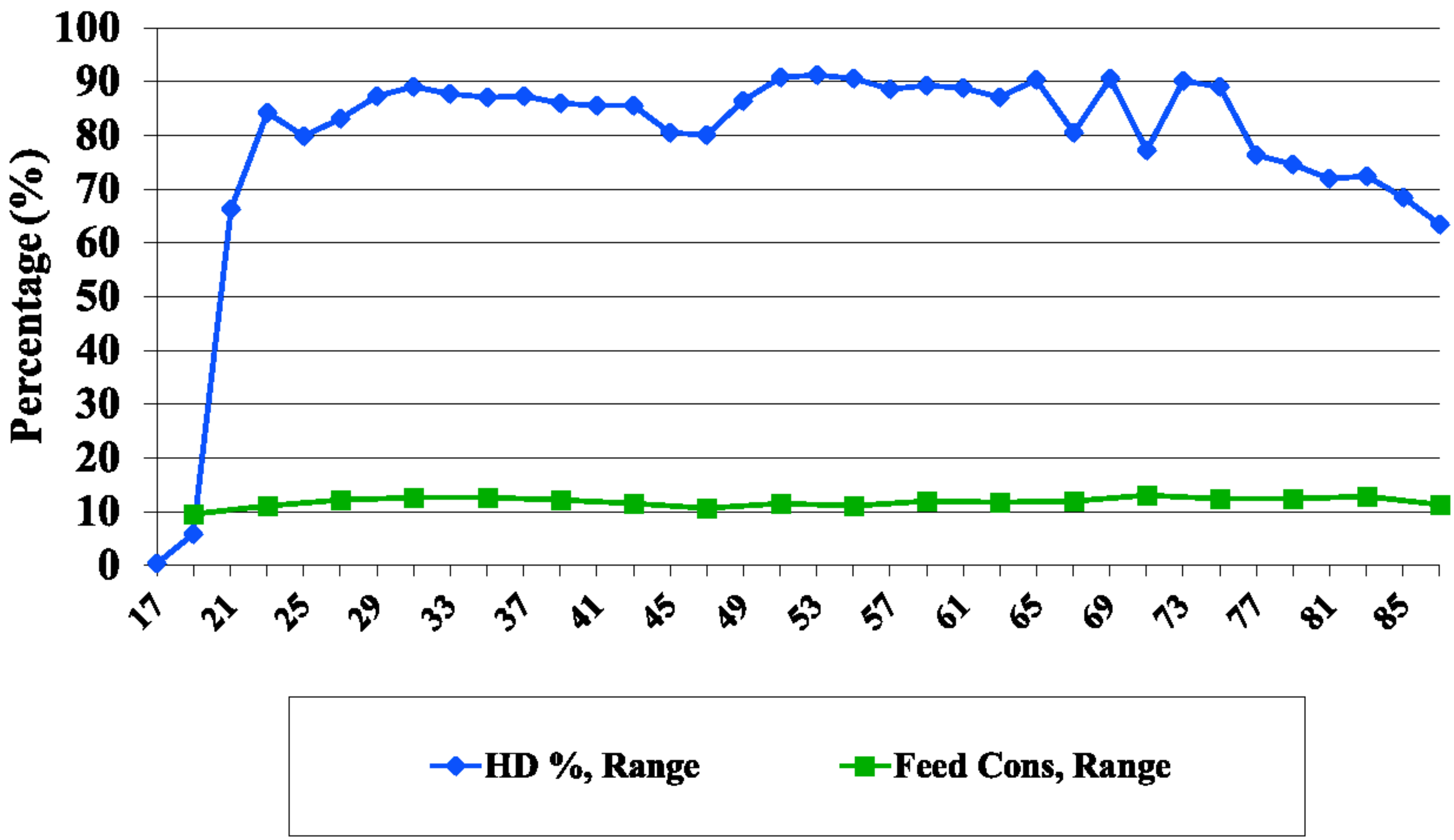
Figure 34. Bovans Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



