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SINGLE CYCLE REPORT OF THE FORTIETH NORTH CAROLINA LAYER PERFORMANCE AND MANAGEMENT TEST[1]

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The North Carolina Layer Performance and Management Tests are conducted under the auspices of the North Carolina Layer Performance and Management Program, 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. Mrs. Teresa Herman is Piedmont Research Station Superintendent; Mrs. Kelly Brannan 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 here represents the analysis of the single production cycle of the 40th North Carolina Layer Performance and Management Test. Performance summary tables are available for each strain and production system tested. Single production cycle data were collected for 18 strains and 5 production systems: Conventional Cage, Colony Housing System, Enriched Colony Housing System, Cage Free, and Free Range.

Copies of current and past reports are maintained for public access at http://www.ces.ncsu.edu/depts/poulsci/tech_manuals/layer_reports/40_first_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.

40th NORTH CAROLINA LAYER PERFORMANCE AND MANAGEMENT TEST
Volume 40 No. 4

Report on the Single Laying Cycle

DESCRIPTION OF DATA TABLE STATISTICS

Single cycle performance data for white and brown-egg strains in the 5 production systems are reported for hens 17-89 weeks of age. Data for Conventional Cage System are reported in Tables 10 to 17. Data for the Colony Housing System and the Enriched Colony Housing System for the same time periods are in Tables 18 to 25. Cage Free and Free Range Data are in Tables 26 to 37. Mortality Summary data are in Table 38.

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Production data for hens 17-89 weeks of age in a Conventional Cage System are reported in Figures 1 to 17. Data for a Colony Housing System and an Enriched Colony Housing System are reported in Figures 18 to 34. Data for a Cage-free System are reported in Figures 35 to 49, and data for a Free-range System are in Figures 50 to 53. Mortality data are in Figures 54 to 58.

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<u>Dates of Importance</u>:

Eighteen strains were accepted or acquired in accordance with the rules and regulations of the test. The eggs were placed into trays and set on May 10, 2016 and were pulled from the hatchers on June 1, 2016. Eleven commercial white-egg strains and 7 commercial brown-egg strains participated in the current test. Table 1 shows the strains included, the source of the laying stock (Breeder), and the 5 test environments (Conventional Cage, Colony Housing System, Enriched Colony Housing System, Cage-free System, and Free-range System). This report covers the 5 production systems used for the single laying cycle data collection.

<u>Experimental Components of Importance</u>:

Samples of fertile eggs provided from the breeding Companies were set and hatched concurrently as described in the hatch report (Hatch/Serology Report Vol. 40, No. 1. At hatch, the chicks were sexed according to breeder recommendations, (*i.e.* feather, color, or vent sexing) to remove the males.

Table 1. 40th North Carolina Layer Performance and Management Test Strain Code Assignments

Strain No.	Source of Stock	Source Code	Strain	Participation[1]
1	ISA	ISA	Bovans White	C, CS, ECS
2	ISA	ISA	Shaver White	C, CS, ECS
3	ISA	ISA	Dekalb White	C, CS, ECS, CF
4	ISA	ISA	Babcock White	C, CS, ECS, CF
5	ISA	ISA	B 400 White	C, CS, ECS
6	Hy-Line	HL	W-80	C, CS, ECS, CF
7	Hy-Line	HL	W-36	C, CS, ECS, CF
8	Hy-Line	HL	White Exp	CF, R
9	Lohmann	L	LSL Lite	C, CS, ECS, CF
10	H&N	H&N	H&N Nick Chick	C, CS, ECS, CF
11	Novogen	N	Novowhite	C, CS, ECS, CF
12	ISA	ISA	Bovans Brown	C, CS, ECS, CF
13	ISA	ISA	ISA Brown	C, CS, ECS, CF
14	Hy-Line	HL	Brown	C, CS, ECS, CF, R
15	Hy-Line	HL	Silver Brown	C, CS, ECS, CF, R
16	Lohmann	L	LB Lite	C, CS, ECS, CF, R
17	Novogen	N	Novobrown	C, CS, ECS, CF
18	Tetra Americana	TA	TETRA Brown	C, CS, ECS, CF

[1] Identifies the test environments each strain participated in: Conventional Cage=C; Colony Housing System=CS; Enriched Colony Housing System=ECS; Cage-Free=CF; Free-Range=R.

The single cycle production records of the laying phase commenced at 17 weeks of age (August 28, 2016) and continued through 89 weeks of age (March 14, 2018). This report includes production data summarized for 17 to 89 weeks for each production system tracked as well as changes in body weights and mortality.

Test Design:

The rearing phase took place in the pullet brood/grow environments. The pullets for either white- or brown-egg strains were randomly assigned to the replicates in a restricted randomized manner in House 8 for those birds destine to some form of cage facility, House 4 for cage-free rearing and Range houses 1-3 for the free-range birds. The randomization requires that all strains were about equally represented in all rooms, rows, and levels, as described earlier under the experimental design. At the conclusion of the 16-wk rearing phase, the pullets were moved to a Conventional Cage, Colony Housing or Enriched Colony Housing System, and then transitioned to the laying phase.

At the initiation of the layer test, the strains of white and brown-egg hens were equally represented in each test environment. With the Cage-free and Free-range Systems, pullets were housed in the same location for both the rearing and laying phases. 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 Houses 4, 5 and 7 and Range Houses 1-3 were strain (18) and production system (5). Not all strains were tested in each of the production systems.

Pullet Housing and Management:

Housing: The hens used in this study were reared in an environment similar to what they would be in during the laying phase (40^{th} NCLP&MT Grow Report, Vol. 40, No. 2). Depending on the production system, white-egg strains occupied approximately 60% of cage replicates, and brown-egg strains occupied the other 40 % in accordance with the # of white-egg strains and brown-egg strains being tested. Individual hens were identified by strain assignment codes that indicated the cage arrangement, replicate identification numbers, and the strain. Brood grow House 8 was used to rear the pullets for the conventional cage, colony housing system, and the enriched colony housing system. The PI and Unit Manager maintained strain codes for identification of birds and record keeping. Birds were individually tagged at hatch for rearing. Pullets were fed *ad libitum*, and 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 40th NCLP&MT Grow Report.

Pullets for Conventional Cage, Colony, and Enriched Colony Housing (House 8) Pullets were reared in an environmentally controlled, windowless brood/grow facility with 3 banks of quad-deck cages in each of 4 rooms. Each room, cage row, and cage section within each row and level per row was assigned a unique replicate number. For statistical analysis, each room was designated a block. Rooms 2-4 each contained 72 replicates (4 cages/rep) for a total of 3,744 pullets per room. Room 1 contained 19 replicates and a total of 988 pullets. Overall, House 8 contained a total of 12,220 pullets. On the day of hatch, each cage (24 in x 26 in, 61 cm x 66 cm) was filled with 13 pullets of a single white-egg or brown-egg strain for a rearing allowance of 48 in^2 (310 cm^2) per bird. Four cages constituted a replicate, and there were 14 replicates per strain. Seventeen of 18 test strains were included (Table 1). All chicks were brooded in the same cage during the entire 16 week rearing period. For the first 7 days, paper was placed on the cage floor within each of the replicate series within each row. After 7 days, paper was removed.

Pullets for Cage-free Housing (House 4) Cage-free pullets were housed in an environmentally controlled, windowless high-rise house (4) modified to accommodate 36 replicates of a cage-free egg production system. The house was set up to provide whole-house heat capabilities to serves the dual purpose of brood/grow and production of the cage-free birds. The house was divided into 36 pens (8 ft x 10 ft or 2.43 m x 3.05 m). Sixty five chicks were added to each pen to produce a rearing allowance of 177 in^2/pullet (1142 cm^2/pullet) and reared following a protocol as similar as possible to the protocol for cage-reared pullets. The slats were covered with landscape cloth and a layer of wood shavings. The litter was removed at 6 wks so the pullets could become accustomed to slats after the brooding period. Pullets were provided 13 cm of roosting space per bird. Feeder and waterer space were designed to meet UEP Guidelines for cage-free facilities. Fifteen of 18 test strains were included (Table 1).

Pullets for Free-range Housing (Range Huts 1-3) Free-range pullets were reared on litter in range huts designed for whole-house heat capabilities. Sixty five chicks were started in each pen 12.1 ft x 6.6 ft (4 m x 2 m) to produce a rearing allowance of 177 in^2 or 1142 cm^2 per pullet. The slats were covered with landscape cloth and a layer of wood shavings. The litter was removed at 6 wks so the pullets could become accustomed to slats after the brooding period. Pullets were provided 5.1 in (13 cm) of roosting space per bird. The range houses had timers for light control and supplemental propane heaters for brooding. Heat was provided until the birds were fully feathered and during cool conditions to maintain an interior house temperature within the Thermal Neutral Zone (TNZ) where body temperature was maintained. At 12 weeks of age, the range pullets were allowed access to their respective range paddocks where the completion of the rearing was done. They had free access to the outdoors throughout the day and night but were enticed 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 cage-free and cage housing systems in order to minimize the variables between flock mates. Range density of 60 ft^2/hen (5.56 m^2/hen) was selected as static equivalency of 721 bird/acre. The range pens were 60 ft x 60 ft (18.3 m x 18.3 m), enclosed by a 6 ft (1.8 m) high fence, and held 60 pullets. In order to facilitate range forage replenishment, each of the paddocks were divided in half with a diagonal fence providing a rotating range density of 30 ft^2/hen (2.78 m^2/hen), and hens were rotated every 4 wks. One week prior to rotation, the replenished paddocks were mowed to an approximate height of 6 in (15 cm). Hen movement was controlled by an access gate. The veranda area was 10 ft x 15 ft (3.04 m x 4.6 m) shaded, bare dirt. Each range pen had 8 nipple drinkers inside the range house and 8 nipple drinkers outside. Tube feeders were inside each pen and a covered feeder was outside providing 2.5 in (6.4 cm) of feeder space per pullet. Four of 18 test strains were included (Table 1).

Layer Housing:

At 16 wks, when transferred to the laying house, each pullet was retagged to identify with the laying house replicate number: row, level and replicate that identifies the strain to the unit manager and PI (Table 2).

Pullet transfer to laying houses (#7 for C and #5 for CS and ECS) was done in accordance with NC State University's IACUC approved methods. The pullets in the CF and R Systems remained in their pens, but the hen populations were set at 60 hens, and hens were tagged with the laying phase identification. The pullets were randomly assigned by strains to the replicates in a way that replicates of white-egg and brown-egg strains were intermingled throughout the houses. The houses contained a feeder system that allowed determination of feed consumption by replicate and layer diet fed. Laying Hen Facilities utilized in this test consisted of 5 houses containing the C, ECS, CS, CF, and R systems (Table 2). The density in the ECS, CS, and C systems were the same: 69 in^2 (445 cm^2) for white-egg strains and 80 in^2 (516 cm^2) for brown-egg strains. All hens in the CF and R systems were at the same pen density, 177 in^2 (1,142 cm^2).

Conventional Cages were in a standard height, windowless, enclosed force-ventilated laying house (#7). The cages consisted of 4 rows of a Conventional Cage system, Tri-Deck Stacked Layer Cage System, Battery Style with Manure Belts. There was 60 ft (18.3 m) of cage row with each side being designated a row. Each row was divided into six 10-ft (3 m) cage-row sections with two 16 in high x 2 in deep x 4 in wide (40.6 cm x 5.1 cm x 10.2 cm) cages per section and a 2-ft (0.61 m) space between cage sections for feed hoppers and feed recovery. This cage design provided for 144 experimental units, each consisting of 2 cages.

The bird population was held constant at 14 white-egg strain hens/cage (69 in^2/hen, 445 cm^2/hen) for 28 hens/replicate and 12 brown-egg strain hens/cage (80 in^2/hen, 516 cm^2/hen) for 24 hens/replicate. Consequently, a total of 3,808 hens were used to test 4 replicates per strain/molt treatment (10 white-egg strains and 7 brown-egg strains in Conventional Cage Housing (Table 2).

House 5 was a standard height, windowless, force-ventilated laying house with battery style cages using a belt manure handling system. There were 4 banks of triple deck cages, two banks used for ECS, and two banks used for CS. Each side of a bank was designated as a row, and each row was divided into nine 10-ft (3 m) cage-row replicates of ECS and CS cages. Cages were 21 in (53 cm) high x 26 in (66 cm) deep x 96 in (244 cm) wide for a total area of 2,496 in^2 (16,103 cm^2) with a 2-ft (0.61 m) space between cage sections for feed hoppers and feed recovery. The Colony Housing System (CS) and the Enriched Colony Housing System (ECS) were the same dimensions and housed in the same building . The CS was a barren colony cage whereas the ECS had a nesting area, roosts and a scratch area. In both the CS and ECS Systems, the bird population was held constant at 36 white-egg strain hens per cage (69 in^2 or 445 cm^2, per hen) or 31 brown-egg strain hens per cage (80 in^2 or 516 cm^2 per hen). In House 5, the total population was 7,356 hens used to test replicates: 132 per white-egg strain and 84 replicates per brown-egg strain (Table 2).

Table 2. Replicate Numbers and Hen Populations in the 5 Experimental Housing Systems: Colony Housing, Enriched Colony Housing, Conventional Cage, Cage-free, and Free-range

House	Cage Style[1]	Egg Color	Molt Trtmt[2]	Number of Replicates	Hens per replicate	Hen No.	Total Hens
5	CS	White	NM	33	36	1,188	
5	ECS	White	NM	33	36	1,188	
5	CS	White	NA	33	36	1,188	
5	ECS	White	NA	33	36	1,188	4,752[3]
5	CS	Brown	NM	21	31	651	
5	ECS	Brown	NM	21	31	651	
5	CS	Brown	NA	21	31	651	
5	ECS	Brown	NA	21	31	651	2,604[4]
7	C	White	NM	44	28	1,232	
7	C	White	NA	44	28	1,232	
7	C	Brown	NM	28	24	672	
7	C	Brown	NA	28	24	672	3,808[5]
4	CF	White	NM	16	60	960	
4	CF	Brown	NM	14	60	840	1,800[6]
R1	R	White	NM	2	60	120	
R1	R	Brown	NM	2	60	120	
R2	R	Brown	NM	4	60	240	480[7]

[1]Conventional Cage=C; Colony Housing System=CS; Enriched Colony Housing System=ECS; Cage –free=CF; Free-range=R
[2]Molt treatment: NA=Non-anorexic molt, NM=Non molted
[3]White-Egg Strains, NM or NA in CS or ECS
[4]Brown-Egg strains, NM or NA in CS or ECS
[5]White-Egg Strains and Brown-Egg Strains NM or NA in C
[6]White-Egg and Brown-Egg Strains NM in CF
[7]White-Egg and Brown Egg-Strains NM in R

The Cage-free (CF) housing for the laying phase was in the same house (#4) and pens used for the rearing phase (8 ft x 10 ft or 2.43 m x 3.05 m). The house was set up to provide house-heat capabilities due to the low density in the house and heat production of the cage free birds The number of birds per pen was adjusted to 60 hens to provide a minimum of 177 in^2 or 1,142 cm^2 per pullet with the feeder space deducted. Hens were provided 6.3 in (16 cm) of roosting space per bird. Feeder and waterer spaces were designed to meet UEP Guidelines for cage-free facilities. Nesting space was 1 nest per 5 hens.

The Free-range (R) housing for the laying phase was in the same curtain-sided range huts (R1, R2, R3) and pens that were used for the rearing phase. To match the CF system, the number of hens per pen (8 ft x 10 ft, 2.43 m x 3.05 m) was adjusted to 60 to provide a minimum of 177 in^2 or 1,142 cm^2 per hen with the feeder space deducted. Hens were provided 6.3 in (16 cm) of roosting space per bird. The range houses had timers for light control and supplemental propane heaters for heating. The heaters were set to maintain a minimum temperature of 45ºF. Heat was provided during cool conditions to maintain an interior temperature within the Effective Thermal Neutral Zone (ETNZ) where body temperature can be maintained without altering the basic metabolic rate. Hens had free access to their respective outdoor range paddocks throughout the day and night, but were enticed to return to the range house during the dark for roosting and protection. The hens accessed the range through an18 in x 18 in (46 cm x 46 cm) pophole. Husbandry, lighting and supplemental feed were-allocated on the same basis as for flock mates in cage-free and cage systems in order to minimize the variables between flock mates. Range density was based upon research of 721 bird/acre static equivalency. The range pens were 60 ft x 60 ft, 3,600 ft^2 (18.3 m x 18.3 m, 335 m^2) and were enclosed by a 6 ft (1.8 m) high fence. In order to facilitate range forage replenishment, each of the paddocks was divided in half providing a rotating range density of 30 ft^2/hen (2.78 m^2/hen), and hens were rotated every 4 wks. One week prior to rotation, the replenished paddocks were mowed to an approximate height of 6 in (15 cm). Hen movement was controlled by an access gate. As was done in the rearing phase, birds were rotated every 4 wks. One week prior to rotation, the replenished paddocks were mowed to an approximate height of 6 in (15 cm). Hen movement between paddocks was controlled by an access gate. The veranda area was 10 ft x15 ft (3.04 m x 4.6 m) of shaded, bare dirt. Each range pen had 8 nipple drinkers inside and 8 nipple drinkers outside. Tube feeders were inside each pen and a covered feeder was outside providing a total of 6.4 cm of feeder space per pullet.

