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SINGLE PRODUCTION CYCLE REPORT OF THE THIRTY EIGHTH

NORTH CAROLINA LAYER PERFORMANCE

AND MANAGEMENT TEST:

ALTERNATIVE PRODUCTION ENVIRONMENTS

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The North Carolina Layer Performance and Management Test is conducted under the auspices of the Cooperative Extension Service, North Carolina Layer Performance and Management Program at North Carolina State University and the North Carolina Department of Agriculture and Consumer Services. The flock is maintained at the Piedmont Research Station, Salisbury, North Carolina. Mr. Joe Hampton is the Superintendent of the Piedmont Research Station; Mr. Aaron Sellers is Resident Manager of the Poultry Unit and oversees the flock protocol; Pam Jenkins is the Statistical Research Assistant; and Dr. Kenneth E. Anderson is Project Leader. The purpose of this program is to provide strain performance and management information that will assist the egg industry in North Carolina, as well as across the U.S.A. and internationally, in the evaluation of commercial layer stocks and management systems.

The data presented herein includes the analysis of a single production cycle of the 38th North Carolina Layer Performance and Management Test. This report summarizes the single cycle (17 to 85 wks) performance of the various strains when housed in several environments including commercial cages, cage-free and free range systems. Performance summary tables are provided for each strain that participated in each environment. In the commercial cages, two densities were used and performance from the two density groups is presented along with the combined results. Tables for each strain that was included in the cage-free and range performance comparisons are provided for each production environment. The first cycle report for the NCLP&MT is available on our website at
http://www.ces.ncsu.edu/depts/poulsci/tech_manuals/layer_reports/38_single_cycle_report.pdf

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38th NORTH CAROLINA LAYER PERFORMANCE AND MANAGEMENT TEST
Procedures Used for the Single Cycle Report

Entries and Strains:

A total of eleven white egg strains, seven brown egg strains, and one heritage strain were entered in the 38th test for a total of nineteen strains. All strains were accepted in accordance with the rules and regulations of the test. The strain names and egg color designations are shown in Table 1. In this report, the production data are from hens that were participation in the test housed in cages (C), cage free (CF), and range (R).

Table 1. 38th North Carolina Layer Performance and Management Test
Strain Code Assignments and

Strain No.	Source of Stock	Source Code	Strain	Participation[1]
1	Hy-Line	HL	W-36	C
2	Hy-Line	HL	W-98	C, CF
3	Lohmann	L	H&N Nick Chick	C
4	Lohmann	L	LSL Lite	C
5	ISA	ISA	Bovans White	C
6	ISA	ISA	Shaver White	C
7	ISA	ISA	Dekalb White	C
8	ISA	ISA	Babcock White	C
9	ISA	ISA	EXP. White	C
10	Novogen	N	White	C
11	ISA	ISA	Bovans Robust	C
12	Hy-Line	HL	Brown	C, CF, R
13	Hy-Line	HL	Silver Brown	C, CF, R
14	Tetra Americana	TA	TETRA Brown	C, CF
15	Tetra Americana	TA	TETRA Amber	C, CF
16	ISA	ISA	Brown	C, CF
17	ISA	ISA	Bovans Brown	C, CF
18	Novogen	N	Brown	C
19	NCSU	NC	BPR	C, CF, R

[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; Cage Free = CF; Range = R

For the cage layer test, approximately 760 white and brown egg type pullets/strain were placed at the initiation of the rearing portion of the test. For the cage-free portion 450 white and brown egg pullets/strain and for the range 160 brown egg pullets/strain were started in the appropriate environment. However, if the number of hens needed were below the prescribed numbers, the hens were divided as equally as possible between the levels and replicates within the layer house and placement number for the layer test was adjusted appropriately.

Dates of Importance:

The nineteen entries for the layer test were hatched on January 6, 2010. The chicks were all sexed according to their genetics (vent, feather, or color), vaccinated for Marek's disease. They were then wing banded for identification before being transferred to the brood/grow house. Table 1, shows the source of the layer strains that were entered, and their participation in the various test environments. Table 28 provides the nane of the breeding company, the source of the hatching eggs used, and the entry status of each strain (i.e. whether they were entered into the Cage, Cage Free, or Range Environment).

The rearing period for the range, cage free, and the cage reared pullets was completed at 16 wks of age. The pullets were then moved to their laying phase environment during their 16th wk of age. The single cycle production records commenced on May 5, 2010 (17 weeks of age) and they continued through August 24, 2011 (85 weeks of age) . Tables for the single cycle production data are provided, along with a table showing the change in body weight from 17 to 85 wk of age.

Cage Pullet Housing:

The chicks from each strain were randomly assigned to the growing cages with white egg and brown egg replicates being intermingled throughout the house. The white egg strains occupied approximately 59 % of the house and brown egg strains occupied the other 42 % of the house. All strains were assigned to be represented as equally as possible in each of the rooms, rows, and levels.

House 8--is an environmental controlled closed brood-grow facility with 3 banks of quad-deck cages in each room. Each room was assigned a number, each side of each bank was assigned a row number, each cage section within each row and level/row has been assigned a replicate number, for statistical analysis pairs of rows have been designated as blocks. Thus, each block consisted of two rows containing 24 replicates on all levels. These 3,744 pullets were housed per room in House 8, resulting in a total of 11,232 pullets housed in the 3 rearing rooms. The white and brown-egg strains were randomly assigned to the replicates in the house. Entrant strains were assigned to the replicates in a restricted randomized manner with the restrictions being that all strains were approximately equally represented in all rows, levels, and rooms. The chicks were brooded in the same cage during the entire 16 wk rearing period. Paper was placed on the cage floor for the first 7 days within each of the replicate series within each row. Each cage within the replicate was filled with 13 white-egg or brown-egg (13 per 24" x 26" cage) pullets on the day of hatch. This provided a rearing allowance of 48 in^2, 4.7 cm (1.8 in) of feeder space/bird, and a ratio of 6.5 birds to each nippledrinker. The same numbers of pullets were grown in each replicate for both white and brown-egg strains. The room dividers were removed for this test so that all birds were essentially reared in one contiguous house.

Cage Free and Range Pullet Housing:

The pullets for the range facilities were reared on litter at a density of 929 cm^2/pullet. They had access to feed, nipple waterers, and roosts (See House 2) in order to make them familiar with roosting behavior and to encourage the usage of their nest boxes. All other rearing procedures and vaccinations were the same as for their cage reared flock mates

Layer Housing:

House 4 is a high rise, environmentally controlled laying facility with three banks of Quad-deck (4-tier) high cages. There are a total of 216 replicates in house 4 which can support 5,184 hens. The replicate blocks contain cages that are either 61 or 81 cm wide. One bank of cages was used with a total of 72 replicates which can support 1,476 hens.

House 5 is a standard height totally enclosed force ventilated laying house with a scraper pit manure handling system. It has 2 banks of tri-deck cages and two banks with quad-deck (4 levels) of cages. There are a total of 252 replicates in house 5 which can support 6,048 hens. It has one banks of quad-deck (4 levels) cages were used for a total of 72 replicates in house 5 which can support 1,476 hens.

Cage Layout Description

In both houses, each side of a bank was designated as a row and each row was divided into 9 8-foot replicates/level. 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.

Cage-free layout Description

House 2 is a slat-litter facility which contained 24 pens 3.7 m x 5.5 m (12' x 18') 2/3 slats and 1/3 litter for a total of 20.4 m^2 (216 sq ft). The hens were housed at approximately 929 cm^2 (144 in^2) per hen for a total hen population of 216 hens/pen. Roosts were provided 13 cm/hen and 1nest/8 hens which provides adequate use of nests by the hens.

Table 2. Description of Replicates and Starting Hen populations in the Layer Housing

House	Replicates	Hens/rep.	hens/cage	Hen No.	Total Hens
4	36	21	7	756	
4	36	20	5	720	1,476
5	36	21	7	756	
5	36	20	5	720	1,476
2	24	216		5,184	5,184
Range Hut 1	4	75		300	
Range Hut 2	4	75		300	600

Range Layout Description

Range pullets were moved from house 2 to the range huts at 12 weeks of age. Hens were provided a minimum of 929 cm^2/pullet in the range hut pens thatwere all slats. Pullets were provided 13 cm of roosting space/hen, and 1 nest/8 hens. The range hut had a timer and light powered via battery and solar pannels, supplemental propane heater for winter conditions to maintain a 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 free access to the outdoors throughout the day and night but, appeared to return to the range hut during the dark for roosting and protection. Husbandry, lighting and supplemental feed were allocated on the same basis as flock mates in cages in order to minimize the variables between flock mates as much as possible. Range density was based upon a 500 hen/acre static equivalency 8.04 m^2/hen (86 ft^2/hen). The range pens were 21.3 m x 21.3 m (70' x 70') and were enclosed by a fence 1.8 m (6 ft) with the lower chain link section being 1.2 m (4 ft) high. In order to facilitate range forage replenishment each of the paddocks were divided in half with a diagnoal fence providing 4.04 m^2/hen (43 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.). Hen movement was controlled by an access a gate that allowed access to one half of the paddock at any point in time. The varanda 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 (turned off in winter to prevent freezing). There were tube feeders in each pen 1 inside and a covered feeder outside providing 5.1 cm of feeder space /hen.

Table 3. Laying House and Range Hut Lighting Schedules:

Age	Date	Houses 2, 4 and 5 (Light Hours)	Range Huts 1 and 2 (Light Hours)
Housing Pullets	April 31to May 4, 2010	10.0	Natural Day
17 Weeks[1]	May5, 2010	11.0	Natural Day
18 Weeks	May 12, 2010	11.5	Natural Day
19 Weeks	May 19, 2010	12.0	Natural Day
20 Weeks	May 26, 2010	12.5	Natural Day
21 Weeks	June 2, 2010	13.0	Natural Day
22 Weeks	June 9, 2010	13.5	Natural Day
23 Weeks	June 16, 2010	14.0	Natural Day
24 Weeks	June 23, 2010	14.25	Natural Day
25 Weeks	June 30, 2010	14.5	Natural Day
26 Weeks	July 7, 2010	14.75	Natural Day
27 Weeks	July 14, 2010	15.0	Natural Day
28 Weeks	July 21, 2010	15.25	Natural Day
29 Weeks	July 28, 2010	15.5	15.5
30 Weeks	Aug. 4, 2010	15.75	15.75
31 Weeks	Aug. 11, 2010	16.0	16.0
Through 85Wks	Aug 24, 2011	16.0	16.0

Test Design:

TheFree Range, Cage-free and Cage laying test was set up as a completely randomized factorial design. The main effects within House 4 and 5 were strain, and density (population). In House 2 (Cage-free) and in the Range Huts (Free Range) strain was the main factor. Following are general descriptions of the main effects and other housing conditions.

Strain

The samples of fertile eggs were provided directly by the breeders involved. All eggs were set and hatched concurrently. A total of nine white egg strains and three brown egg strains participated in the test. See the 38th Hatch Report (Vol. 38, No. 1) for details.

Density

In Houses 4 and 5, all individual replicates within each block contained one strain of layer. The cage density in both houses was dictated by the cage size that was either 61 or 81 cm wide and 41 cm deep. This allowed for two density combinations of 73 in^2 (471 cm^2) at 7 hens/cage (81 x 41 cm) and 77 in^2 (497 cm^2) at 5 hens/cage (61x 41 cm).

House 2 is a slat-litter facility which contained 24 pens 3.7 m x 5.5 m (12' x 18') 2/3 slats and 1/3 litter for a total of 20.4 m^2 (216 sq ft). The hens were housed at approximately 929 cm^2 (144 in^2) per hen for a total hen population of 216 hens/pen.

Range pullets were moved from house 2 to the range huts at 12 weeks of age. Hens were provided a minimum of 929 cm^2/pullet in the full slat range hut pens. Range density was based upon a 500 hen/acre static equivalency 8.04 m^2/hen (86 ft^2/hen). The range pens were 21.3 m x 21.3 m (70' x 70') and were enclosed by a fence 1.8 m (6 ft) with the lower chain link section being 1.2 m (4 ft) high. In order to facilitate range forage replenishment each of the paddocks was divided in half with a diagnoal fence providing 4.04 m^2/hen (43 ft^2/hen) and rotated every 4 wks.

Table 4. Population and Density Allocations in Houses 4, 5, 2, and in the Range huts.

Production House	Hens/Cage, Pen, or Range paddock population	Cage or pen size or Range Width x Depth	Floor Space per Bird	Feeder Space per Bird	Water Nipples per Cage or Range
Houses 4 & 5	5	61 cm x 40.7 cm	497 cm^2 (77 in^2)	12.2 cm 4.8 in	2
Houses 4 & 5	7	81.2 cm x 40.7 cm	471 cm^2 (73 in^2)	11.6 cm 4.6 in	2
House 2	216	3.7 m x 5.5 m	929 cm^2 (144 in^2)	2.54 cm 1 in	20
Range Huts 1 and 2	75	Pen 3.04 m x 2.3 m Paddock 21.3 m x 21.3m	929 cm^2 (144 in^2) 8.04 m^2 (86 ft^2)	3.9 cm 1.5 in	16

Layer Nutrition:

Layer 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 below. 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.