[1] kg per 100 Hens

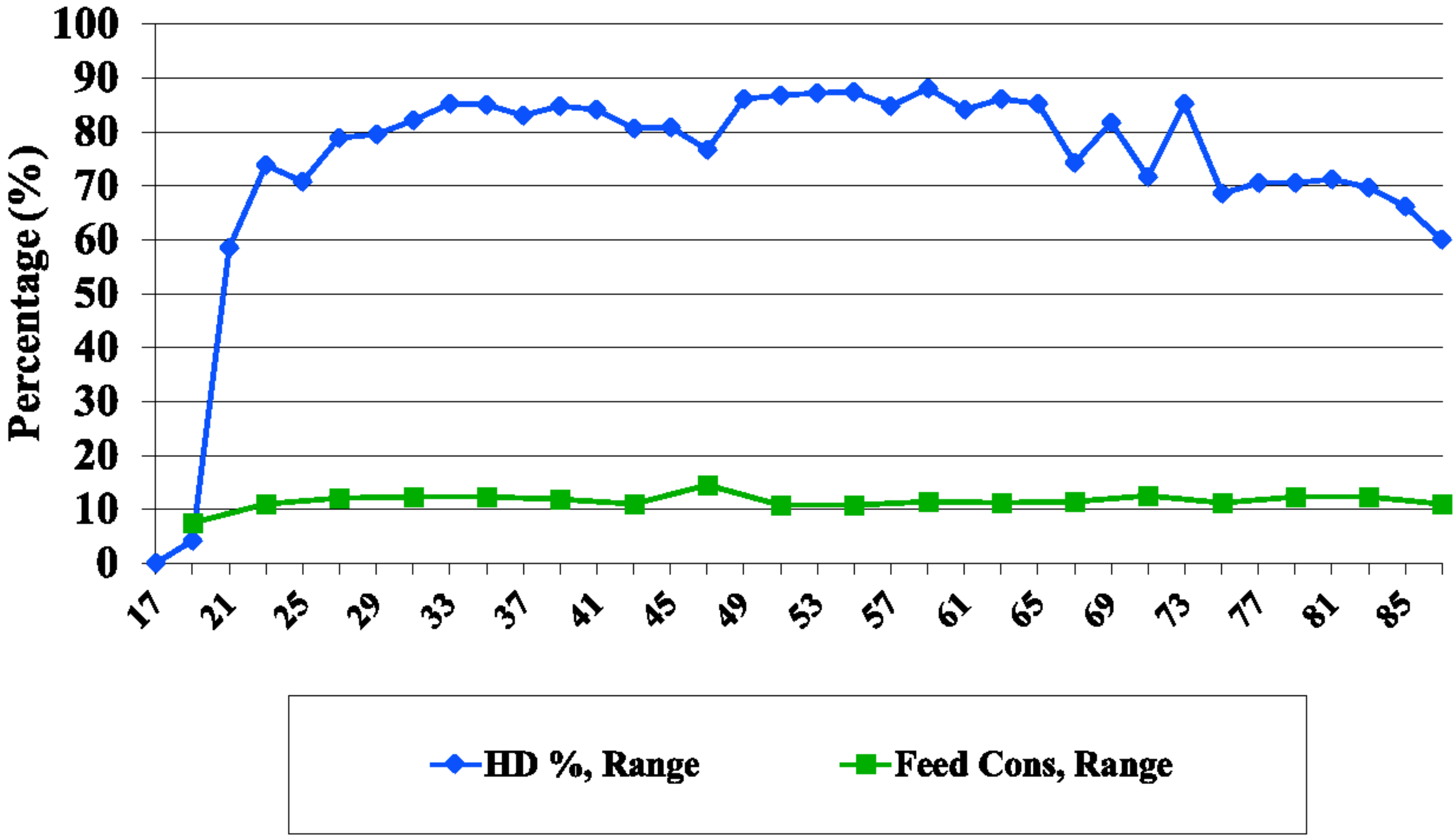
Production Graphs for Laying Hens in the Free Range Environment

Figure 35. Hy-Line Silver Brown, Bi-weekly Percent Egg Production and Period Feed Consumption[1] in Hens kept on Range