Lighting

The lighting periods for the hens in the C, CS, and ECS controlled environment facilities increased with hen age (Table 3).

FDA Egg Safety Testing

In accordance with the Egg Safety Rule and the NCLP&MT Egg Safety Plan, the birds in the cage, cage-free and range environments were tested for the presence of *Salmonella enteritidis* when pullets were between the ages of 14 and 16 weeks and layers were between the ages of 40 and 44 weeks. Environmental swabs were collected in accordance with our FDA Egg Safety Plan.

Table 3. Layer House Lighting Schedules

Age	Date	Photo Period[1]
(weeks)		(Daylight hrs)
16-17	Sept. 21, 2016	10.0
17	Sept. 28, 2016	11.0
18	Oct. 5, 2016	11.5
19	Oct. 12, 2016	12.0
20	Oct. 19, 2016	12.5
21	Oct. 26, 2016	13.0
22	Nov. 2, 2016	13.5
23	Nov. 9, 2016	14.0
24	Nov. 16, 2016	14.25
25	Nov. 23, 2016	14.5
26	Nov. 30, 2016	14.75
27	Dec. 7, 2016	15.0
28	Dec. 14, 2016	15.25
29	Dec. 21, 2016	15.5
30	Dec. 28, 2016	15.75
31-89	Mar. 14, 2017	16.0

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[1]Supplemental lighting schedules were the same for C, CS, ECS, CF and R hens. Range hens also had natural light

[2]Light intensity was 0.5 to 0.7 ft candle at the second tier, except for range hens which had natural light

Salmonella Enteritidis assessment- On Monday, November 27, 2017, 23 environmental swabs were received at the lab from NC State University's Prestage Department of Poultry Science (PI – Anderson) for Salmonella Enteritidis assessment of the 40th NCLP&MT. All swabs were pre-enriched overnight in sterile buffered peptone water (37ºC). Aliquots from each sample were then transferred to both TT and RV selective-enrichment broths overnight (42ºC). Selective enrichments were then struck onto both BGS and XLT-4 selective agars. Twenty-two samples were negative on both BGS and XLT-4. Therefore, no further transfers were required for these samples. One sample was positive on both TT and RV enriched XLT-4. The sample was subsequently positive on LIA and TSI slants for general *Salmonella* spp. and latex agglutination as well. However, the sample was negative for Group D agglutination so it was not *Salmonella enteritidis*. Both negative and positive controls grew appropriately through each stage of growth.

Layer Nutrition

Layer diets were identified as Diets D, E, F, G, H, I, M, N, and O which consisted 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 (Tables 4-6).

Table 4. Minimum Daily Intake of Nutrients Per Bird at Various Stages of Production

	Production Stage[1]			
Daily Intake	Pre-Peak > 87%	87-80%	80-70%	<70%
White-Egg Layers				
Protein[2](g/day)	19.00	18.0	17.00	16.00
Calcium (g/day)	4.00	4.10	4.20	4.30
Lysine (mg/day	820.00	780.00	730.00	690.00
TSAA (mg/day)	700.00	670.00	630.00	590.00
Brown-Egg Layers				
Protein[2](g/day)	20.00	19.00	18.00	17.00
Calcium (g/day)	4.00	4.00	4.10	4.20
Lysine (mg/day	830.00	820.00	780.00	730.00
TSAA (mg/day)	710.00	700.00	670.00	630.00

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[1]Predicted Production, as determined by Hen-Day Egg Production

[2]If the egg production was higher than predicted values, protein intake was increased by 1%

Table 5: Layer Feeding Program

Rate of Production	Consumption (kg/100 Birds/Day)	Diet Fed: White-egg Strains	Diet Fed: Brown-egg Strains
Pre-production (15-17 wks)	< 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

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

Table 6. Laying Periods Feed Formulations[1] D through G

Ingredients	D	E	F	G
	(lbs.)	(lbs.)	(lbs.)	(lbs.)
Corn	879.44	1,166.03	1,202.70	1,240.88
Soybean meal	636.39	564.55	533.71	506.44
Fat (Lard)	10.00	10.00	-	-
D.L. Methionine	3.41	2.92	2.31	2.04
Soybean oil	45.85	25.90	36.29	25.06
Ground Limestone	124.15	122.36	121.69	110.55
Coarse Limestone	70.00	70.00	70.00	75.00
Bi-Carbonate	2.00	2.00	2.00	3.00
Phosphate Mono/D	21.93	21.50	17.93	26.03
Salt	6.96	6.41	5.88	5.00
Vit. premix	1.00	1.00	1.00	1.00
Min. premix	1.00	1.00	1.00	1.00
HyD3 Broiler(62.5 mg/lb)	-	-	0.50	-
Prop Acid 50% Dry	1.00	1.00	1.00	1.00
T-Premix	1.00	1.00	1.00	1.00
0.06% Selenium Premix	1.00	1.00	1.00	1.00
Choline Cl 60%	1.62	1.94	1.59	1.00
Avizyme	1.00	1.00	-	-
Ronozyme P-CT 54%	0.40	0.40	0.40	-
Calculated Analysis				
Protein %	19.43	18.10	17.50	17.00
ME kcal/kg	2,926.00	2,904.00	2,882.00	2,860.00
Calcium %	4.10	4.05	4.00	3.95
A. Phos. %	0.45	0.44	0.40	0.38
Lysine %	1.10	1.00	0.96	0.91
TSAA %	0.80	0.74	0.69	0.66

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[1] Feed formulations by Dr L. Minear, Consulting Nutritionist, and manufacturing by Land'O Lakes

Data Collection – Terms, Schedule and Procedures:

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

Breeder (Strain)-- Short identification codes of the breeder and stock (Tables 1)

Body weights--Birds were weighed at the start of the test (17 wks) and end of the single cycle (89 wks). Body weight gain during the single cycle was reported for each strain-test environment.

Egg Income--Egg income per hen housed was calculated using the test's egg production values for the current production year calendar and applying the regional 3-year average egg prices (11/27/2015 to 11/25/2017, Table 7). The prices are 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). The egg income calculation was as follows. The loss eggs were subtracted from the egg numbers then the B and Checks egg numbers were calculated based on their percent of eggs produced and price. The remaining grade A eggs were priced based on the egg size distribution percentages. The egg income was calculated for each replicate for analysis.

Table 7. Regional Three-year Average Egg Prices

Grade	Size	$/Dozen[1]
A	Extra Large	1.44
A	Large	1.40
A	Medium	1.07
A	Small	0.78
A[2]	Pee Wee	0.39
B[3]	All	0.74
Checks[3]	All	0.74

[1]Price per dozen calculated from the SE Regional Egg Prices reported to USDA-AMS
[2]Prices are estimates based upon the formula provided by D.D. Bell (Small x 0.5)
[3]Prices are estimates based upon the formula provided by D.D. Bell (Large x 0.53)

Egg Production--All eggs that had the potential of being marketed were credited toward the test unit's (replicate's) egg production, regardless of the shell condition at the time of collection. All eggs were collected and recorded daily. Egg production was summarized at 28-day intervals, and was reported on a Hen-Housed and Hen-Day basis.

1. Hen Housed Egg Production (per Bird): The total number of eggs produced divided by the number of birds housed.
2. Hen Day Egg Production: The average daily number of eggs produced per 100 hens (%)

Egg Weight--At 28-day intervals, all eggs produced in the previous 24-hour period were weighed and sorted by size (See egg size distribution). Average egg weight (g/hen), and egg mass (g), as well as percentages of eggs within each size category were reported.

1. Egg Mass: The average daily production of egg mass in grams per hen day.

2. 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 Quality--At 28-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 Size Distribution--At 28-day intervals, all eggs produced within the previous 24 hours were weighed and sorted according to current USDA standards for egg size classifications (Table 8). There was blending of egg size in this test using the weight cutoff of 23.5 g between medium and large eggs. This maximizes the number of USDA large eggs just as would occur in a commercial plant. Size distribution was reported as the proportion of eggs falling into each size category.

Table 8. USDA Egg Weights Used to Establish the Egg Size Distribution

Size Category	Ounces[1]/Dozen	Grams/Egg
Pee Wee	< 18	<42.6
Small	18 – 21	42.6 < 56.8
Medium	21 - 24	49.7 < 56.8
Large	24 – 27	56.8 -63.9
Extra Large	> 27	>63.9

[1]1 oz. = 28.4 g

Feed Consumption --All feed offered for consumption was recorded for each replicate. At 28-day intervals, feed not consumed was weighed back to calculate daily feed consumption (kg feed/100 hens/day). Values were combined to determine overall feed consumption between 17 – 89 wks expressed in units of daily feed intake.

Feed Conversion--The grams of eggs produced per gram of feed consumed calculated at 28-day intervals.

Table 9. Average Contract Feed Prices for Feed Purchases during the Single Cycle

Diets	Price ($) / Ton
D	338.60
E	327.15
F	319.24
G	307.34
H	299.67
I	306.38

Feed Costs--Calculation of feed cost per hen housed using the kilograms of feed consumed and the average price of each diet per ton based on the actual feed prices for each feed delivery. Calculated costs for the complete production cycle (Table 9).

Grade Information-- The average grade, according to USDA grading standards, of all eggs sampled over all sampling periods. Grades were determined by personnel trained in accordance with the USDA grading standards (USDA Egg Grading Manual).

Mortality--All mortalities were recorded daily, and when possible, the potential causes of the mortalities were documented. Mortalities due to obvious accidents were not included in numbers reported. Veterinarians collected mortality samples for necropsy at intervals during the single cycle, and percent mortalities during Single Cycle (17-89 wks) were reported separately (Table 38 and Figures 54-58).

Statistical Analyses and Separation of Means:

All data were subjected to ANOVA testing utilizing the GLM procedure of JMP with main effects of strain, density, and production system used herein. Separate analyses were conducted for white and brown-egg strains, the densities within production systems, and between the conventional cage, colony housing system and enriched colony housing system. Significant differences ($P < 0.01$) within white and brown-egg strains were noted by differing letters among columns of means. First and second order interactions were tested for significance. The LS Means from the GLM Procedure were separated via the PDIFF option.

Table 10. Effect of White-egg Strain on Performance of Hens (17-89 wks) in Conventional Cages

Breeder	Density[1]	Feed Consumption	Feed Conversion	Eggs per Bird Housed	Hen-Day Egg Production[2]	Egg Mass	Mortality	Age at 50% Production
(Strain)	(in^2/hen)	(kg/100 hens/d)	(g egg/g feed)	(#)	(%)	(g/HD)[3]	(%)	(Days)
Bovans White	69	10.18^{bcde}	0.50	408.46^{ab}	86.08	51.62	8.93	141^{abc}
Shaver White	69	10.02^{cdef}	0.53	412.17^{ab}	88.82	53.35	20.54	134^{c}
Dekalb White	69	10.78^{c}	0.50	444.80^{a}	89.25	54.52	9.82	140^{abc}
Babcock White	69	10.41^{abcd}	0.52	439.73^{ab}	89.71	55.09	8.04	139^{bc}
ISA B-400	69	9.64^{f}	0.55	427.00^{ab}	88.70	53.74	6.25	139^{c}
Hy-Line W-80	69	9.97^{def}	0.51	399.36^{ab}	86.25	51.67	14.29	142^{abc}
Hy-Line W-36	69	9.79^{ef}	0.51	404.40^{ab}	82.91	50.26	3.57	143^{a}
Lohmann LSL Lite	69	10.40^{abcd}	0.51	401.17^{ab}	85.69	53.86	12.50	143^{ab}
H&N Nick Chick	69	10.55^{ab}	0.52	404.83^{ab}	86.33	55.22	16.07	143^{a}
Novogen Novowhite	69	10.49^{abc}	0.50	380.51^{b}	85.17	52.73	23.22	142^{abc}
All Strains	69	10.22	0.52	412.24	86.89	53.21	12.31	141

40th NCLP&MT

[1]In each test environment (C, CS, ECS), all white-egg strains were housed at the same density (69 in^2/hen; 445 cm^2/hen)

[2]The average daily number of eggs produced per 100 hens (%)

[3] HD = hen day

a,b,c,d,e,f - Different letters within the same column denote significant differences (P<0.01) for comparisons made among strains.

Table 11. Effect of White-egg Strain on Egg Weight and Size Distribution of Eggs Produced by Hens (17-89 wks) in Conventional Cages.

Breeder	Density[1]	Egg Weight	Pee Wee	Small	Medium	Large	Extra Large
(Strain)	(in^2/hen)	(g/egg)	(%)	(%)	(%)	(%)	(%)
Bovans White	69	59.17^{b}	0.11	5.08	4.57	35.54^{a}	54.70^{d}
Shaver White	69	59.32^{b}	0.20	4.09	3.60	34.33^{a}	57.78^{cd}
Dekalb White	69	60.23^{ab}	0.00	4.37	3.73	28.07^{abc}	63.82^{bcd}
Babcock White	69	60.67^{ab}	0.12	3.95	3.22	26.89^{abc}	65.82^{abcd}
ISA B-400	69	59.94^{b}	0.04	3.08	4.67	31.51^{ab}	60.69^{bcd}
Hy-Line W-80	69	59.01^{b}	0.26	5.26	3.65	34.64^{a}	56.19^{d}
Hy-Line W-36	69	59.73^{b}	0.00	4.52	4.58	30.52^{abc}	60.38^{bcd}
Lohmann LSL Lite	69	61.79^{ab}	0.00	4.13	3.62	21.09^{cd}	71.16^{ab}
H&N Nick Chick	69	62.80^{a}	0.11	4.07	3.03	14.78^{d}	78.00^{a}
Novogen Novowhite	69	60.99^{ab}	0.00	4.14	3.80	22.49^{bcd}	69.57^{abc}
All Strains	69	60.36	0.08	4.27	3.85	27.99	63.81

40th NCLP&MT

[1]In each test environment (C, CS, ECS), all white-egg strains were housed at the same density (69 in^2/hen; 445 cm^2/hen)

a,b,c,d,- Different letters within the same column denote significant differences (P<0.01), comparisons made among strains

Table 12. Effect of White-egg Strain on Egg Quality, Income and Feed Costs of Hens (17-89 wks) in Conventional Cages

Breeder	Density[1]	Grade A	Grade B	Cracks	Loss	Egg Income	Feed Costs
(Strain)	(in²/hen)	(%)	(%)	(%)	(%)	($/hen)	($/hen)
Bovans White	69	91.84	0.48	7.22	0.45	48.02[bc]	18.73
Shaver White	69	91.35	0.82	7.61	0.22	51.11[abc]	18.45
Dekalb White	69	93.18	0.37	6.22	0.22	50.32[abc]	18.76
Babcock White	69	92.37	0.44	7.02	0.16	52.53[ab]	18.33
ISA B-400	69	91.86	0.69	7.31	0.14	50.64[abc]	19.15
Hy-Line W-80	69	93.46	0.50	5.90	0.13	49.37[abc]	19.08
Hy-Line W-36	69	92.75	0.15	6.56	0.24	47.56[c]	19.18
Lohmann LSL Lite	69	91.15	0.65	7.92	0.27	50.26[abc]	17.85
H&N Nick Chick	69	93.29	0.54	6.06	0.11	52.60[a]	18.22
Novogen Novowhite	69	93.88	0.64	5.21	0.26	49.41[abc]	19.25
All Strains	69	92.51	0.56	6.70	0.22	50.18	18.70

40th NCLP&MT

[1] In each test environment (C, CS, ECS), all white-egg strains were housed at the same density. (69 in²/hen; 445 cm²/hen)

a,b,c - Different letters within the same column denote significant differences (P<0.01), comparisons made among strain average values.