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 38th 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. 38th NCLP&MT Laying House Feeding Program

Rate of Production	Consumption Per 100 Birds/Day (kg)	Diet Fed: White Egg Strains	Diet Fed: Brown Egg Strains
Weeks 17-26	< 9.52	D	D
Pre-Peak and > 87%	< 9.52	D	D
	9.57-10.39	F	E
	10.43-11.29	H	G
	11.34-12.20	I	H
	12.25-13.11	M	I
	>13.15	N	M
80-87%	< 9.52	F	E
	9.57-10.39	G	F
	10.43-11.29	I	H
	11.34-12.20	M	I
	12.25-13.11	N	M
	>13.15	O	N
70-80%	< 9.52	H	G
	9.57-10.39	I	H
	10.43-11.29	M	I
	11.34-12.20	N	M
	12.25-13.11	O	N
	>13.15	O	O
< 70%	< 9.52	H	G
	9.57-10.39	I	H
	10.43-11.29	N	M
	11.34-12.20	O	N
	12.25-13.11	O	O
	>13.15	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. 38th NCLP&MT Laying Periods Feed Formulations D through G

Ingredients	D	E	F	G
Corn	866.71	925.46	997.91	1068.19
Soybean meal	663.18	621.10	552.33	499.80
Wheat Midds				
Fat (Tallow)	110.88	102.43	87.73	74.61
Gluten Meal 60%	95.83	88.37	100.00	99.23
D.L. Methionine	3.08	2.89	2.52	2.26
Lysine 78.8%				
Soybean Hulls				
Ground Limestone	132.42	133.70	135.07	134.02
Coarse Limestone	75.00	75.00	75.00	75.00
Bi-Carbonate	3.00	3.00	3.00	3.00
Phosphate Mono/D	36.77	34.73	32.84	30.36
Salt	6.00	5.99	5.95	5.93
Vit. premix	1.00	1.00	1.00	1.00
Min. premix	1.00	1.00	1.00	1.00
Mold Inhibitor	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%	2.14	2.33	2.65	2.59
Calculated Analysis				
Protein %	22.0	21.0	20.00	19.00
ME kcal/kg	2926.0	2926.0	2926.0	2926.0
Calcium %	4.45	4.45	4.45	4.40
T. Phos. %	0.71	0.68	0.65	0.61
Lysine %	1.15	1.09	1.00	0.93
TSAA %	0.89	0.85	0.81	0.77

Table 8. 38th NCLP&MT Laying Periods Feed Formulations H through M

Ingredients	H	I	M
Corn	1131.97	1199.47	1258.28
Soybean meal	457.65	406.08	363.91
Wheat Midds			
Fat (Tallow)	64.32	52.26	43.80
Gluten Meal 60%	90.80	89.84	82.64
D.L. Methionine	2.48	2.02	1.62
Lysine 78.8%			
Soybean Hulls			
Ground Limestone	132.50	158.82	160.10
Coarse Limestone	75.00	50.00	50.00
Bi-Carbonate	3.00	3.00	3.00
Phosphate Mono/D	28.79	26.79	24.75
Salt	5.92	5.90	5.89
Vit. premix	1.00	1.00	1.00
Min. premix	1.00	1.00	1.00
Mold Inhibitor	1.00	1.00	1.00
T-Premix	1.00	1.00	1.00
.06% Selenium Premix	1.00	1.00	1.00
Choline Cl 60%	2.57	0.83	1.02
Calculated Analysis			
Protein %	18.0	17.00	16.00
ME kcal/kg	2926.0	2926.0	2926.0
Calcium %	4.35	4.35	4.35
T. Phos. %	0.59	0.56	0.52
Lysine %	0.87	0.80	0.74
TSAA %	0.75	0.70	0.65

Data Collection Schedule and Procedures:

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

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

Egg Quality--At twenty-eight day intervals, all eggs produced within the previous 24 hours were examined by candling light and graded according to current USDA standards for egg quality. Eggs were graded in the pilot processing facility and handled as they would be in a commercial off-line facility.

Egg Income--Egg income was calculated using current year regional average prices for farm value of eggs based on egg production and quality evaluation.

Feed Consumption and Conversion--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.

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 single cycle (85 wks). Body weight gain for the single cycle was calculated and reported for each strain in each environment.

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

Statistical Analyses and Separation of Means:

Analyses of variance were performed on all data. Separate analyses were conducted for white and brown egg strains. Preliminary analysis was conducted on all brown egg strains including the heritage strain. Then the final analysis included only the commercial strains. The Heritage Barred Plymouth Rock Hens were found to be different from all of the commercial Brown Strains in most instances. Where they are not different it will be indicated at ($P < 0.01$) with **†** symbol.

Significant differences ($P < 0.01$) within white and brown egg strains are noted by differing letters among columns of means. All data were subjected to ANOVA utilizing the GLM procedure of SAS, with the main effect of strain. First and second order interactions were tested for significance. Mean differences were separated via the PDIFF option of the GLM procedure.

DESCRIPTION OF DATA TABLE STATISTICS

Single cycle performance of white and brown egg strains in cages are shown on Tables 12 to 19. Single cycle performance of white and brown egg strains in cage-free pens are shown on Tables 20 to 23. The single cycle range hen data for the brown egg strains are shown on Tables 24 to 27.

Breeder (Strain):

Short identification codes of the breeder and strain of the stock were developed. See more complete information following data tables in Table 24.

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 595 days of age

Feed Consumption:

The kilograms of feed consumed daily per 100 hens per day (hen days).

Feed Conversion:

The grams of egg produced per gram of feed consumed.

Egg Weight:

The average egg weight (gms) 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 year regional average egg prices 5/5/2010 to 8/24/2011.

Table 9. Three Year Regional Average Egg Prices

Grade	Size	$$/Dozen 1st Cycle
A	Extra Large	1.19
A	Large	1.16
A	Medium	0.93
A	Small	0.79
A	Pee Wee	0.39
B	All	0.61
Checks	All	0.61

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:

The following size classifications (Table 9) were 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 ounces/doz. This maximizes the number of USDA large eggs just as would occur in a commercial plant.

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

Size Category	Ounces/Dozen
Pee Wee	< 18
Small	18 - 21
Medium	21 - 23.5
Large	23.5 - 27
Extra Large	> 27

Feed Cost:

The calculated feed cost per hen housed at 119 days, using the pounds/diet consumed and the average price of each diet per ton purchased from 10/3/2007 to 12/30/2008.

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

Diets	Price Per Ton
D	325.30
E	333.13
F	344.43
G	360.23
H	376.58
I	399.70
M	405.88

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 DENSITY ON PERFORMANCE OF HENS IN THE 38th NCLP&MT (119-595 DAYS)

Breeder	Density[1]	Feed Consumption	Feed Conversion	Eggs Per Bird Housed	Egg Production	Egg Mass	Mortality	Age at 50% Production
(Strain)	(in^2/hen)	(kg/100/hen/d)	(g egg/g feed)		(HD%)	(g/HD)	(%)	(Days)
Hy-Line	73	9.7	0.51	373.9	80.1	49.0	6.0	143.8
W-36	77	10.1	0.50	380.4	81.1	50.3	6.3	146.0
	Average	9.9^{B}	0.50	377.1	80.6^{D}	49.7^{C}	6.1	144.9^{B}
Hy-Line	73	11.3	0.47	369.2	82.1	53.4	7.2	141.3
W-98	77	11.1	0.47	382.1	82.3	53.0	3.3	139.0
	Average	11.2^{A}	0.47	375.6	82.2^{CD}	53.2^{AB}	5.2	140.1^{C}
H&N	73	10.9	0.49	381.3	85.0	53.8	9.5	142.8
Nick Chick	77	11.1	0.49	390.3	85.1	54.2	5.0	142.8
	Average	11.0^{A}	0.49	385.8	85.0^{ABC}	54.0^{A}	7.3	142.8^{BC}
Lohmann	73	11.2	0.48	376.6	87.1	54.4	15.9	147.3
LSL-Lite	77	11.1	0.48	396.0	85.8	53.6	7.5	145.0
	Average	11.1^{A}	0.48	386.3	86.5^{A}	54.0^{A}	11.7	146.2^{AB}
Bovans	73	10.7	0.48	387.6	86.0	52.1	9.5	141.8
White	77	10.8	0.49	390.5	86.8	53.4	15.0	144.3
	Average	10.8^{A}	0.49	389.0	86.4^{A}	52.8^{AB}	12.3	143.0^{B}
Shaver	73	9.9	0.51	393.8	84.6	51.0	7.2	148.0
White	77	9.8	0.51	384.0	83.5	50.6	11.7	151.3
	Average	9.9^{B}	0.51	388.9	84.0^{ABC}	50.8^{BC}	9.4	149.7^{A}
DeKalb	73	11.3	0.47	402.4	85.3	53.4	8.3	143.5
White	77	11.4	0.47	382.0	84.6	54.0	8.8	145.5
	Average	11.3^{A}	0.47	392.2	84.9^{ABC}	53.7^{A}	8.5	144.5^{B}
ISA Babcock	73	11.1	0.49	406.5	86.0	55.0	1.6	143.7
White	77	10.6	0.50	399.4	84.6	53.2	3.8	141.8
	Average	10.8^{A}	0.50	402.9	85.3^{AB}	54.1^{A}	2.7	142.7^{BC}
ISA	73	10.4	0.51	389.7	85.9	53.3	9.5	140.0
Exp. White	77	10.8	0.49	388.5	85.5	53.8	11.7	139.3
	Average	10.6^{AB}	0.50	389.1	85.7^{AB}	53.6^{A}	10.6	139.7^{C}
Novogen	73	10.6	0.50	384.2	82.8	53.6	8.3	147.3
White	77	10.5	0.49	385.8	83.5	52.4	6.3	146.3
	Average	10.6^{AB}	0.49	385.0	83.1^{BCD}	53.0^{AB}	7.3	146.8^{AB}
Bovans	73	10.5	0.51	391.1	85.4	53.9	10.7	146.3
Robust	77	11.0	0.50	390.2	86.5	55.3	12.9	143.8
	Average	10.8^{A}	0.50	390.6	86.0^{AB}	54.6^{A}	11.8	145.0^{B}
All	73	10.7	0.49	386.9	84.6	53.0	8.5	144.1
Strains	77	10.7	0.49	388.1	84.5	53.1	8.4	144.1

[1]All strains were housed such that each strain is equally represented in each density.

A,B,C,D - Different letters denote significant differences (P<0.01), comparisons made among strain average values.

TABLE 13. EFFECT OF WHITE EGG STRAIN AND DENSITY ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF HENS IN THE 38th NCLP&MT (119-595 DAYS)

Breeder	Density[1]	Egg Weight	Pee Wee	Small	Medium	Large	Extra Large
(Strain)	(in^2/hen)	(g/egg)	(%)	(%)	(%)	(%)	(%)
Hy-Line	73	60.8	0.3	5.3	9.6	27.1	57.3
W-36	77	61.4	0.9	2.9	10.7	21.2	64.2
	Average	61.1^{BCD}	0.6	4.1	10.1^{A}	24.1^{BC}	60.7^{BC}
Hy-Line	73	64.6	0.0	3.6	7.1	12.6	76.1
W-98	77	63.8	0.6	3.7	6.7	15.7	73.1
	Average	64.2^{A}	0.3	3.6	6.9^{ABC}	14.1^{D}	74.6^{A}
H&N	73	62.4	0.3	4.5	7.1	19.6	68.0
Nick Chick	77	63.0	0.5	3.1	7.4	18.4	70.2
	Average	62.7^{AB}	0.4	3.8	7.3^{ABC}	19.0^{CD}	69.1^{AB}
Lohmann	73	61.6	0.0	3.3	8.0	24.0	64.0
LSL-Lite	77	61.8	0.0	5.4	7.1	24.5	62.8
	Average	61.7^{BC}	0.0	4.3	7.6^{ABC}	24.3^{BC}	63.4^{BC}
Bovans	73	60.0	0.0	5.6	9.3	30.7	53.6
White	77	60.6	0.5	4.6	9.8	29.8	54.9
	Average	60.3^{CD}	0.3	5.1	9.6^{A}	30.2^{AB}	54.3^{CD}
Shaver	73	59.6	0.5	5.5	8.1	37.5	48.1
White	77	59.8	1.0	4.6	10.2	37.2	46.8
	Average	59.7^{D}	0.7	5.1	9.1^{AB}	37.3^{A}	47.5^{D}
DeKalb	73	61.7	0.1	5.6	4.9	26.1	63.0
White	77	63.0	0.0	5.5	5.6	15.2	73.6
	Average	62.4^{B}	0.0	5.6	5.3^{C}	20.7^{CD}	68.3^{AB}
ISA Babcock	73	63.2	0.4	1.1	7.2	17.9	72.4
White	77	62.2	0.6	3.9	6.5	21.4	67.0
	Average	62.7^{AB}	0.5	2.5	6.9^{ABC}	19.6^{CD}	69.7^{AB}
ISA	73	61.5	0.2	3.5	9.0	24.2	62.8
Exp. White	77	62.4	0.0	3.3	7.3	19.5	69.0
	Average	62.0^{BC}	0.1	3.4	8.2^{ABC}	21.8^{BCD}	65.9^{AB}
Novogen	73	63.3	0.2	3.0	5.0	21.5	69.9
White	77	62.0	0.3	4.4	6.8	25.7	62.3
	Average	62.7^{AB}	0.2	3.7	5.9^{BC}	23.6^{BC}	66.1^{AB}
Bovans	73	62.3	0.4	4.4	7.8	20.8	66.2
Robust	77	63.2	0.0	2.7	7.2	19.7	69.6
	Average	62.8^{AB}	0.2	3.5	7.5^{ABC}	20.2^{CD}	67.9^{AB}
All	73	61.9	0.2	4.1	7.6	23.8	63.8
Strains	77	62.1	0.4	4.0	7.8	22.6	64.9

[1]All strains were housed such that each strain is equally represented in each density

A,B,C,D - Different letters denote significant differences ($P<0.01$), comparisons made among strain average values.