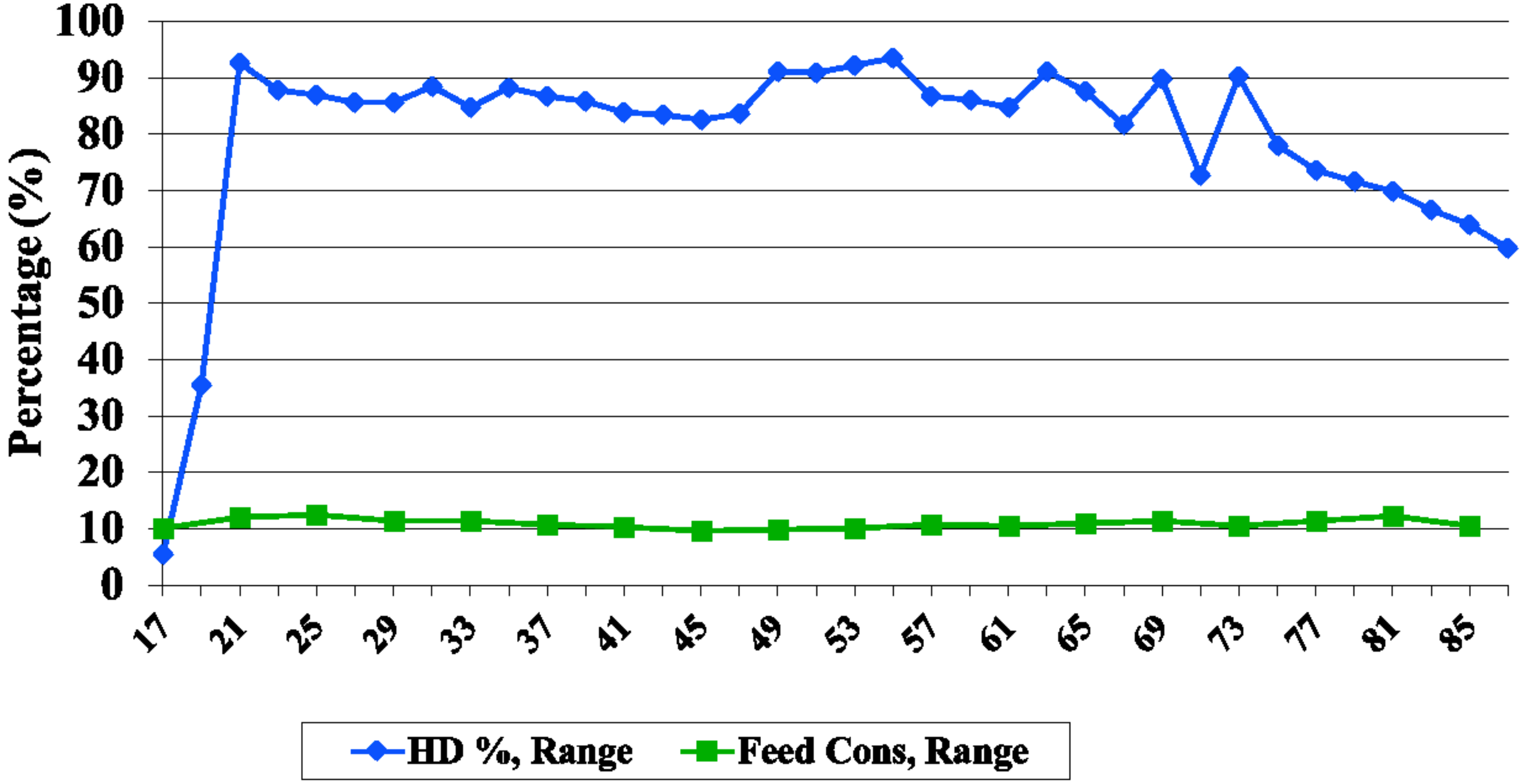
[1] kg per 100 Hens

Figure 36. Hy-Line Brown, Bi-weekly Percent Egg Production and Period Feed Consumption[1] in Hens kept on Range



[1] kg per 100 Hens

Figure 37. Hy-Line CV-22, Bi-weekly Percent Egg Production and Period Feed Consumption[1] in Hens kept on Range



[1] kg per 100 Hens

Table 40. 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 Hy-Line Brown Hy-Line Silver Brown CV22 CV24 CV26	I-A I-A III-A II-A II-A II-A	Hy-Line North America 4432 Highway 213, Box 309 Mansfield, GA 30255 (Same) (Same) (Same) (Same) (Same)
Lohmann Tierzucht Gmbh Am Seedeich 9-11 . P.O.Box 460 D-27454 Cuxhaven, Germany	Lohmann LSL-Lite Lohmann LB-Lite	I-A I-A	Hy-Line North America Elizabeth-town 79 Industrial Rd Elizabethtown, PA 17022 (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 Dekalb White Bovans Brown Babcock White B 400 Shaver White ISA Brown	I-A I-A I-A II-A II-A I-A I-A	CPI-South Central Hatchery 5087 County Road 35 Bremen, AL 35033 (Same) (Same) Institute de Sélection Animale 650 Riverbend Dr. Suite C Kitchener, Ontario N2K 3S2 Canada (Same) Midwest Farms, LLC. 135 S. Epes St. Blackstone, VA 23824 (Same)
Tetra Americana, LLC 1105 Washington Road Lexington, GA 30648	TETRA Brown TETRA Amber	I-A I-A	CPI-MidAmerica Hatchery Lexington, GA 30648 (Same)
NOVOGEN S.A.S. Mauguérand – Le Foeil BP 265 22 800 QUINTIN - FRANCE	NOVOgen BROWN NOVOgen WHITE	I-A I-A	Morris Hatchery 18370 SW 232 Street, Goulds, FL 33170-5399 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