Table 13. Effect of Brown-egg Strain on Performance of Hens (17–89 wks) in Conventional Cages

Breeder	Density[1]	Feed Consumption	Feed Conversion	Eggs Per Bird Housed	Hen-Day Egg Production[2]	Egg Mass	Mortality	Age at 50% Production
(Strain)	(in^2/hen)	(kg/100 hens/d)	(g egg/g feed)	(#)	(%)	(g/HD)[3]	(%)	(Days)
Bovans Brown	80	10.71[ab]	0.48[ab]	416.12	84.07	52.29[ab]	12.50	140[a]
ISA Brown	80	10.57[ab]	0.50[a]	421.36	86.09	53.64[a]	6.25	140[a]
Hy-Line Brown	80	10.34[b]	0.46[ab]	389.82	79.76	48.14[b]	7.29	139[ab]
Hy-Line Silver Brown	80	10.77[a]	0.44[b]	399.32	80.61	47.33[b]	7.29	138[ab]
Lohmann LB-Lite	80	10.36[b]	0.49[ab]	357.20	82.10	50.71[ab]	40.62	137[b]
Novogen Novobrown	80	10.53[ab]	0.49[ab]	401.06	83.47	52.04[ab]	19.79	140[ab]
TETRA Brown	80	10.64[ab]	0.46[ab]	397.86	81.28	49.72[ab]	11.46	138[ab]
All Strains	80	10.56	0.48	397.88	82.88	50.71	15.03	139

40th NCLP&MT

[1]In each test environment (C, CS, ECS), all brown-egg strains were housed at the same density (80 in^2/hen; 516 cm^2/hen)

[2]The average daily number of eggs produced per 100 hens (%)

[3]HD = hen day

a.b - Different letters in the same column denote significant differences ($P<0.01$), comparisons made among strain average values.

Table 14. Effect of Brown-egg Strain on Egg Weight and Size Distribution of Eggs Produced by Hens (17–89 wks) in Conventional Cages

Breeder	Density[1]	Egg Weight	Pee Wee	Small	Medium	Large	Extra Large
(Strain)	(in^2/hen)	(g/egg)	(%)	(%)	(%)	(%)	(%)
Bovans Brown	80	61.51[a]	0.08	2.12	4.93	24.41[bc]	68.46[a]
ISA Brown	80	61.58[a]	0.00	1.58	5.29	22.46[c]	70.66[a]
Hy-Line Brown	80	60.03[a]	0.00	0.97	5.92	31.53[b]	61.58[a]
Hy-Line Silver Brown	80	58.18[b]	0.00	2.05	6.63	47.62[a]	43.69[b]
Lohmann LB-Lite	80	61.33[a]	0.00	1.93	4.91	25.64[bc]	67.52[a]
Novogen Novobrown	80	61.66[a]	0.34	2.63	3.66	21.47[c]	71.90[a]
TETRA Brown	80	60.75[a]	0.12	1.75	5.06	28.72[bc]	64.35[a]
All Strains	80	60.66	0.08	1.88	5.31	29.28	63.45

40th NCLP&MT

[1]In each test environment (C, CS, ECS), all brown-egg strains were housed at the same density (80 in^2/hen; 516 cm^2/hen)

a,b,c, - Different letters in the same column denote significant differences (P<0.01), comparisons made among strains.

Table 15. Effect of Brown-egg Strain on Egg Quality, Income and Feed Costs of Hens (17–89 wks) in Conventional Cages

Breeder	Density[1]	Grade A	Grade B	Cracks	Loss	Egg Income	Feed Costs
(Strain)	(in^2/hen)	(%)	(%)	(%)	(%)	($/hen)	($/hen)
Bovans Brown	80	90.05	0.44	9.34^{a}	0.16	47.03	20.21
ISA Brown	80	92.40	0.63	6.66^{ab}	0.32	49.22	19.38
Hy-Line Brown	80	90.10	0.46	9.14^{ab}	0.30	44.17	19.08
Hy-Line Silver Brown	80	92.03	0.62	6.71^{ab}	0.25	44.11	18.50
Lohmann LB-Lite	80	91.07	0.83	7.73^{ab}	0.38	46.64	18.79
Novogen Novobrown	80	92.22	1.30	6.24^{b}	0.24	48.54	19.14
TETRA Brown	80	91.73	0.44	7.83^{ab}	0.00	45.88	19.26
All Strains	80	91.44	0.67	7.66	0.24	46.55	19.20

40th NCLP&MT

[1] In each test environment (C, CS, ECS), all brown-egg strains were housed at the same density (80 in^2/hen; 516 cm^2/hen)

a,b - Different letters in the same column denote significant differences ($P<0.01$), comparisons made among strains.

Table 16. Effect of White-egg Strain on Body Weight of Hens (17-89 wks) in Conventional Cages

Breeder	Density[1]	17-Wk Body Wt	89-Wk Body Wt	Single Cycle Wt Gain
(Strain)	(in^2/hen)	(kg)	(kg)	(%)
Bovans White	69	1.10	1.71^{ab}	35.6
Shaver White	69	1.16	1.77^{ab}	34.5
Dekalb White	69	1.13	1.71^{ab}	33.9
Babcock White	69	1.18	1.85^{a}	36.0
ISA B-400	69	1.13	1.67^{b}	32.1
Hy-Line W-80	69	1.16	1.84^{a}	36.4
Hy-Line W-36	69	1.12	1.78^{ab}	36.8
Lohmann LSL Lite	69	1.16	1.79^{ab}	34.9
H&N Nick Chick	69	1.24	1.81^{ab}	31.3
Novogen Novowhite	69	1.13	1.70^{ab}	33.05
All Strains	69	1.15	1.76	34.5

40th NCLP&MT

[1] In each test environment (C, CS, ECS), all white-egg strains were housed at the same density (69 in^2/hen; 445 cm^2/hen)

a,b - Different letters in the same column denote significant differences (P<0.01), comparisons made among strains

Table 17. Effect of Brown-egg Strain on Body Weight of Hens (17-89 wks) in Conventional Cages

Breeder	Density[1]	17-Wk Body Wt	89-Wk Body Wt	Single Cycle Wt Gain
(Strain)	(in^2/hen)	(kg)	(kg)	(%)
Bovans Brown	80	1.40	2.05	31.7
ISA Brown	80	1.30	2.04	36.3
Hy-Line Brown	80	1.40	2.07	32.2
Hy-Line Silver Brown	80	1.46	2.14	31.8
Lohmann LB-Lite	80	1.40	2.00	29.7
Novogen Novobrown	80	1.39	2.09	33.7
TETRA Brown	80	1.40	2.07	32.5
All Strains	80	1.39	2.07	32.6

40th NCLP&MT

[1] In each test environment (C, CS, ECS), all brown-egg strains were housed at the same density (80 in^2/hen; 516 cm^2/hen)

No significant differences (P<0.01) with comparisons made among strains

Table 18. Effect of White-egg Strain and Housing System[1,2] on Performance of Hens (17-89 wks) in a Colony Housing System and an Enriched Colony Housing System

Breeder	Housing System[1]	Feed Consumption	Feed Conversion	Eggs Per Bird Housed	Hen Day Egg Production[3]	Egg Mass	Mortality	Age at 50% Production
(Strain)		(kg/100 hens/d)	(g egg/g feed)	(#)	(%)	(g/HD)[4]	(%)	(Days)
Bovans	CS	10.78	0.46	366.94	82.85	49.66	28.70	142
White	ECS	10.58	0.48	377.59	86.19	51.39	12.93	140
	Average	10.68^{ABC}	0.47	372.27	84.52	50.53	20.82	141^{CD}
Shaver	CS	10.20	0.47	359.27	82.49	48.05	47.23	138
White	ECS	10.24	0.50	358.29	86.06	51.05	16.67	137
	Average	10.22^{CDE}	0.48	358.78	84.28	49.88	31.95	137^{F}
Dekalb	CS	11.02	0.45	356.37	82.91	49.82	29.67	141
White	ECS	10.64	0.49	372.66	87.92	52.94	11.10	140
	Average	10.83^{AB}	0.47	364.52	85.42	51.38	20.38	140^{DE}
Babcock	CS	10.85	0.47	334.82	83.48	51.14	39.80	138
White	ECS	10.45	0.52	401.21	89.97	54.76	4.67	137
	Average	10.65^{ABC}	0.49	368.02	86.73	52.95	22.23	137^{F}
ISA	CS	10.07	0.45	366.65	77.91	46.48	20.37	139
B-400	ECS	10.14	0.52	384.24	88.69	53.29	14.80	137
	Average	10.11^{DE}	0.49	375.44	83.30	49.88	17.58	138^{EF}
Hy-Line	CS	10.67	0.45	358.52	81.21	48.75	27.80	144
W-80	ECS	10.52	0.48	352.21	85.11	51.01	21.30	143
	Average	10.60^{BCD}	0.47	355.36	83.16	49.88	24.55	143^{ABC}
Hy-Line	CS	9.99	0.49	379.46	82.51	49.58	7.40	144
W-36	ECS	9.87	0.50	370.32	82.76	49.75	3.73	145
	Average	9.93^{E}	0.49	374.89	82.63	49.66	5.57	144^{A}
Lohmann	CS	11.09	0.44	337.52	79.50	49.60	37.03	143
LSL Lite	ECS	10.52	0.50	369.58	86.35	53.55	18.53	143
	Average	10.81^{AB}	0.47	353.55	82.92	51.57	27.78	143^{ABC}
H&N	CS	11.15	0.45	354.26	79.95	50.37	32.40	144
Nick Chick	ECS	11.05	0.49	360.84	86.52	54.62	26.83	144
	Average	11.10^{A}	0.47	357.55	83.24	52.49	29.62	144^{AB}
Novogen	CS	11.07	0.45	361.63	83.42	51.16	37.97	142
Novowhite	ECS	10.52	0.49	368.21	84.98	52.01	19.43	141
	Average	10.80^{AB}	0.47	364.92	84.20	51.58	28.70	142^{BCD}
All	CS	10.69^{Y}	0.46^{Y}	357.54	81.62^{Z}	52.43^{Y}	30.84^{Z}	141
Strains	ECS	10.45^{Z}	0.50^{Z}	371.51	86.46^{Y}	49.53^{Z}	15.00^{Y}	141
	Average	10.57	0.48	364.53	84.04	50.98	22.92	141

40th NCLP&MT

[1]Colony Housing System=CS; Enriched Colony Housing System=ECS

[2]All white-egg strains were equally represented in each production system, and C, CS and ECS hens were housed at (69 in^2/hen; 445 cm^2/hen).

[3]The average daily number of eggs produced per 100 hens (%)

[4]HD = hen day

A,B,C,D,E,F - Different letters in the same column denote significant differences (P<0.01), comparisons made among strains using average of CS and ECS values.

Y,Z – Different letters in the same column denote significant differences (P<0.01), overall comparison of CS vs. ES housing system using average for all strains

Table 19. Effect of White-egg Strain and Housing System[1,2] on Egg Weight and Size Distribution of Eggs Produced by Hens (17-89 wks) in a Colony Housing System and an Enriched Colony Housing System

Breeder	Housing System[1]	Egg Weight	Pee Wee	Small	Medium	Large	Extra Large
(Strain)		(g/egg)	(%)	(%)	(%)	(%)	(%)
Bovans	CS	59.08	1.19	5.11	4.06	31.99	57.65
White	ECS	58.86	0.00	5.12	5.46	35.52	53.90
	Average	58.97[C]	0.60	5.12	4.76	33.76[ABC]	55.77[CD]
Shaver	CS	58.44	0.11	5.17	4.53	39.04	51.15
White	ECS	58.72	0.05	4.30	5.54	37.06	53.05
	Average	58.58[C]	0.08	4.73	5.04	38.05[B]	52.10[D]
Dekalb	CS	59.29	0.34	5.20	4.18	33.14	57.14
White	ECS	59.44	0.00	4.65	4.35	31.48	59.52
	Average	59.37[BC]	0.17	4.93	4.26	32.31[ABC]	58.33[BCD]
Babcock	CS	60.54	0.00	3.79	4.52	24.77	66.92
White	ECS	60.18	0.05	3.28	5.94	28.45	62.27
	Average	60.36[ABC]	0.03	3.53	5.23	26.61[BCD]	64.60[ABC]
ISA	CS	59.09	0.00	4.60	4.84	34.29	56.26
B-400	ECS	59.42	0.00	4.14	5.66	32.43	57.76
	Average	59.25[BC]	0.00	4.37	5.25	33.36[ABC]	57.01[CD]
Hy-Line	CS	59.11	0.13	6.10	5.16	31.55	57.05
W-80	ECS	59.11	0.42	5.04	5.56	34.76	54.21
	Average	59.11[BC]	0.28	5.57	5.36	33.16[ABC]	55.63[CD]
Hy-Line	CS	59.44	0.00	4.21	6.35	33.71	55.72
W-36	ECS	59.38	0.00	3.15	7.25	34.49	55.11
	Average	59.41[BC]	0.00	3.68	6.80	34.10[AB]	55.42[CD]
Lohmann	CS	61.55	0.00	3.65	6.26	21.55	68.53
LSL Lite	ECS	61.03	0.09	4.84	3.94	23.25	67.87
	Average	61.29[AB]	0.04	4.24	5.10	22.40[DE]	68.20[AB]
H&N	CS	62.02	0.00	5.07	4.15	17.21	73.57
Nick Chick	ECS	62.03	0.00	4.72	3.79	18.08	73.41
	Average	62.03[A]	0.00	4.90	3.97	17.65[E]	73.49[A]
Novogen	CS	60.53	0.00	5.16	4.16	26.82	63.86
Novowhite	ECS	60.35	0.00	4.30	5.97	25.80	63.92
	Average	60.44[ABC]	0.00	4.73	5.07	26.31[CD]	63.89[ABC]
All	CS	59.91	0.18	4.81	4.82	29.41	60.78
Strains	ECS	59.85	0.06	4.35	5.34	30.12	60.10
	Average	59.88	0.12	4.58	5.08	29.77	60.44

40th NCLP&MT

[1]Colony Housing System=CS; Enriched Colony Housing System=ECS

[2]All strains were equally represented in each production system, and C, CS and ECS hens were housed at (69 in^2/hen; 445 cm^2/hen).

A,B,C,D,E - Different letters in the same column denote significant differences (P<0.01), comparisons made among strains using average of CS and ECS values.

Table 20. Effect of White-egg Strain and Housing System[1,2] on Egg Quality, Income and Feed Costs of Hens (17-89 wks) in a Colony Housing System and an Enriched Colony Housing System

Breeder	Housing System[1]	Grade A	Grade B	Cracks	Loss	Egg Income	Feed Costs
(Strain)		(%)	(%)	(%)	(%)	($/hen)	($/hen)
Bovans	CS	89.94	0.17	9.60	0.19	50.69	19.73
White	ECS	89.54	0.43	9.50	0.45	48.85	19.25
	Average	89.74	0.30	9.55	0.32	49.77	19.49[ABC]
Shaver	CS	92.17	0.33	7.36	0.17	48.45	18.29
White	ECS	91.10	0.42	8.30	0.26	49.24	18.51
	Average	91.63	0.38	7.83	0.21	48.85	18.40[BC]
Dekalb	CS	90.11	0.40	9.20	0.28	48.32	20.41
White	ECS	90.84	0.40	8.16	0.51	51.11	19.42
	Average	90.48	0.40	8.68	0.40	49.72	19.91[AB]
Babcock	CS	90.60	0.26	8.89	0.41	50.38	19.78
White	ECS	89.81	0.32	9.39	0.50	52.38	19.07
	Average	90.21	0.29	6.14	0.45	51.32	19.43[ABC]
ISA	CS	89.57	0.30	9.83	0.30	44.86	18.43
B-400	ECS	91.87	0.54	7.22	0.26	51.38	18.21
	Average	90.72	0.42	8.52	0.28	48.12	18.32[BC]
Hy-Line	CS	90.99	0.54	8.26	0.19	47.37	19.72
W-80	ECS	90.04	0.56	9.09	0.22	48.21	19.05
	Average	90.52	0.55	8.68	0.20	47.79	19.38[ABC]
Hy-Line	CS	92.62	0.37	6.75	0.21	47.97	17.76
W-36	ECS	92.65	0.32	6.68	0.30	49.15	17.84
	Average	92.64	0.35	6.71	0.26	48.56	17.80[C]
Lohmann	CS	91.21	0.55	8.08	0.32	48.79	21.00
LSL Lite	ECS	91.74	0.59	7.54	0.08	50.83	19.51
	Average	91.48	0.57	7.81	0.20	49.81	20.25[A]
H&N	CS	90.48	0.85	8.28	0.38	47.93	20.34
Nick Chick	ECS	91.75	0.92	6.79	0.75	51.81	20.27
	Average	91.11	0.89	7.54	0.57	49.87	20.30[A]
Novogen	CS	91.20	0.95	7.85	0.07	48.32	20.11
Novowhite	ECS	91.35	0.89	7.45	0.33	51.41	19.17
	Average	91.28	0.92	7.65	0.20	49.86	19.64[AB]
All	CS	90.89	0.47	8.41	0.25	48.30[Y]	19.56
Strains	ECS	91.07	0.54	8.01	0.37	50.44[Z]	19.03
	Average	90.98	0.51	8.21	0.31	49.37	19.29

40th NCLP&MT

[1]Colony Housing System=CS; Enriched Colony Housing System=ECS

[2]All strains were equally represented in each production system, and C, CS and ECS hens were housed at (69 in^2/hen; 445 cm^2/hen)

A,B,C - Different letters in the same column denote significant differences (P<0.01), comparisons made among strains using average of CS and ECS values.