TABLE 14. EFFECT OF WHITE EGG STRAIN AND DENSITY ON EGG QUALITY, INCOME AND FEED COSTS OF HENS IN THE 38th NCLP&MT (119-595 DAYS)

Breeder	Density[1]	Grade A	Grade B	Cracks	Loss	Egg Income	Feed Costs
(Strain)	(in^2/hen)	(%)	(%)	(%)	(%)	($/hen)	($/hen)
Hy-Line	73	95.5	2.7	1.4	0.5	34.32	14.44
W-36	77	95.5	1.1	3.1	0.3	35.14	15.02
	Average	95.5	1.9	2.2	0.4	34.73	14.73
Hy-Line	73	93.8	3.2	2.5	0.6	34.12	15.85
W-98	77	95.5	2.5	1.7	0.2	35.66	15.49
	Average	94.6	2.8	2.1	0.4	34.89	15.67
H&N	73	96.1	1.6	1.7	0.6	35.41	15.66
Nick Chick	77	95.3	2.6	1.7	0.5	36.31	16.20
	Average	95.7	2.1	1.7	0.5	35.86	15.93
Lohmann	73	95.4	2.4	1.4	0.8	34.84	15.58
LSL-Lite	77	94.5	3.4	1.9	0.3	36.58	16.49
	Average	94.9	2.9	1.7	0.5	35.71	16.04
Bovans	73	95.7	2.2	1.2	0.9	35.43	15.39
White	77	94.3	3.5	1.8	0.5	35.63	15.74
	Average	95.0	2.8	1.5	0.7	35.53	15.56
Shaver	73	94.7	2.1	2.8	0.4	36.03	14.69
White	77	94.9	3.1	1.8	0.2	35.07	14.41
	Average	94.8	2.6	2.3	0.3	35.55	14.55
DeKalb	73	95.9	2.0	1.7	0.4	37.49	16.39
White	77	96.4	2.3	1.2	0.2	35.85	15.90
	Average	96.1	2.2	1.4	0.3	36.67	16.15
ISA Babcock	73	93.2	3.6	2.3	0.9	37.44	16.42
White	77	95.3	2.5	1.6	0.7	36.90	16.17
	Average	94.2	3.1	1.9	0.8	37.17	16.30
ISA	73	96.8	1.6	1.4	0.3	36.43	15.19
Exp. White	77	94.7	2.3	2.1	0.9	35.82	15.51
	Average	95.7	1.9	1.8	0.6	36.13	15.35
Novogen	73	94.3	3.4	1.9	0.5	35.78	15.81
White	77	94.4	2.3	2.9	0.5	35.57	15.64
	Average	94.3	2.8	2.4	0.5	35.67	15.73
Bovans	73	93.3	3.7	2.6	0.4	35.89	15.31
Robust	77	96.1	2.2	0.9	0.9	36.37	15.56
	Average	94.7	3.0	1.8	0.6	36.13	15.43
All	73	95.0	2.6	1.9	0.6	35.74	15.52
Strains	77	95.2	2.5	1.9	0.5	35.90	15.65

[1]All strains were housed such that each strain is equally represented in each density.

TABLE 15. EFFECT OF BROWN EGG STRAIN AND DENSITY ON PERFORMANCE OF HENS IN THE 38th NCLP&MT (119-595 DAYS)

Breeder	Density[1]	Feed Consumption	Feed Conversion	Eggs Per Bird Housed	Egg Production	Egg Mass	Mortality	Age at 50% Production
(Strain)	(in^2/hen)	(kg/100/hen/d)	(g egg/g feed)		(HD%)	(g/HD)	(%)	(Days)
Hy-Line	73	10.3	0.49	365.3	79.8	51.1	7.2	144.5
Brown	77	10.8	0.49	386.0	82.9	53.7	3.8	141.8
	Average	10.5	0.49^{A}	375.7^{AB}	81.3^{A}	52.4^{AB}	5.5	143.1
Hy-Line	73	10.7	0.46	379.8	82.5	49.2	7.1	143.3
Silver Brown	77	10.8	0.47	399.8	84.4	50.7	2.5	142.8
	Average	10.7	0.46^{AB}	389.8^{A}	83.5^{A}	50.0^{BC}	4.8	143.0
TETRA	73	10.4	0.45	342.1	74.2	47.3	9.5	145.3
Brown	77	11.2	0.46	342.8	80.0	51.5	17.5	141.8
	Average	10.8	0.45^{B}	342.5^{C}	77.1^{B}	49.4^{C}	13.5	143.5
TETRA	73	10.1	0.48	376.4	81.4	48.8	8.4	141.3
Amber	77	11.7	0.42	364.4	81.1	49.4	11.3	142.0
	Average	10.9	0.45^{B}	370.4^{AB}	81.2^{A}	49.1^{C}	9.8	141.6
ISA	73	11.0	0.48	379.5	83.0	53.4	9.5	147.0
Brown	77	11.3	0.47	390.2	84.3	53.7	10.0	143.5
	Average	11.1	0.48^{AB}	384.8^{AB}	83.7^{A}	53.5^{A}	9.8	145.3
Bovans	73	10.8	0.48	392.3	84.1	52.6	12.8	144.7
Brown	77	11.0	0.49	386.7	83.8	54.1	5.0	145.0
	Average	10.9	0.48^{AB}	389.5^{A}	84.0^{A}	53.3^{A}	8.9	144.8
Novogen	73	10.6	0.48	360.0	81.6	50.8	17.9	144.5
Brown	77	10.9	0.47	368.8	82.5	51.6	11.4	145.0
	Average	10.7	0.48^{AB}	364.4^{BC}	82.0^{A}	51.2^{ABC}	14.6	144.8
All	73	10.5^{Z}	0.47	370.8	80.9	50.5^{Z}	10.3	144.3
Strains	77	11.1^{Y}	0.47	376.9	82.7	52.1^{Y}	8.8	143.1
NCSU Barred	73	9.1	0.31	233.0	51.2	28.2	4.7†	159.0
Plym. Rock	77	9.8	0.28	220.1	50.7	28.7	13.4†	171.7

[1]All strains were housed such that each strain is equally represented in each density.

A,B,C - Different letters denote significant differences (P<0.01), comparisons made among strain average values.

Y,Z - Different letters denote significant differences (P<0.01), comparisons made among density average values.

TABLE 16. EFFECT OF BROWN EGG STRAIN AND DENSITY ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF HENS IN THE 38th NCLP&MT (119-595 DAYS)

Breeder	Density[1]	Egg Weight	Pee Wee	Small	Medium	Large	Extra Large
(Strain)	(in^2/hen)	(g/egg)	(%)	(%)	(%)	(%)	(%)
Hy-Line	73	63.5	0.0	1.7	7.6	20.0	70.2
Brown	77	64.2	0.1	0.7	6.1	20.4	72.4
	Average	63.9^{A}	0.0	1.2^{B}	6.8^{C}	20.2^{CD}	71.3^{A}
Hy-Line	73	59.1	0.6	3.3	11.7	41.2	43.1
Silver Brown	77	59.5	0.0	2.9	11.8	34.8	50.1
	Average	59.3^{C}	0.3	3.1^{AB}	11.7^{A}	38.0^{A}	46.6^{C}
TETRA	73	63.0	0.0	2.1	8.8	18.5	70.5
Brown	77	63.9	0.3	1.5	7.4	17.4	73.2
	Average	63.5^{A}	0.2	1.8^{B}	8.1^{ABC}	17.9^{D}	71.8^{A}
TETRA	73	59.5	0.1	4.6	10.7	35.4	48.7
Amber	77	60.0	0.1	5.1	10.7	35.9	47.7
	Average	59.7^{C}	0.1	4.9^{A}	10.7^{AB}	35.6^{A}	48.2^{C}
ISA	73	63.6	0.0	1.3	7.1	18.8	72.3
Brown	77	63.0	0.4	2.7	6.9	21.3	68.5
	Average	63.3^{A}	0.2	2.0^{B}	7.0^{BC}	20.0^{CD}	70.4^{A}
Bovans	73	61.8	0.0	3.5	5.2	28.2	63.0
Brown	77	63.8	0.0	0.7	7.4	23.5	68.1
	Average	62.8^{AB}	0.0	2.1^{B}	6.3^{C}	25.8^{BC}	65.5^{AB}
Novogen	73	61.7	0.7	2.3	9.3	26.9	60.4
Brown	77	61.9	0.1	2.6	9.1	28.3	60.0
	Average	61.8^{B}	0.4	2.5^{B}	9.2^{ABC}	27.6^{B}	60.2^{B}
All	73	61.7	0.2	2.7	8.6	27.0	61.2
Strains	77	62.3	0.1	2.3	8.5	25.9	62.8
NCSU Barred	73	53.9	1.0†	14.5	20.5	43.0†	19.9
Plym. Rock	77	54.5	1.5†	13.0	20.7	42.7†	20.8

[1]All strains were housed such that each strain is equally represented in each density.

A,B,C - Different letters denote significant differences (P<0.01), comparisons made among strain average values.

TABLE 17. EFFECT OF BROWN EGG STRAIN AND DENSITY ON EGG QUALITY, INCOME AND FEED COSTS OF HENS IN THE 38th NCLP&MT (119-595 DAYS)

Breeder	Density[1]	Grade A	Grade B	Cracks	Loss	Egg Income	Feed Costs
(Strain)	(in^2/hen)	(%)	(%)	(%)	(%)	($/hen)	($/hen)
Hy-Line	73	95.5	1.7	2.1	0.7	34.15	16.70
Brown	77	94.0	2.2	3.4	0.4	36.17	17.86
	Average	94.7	2.0	2.8	0.5	35.16^{AB}	17.28
Hy-Line	73	97.3	1.7	0.8	0.2	35.17	17.53
Silver Brown	77	96.4	1.2	2.1	0.4	37.03	18.32
	Average	96.9	1.4	1.4	0.3	36.10^{AB}	17.92
TETRA	73	94.9	2.9	2.2	0.1	32.05	17.14
Brown	77	95.7	2.5	1.6	0.2	32.28	17.16
	Average	95.3	2.7	1.9	0.2	32.17^{C}	17.15
TETRA	73	93.9	3.8	1.8	0.5	34.22	16.87
Amber	77	95.8	2.0	1.7	0.6	33.40	18.63
	Average	94.8	2.9	1.7	0.5	33.81^{BC}	17.75
ISA	73	93.4	4.1	2.1	0.5	35.29	18.08
Brown	77	94.4	3.6	1.7	0.4	36.25	18.84
	Average	93.9	3.9	1.9	0.4	35.77^{AB}	18.46
Bovans	73	95.9	1.6	2.3	0.1	36.92	17.51
Brown	77	95.0	2.7	1.9	0.4	36.31	18.14
	Average	95.5	2.2	2.1	0.3	36.61^{A}	17.82
Novogen	73	95.1	3.5	1.1	0.3	33.33	16.65
Brown	77	95.1	3.4	1.6	0.0	34.43	17.27
	Average	95.1	3.4	1.3	0.2	33.88^{BC}	16.96
All	73	95.1	2.8	1.8	0.3	34.45	17.21
Strains	77	95.2	2.5	2.0	0.3	35.12	18.03
NCSU Barred	73	87.3	7.9	3.8†	1.1†	19.10	15.30†
Plym. Rock	77	94.2†	3.5	1.2†	1.2†	18.62	15.77†

[1]All strains were housed such that each strain is equally represented in each density.
A,B,C - Different letters denote significant differences (P<0.01), comparisons made among strain average values.

TABLE 18. EFFECT OF WHITE EGG STRAIN AND DENSITY ON BODY WEIGHT OF HENS IN THE 38th NCLP&MT (119-595 DAYS)

Breeder (Strain)	Density[1] (in^2/hen)	17 Wk Body Wt (kg)	85 Wk Body Wt (kg)	Wt Gain (kg)	Wt Gain (%)
Hy-Line	73	1.23	1.79	0.55	44.9
W-36	77	1.19	1.88	0.69	57.6
	Average	1.21^{CDE}	1.83^{BC}	0.62^{B}	51.2^{AB}
Hy-Line	73	1.29	2.02	0.72	55.8
W-98	77	1.28	2.05	0.77	60.1
	Average	1.29^{AB}	2.03^{A}	0.75^{A}	58.0^{A}
H&N	73	1.27	1.86	0.59	46.6
Nick Chick	77	1.30	1.92	0.63	48.5
	Average	1.28^{AB}	1.89^{B}	0.61^{BC}	47.5^{BCD}
Lohmann	73	1.23	1.79	0.56	45.9
LSL-Lite	77	1.27	1.82	0.55	43.0
	Average	1.25^{BCD}	1.80^{BC}	0.55^{BCDE}	44.4^{BCDE}
Bovans	73	1.20	1.75	0.56	46.1
White	77	1.15	1.73	0.58	50.2
	Average	1.18^{E}	1.74^{CD}	0.57^{BCDE}	48.2^{BC}
Shaver	73	1.20	1.70	0.50	41.8
White	77	1.19	1.66	0.47	39.5
	Average	1.19^{DE}	1.68^{D}	0.49^{EF}	40.6^{DEF}
DeKalb	73	1.24	1.79	0.55	43.8
White	77	1.28	1.85	0.57	44.8
	Average	1.26^{BC}	1.82^{BC}	0.56^{BCDE}	44.3^{BCDE}
ISA Babcock	73	1.32	1.93	0.60	45.6
White	77	1.32	1.87	0.56	42.3
	Average	1.32^{A}	1.90^{B}	0.58^{BCD}	44.0^{BCDE}
ISA	73	1.30	1.76	0.46	35.3
Exp. White	77	1.28	1.72	0.44	34.4
	Average	1.29^{AB}	1.74^{CD}	0.45^{F}	34.9^{F}
Novogen	73	1.28	1.80	0.51	39.9
White	77	1.26	1.78	0.52	40.8
	Average	1.27^{AB}	1.79^{C}	0.51^{DEF}	40.4^{EF}
Bovans	73	1.20	1.75	0.55	45.6
Robust	77	1.30	1.81	0.51	39.4
	Average	1.25^{BCD}	1.78^{C}	0.53^{CDEF}	42.5^{CDE}
All	73	1.25	1.81	0.56	44.7
Strains	77	1.26	1.83	0.57	45.5

[1]All strains were housed such that each strain is equally represented in each density.

A,B,C,D,E,F - Different letters denote significant differences (P<0.01), comparisons made among molt program average values.