Y,Z - Different letters in the same column denote significant differences (P<0.01), comparisons made among each strain-housing combination

Table 21. Effect of Brown-egg Strain and Housing System on Performance of (17-89 wks) Hens in a Colony Housing System and an Enriched Colony Housing System

Breeder	Housing System[1]	Feed Consumption	Feed Conversion	Eggs Per Bird Housed	Hen Day Egg Production[2]	Egg Mass	Mortality	Age at 50% Production
(Strain)		(kg/100 hens/d)	(g egg/g feed)	(#)	(%)	(g/HD)[3]	(%)	(Days)
Bovans	CS	11.40	0.47	396.84	85.26	53.41	18.27	142
Brown	ECS	11.40	0.47	381.99	86.51	54.23	11.87	142
	Average	11.40^{A}	0.47^{AB}	389.42	85.89	53.82^{A}	15.07^{AB}	142^{A}
ISA	CS	11.15	0.47	388.81	85.27	53.10	27.97	141
Brown	ECS	11.01	0.48	389.13	86.26	53.36	11.80	141
	Average	11.08^{AB}	0.48^{A}	388.97	85.77	53.23^{AB}	19.88^{AB}	141^{AB}
Hy-Line	CS	11.02	0.47	371.57	84.24	51.56	23.70	138
Brown	ECS	11.04	0.47	370.57	84.87	51.85	8.63	138
	Average	11.03^{AB}	0.47^{AB}	371.22	84.55	51.70^{AB}	16.17^{AB}	138^{C}
Hy-Line	CS	11.35	0.44	397.96	84.46	49.73	11.87	140
Silver Brown	ECS	11.38	0.43	375.63	84.75	49.31	6.43	139
	Average	11.36^{A}	0.43^{B}	386.79	84.61	49.52^{B}	9.15^{B}	139^{BC}
Lohmann	CS	10.77	0.47	337.02	81.87	51.14	65.60	138
LB-Lite	ECS	10.79	0.48	365.02	83.25	52.40	33.33	139
	Average	10.78^{B}	0.48^{A}	351.40	82.56	51.77^{AB}	49.47^{A}	138^{C}
Novogen	CS	11.42	0.47	385.02	84.09	53.64	38.70	141
Novobrown	ECS	11.09	0.48	381.49	85.08	53.32	23.63	141
	Average	11.26^{A}	0.47^{A}	383.26	84.59	53.48^{AB}	31.17$_{AB}$	141^{AB}
TETRA	CS	11.15	0.46	384.03	83.36	51.15	18.27	138
Brown	ECS	10.94	0.47	385.31	83.88	51.35	6.47	139
	Average	11.04^{AB}	0.46^{AB}	384.67	83.62	51.25^{AB}	12.37^{B}	139^{BC}
All	CS	11.18	0.46	380.33	84.08	51.96	29.19	140
Strains	ECS	11.09	0.47	378.45	84.94	52.26	14.59	140
	Average	11.14	0.47	379.39	84.51	52.11	21.90	140

40th NCLP&MT

[1]Colony Housing System=CS; Enriched Colony Housing System=ECS

All strains were equally represented in each production system, and C, CS and ECS hens were housed at (80 in^2/hen; 516 cm^2/hen)

[2]The average daily number of eggs produced per 100 hens (%)

[3]HD=hen day

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

Table 22. Effect of Brown-egg Strain and Housing System on Egg Weight and Size Distribution of Eggs Produced by Hens (17-89 wks) in a Colony Housing System and an Enriched Colony Housing System

Breeder	Housing System[1]	Egg Weight	Pee Wee	Small	Medium	Large	Extra Large
(Strain)		(g/egg)	(%)	(%)	(%)	(%)	(%)
Bovans	CS	61.88	0.00	3.02	4.73	21.02	71.23
Brown	ECS	61.91	0.00	2.13	5.50	21.40	70.97
	Average	61.90^{A}	0.00	2.57	5.12	21.21^{CD}	71.10^{A}
ISA	CS	61.53	0.00	3.53	5.29	20.71	70.47
Brown	ECS	61.16	0.00	2.40	5.11	23.89	68.60
	Average	61.34^{A}	0.00	2.97	5.20	22.30^{BCD}	69.53^{A}
Hy-Line	CS	60.80	0.00	1.52	5.03	29.66	63.80
Brown	ECS	60.68	0.04	0.68	6.45	27.30	65.53
	Average	60.74^{A}	0.02	1.10	5.74	28.48^{B}	64.67^{A}
Hy-Line	CS	58.44	0.00	2.67	6.28	43.07	47.98
Silver Brown	ECS	57.77	0.00	2.29	7.77	46.87	43.07
	Average	58.10^{B}	0.00	2.48	7.03	44.97^{A}	45.52^{B}
Lohmann	CS	61.91	0.00	1.83	5.74	20.37	72.05
LB-Lite	ECS	62.46	0.32	1.19	5.85	19.32	73.32
	Average	62.19^{A}	0.16	1.51	5.80	19.84^{CD}	72.69^{A}
Novogen	CS	62.98	0.00	2.89	4.28	16.58	76.24
Novobrown	ECS	61.77	0.00	3.39	4.34	21.10	71.17
	Average	62.38^{A}	0.00	3.14	4.31	18.84^{D}	73.70^{A}
TETRA	CS	60.93	0.00	1.10	6.88	24.97	67.04
Brown	ECS	60.70	0.16	1.70	5.62	27.60	64.93
	Average	60.82^{A}	0.08	1.40	6.25	26.28^{BC}	65.99
All	CS	61.21	0.00	2.37	5.46	25.20	66.97
Strains	ECS	60.92	0.07	1.97	5.80	26.78	65.37
	Average	61.07	0.04	2.17	5.63	25.99	66.17

40th NCLP&MT

[1]Colony Housing System=CS; Enriched Colony Housing System=ECS

All strains were equally represented in each production system, and C, CS and ECS hens were housed at (80 in^2/hen; 516 cm^2/hen)

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

Table 23. Effect of Brown-egg Strain and Housing System on Egg Quality, Income and Feed Costs of Hens (17-89 wks) in a Colony Housing System and an Enriched Colony Housing System

Breeder	Housing System[1]	Grade A	Grade B	Cracks	Loss	Egg Income	Feed Costs
(Strain)		(%)	(%)	(%)	(%)	($/hen)	($/hen)
Bovans	CS	85.52	0.59	13.17^{a}	0.81	50.08	21.08
Brown	ECS	87.84	1.09	10.67^{abc}	0.24	50.98	20.62
	Average	86.68^{B}	0.84	11.92^{A}	0.52	50.53	20.85^{A}
ISA	CS	90.21	0.88	8.47^{bc}	0.65	48.88	20.24
Brown	ECS	88.887	0.35	10.31^{abc}	0.81	51.05	19.85
	Average	89.54^{AB}	0.61	9.30^{AB}	0.73	49.97	20.04^{AB}
Hy-Line	CS	88.22	0.46	10.61^{abc}	0.66	49.34	19.99
Brown	ECS	86.91	0.84	11.74^{ab}	0.48	47.56	19.71
	Average	87.56^{B}	0.65	11.17^{A}	0.57	48.45	19.85^{AB}
Hy-Line	CS	90.54	0.46	8.50^{abc}	0.49	48.29	20.89
Silver Brown	ECS	92.48	0.57	6.46^{c}	0.61	48.11	20.78
	Average	91.51^{A}	0.52	7.48^{B}	0.55	48.20	20.84^{A}
Lohmann	CS	88.90	1.44	8.48^{bc}	1.12	49.17	19.54
LB-Lite	ECS	86.72	0.95	11.18^{ab}	1.51	50.36	19.48
	Average	87.81^{B}	1.20	9.83^{AB}	1.32	49.76	19.51^{B}
Novogen	CS	88.14	1.14	10.06^{abc}	1.21	51.17	21.06
Novobrown	ECS	87.82	1.05	10.08^{abc}	0.62	49.68	19.82
	Average	87.98^{B}	1.10	10.07^{AB}	0.91	50.43	20.44^{AB}
TETRA	CS	87.86	0.82	10.42^{abc}	1.01	47.68	20.38
Brown	ECS	86.00	0.32	12.81^{ab}	0.77	47.99	19.89
	Average	86.93^{B}	0.57	11.61^{A}	0.89	47.83	20.14^{AB}
All	CS	88.48	0.83	9.96	0.85	49.23	20.45
Strains	ECS	88.09	0.74	10.44	0.72	49.39	20.02
	Average	88.29	0.78	10.20	0.79	49.31	20.24

40th NCLP&MT

[1]Colony Housing System=CS; Enriched Colony Housing System=ECS

All strains were equally represented in each production system, and C, CS and ECS hens were housed at (80 in^2/hen; 516 cm^2/hen)

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

a, b, c - Different letters in the same column denote significant differences (P<0.01), comparisons made among strains using average of CS and ECS values.

Table 24. Effect of White-egg Strains on Body Weight of Hens (17-89 wks) in a Colony Housing System and an Enriched Colony Housing System

Breeder (Strain)	Housing System[1]	17-Wk Body Wt (kg)	89-Wk Body Wt (kg)	Single Cycle Wt Gain (%)
Bovans	CS	1.16	1.74^{abcdef}	33.2^{abc}
White	ECS	1.15	1.79^{abc}	35.4^{a}
	Average	1.16^{ABC}	1.76^{ABC}	34.3^{AB}
Shaver	CS	1.10	1.73^{abcdef}	36.3^{a}
White	ECS	1.11	1.66^{cdef}	33.1^{abc}
	Average	1.11^{C}	1.69^{BCD}	34.7^{AB}
Dekalb	CS	1.17	1.76^{abcde}	33.3^{abc}
White	ECS	1.14	1.63^{ef}	30.1^{abc}
	Average	1.16^{ABC}	1.69^{BCD}	31.7^{AB}
Babcock	CS	1.22	1.82^{a}	32.7^{abc}
White	ECS	1.15	1.77^{abcd}	35.2^{a}
	Average	1.19^{AB}	1.80^{A}	33.9^{AB}
ISA	CS	1.13	1.70^{abcdef}	34.0^{abc}
B-400	ECS	1.00	1.64^{def}	33.1^{abc}
	Average	1.11^{C}	1.67^{D}	33.6^{AB}
Hy-Line	CS	1.16	1.80^{ab}	35.4^{a}
W-80	ECS	1.14	1.75^{abcde}	34.6^{abc}
	Average	1.15^{ABC}	1.77^{AB}	35.0^{A}
Hy-Line	CS	1.13	1.67^{bcdef}	32.6^{abc}
W-36	ECS	1.11	1.68^{bcdef}	33.8^{abc}
	Average	1.12^{BC}	1.68^{CD}	33.2^{AB}
Lohmann	CS	1.19	1.80^{ab}	33.6^{ab}
LSL Lite	ECS	1.22	1.73^{abcdef}	29.5^{abc}
	Average	1.21^{A}	1.76^{ABC}	31.6^{AB}
H&N	CS	1.17	1.75^{abcde}	32.8^{abc}
Nick Chick	ECS	1.22	1.67^{bcdef}	27.0^{bc}
	Average	1.20^{A}	1.71^{ABCD}	29.9^{B}
Novogen	CS	1.15	1.73^{abcdef}	33.3^{abc}
Novowhite	ECS	1.16	1.61^{f}	27.7^{c}
	Average	1.16^{ABC}	1.67^{D}	30.5^{B}
All	CS	1.16	1.75^{Y}	33.7^{Y}
Strains	ECS	1.15	1.69^{Z}	32.0^{Z}
	Average	1.16	1.72	32.8

40th NCLP&MT

[1]Colony Housing System=CS; Enriched Colony Housing System=ECS (69 in^2/hen; 445 cm^2/hen)

A, B, C - Different letters in the same column denote significant differences (P<0.01), comparisons made among strains using average of CS and ECS values.

a, b, c, d, e, f - Different letters in the same column denote significant differences (P<0.01), comparisons made among strains using average of CS and ECS values

Y, Z - Different letters in the same column denote significant differences (P<0.01), comparisons made among each strain-housing combination

Table 25. Effect of Brown-egg Strains on Body Weight of Hens (17-89 wks) in a Colony Housing System and an Enriched Colony Housing System

Breeder	System[1]	17-Wk Body Wt	89-Wk Body Wt	Single Cycle Wt Gain
(Strain)		(kg)	(kg)	(%)
Bovans	CS	1.40	2.02	30.6
Brown	ECS	1.42	2.04	30.1
	Average	1.41^{BC}	2.03^{BC}	30.3^{AB}
ISA	CS	1.35	1.91	29.9
Brown	ECS	1.40	1.97	28.6
	Average	1.38^{C}	1.94^{C}	29.3^{AB}
Hy-Line	CS	1.40	2.01	30.6
Brown	ECS	1.47	2.07	29.2
	Average	1.43^{ABC}	2.04^{BC}	29.9^{AB}
Hy-Line	CS	1.53	2.20	30.1
Silver Brown	ECS	1.48	2.16	31.4
	Average	1.51^{A}	2.18^{A}	30.7^{A}
Lohmann	CS	1.49	1.96	23.8
LB-Lite	ECS	1.43	1.93	25.8
	Average	1.46^{ABC}	1.95^{C}	24.9^{B}
Novogen	CS	1.50	2.00	25.8
Novobrown	ECS	1.45	1.98	26.8
	Average	1.47^{AB}	1.99^{BC}	26.0^{AB}
TETRA	CS	1.42	2.07	31.1
Brown	ECS	1.44	2.11	32.0
	Average	1.43^{ABC}	2.09^{AB}	31.6^{A}
All	CS	1.44	2.02	28.8
Strains	ECS	1.44	2.04	29.1
	Average	1.44	2.03	29.0

40th NCLP&MT

[1]Colony Housing System=CS; Enriched Colony Housing System=ECS (80 in^2/hen; 516 cm^2/hen)

A, B, C - Different letters in the same column denote significant differences (P<0.01), comparisons made among strains using average of CS and ECS values

Table 26. Effect of White-egg Strain on Performance of Hens (17-89 wks) in a Cage-free System

Breeder	Density[1]	Feed Consumption	Feed Conversion	Eggs per Bird Housed	Hen-Day Egg Production[2]	Egg Mass	Mortal-ity	Age at 50% Production
(Strain)	(in^2/hen)	(kg/100 hens/d)	(g egg/g feed)	(#)	(%)	(g/HD)[3]	(%)	(Days)
Dekalb White	177	10.52[c]	0.52	450.86	91.33[a]	54.49[ab]	3.33	132
Babcock White	177	10.23[abc]	0.53	447.55	89.89[a]	53.38[abc]	3.33	133
Hy-Line W-80	177	9.92[bcd]	0.49	409.52	81.72[ab]	48.14[bcd]	2.50	139
Hy-Line W-36	177	9.74[cd]	0.46	372.95	75.21[b]	45.28[c]	2.50	141
Hy-Line White Exp.	177	9.61[d]	0.48	376.56	76.08[b]	45.59[cd]	3.33	140
Lohmann LSL Lite	177	10.34[ab]	0.51	416.01	84.08[ab]	52.51[abcd]	4.16	139
H&N Nick Chick	177	10.48[a]	0.54	438.74	88.83[ab]	56.32[a]	3.34	141
Novogen Novowhite	177	10.37[ab]	0.51	428.19	85.12[ab]	52.45[abcd]	0.84	138
All Strains	177	10.15	0.50	417.54	84.02	51.04	2.92	138

40th NCLP&MT

[1](177 in^2/hen; 1142 cm^2/hen)

[2]The average daily number of eggs produced per 100 hens (%)

[3]HD = hen day

a,b,c,d - Different letters in the same column denote significant differences (P<0.01) for comparisons made among strains.

Table 27. Effect of White-egg Strain on Egg Weight and Size Distribution of Eggs Produced by Hens (17-89 wks) in a Cage-free System.

Breeder	Density[1]	Egg Weight	Pee Wee	Small	Medium	Large	Extra Large
(Strain)	(in^2/hen)	(g/egg)	(%)	(%)	(%)	(%)	(%)
Dekalb White	177	59.25[ab]	0.00	2.59	4.65	35.49[abc]	57.26[ab]
Babcock White	177	59.34[ab]	0.00	2.41	5.13	38.23[ab]	54.09[ab]
Hy-Line W-80	177	58.69[b]	0.00	2.59	6.01	41.65[a]	49.73[b]
Hy-Line W-36	177	59.92[ab]	0.00	2.10	5.00	34.81[abc]	57.44[ab]
Hy-Line White Exp.	177	59.61[ab]	0.00	3.16	4.34	37.73[ab]	54.45[ab]
Lohmann LSL Lite	177	61.95[ab]	0.00	1.95	4.17	22.74[bc]	70.73[ab]
H&N Nick Chick	177	63.02[a]	0.00	2.04	3.15	18.93[c]	75.87[a]
Novogen Novowhite	177	61.00[ab]	0.00	2.69	3.34	29.67[abc]	64.29[ab]
All Strains	177	60.34	0.00	2.44	4.47	32.41	60.28

40th NCLP&MT
(177 in^2/hen; 1142 cm^2/hen)
a,b,c,d,- Different letters denote significant differences (P<0.01), comparisons made among strains

Table 28. Effect of White-Egg Strain on Egg Quality, Income and Feed Costs of Hens (17-89 wks) in Cage Free

Breeder	Density[1]	Grade A	Grade B	Cracks	Loss	Egg Income	Feed Costs
(Strain)	(in^2/hen)	(%)	(%)	(%)	(%)	($/hen)	($/hen)
Dekalb White	177	96.86	0.18	2.59	0.37	50.83	18.88
Babcock White	177	95.52	0.49	3.89	0.09	49.06	18.36
Hy-Line W-80	177	94.44	0.74	4.81	0.00	44.48	17.83
Hy-Line W-36	177	94.87	0.56	4.29	0.28	42.97	17.54
Hy-Line White Exp.	177	96.65	0.38	2.88	0.09	42.88	17.27
Lohmann LSL Lite	177	95.93	0.46	3.41	0.19	49.17	18.60
H&N Nick Chick	177	94.63	0.92	4.35	0.09	52.64	18.82
Novogen Novowhite	177	95.88	0.66	3.26	0.18	49.60	18.67
All Strains	177	95.60	0.55	3.69	0.16	47.74	18.25

40th NCLP&MT

[1](177 in^2/hen; 1142 cm^2/hen)

Table 29. Effect of Brown-egg Strain on Performance of Hens (17–89 wks) in a Cage-free System

Breeder	Density[1]	Feed Consumption	Feed Conversion	Eggs Per Bird Housed	Hen-Day Egg Production[2]	Egg Mass	Mortality	Age at 50% Production
(Strain)	(in^2/hen)	(kg/100 hens/d)	(g egg/g feed)	(#)	(%)	(g/HD)[3]	(%)	(Days)
Bovans Brown	177	10.83^{ab}	0.47^{ab}	388.68	82.70	51.54	14.16	140
ISA Brown	177	10.97^{a}	0.46^{ab}	362.28	81.09	50.18	30.83	137
Hy-Line Brown	177	10.43^{bc}	0.47^{ab}	334.66	78.73	47.78	5.00	140
Hy-Line Silver Brown	177	11.19^{a}	0.44^{ab}	392.15	82.55	49.02	18.34	137
Lohmann LB-Lite	177	10.15^{c}	0.50^{a}	320.39	79.09	49.52	26.66	139
Novogen Novobrown	177	10.88^{ab}	0.47^{ab}	367.45	81.63	50.64	26.66	139
TETRA Brown	177	10.70^{ab}	0.42^{b}	344.38	72.52	44.79	13.33	138
All Strains	177	10.66	0.46	351.67	79.62	49.00	19.28	139

40th NCLP&MT

[1](177 in^2/hen; 1142 cm^2/hen)

[2]The average daily number of eggs produced per 100 hens (%)

[3]HD = hen day

a,b, c - Different letters in the same column denote significant differences (P<0.01), comparisons made among strain average values.

Table 30. Effect of Brown-egg Strain on Egg Weight and Size Distribution of Eggs Produced by Hens (17–89 wks) in a Cage-free System

Breeder	Density[1]	Egg Weight	Pee Wee	Small	Medium	Large	Extra Large
(Strain)	(in^2/hen)	(g/egg)	(%)	(%)	(%)	(%)	(%)
Bovans Brown	177	61.80[ab]	0.00	1.09	4.88	24.05[b]	69.96[a]
ISA Brown	177	61.46[ab]	0.00	2.04	4.64	26.00[b]	67.31[ab]
Hy-Line Brown	177	60.23[ab]	0.00	1.29	5.43	31.92[ab]	61.34[ab]
Hy-Line Silver Brown	177	59.00[b]	0.00	1.95	4.90	43.08[a]	50.06[b]
Lohmann LB-Lite	177	62.07[a]	0.00	1.99	4.97	21.16[b]	71.88[a]
Novogen Novobrown	177	61.47[ab]	0.00	2.06	3.50	26.79[b]	67.65[ab]
TETRA Brown	177	61.41[ab]	0.00	1.10	4.57	27.69[b]	66.63[ab]
All Strains	177	61.07	0.00	1.60	4.78	28.30	65.25

40th NCLP&MT

[1](177 in^2/hen; 1142 cm^2/hen)

a,b - Different letters in the same column denote significant differences (P<0.01), comparisons made among strains.

Table 31. Effect of Brown-egg Strain on Egg Quality, Income and Feed Costs of Hens (17–89 wks) in a Cage-free System.

Breeder	Density[1]	Grade A	Grade B	Cracks	Loss	Egg Income	Feed Costs
(Strain)	(in^2/hen)	(%)	(%)	(%)	(%)	($/hen)	($/hen)
Bovans Brown	177	97.40	0.55	1.85	0.20	47.07	19.47
ISA Brown	177	96.87	1.30	1.64	1.19	47.07	19.72
Hy-Line Brown	177	96.08	1.36	2.46	0.10	45.52	18.74
Hy-Line Silver Brown	177	97.87	0.92	1.20	0.00	45.17	20.13
Lohmann LB-Lite	177	97.24	0.81	1.78	0.17	48.38	18.37
Novogen Novobrown	177	97.73	0.46	1.39	0.42	46.45	19.53
TETRA Brown	177	96.69	0.26	2.54	0.32	40.75	19.25
All Strains	177	97.04	0.86	1.89	0.19	45.77	19.32

40th NCLP&MT

[1](177 in^2/hen; 1142 cm^2/hen)

Table 32. Effect of White-egg Strain on Body Weight of Hens (17-89 wks) in a Cage-free System

Breeder	Density[1]	17-Wk Body Wt	89-Wk Body Wt	Single Cycle Wt Gain
(Strain)	(in^2/hen)	(kg)	(kg)	(%)
Dekalb White	177	1.10	1.79	35.3
Babcock White	177	1.16	1.90	37.1
Hy-Line W-80	177	1.13	1.82	34.3
Hy-Line W-36	177	1.18	1.82	36.3
Hy-Line White Exp.	177	1.13	1.78	36.6
Lohmann LSL Lite	177	1.16	1.81	31.9
H&N Nick Chick	177	1.12	1.83	33.6
Novogen Novowhite	177	1.16	1.80	33.3
All Strains	177	1.15	1.82	34.8

40th NCLP&MT

[1](177 in^2/hen; 1142 cm^2/hen)

Table 33. Effect of Brown-egg Strain on Body Weight of Hens (17-89 wks) in a Cage-free System.

Breeder	Density[1]	17-Wk Body Wt	89-Wk Body Wt	Single Cycle Wt Gain
(Strain)	(in^2/hen)	(kg)	(kg)	(%)
Bovans Brown	177	1.40	2.01^{ab}	33.8
ISA Brown	177	1.30	1.88^{b}	28.9
Hy-Line Brown	177	1.40	2.07^{ab}	33.4
Hy-Line Silver Brown	177	1.46	2.29^{a}	36.4
Lohmann LB-Lite	177	1.40	1.96^{ab}	30.5
Novogen Novobrown	177	1.39	2.12^{ab}	35.4
TETRA Brown	177	1.40	2.18^{ab}	36.0
All Strains	177	1.39	2.07	33.5

40th NCLP&MT

[1](177 in^2/hen; 1142 cm^2/hen)

a,b - Different letters denote significant differences (P<0.01), comparisons made among strains

Table 34. Effect of Egg Strain on Performance of Hens (17–89 wks) in a Free-range System.

Breeder	Density[3]	Feed Consumption	Feed Conversion	Eggs Per Bird Housed	Hen-Day Egg Production[4]	Egg Mass	Mortality	Age at 50% Production
(Strain)	(in^2/hen)	(kg/100 hens/d)	(g egg/g feed)	(#)	(%)	(g/HD)[5]	(%)	(Days)
Hy-Line White Exp.[1]	177	10.68	0.45	354	77.46	48.75	11.67	151
Hy-Line Brown[2]	177	11.27[a]	0.46	377	80.38	51.94	3.28	152
Hy-Line Silver Brown[2]	177	11.51[a]	0.44	390	82.47	51.21	5.83	148
Lohmann LB-Lite[2]	177	10.68[b]	0.51	394	82.94	54.58	7.50	148
All Brown-Egg Strains[2]	177	11.09	0.47	387	81.84	52.79	5.53	150

40th NCLP&MT
[1]White-EggStrain
[2]Brown-Egg Strain
[3](177 in^2/hen; 1142 cm^2/hen)
[4]The average daily number of eggs produced per 100 hens
[5]HD = hen day
a.b - Different letters in the same column denote significant differences (P<0.01), comparisons made among strain average values.

Table 35. Effect of Egg Strain on Egg Weight and Egg Size Distribution of Hens (17–89 wks) in a Free-range System.

Breeder	Density[3]	Egg Weight	Pee Wee	Small	Medium	Large	Extra Large
(Strain)	(in^2/hen)	(g/egg)	(%)	(%)	(%)	(%)	(%)
Hy-Line White Exp.[1]	177	61.99	0.00	2.6	3.51	24.36	69.46
Hy-Line Brown[2]	177	63.55	0.00	1.40	4.67	15.18[b]	78.74
Hy-Line Silver Brown[2]	177	61.45	0.00	0.76	4.72	27.04[a]	67.47
Lohmann LB-Lite[2]	177	64.52	0.00	2.58	4.38	12.55[b]	80.49
All Brown-Egg Strains[2]	177	63.45	0.00	1.71	4.57	16.85	76.86

40th NCLP&MT

[1]White-EggStrain

[2]Brown-Egg Strain

[3](177 in^2/hen; 1142 cm^2/hen)

a,b - Different letters in the same column denote significant differences (P<0.01), comparisons made among strains.

Table 36. Effect of Egg Strain on Egg Quality, Income and Feed Costs of Hens (17–89 wks) in a Free-range System

Breeder (Strain)	Density[3] (in²/hen)	Grade A (%)	Grade B (%)	Cracks (%)	Loss (%)	Egg Income ($/hen)	Feed Costs ($/hen)
Hy-Line White Exp.[1]	177	95.16	0.83	3.64	0.37	46.40	19.21
Hy-Line Brown[2]	177	97.75	0.43	1.55	0.27	47.67	20.63
Hy-Line Silver Brown[2]	177	97.89	0.65	1.37	0.09	49.55	20.80
Lohmann LB-Lite[2]	177	97.70	0.54	1.43	0.32	50.17	19.52
All Brown-Egg Strains[2]	177	97.28	0.57	1.86	0.27	49.13	20.32

40th NCLP&MT
[1]White-EggStrain
[2]Brown-Egg Strain
[3](177 in^2/hen; 1142 cm^2/hen)

Table 37. Effect of Egg Strain on Body Weight of Hens (17-89 wks) in a Free-range System

Breeder (Strain)	Density[3] (in²/hen)	17-Wk Body Wt (kg)	89-Wk Body Wt (kg)	Single Cycle Wt Gain (%)
Hy-Line White Exp.[1]	177	1.10	1.78	37.9
Hy-Line Brown[2]	177	1.40	2.22	36.7
Hy-Line Silver Brown[2]	177	1.46	2.27	35.7
Lohmann LB-Lite[2]	177	1.40	2.03	31.1
All Brown-Egg Strains[2]	177	1.39	2.17	34.7

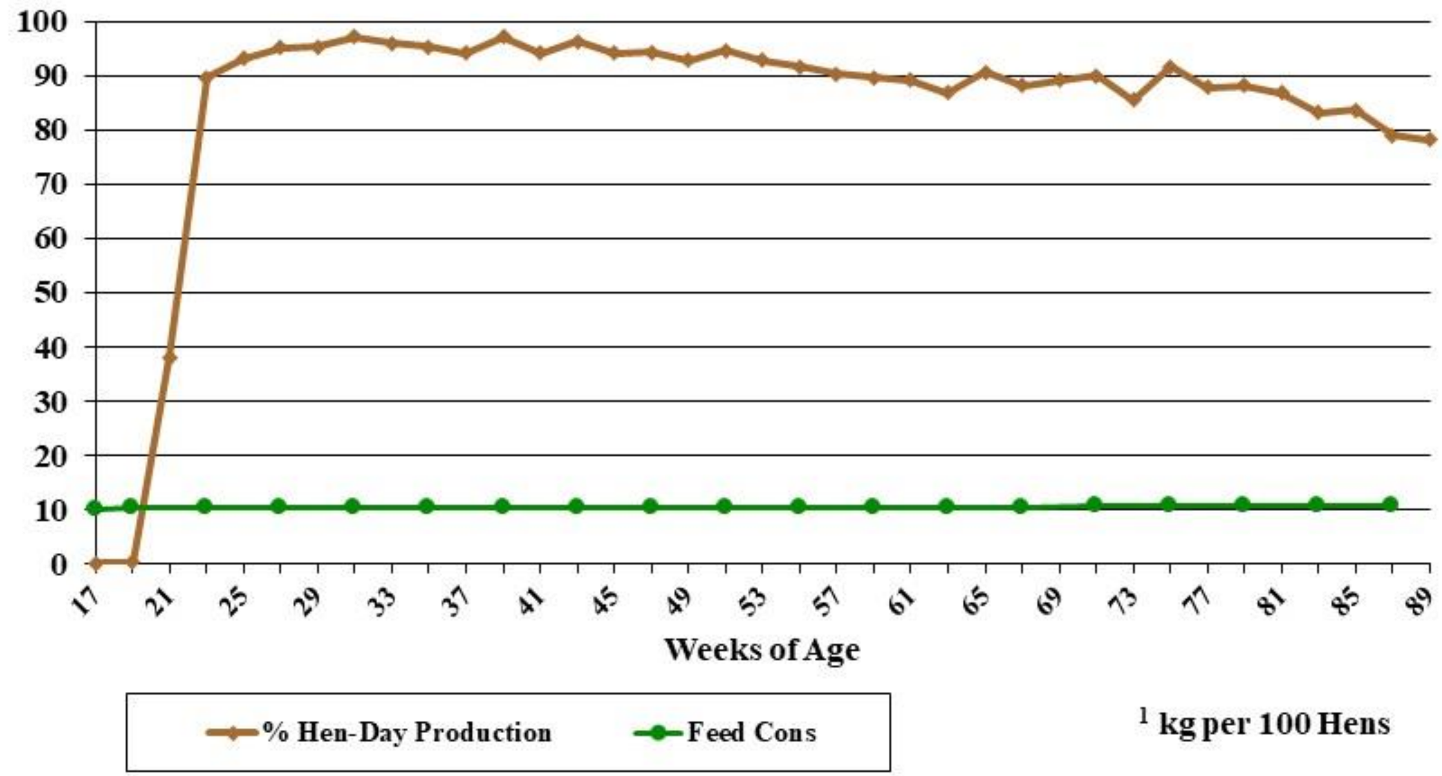
40th NCLP&MT
[1]White-EggStrain
[2]Brown-Egg Strain
[3](177 in^2/hen; 1142 cm^2/hen)