TABLE 19. EFFECT OF BROWN EGG STRAIN AND POPULATION ON BODY WEIGHT OF HENS IN THE 38th NCLP&MT (119-595DAYS)

Breeder	Density[1]	17 Wk Body Wt	85 Wk Body Wt	Wt Gain	Wt Gain
(Strain)	(in^2/hen)	(kg)	(kg)	(kg)	(%)
Hy-Line	73	1.47	2.06	0.60	40.5
Brown	77	1.54	2.09	0.56	36.7
	Average	1.50	2.08^{BC}	0.58^{AB}	38.6^{AB}
Hy-Line	73	1.54	2.12	0.59	38.1
Silver Brown	77	1.57	2.23	0.66	42.0
	Average	1.55	2.18^{A}	0.62^{A}	40.1^{A}
TETRA	73	1.48	1.99	0.51	34.0
Brown	77	1.48	2.07	0.59	40.3
	Average	1.48	2.03^{CD}	0.55^{ABC}	37.2^{AB}
TETRA	73	1.56	2.09	0.53	33.9
Amber	77	1.55	2.18	0.63	40.6
	Average	1.56	2.14^{AB}	0.58^{AB}	37.2^{AB}
ISA	73	1.53	2.06	0.53	34.8
Brown	77	1.56	2.05	0.49	31.6
	Average	1.54	2.05^{BCD}	0.51^{BC}	33.2^{ABC}
Bovans	73	1.53	1.98	0.45	29.4
Brown	77	1.55	1.94	0.39	25.4
	Average	1.54	1.96^{D}	0.42^{C}	27.4^{C}
Novogen	73	1.56	2.03	0.46	29.7
Brown	77	1.54	2.03	0.49	32.1
	Average	1.55	2.03^{CD}	0.48^{BC}	30.9^{BC}
All	73	1.52	2.05	0.52	34.3
Strains	77	1.54	2.08	0.54	35.5
NCSU Barred	73	1.24	2.15†	0.91	74.0
Plym. Rock	77	1.27	2.10†	0.84	66.1

[1]All strains were housed such that each strain is equally represented in each density.

A,B,C - Different letters denote significant differences (P<0.01), comparisons made among strain average values.

TABLE 20. EFFECT OF STRAIN HOUSED IN A CAGE-FREE SYSTEM ON PERFORMANCE OF HENS IN THE 38th NCLP&MT (119-595 DAYS)

Breeder	Feed Consumption	Feed Conversion	Eggs Per Bird Housed	Egg Production	Egg Mass	Mortality	Age at 50% Production
(Strain)	(kg/100/hen/d)	(g egg/g feed)		(HD%)	(g/HD)	(%)	(Days)
Hy-Line Brown	10.6	0.50	389.2	83.4	52.8^{AB}	5.9	133.6
Hy-Line Silver Brown	10.8	0.46	389.0	85.0	50.0^{BC}	11.5	133.3
TETRA Brown	10.7	0.47	367.6	80.5	50.8^{ABC}	9.2	134.0
TETRA Amber	10.7	0.45	388.0	83.2	48.5^{C}	6.2	131.0
ISA Brown	11.3	0.47	386.5	83.8	53. 2^{A}	7.3	135.0
Bovans Brown	11.1	0.48	392.5	85.4	53.2^{A}	9.8	131.7
Average	10.9	0.47	385.5	83.6	51.4	8.3	133.1
Hy-Line W-98	10.3	0.51	385.7	82.9	52.4	6.2	129.0
Barred Plym. Rock	9.1	0.29	224.1	49.6	26.6	10.7†	155.5

A,B,C - Different letters denote significant differences (P<0.01), comparisons made among strain average values.

TABLE 21. EFFECT OF STRAIN HOUSED IN A CAGE-FREE SYSTEM ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF HENS IN THE 38th NCLP&MT (119-595 DAYS)

Breeder (Strain)	Egg Weight (g/egg)	Pee Wee (%)	Small (%)	Medium (%)	Large (%)	Extra Large (%)
Hy-Line Brown	63.1^{A}	0.0	0.7^{C}	5.5^{B}	20.7^{A}	72.6^{A}
Hy-Line Silver Brown	58.6^{B}	0.0	3.4^{B}	10.2^{A}	42.5^{B}	43.5^{B}
TETRA Brown	62.9^{A}	0.1	1.2^{C}	5.6^{B}	20.9^{A}	72.0^{A}
TETRA Amber	58.1^{B}	0.0	5.1^{A}	10.9^{A}	42.8^{B}	40.9^{B}
ISA Brown	63.2^{A}	0.1	1.3^{C}	5.7^{B}	21.2^{A}	71.3^{A}
Bovans Brown	62.0^{A}	0.1	1.5^{C}	6.1^{B}	27.7^{A}	64.4^{A}
Average	61.3	0.0	2.2	7.3	29.3	60.8
Hy-Line W-98	63.2	0.0	1.1	7.3	18.5	72.2
Barred Plym. Rock	53.2	3.1	15.3	17.4	48.8	14.7

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

TABLE 22. EFFECT OF STRAIN HOUSED IN A CAGE-FREE SYSTEM ON EGG QUALITY, INCOME AND FEED COSTS OF HENS IN THE 38th NCLP&MT (119-595 DAYS)

Breeder	Grade A	Grade B	Cracks	Loss	Egg Income	Feed Costs
(Strain)	(%)	(%)	(%)	(%)	($/hen)	($/hen)
Hy-Line Brown	93.6	3.8	2.2	0.4	36.45	20.10
Hy-Line Silver Brown	96.6	1.8	1.2	0.4	36.05	20.05
TETRA Brown	92.5	4.2	3.0	0.3	34.20	19.91
TETRA Amber	95.2	3.2	1.3	0.3	35.49	20.14
ISA Brown	93.3	4.7	1.7	0.3	36.08	20.64
Bovans Brown	93.6	4.0	2.2	0.3	36.62	20.56
Average	94.1	3.6	1.9	0.3	35.82	20.23
Hy-Line W-98	91.4	4.2	3.4	1.0	35.25	19.36
Barred Plym. Rock	94.3†	3.8†	1.2†	0.8†	18.79	16.79

There are no significant differences among these means.

TABLE 23. EFFECT OF STRAIN HOUSED IN A CAGE-FREE SYSTEM ON BODY WEIGHT OF HENS IN THE 38th NCLP&MT (119-595 DAYS)

Breeder	17 Wk Body Wt	85 Wk Body Wt	Wt Gain	Wt Gain
(Strain)	(kg)	(kg)	(kg)	(%)
Hy-Line Brown	1.33	1.94	0.61	46.19
Hy-Line Silver Brown	1.37	1.99	0.63	46.31
TETRA Brown	1.32	1.92	0.60	45.75
TETRA Amber	1.38	1.95	0.57	41.62
ISA Brown	1.40	1.93	0.53	38.30
Bovans Brown	1.37	1.86	0.49	35.72
Average	1.36	1.93	0.57	42.31
Hy-Line W-98	1.22	1.70	0.47	38.72
Barred Plym. Rock	1.23	1.99†	0.76	61.45

There are no significant differences among these means.

TABLE 24. EFFECT OF STRAIN HOUSED IN A RANGE SETTING ON PERFORMANCE OF HENS IN THE 38th NCLP&MT (119-595 DAYS)

Breeder	Feed Consumption	Feed Conversion	Eggs Per Bird Housed	Egg Production	Egg Mass	Mortality	Age at 50% Production
(Strain)	(kg/100/hen/d)	(g egg/g feed)		(HD%)	(g/HD)	(%)	(Days)
Hy-Line Brown	11.0	0.50	376.8	86.9	54.6	13.5	130.5^{A}
Hy-Line Silver Brown	11.5	0.46	334.8	88.3	51.8	30.7	125.0^{B}
NCSU Barred Plym. Rock	9.4	0.33	233.3	56.4	32.2	32.0†	161.0

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

TABLE 25. EFFECT OF STRAIN HOUSED IN A RANGE SETTING ON EGG WEIGHT AND EGG SIZE DISTRIBUTION OF HENS IN THE 38th NCLP&MT (119-595 DAYS)

Breeder	Egg Weight	Pee Wee	Small	Medium	Large	Extra Large
(Strain)	(g/egg)	(%)	(%)	(%)	(%)	(%)
Hy-Line Brown	62.7^{A}	0.0	2.4	3.6	23.9	70.0^{A}
Hy-Line Silver Brown	58.7^{B}	0.0	2.0	13.0	43.0	41.7^{B}
NCSU Barred Plym. Rock	54.4	0.6†	15.8	20.4†	43.9	18.5

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

TABLE 26. EFFECT OF STRAIN HOUSED IN A RANGE SETTING ON EGG QUALITY, INCOME AND FEED COSTS OF HENS IN THE 38th NCLP&MT (119-595 DAYS)

Breeder	Grade A	Grade B	Cracks	Loss	Egg Income	Feed Costs
(Strain)	(%)	(%)	(%)	(%)	($/hen)	($/hen)
Hy-Line Brown	96.5	2.7	0.8	0.1	35.88	19.35
Hy-Line Silver Brown	96.7	2.1	0.9	0.4	30.94	17.44
NCSU Barred Plym. Rock	88.7	9.7	0.7†	1.0†	19.24	15.50†

There are no significant differences among these means.

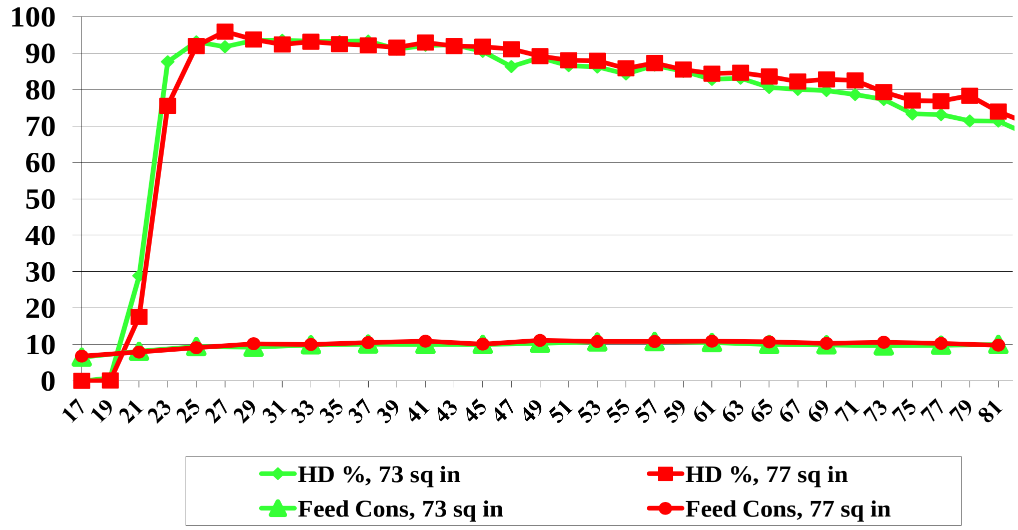
TABLE 27. EFFECT OF STRAIN HOUSED IN A RANGE SETTING ON BODY WEIGHT OF HENS IN THE 38th NCLP&MT (119-595DAYS)

Breeder	17 Wk Body Wt	85 Wk Body Wt	Wt Gain	Wt Gain
(Strain)	(kg)	(kg)	(kg)	(%)
Hy-Line Brown	1.45^{B}	2.06	0.61	42.25
Hy-Line Silver Brown	1.60^{A}	2.11	0.51	31.83
NCSU Barred Plym. Rock	1.30	1.98†	0.69	52.77

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

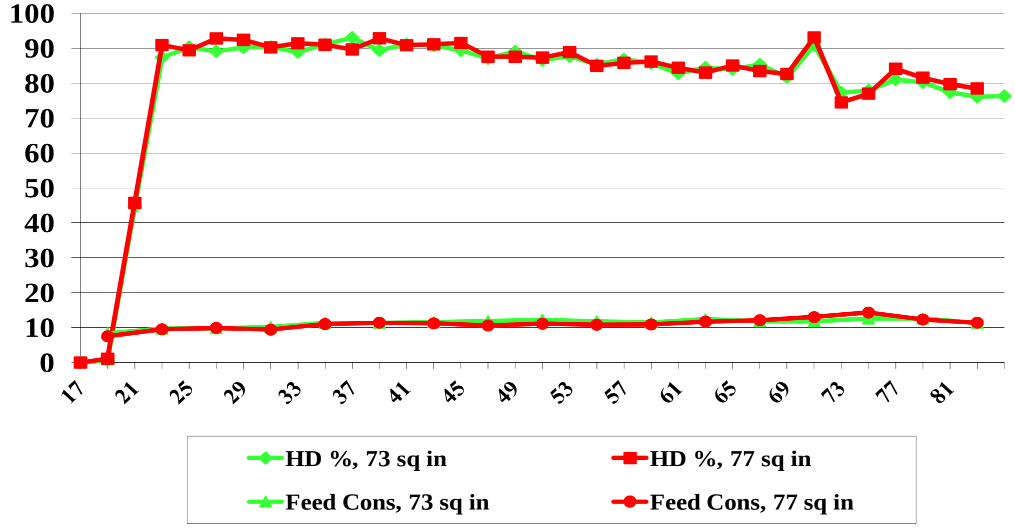
Production Graphs for Laying Hens in Cages at Densities of 73 and 77 sq. in.