Table 38. Cause of mortality by house/environment as determined by postmortem examination

House	Prolapse	Neoplasia	Septicemic	Salpingites	Internal layer	Dehydatation	Trauma	Undetermined	Osteoporosis	Total
House 5 (Colony Cages)	83	17	53	9	14	14	57	82	1	330
House 7 (Conventional Cages)	42	7	8	1	2	2	12	17	3	94
House 4 (Cage-Free)	9	3	17	0	5	0	3	8	0	45
Free-Range	1	1	2	1	0	0	1	6	0	12

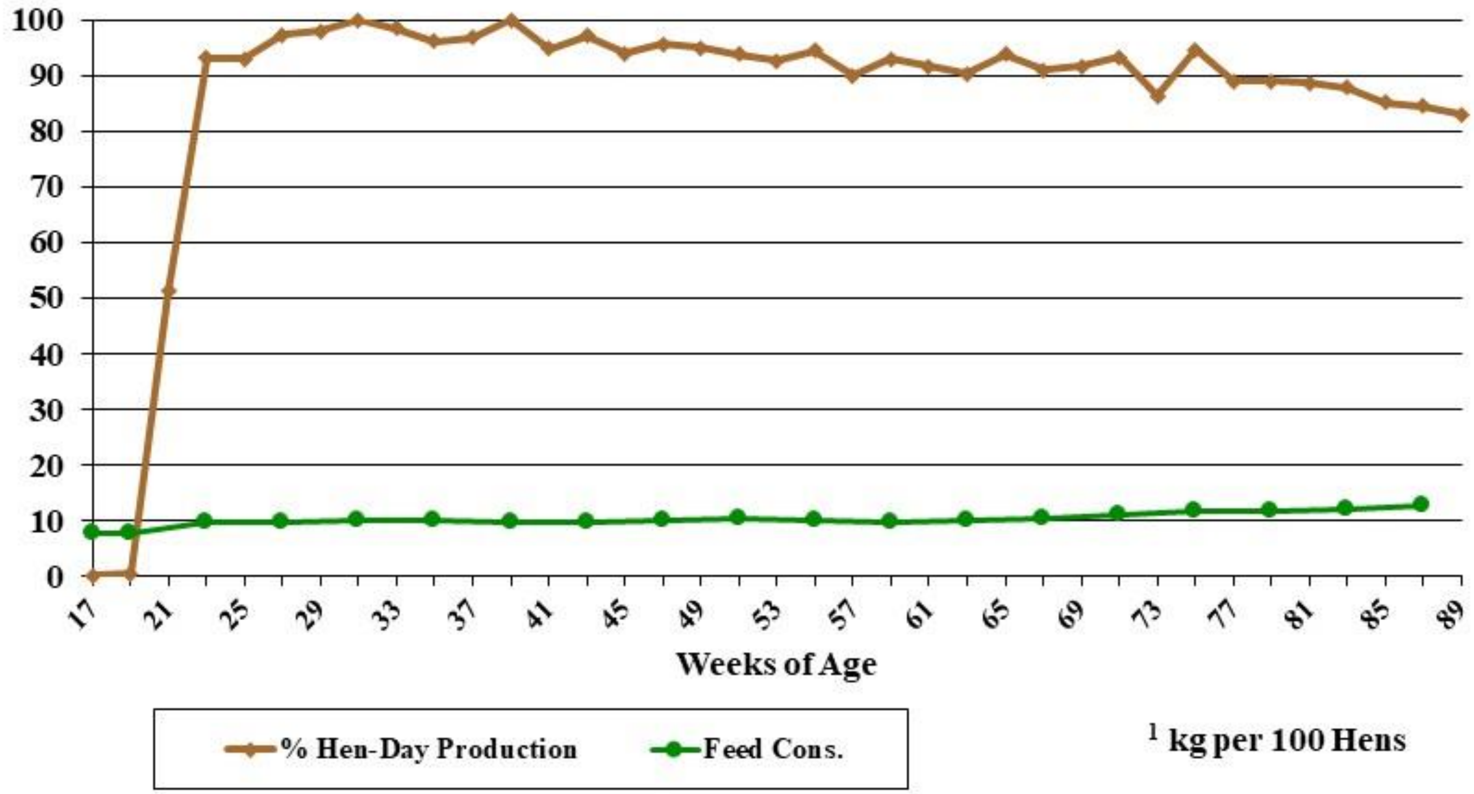
Production Figures for Laying Hens in Conventional Cages: White-egg Strains 69 in^2 (445 cm^2) Brown-egg Strains 80 in^2 (516 cm^2)

Figure 1. Bovans White, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in Conventional Cages (69 in^2). 40th NCLP & MT.



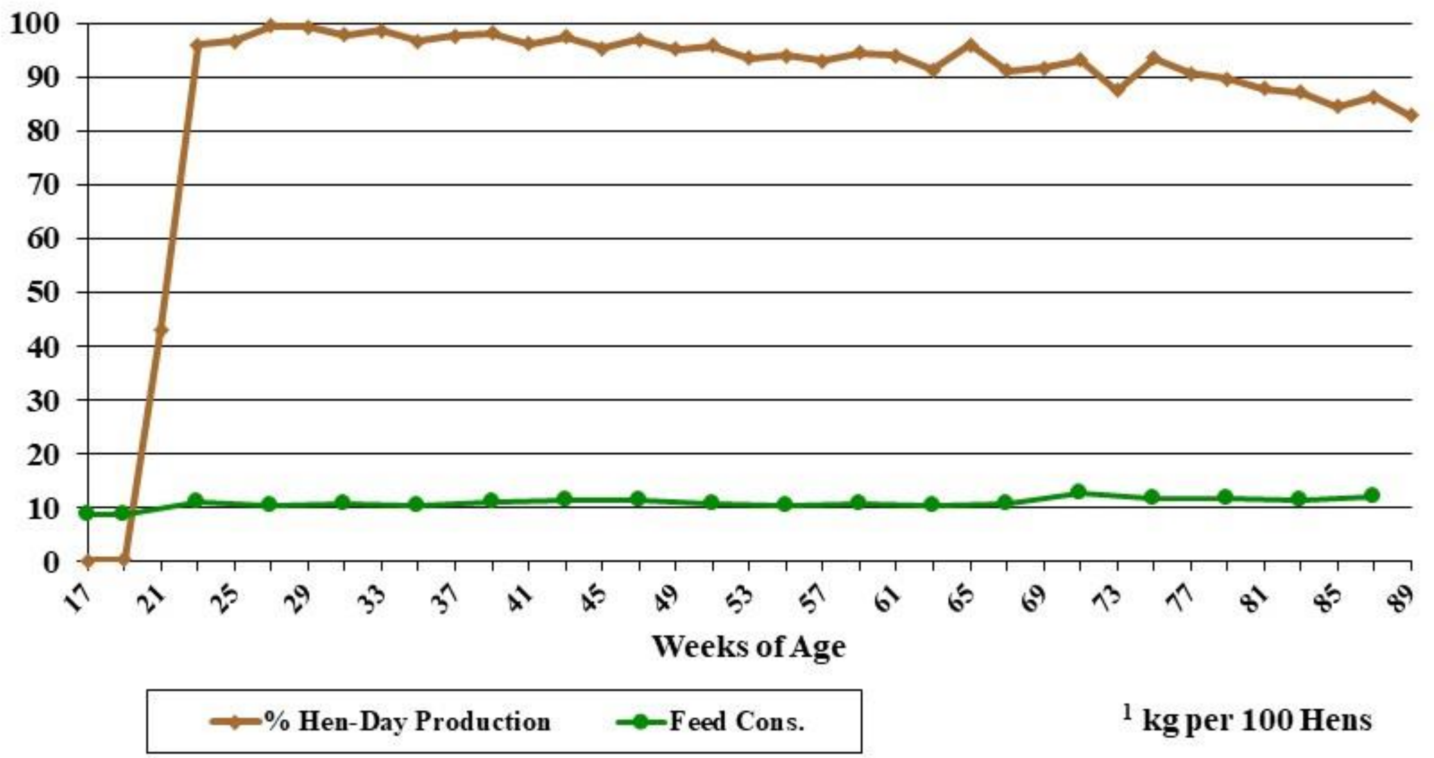
[1] kg per 100 Hens

Figure 2. Shaver, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in Conventional Cages (69 in^2). 40th NCLP & MT.



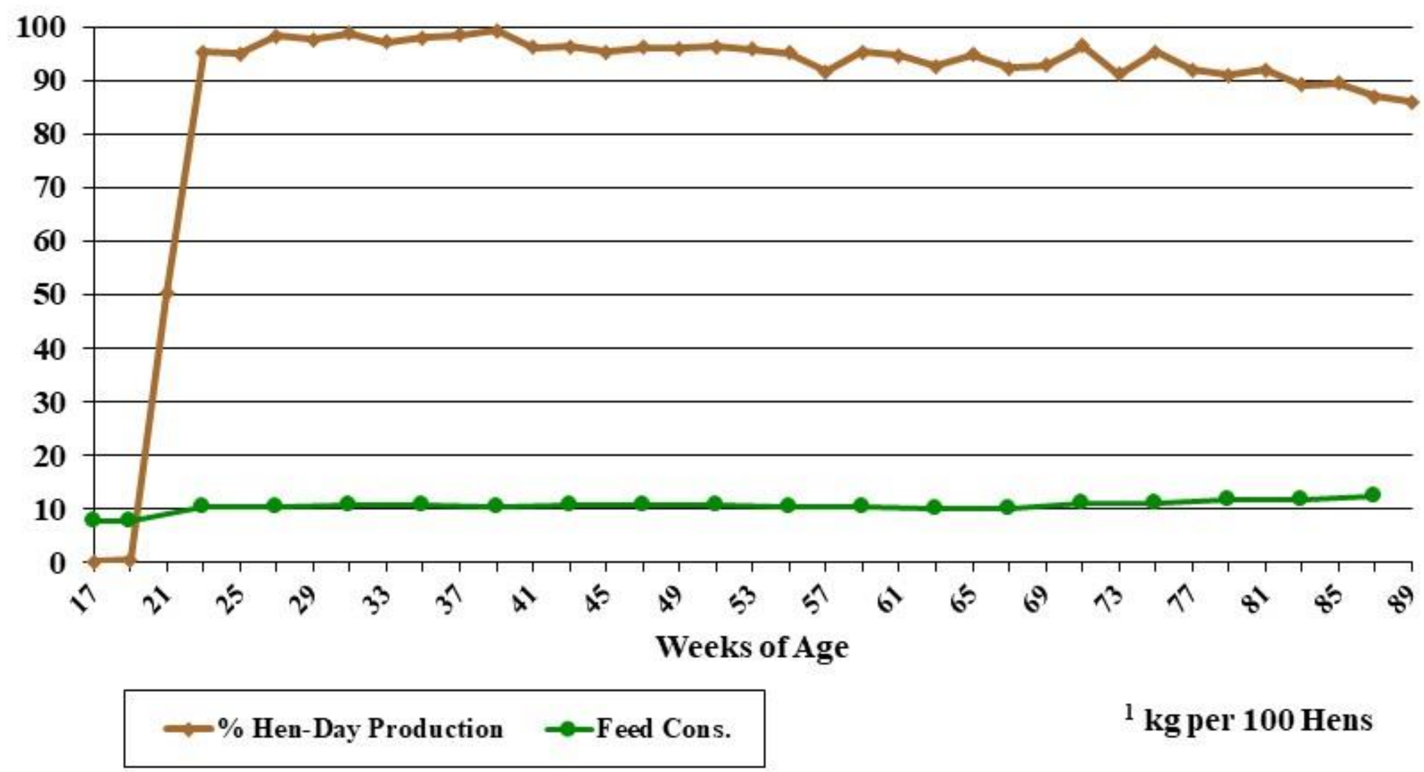
[1] kg per 100 Hens

Figure 3. Dekalb, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in Conventional Cages (69 in^2). 40th NCLP & MT.



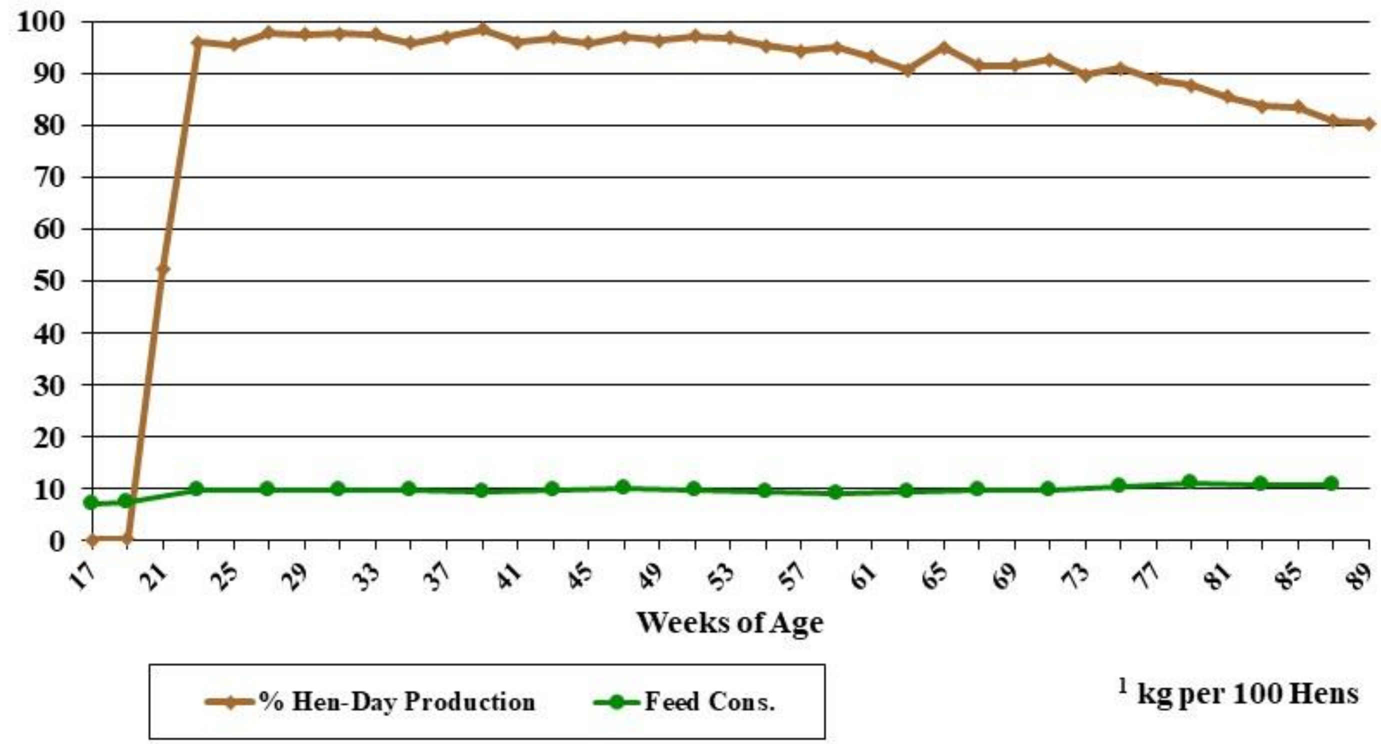
[1] kg per 100 Hens

Figure 4. Babcock, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in Conventional Cages (69 in²). 40th NCLP & MT.



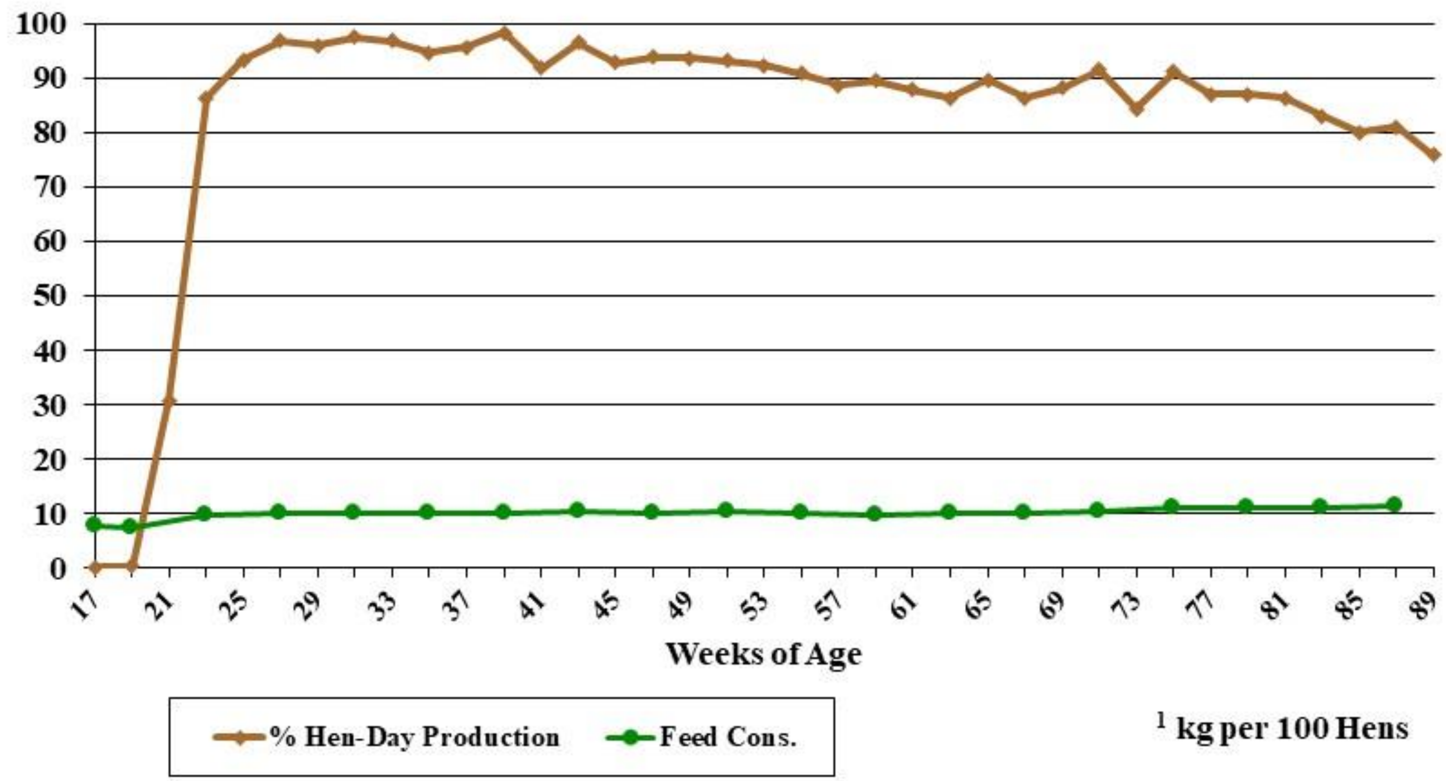
[1] kg per 100 Hens

Figure 5. B-400, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Strains Hens in Conventional Cages (69 in^2). 40th NCLP & MT.



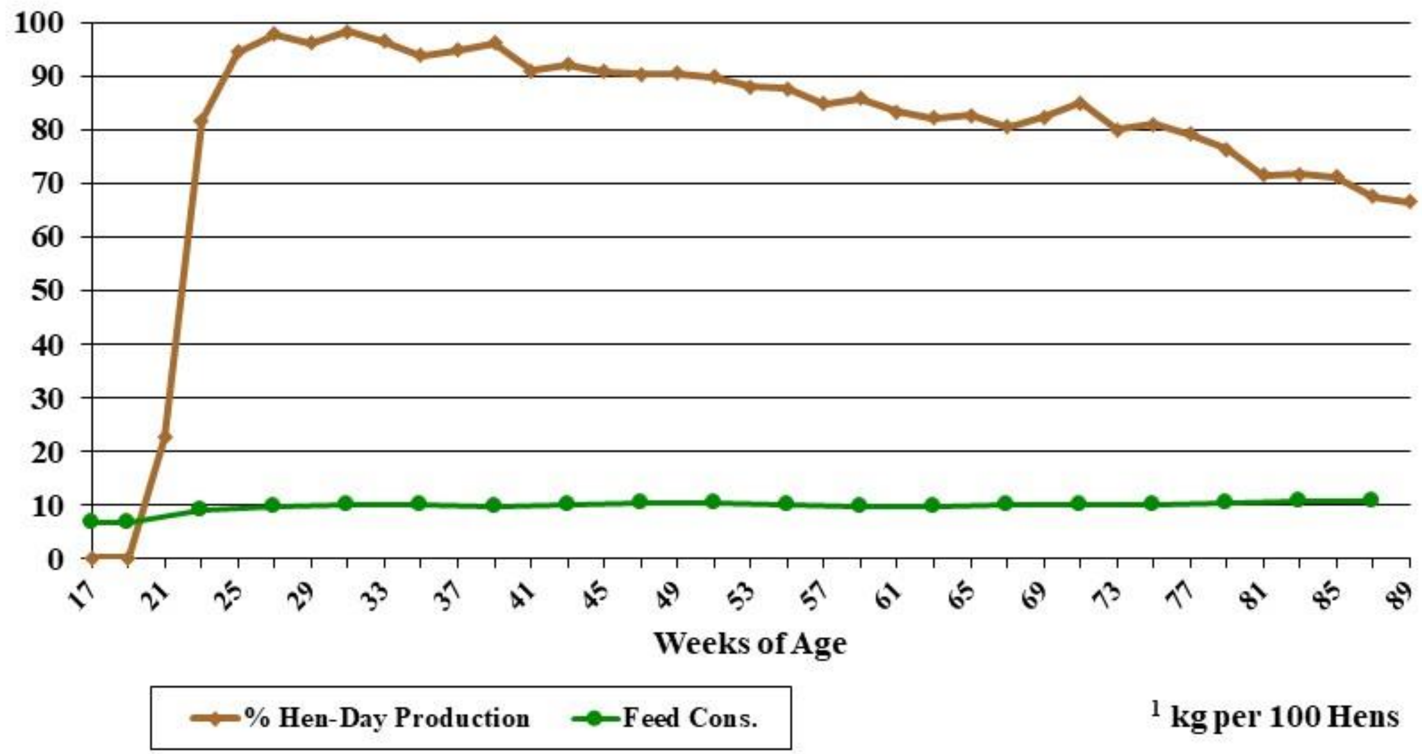
[1] kg per 100 Hens

Figure 6. Hy-Line W-80, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in Conventional Cages (69 in^2). 40th NCLP & MT.



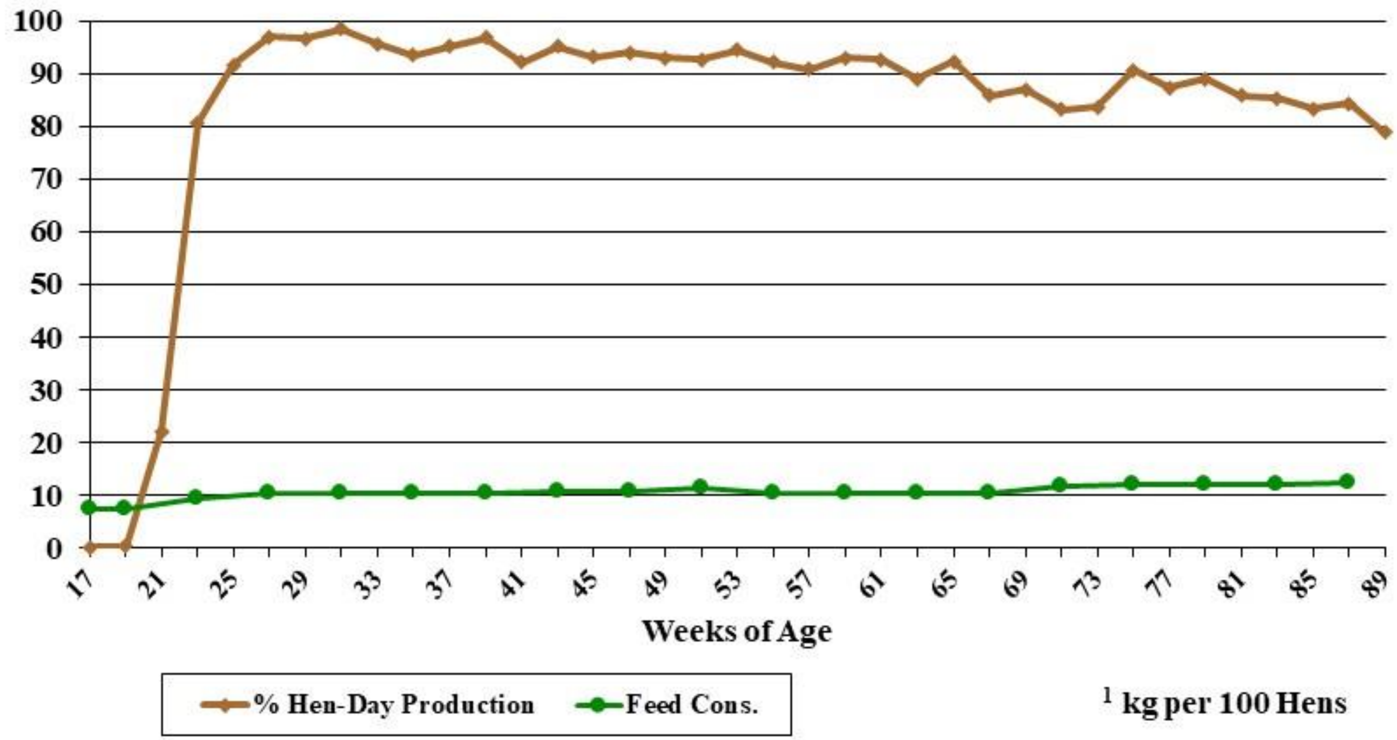
[1] kg per 100 Hens

Figure 7. Hy-Line W-36, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in Conventional Cages (69 in²). 40th NCLP & MT.



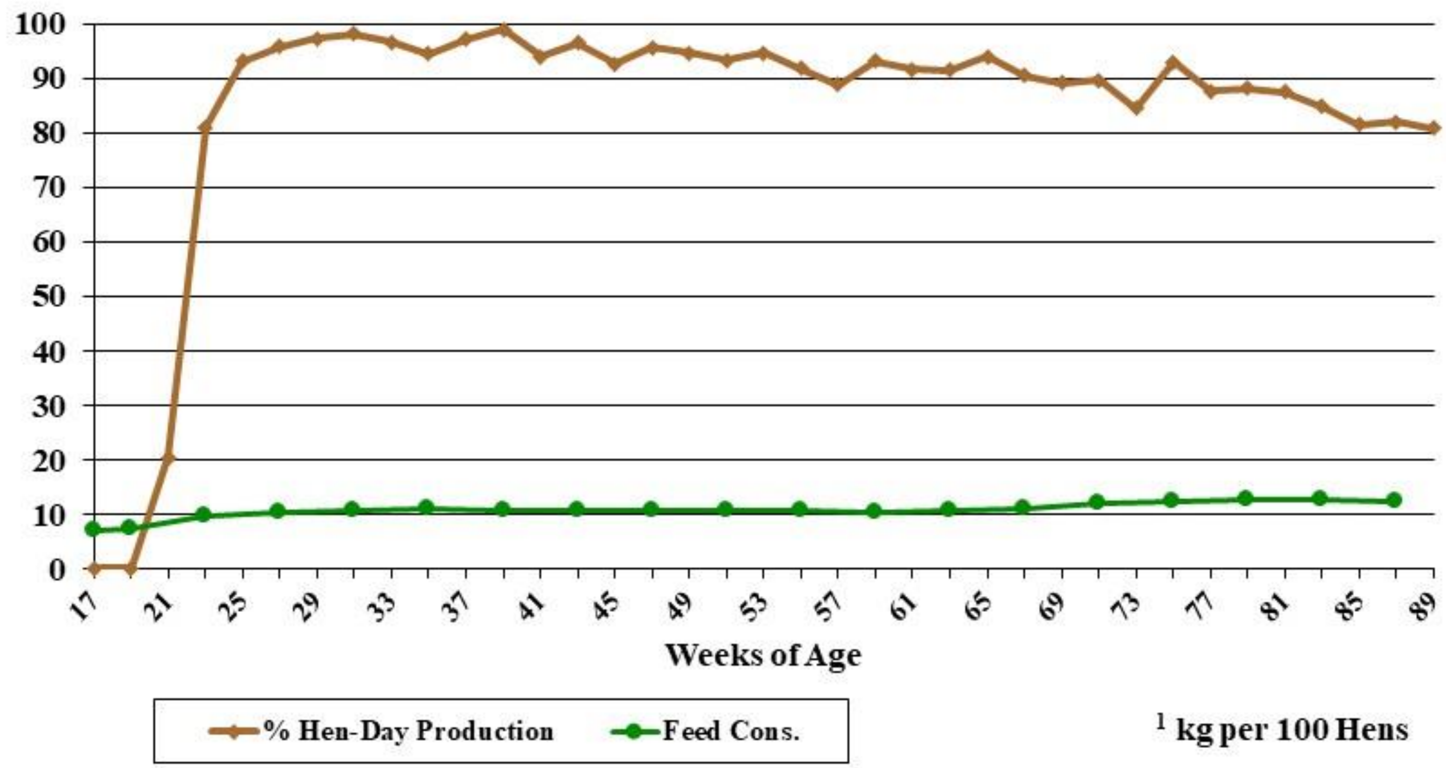
[1] kg per 100 Hens

Figure 8. Lohmann, LSL-Lite, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in Conventional Cages (69 in^2). 40^{th} NCLP & MT.



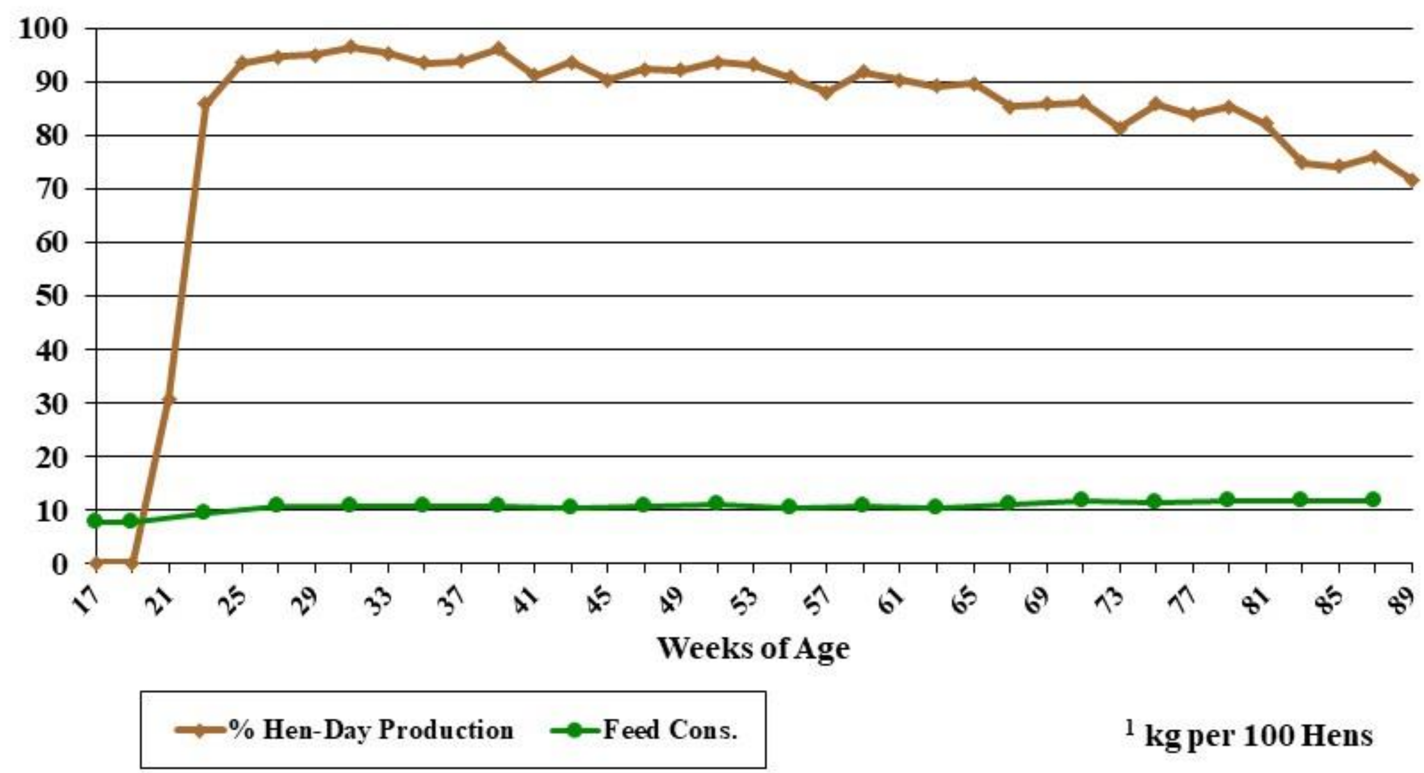
[1] kg per 100 Hens

Figure 9. H&N "Nick Chick", Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in Conventional Cages (69 in^2). 40th NCLP & MT.