Figure 1. Hy-Line W-36, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (73 and 77 in^2)



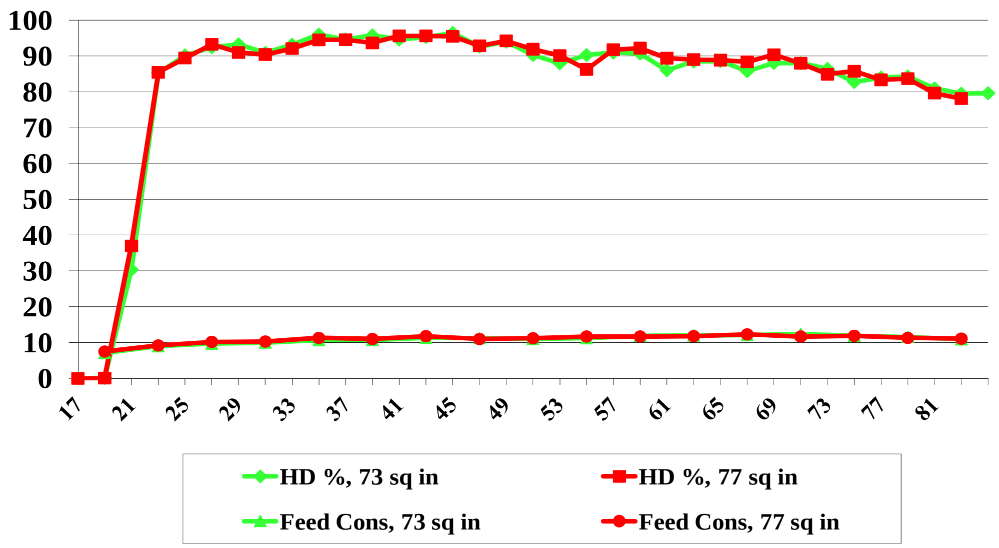
[1] kg per 100 Hens

Figure 2. Hy-Line W-98, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (73 and 77 in²)



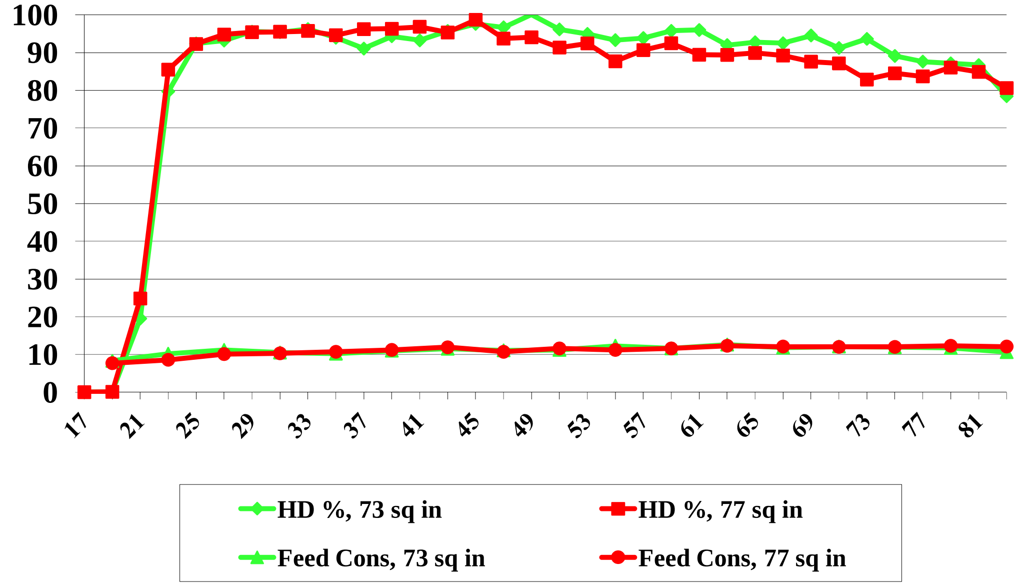
[1] kg per 100 Hens

Figure 3. H & N "Nick Chick", Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (73 and 77 in²)



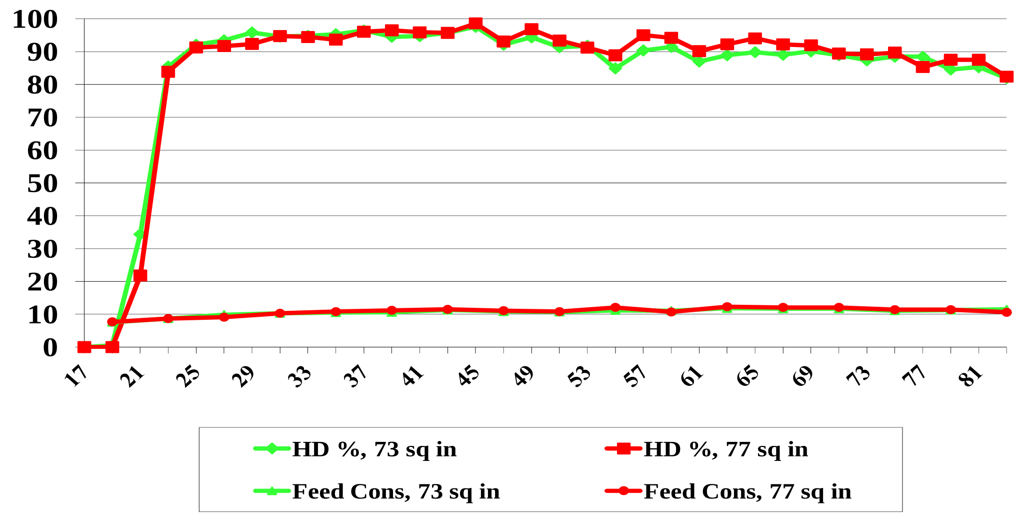
[1] kg per 100 Hens

Figure 4. Lohmann LSL Lite, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (73 and 77 in^2)



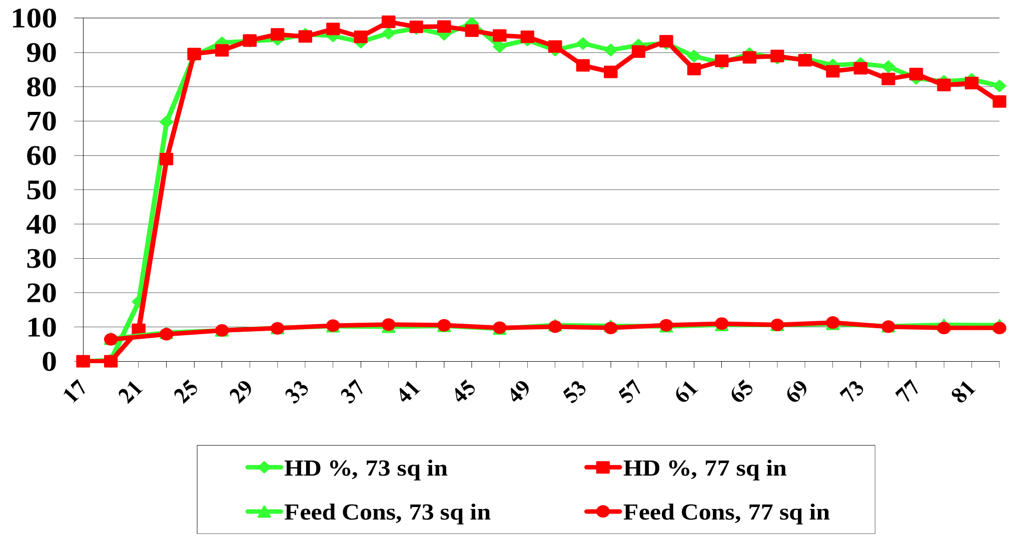
[1] kg per 100 Hens

Figure 5. ISA Bovans White, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (73 and 77 in^2)



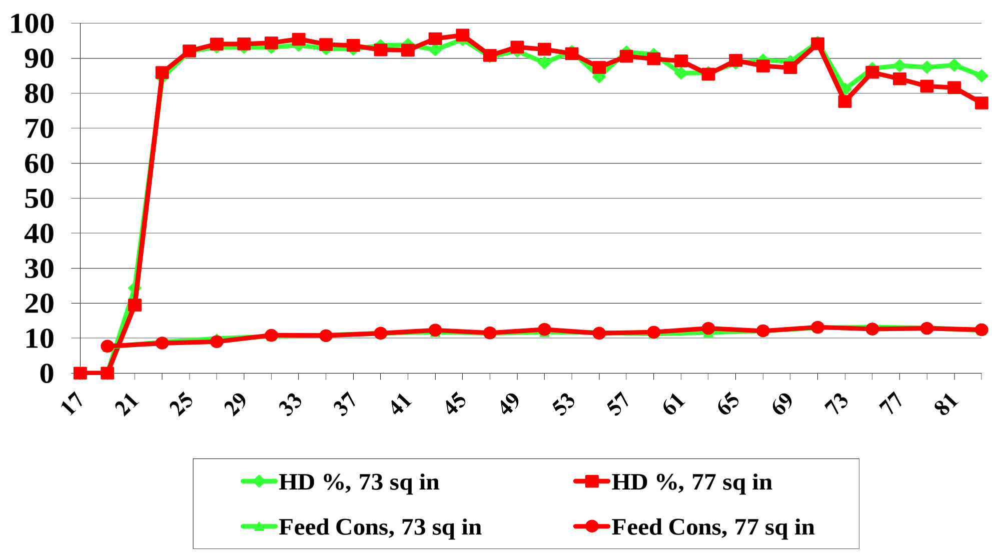
[1] kg per 100 Hens

Figure 6. ISA Shaver White, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (73 and 77 in²)



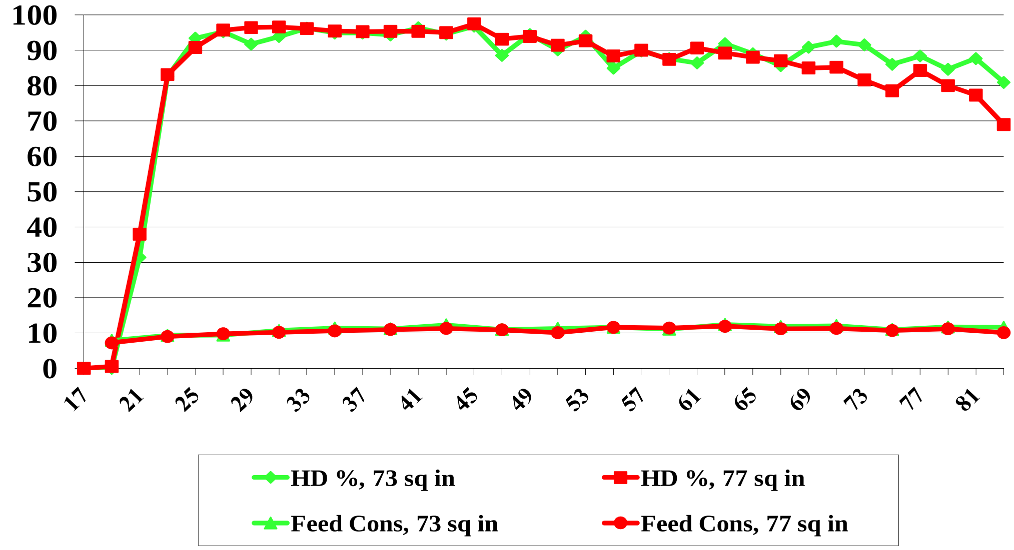
[1] kg per 100 Hens

Figure 7. ISA Dekalb White, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (73 and 77 in²)



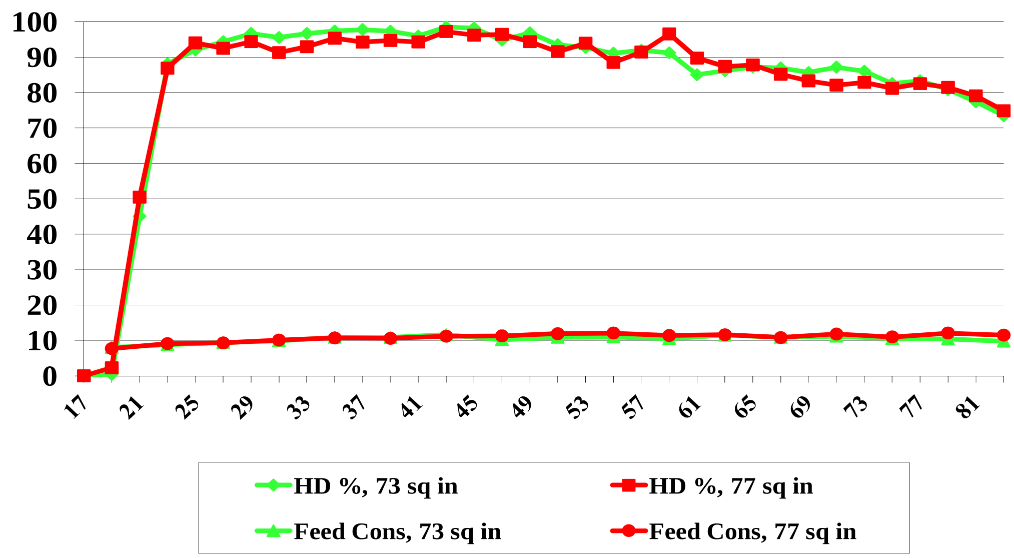
[1] kg per 100 Hens

Figure 8. ISA Babcock White, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (73 and 77 in²)



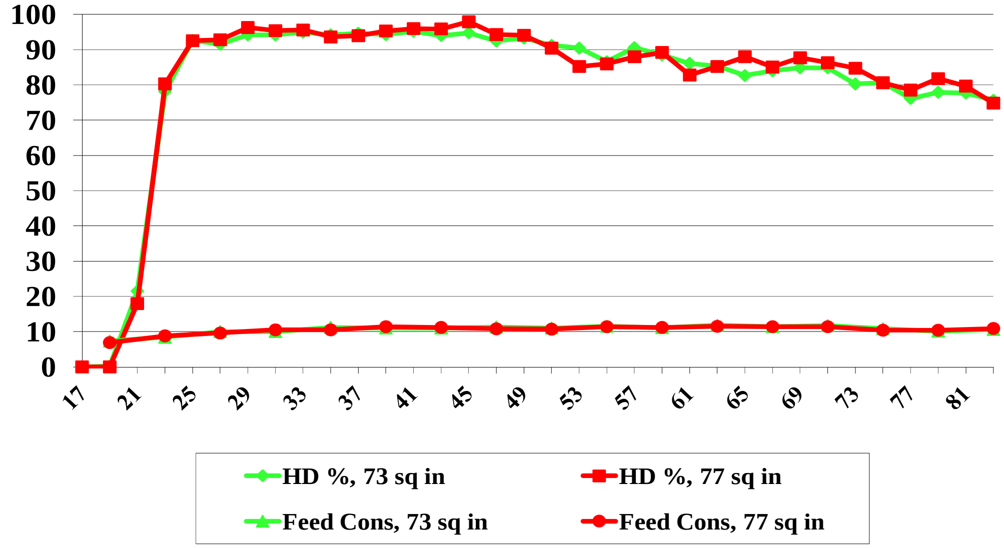
[1] kg per 100 Hens

Figure 9. ISA Experimental White, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (73 and 77 in²)



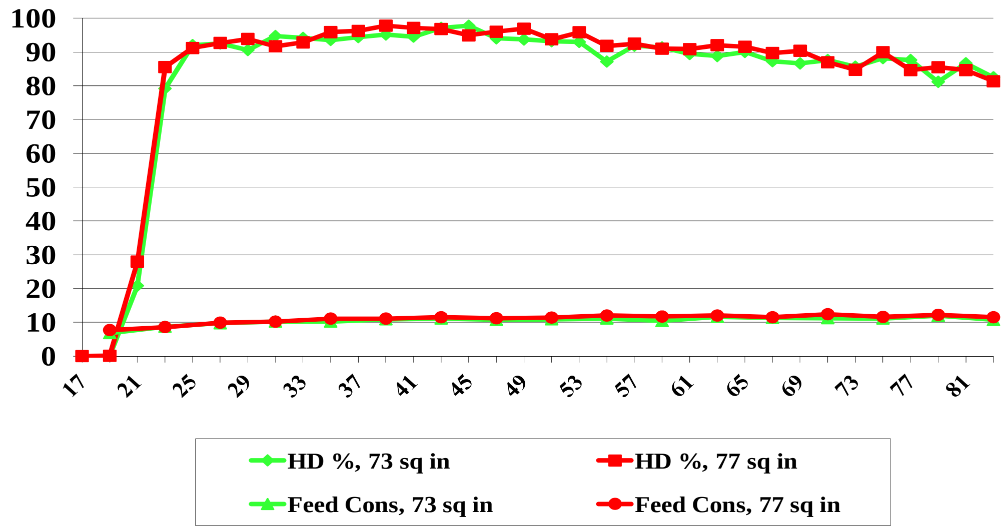
[1] kg per 100 Hens

Figure 10. Novogen White, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (73 and 77 in^2)



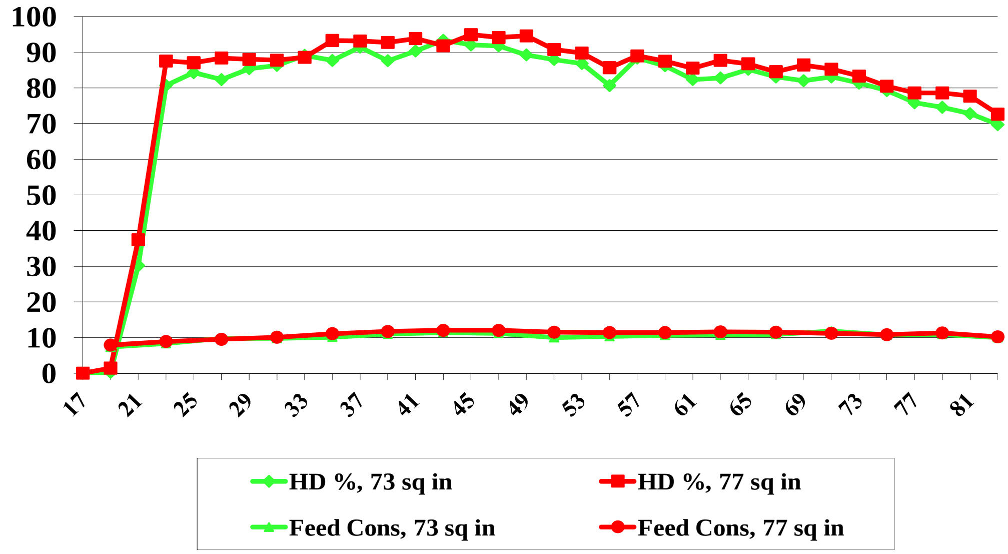
[1] kg per 100 Hens

Figure 11. ISA Bovans Robust, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (73 and 77 in^2)



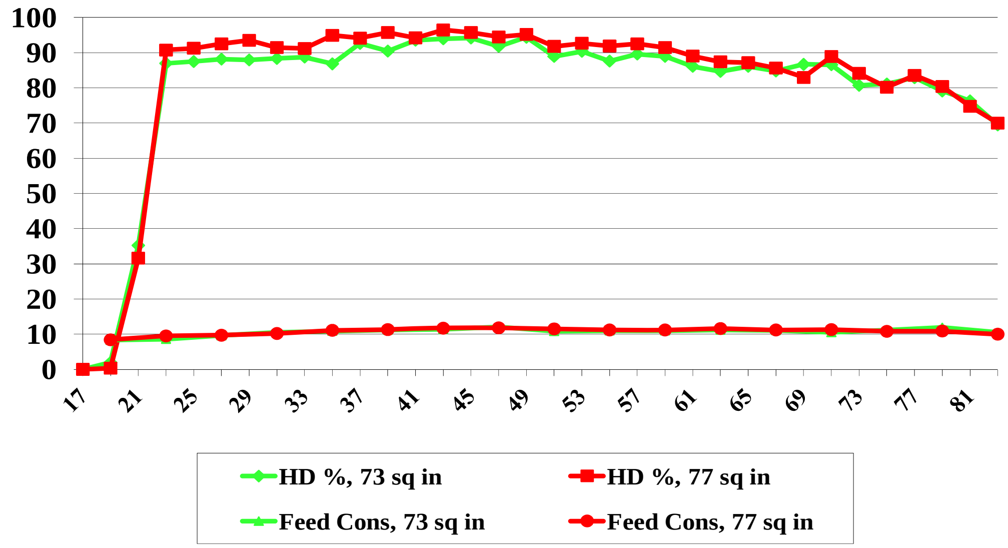
[1] kg per 100 Hens

Figure 12. Hy-Line Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (73 and 77 in²)



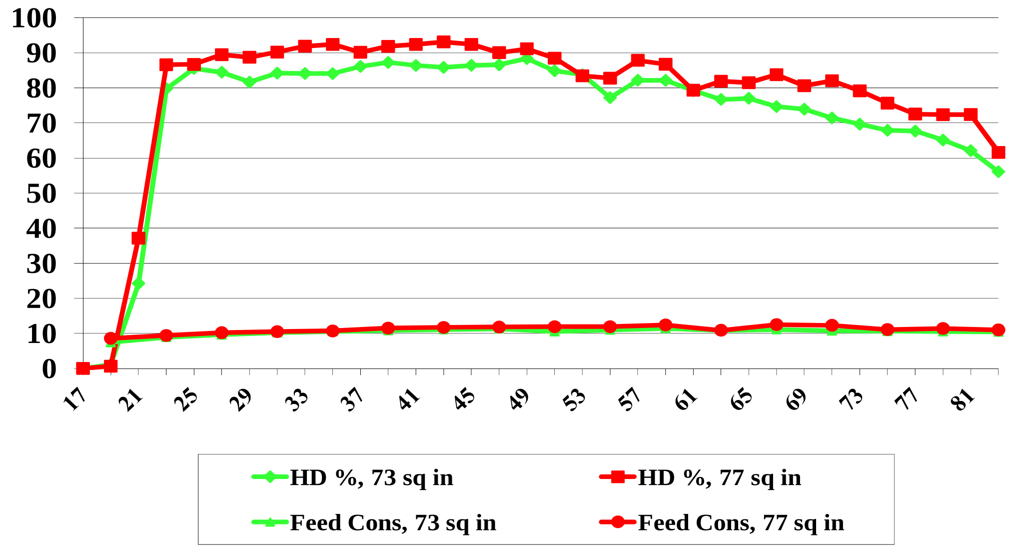
[1] kg per 100 Hens

Figure 13. Hy-Line Silver Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (73 and 77 in²)



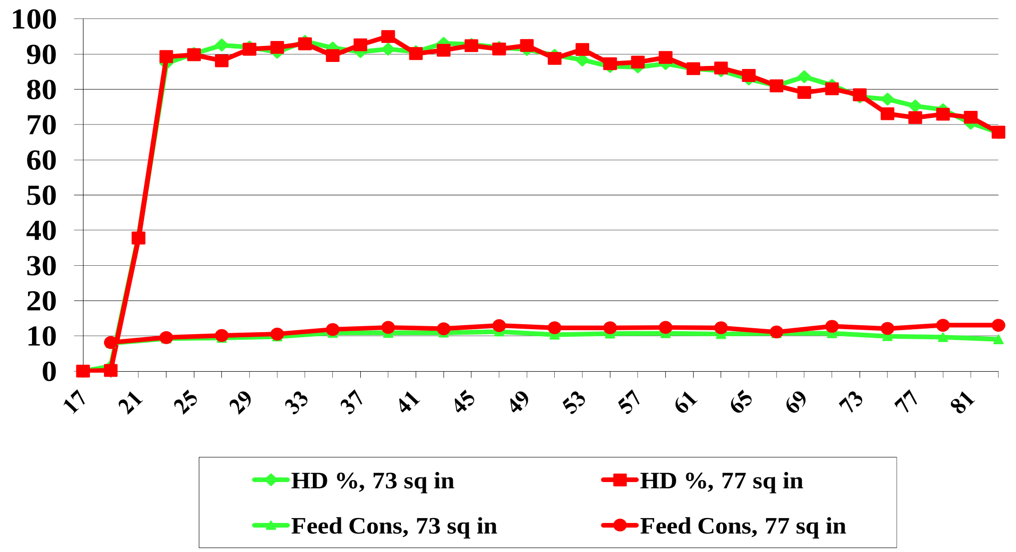
[1] kg per 100 Hens

Figure 14. Tetra Americana- TETRA Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (73 and 77 in^2)



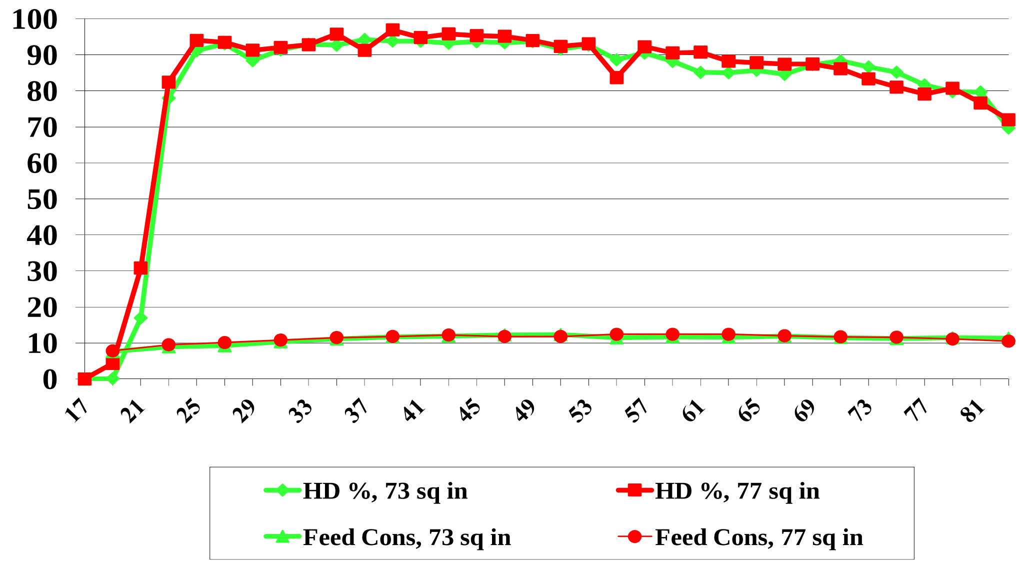
[1] kg per 100 Hens

Figure 15. Tetra Americana- TETRA Amber, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (73 and 77 in^2)



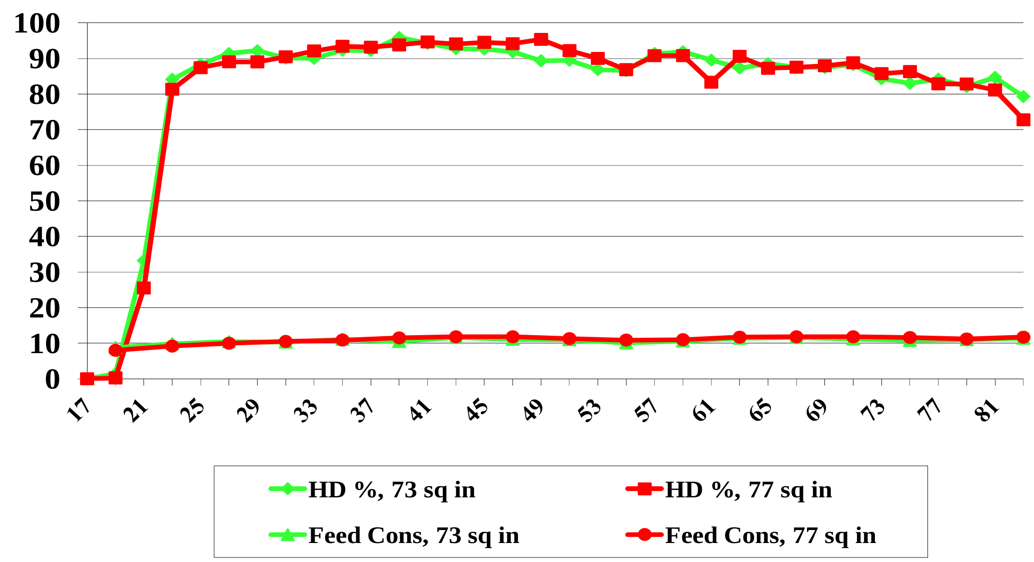
[1] kg per 100 Hens

Figure 16. ISA Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (73 and 77 in^2)



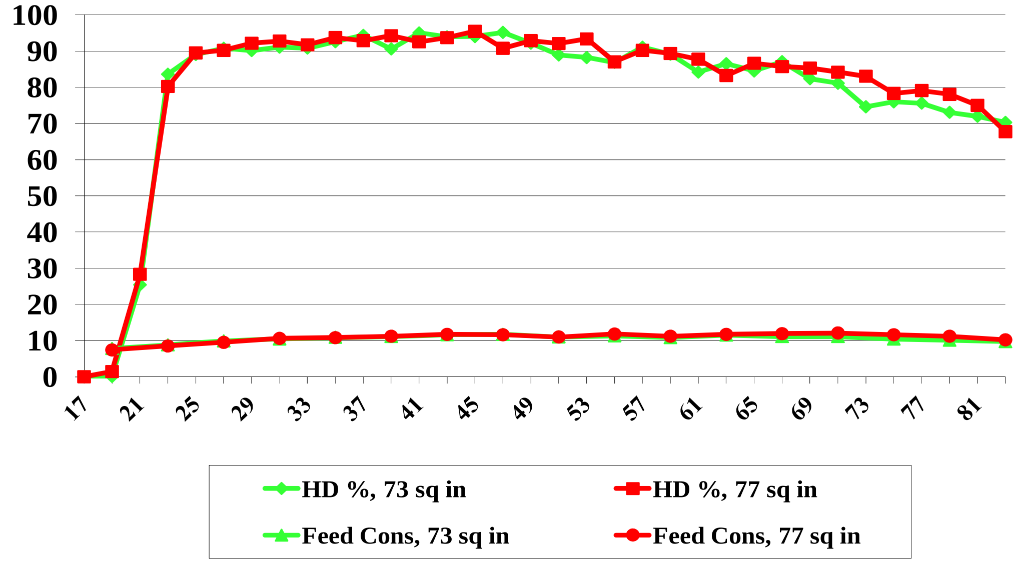
[1] kg per 100 Hens

Figure 17. ISA Bovans Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (73 and 77 in^2)



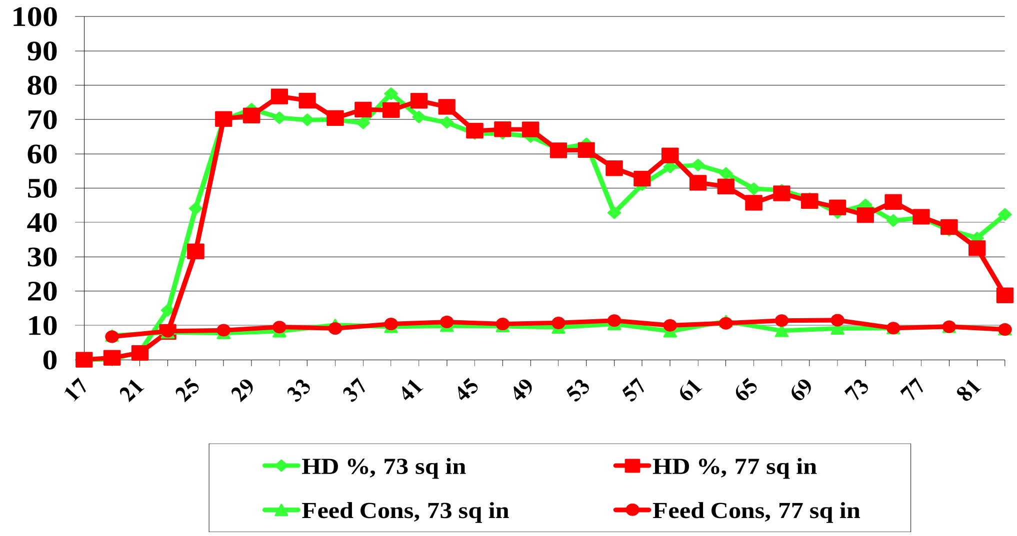
[1] kg per 100 Hens

Figure 18. Novogen Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (73 and 77 in^2)



[1] kg per 100 Hens

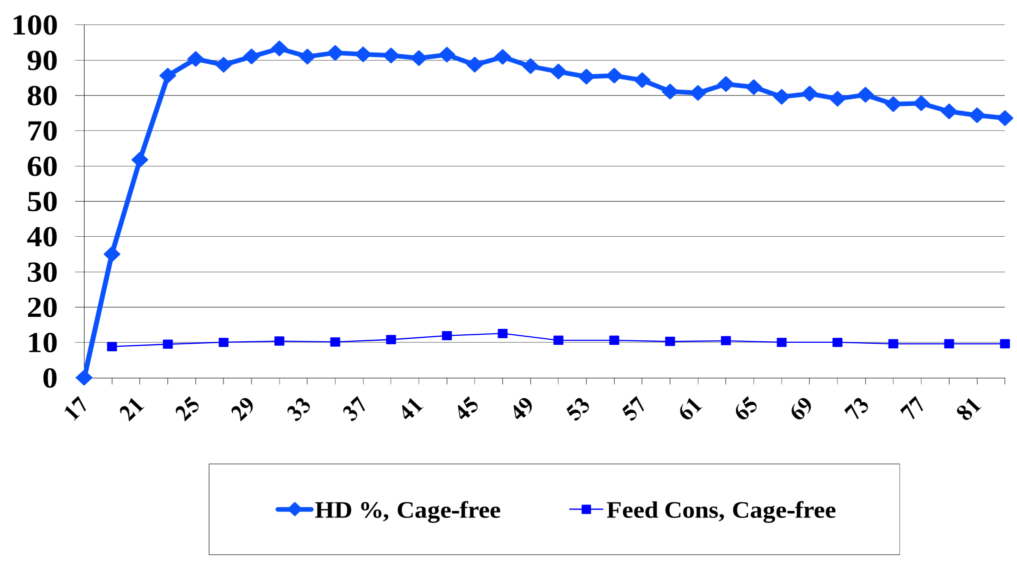
Figure 19. Heritage Barred Plymouth Rock, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] by hen density (73 and 77 in^2)



[1] kg per 100 Hens

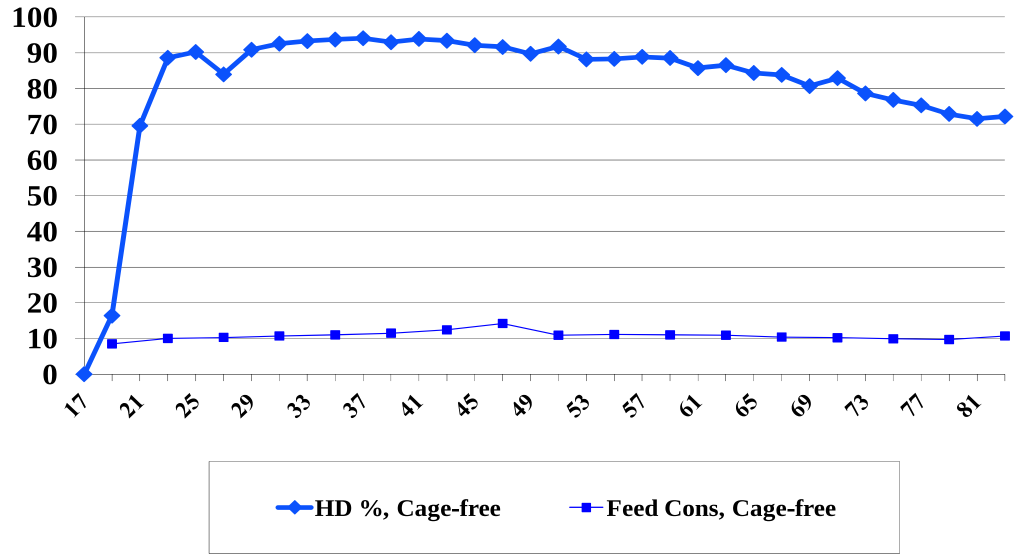
Production Graphs for Laying Hens in a Cage-free Environment which was 2/3 slat and 1/3 litter

Figure 20. Hy-Line W-98, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



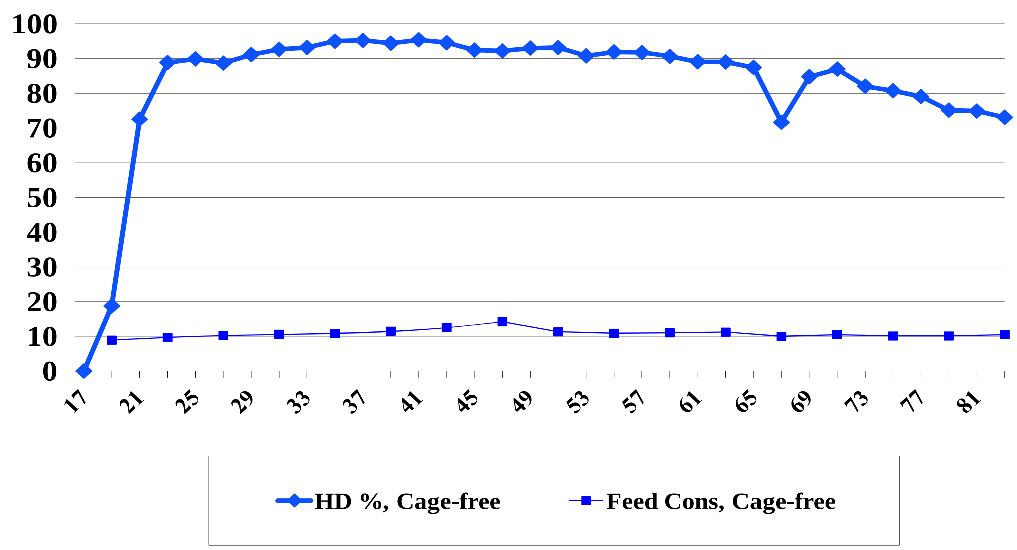
[1] kg per 100 Hens

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



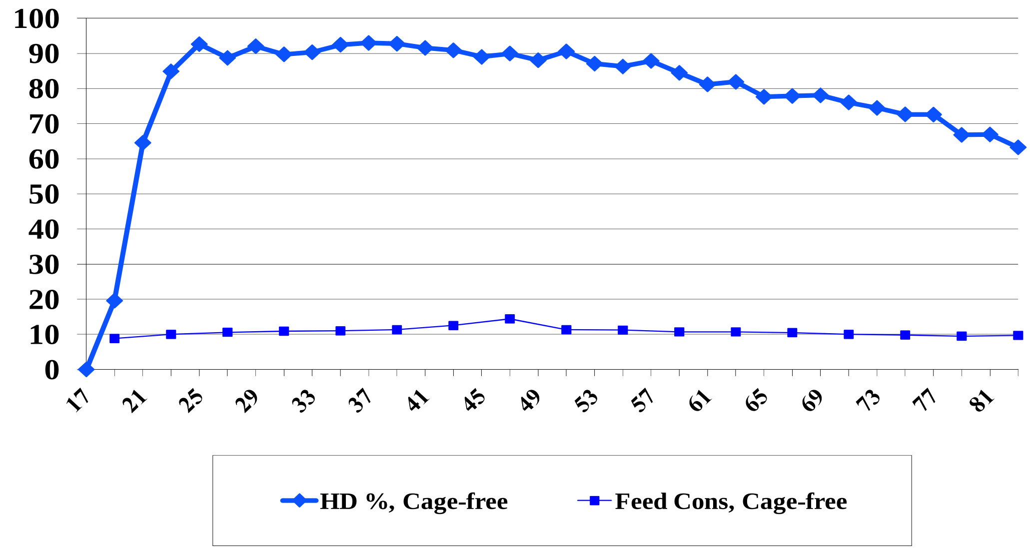
[1] kg per 100 Hens

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



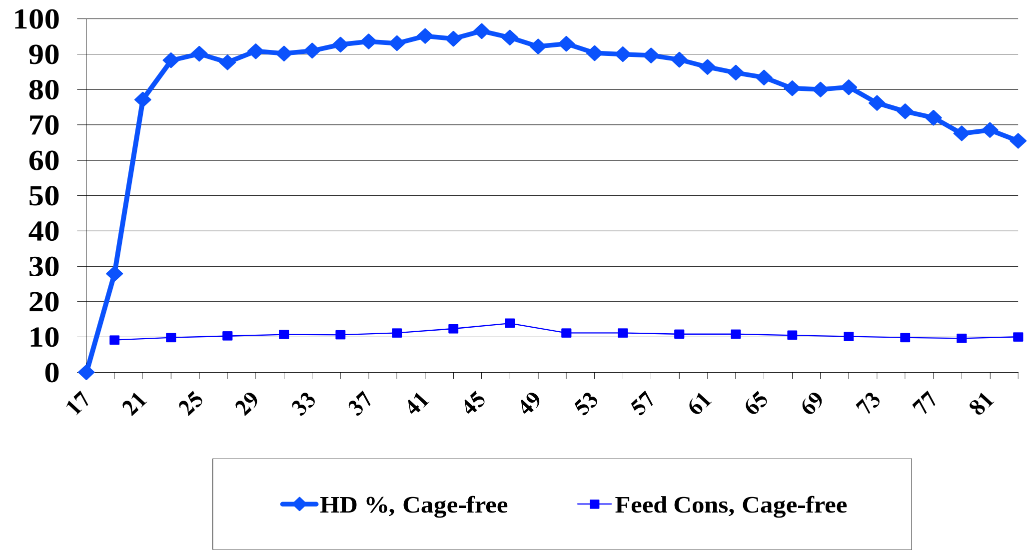
[1] kg per 100 Hens

Figure 23. Tetra Americana TETRA Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



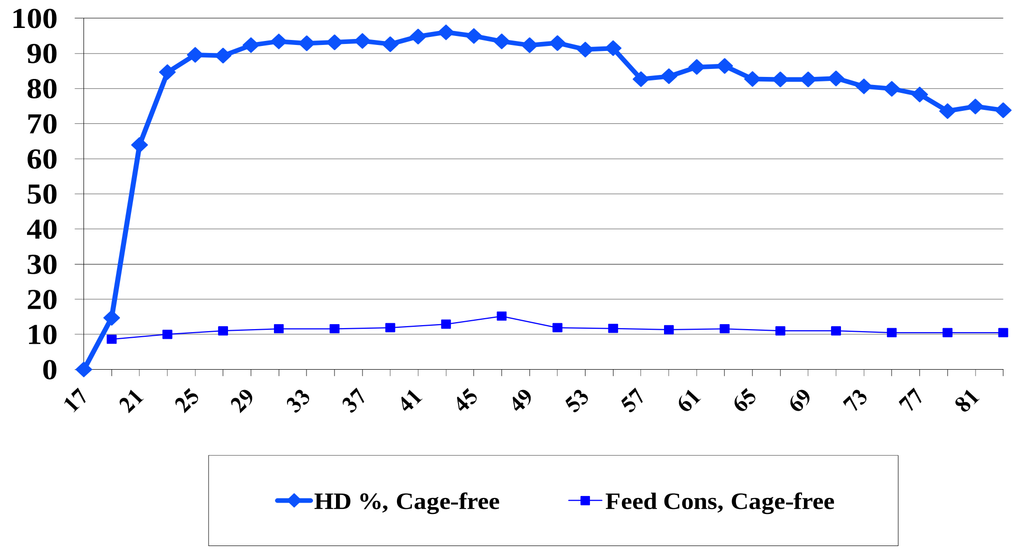
[1] kg per 100 Hens

Figure 24. Tetra Americana TETRA Amber, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



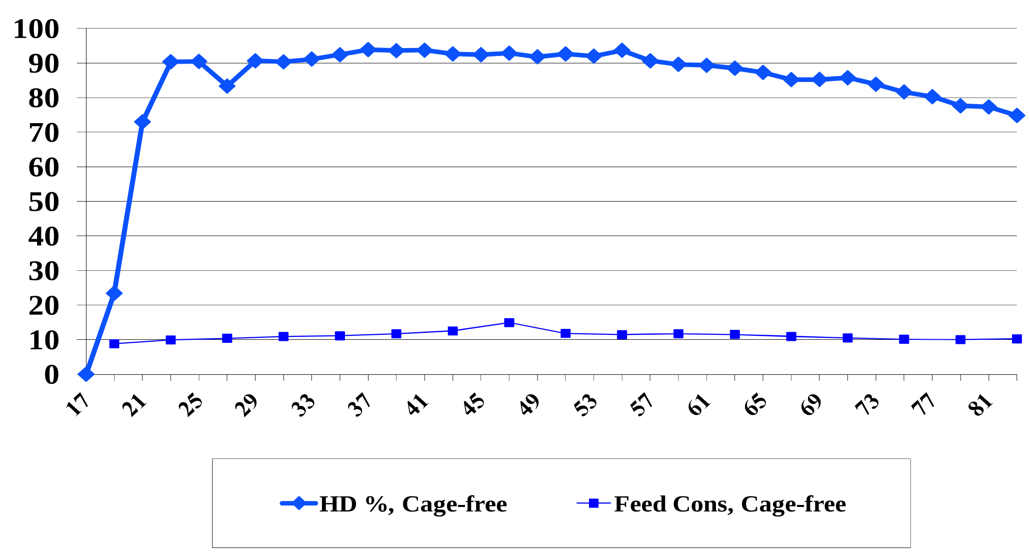
[1] kg per 100 Hens

Figure 25. ISA Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



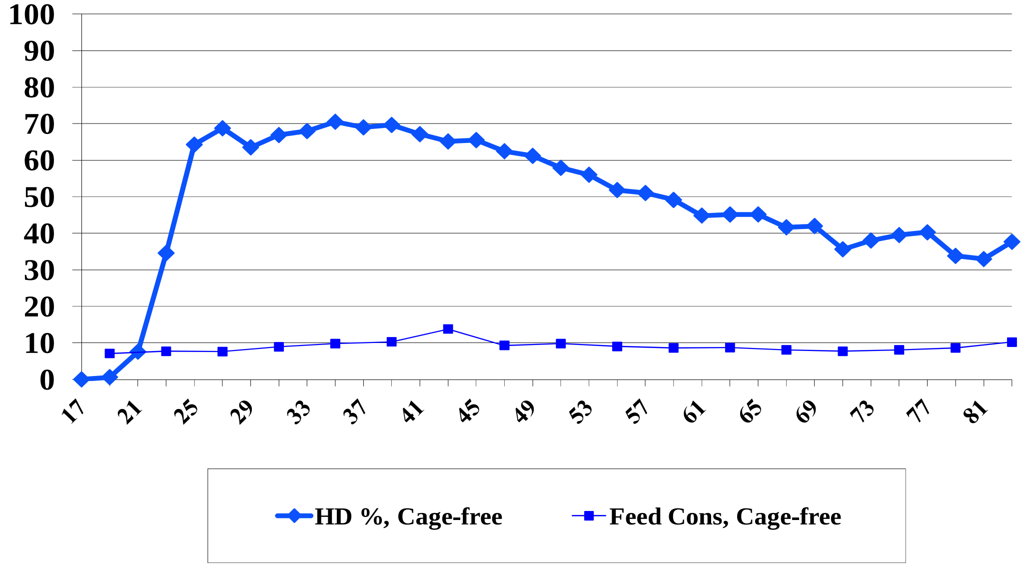
[1] kg per 100 Hens

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



[1] kg per 100 Hens

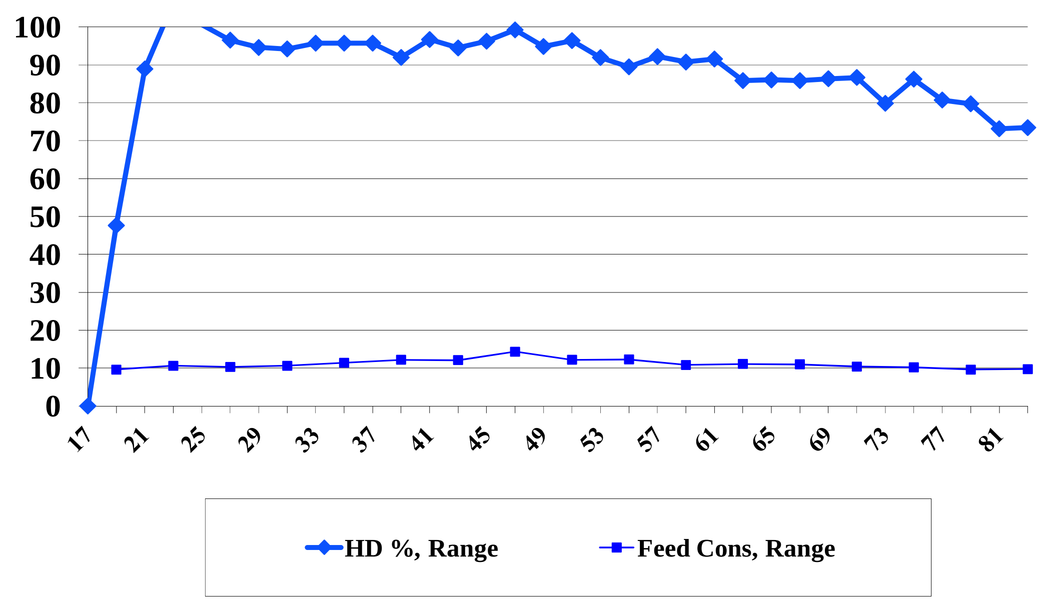
Figure 27. Heritage Barred Plymouth Rock, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] in a Cage-free Environment



[1] kg per 100 Hens

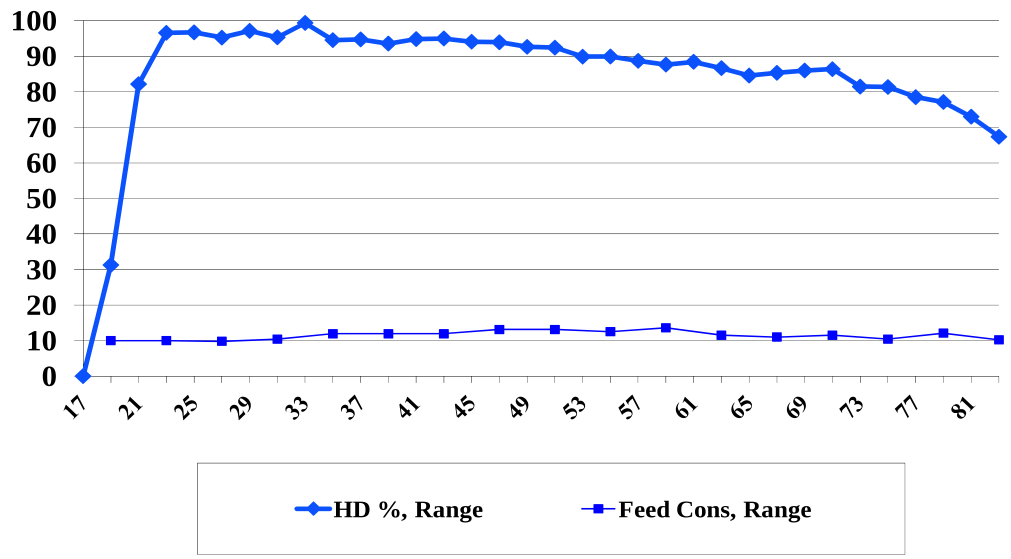
Production Graphs for Laying Hens in a Free Range Environment

Figure 28. Hy-Line Brown, Bi-weekly Percent Egg Production and Period Feed Consumption[1] in Hens kept on Range



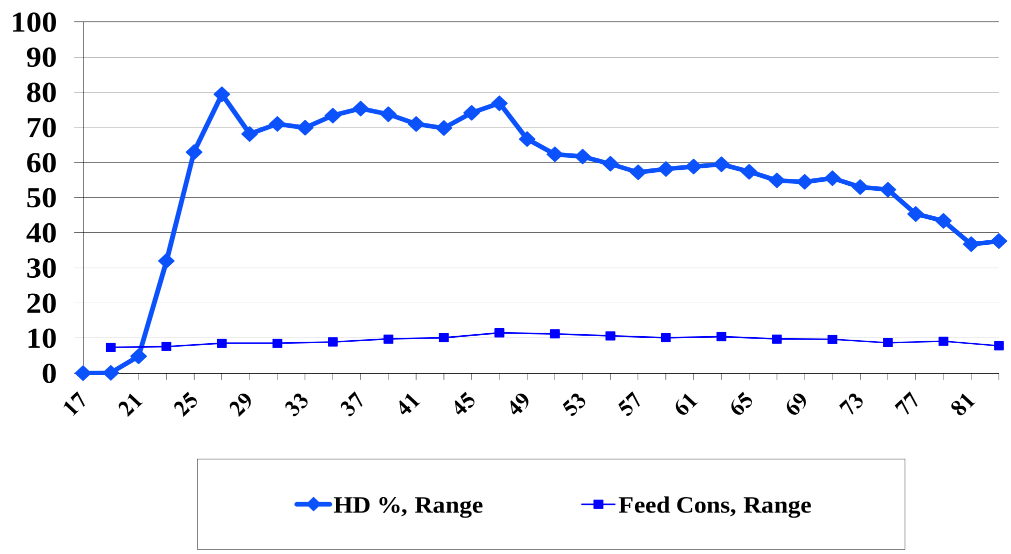
[1] kg per 100 Hens

Figure 29. 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 30. Heritage Barred Plymouth Rock, Bi-weekly Percent Egg Production and Period Feed Consumption[1] in Hens kept on Range



[1] kg per 100 Hens

Table 28 . Entries in the 38th NCLP&MT by Breeder, Stock Suppliers, and Categories

Breeder	Stock	Category[1]	Source
Hy-Line International 2583 240th Street Dallas Center, IA 50063	W-36	I-A	Hy-Line International 4432 Highway 213, Box 309 Mansfield, GA 30255
	Hy-Line Brown	I-A	(Same)
	W-98	I-A	Hy-Line International 17458 G. Avenue Perry, IA 50220
	Hy-Line Silver Brown	I-A	Dallas Center Research Farm 2418 N Ave. Dallas Center, IA 50063
Lohmann Tierzucht Gmbh Am Seedeich 9-11 . P.O.Box 460 D-27454 Cuxhaven, Germany	Lohmann LSL-Lite	I-A	Hy-Line North America 1755 West Lakes Parkway West Des Moines, IA 50266
H&N International 321 Burnett Ave South, Suite 300 Renton, Washington 98055	H&N "Nick Chick"	I-A	Feather Land Farms 32832 E. Peral Road Coberg, OR 97408
Instiut de Selection Animale (A Hendrix Genetic Company) ISA North America 650 Riverbend Drive, Suite C Kitchener, Ontario N2K 3S2 Canada	Bovans White	I-A	CPI-South Central Hatchery 5087 County Road 35 Bremen, AL 35033
	Bovans Robust	II-A	(Same)
	Bovans Brown	I-A	(Same)
	Babcock White	I-A	ISA North America 650 Riverbend Drive Kitchener, Ontario N2K 3S2 Canada
	Dekalb White	I-A	(Same)
	Experimental White	III-A	(Same)
	Shaver White	II-A	Brickland Hatchery Midwest Farms, LLC. 135 S. Epes St. Blackstone, VA 23824
	ISA Brown	II-A	Westwind Hatchery 8382 Lakeview St. Interlaken, NY 14847
North Carolina State University Dept of Poultry Science Box 7608 Raleigh, NC 27695	NCSU Barred Plymouth Rock	III-C	North Carolina State University Dept of Poultry Science Box 7608 Raleigh, NC 27695
Tetra Americana, LLC 1105 Washington Road Lexington, GA 30648	TETRA Brown	I-A	CPI-MidAmerica Hatchery 111 Stoddart Street Beaver Dam, WI 53916
	TETRA Amber	I-A	(Same)
NOVOGEN S.A.S. Mauguérand – Le Foeil BP 265 22 800 QUINTIN - FRANCE	NOVOgen WHITE	I-A	Kendrick Farm 25 Dr Breley Rd East Freetown, PA 02717
	NOVOgen BROWN	I-A	Highland Hills Farm 105 Hurricane Road Westmoreland, NH 03467

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

A = Entry requested
C = Entry <u>not</u> requested