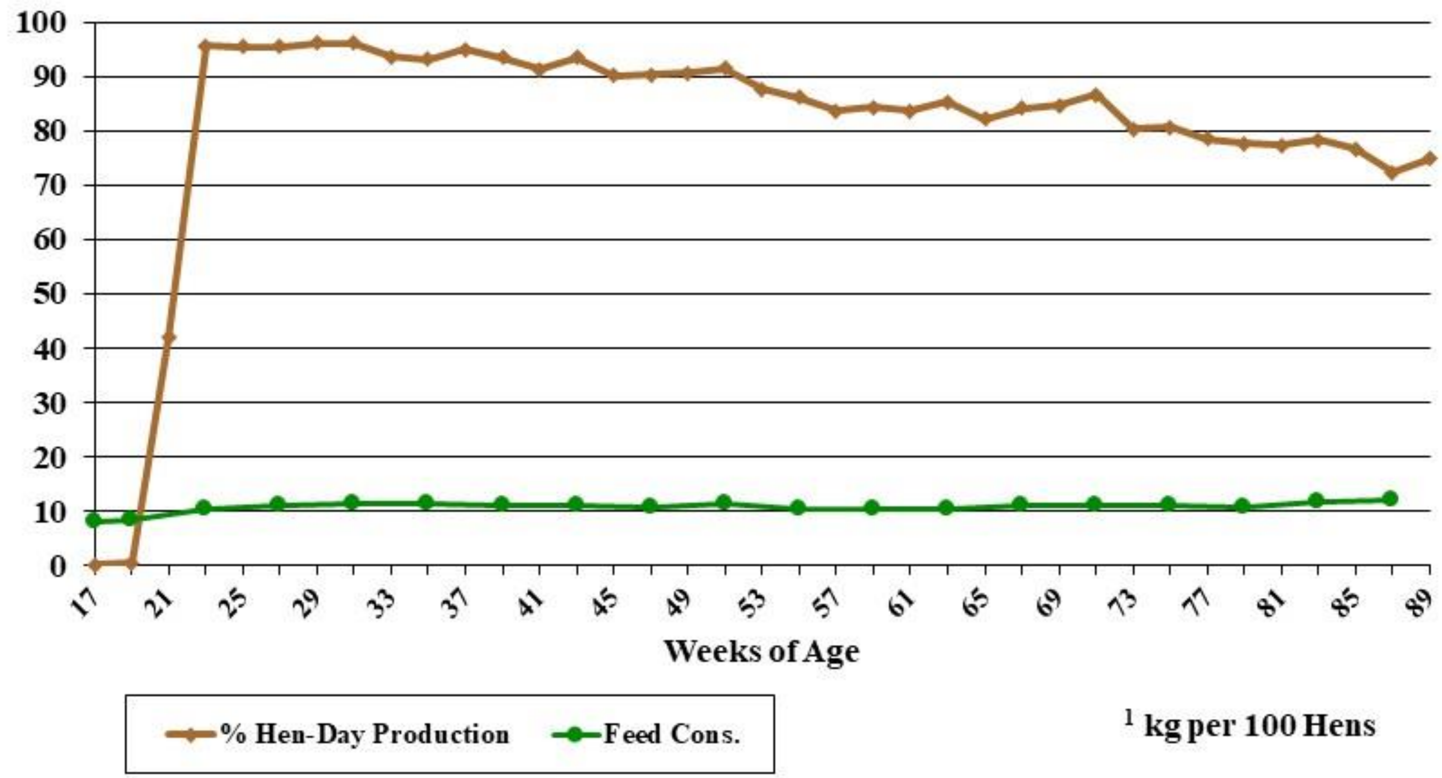
[1] kg per 100 Hens

Figure 10. Novogen Novowhite, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in Conventional Cages (69 in^2). 40th NCLP & MT.



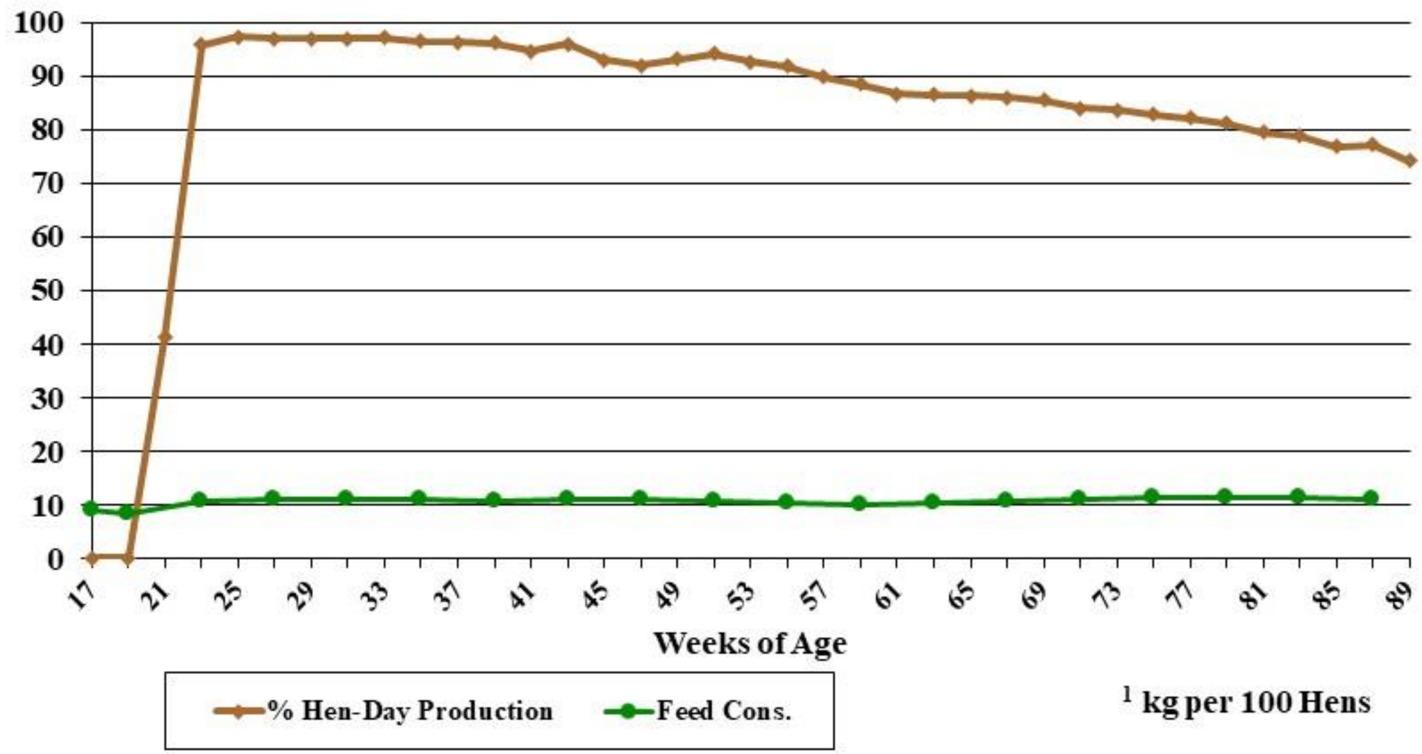
[1] kg per 100 Hens

Figure 11. Bovans Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in Conventional Cages (80 in^2). 40th NCLP & MT.



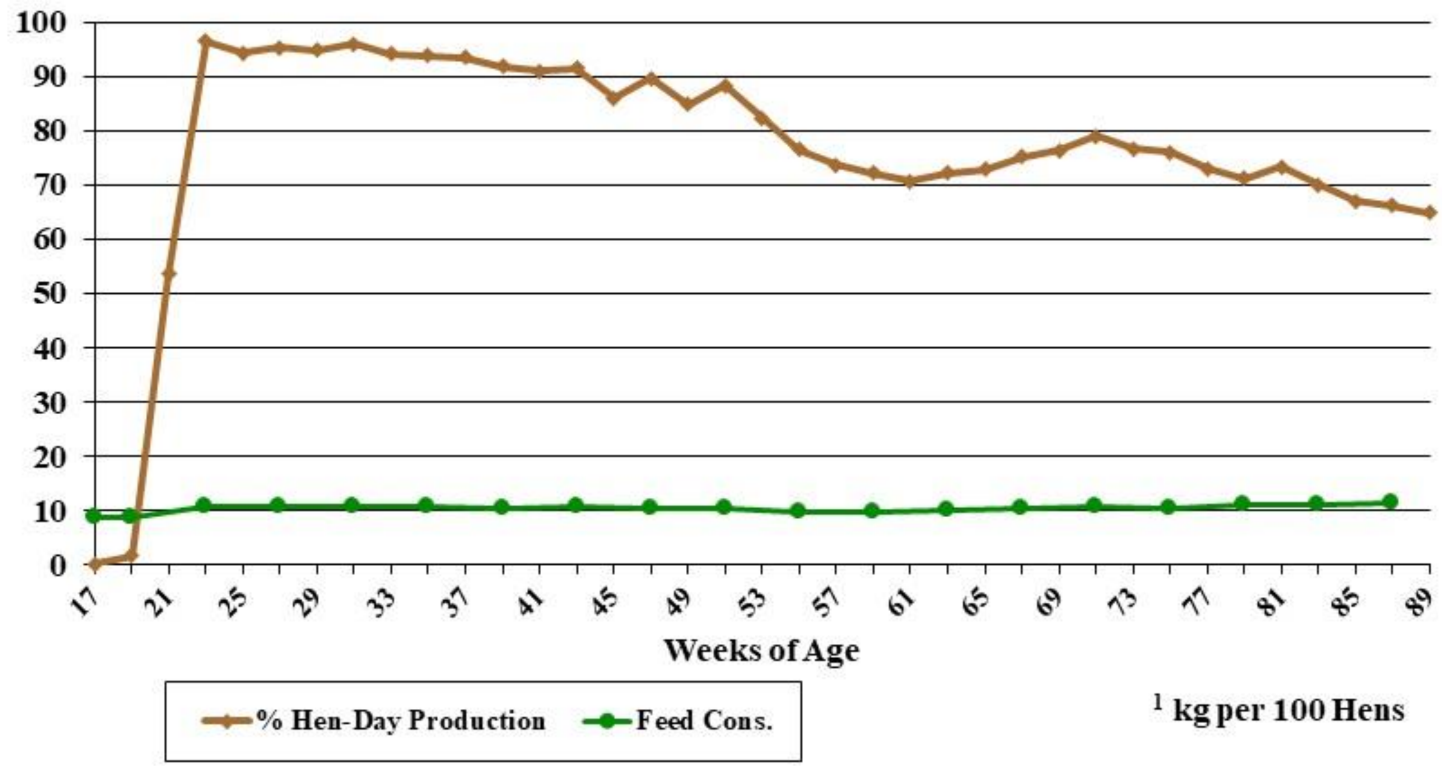
[1] kg per 100 Hens

Figure 12. ISA Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in Conventional Cages (80 in^2). 40th NCLP & MT.



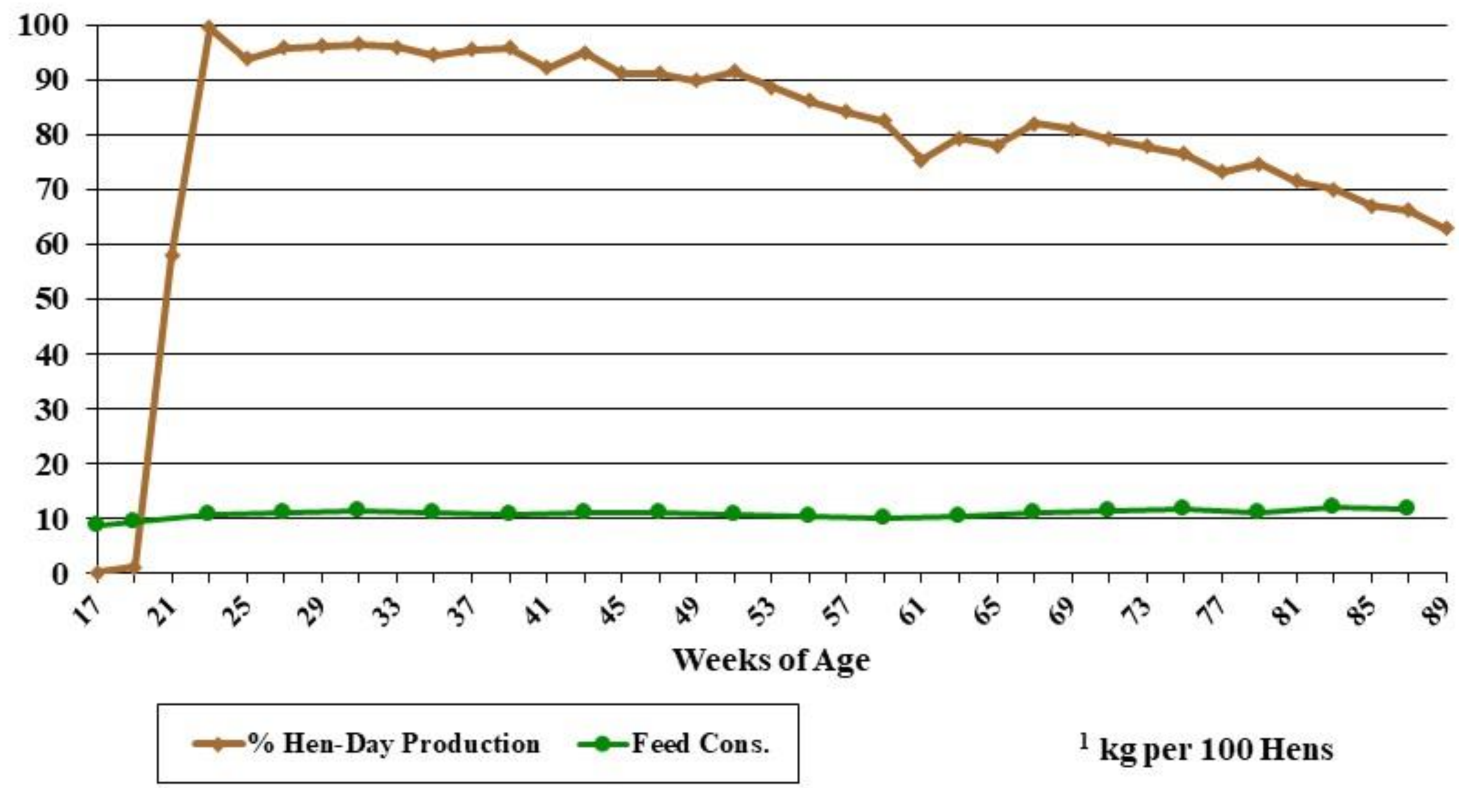
[1] kg per 100 Hens

Figure 13. Hy-Line Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in Conventional Cages (80 in^2). 40th NCLP & MT.



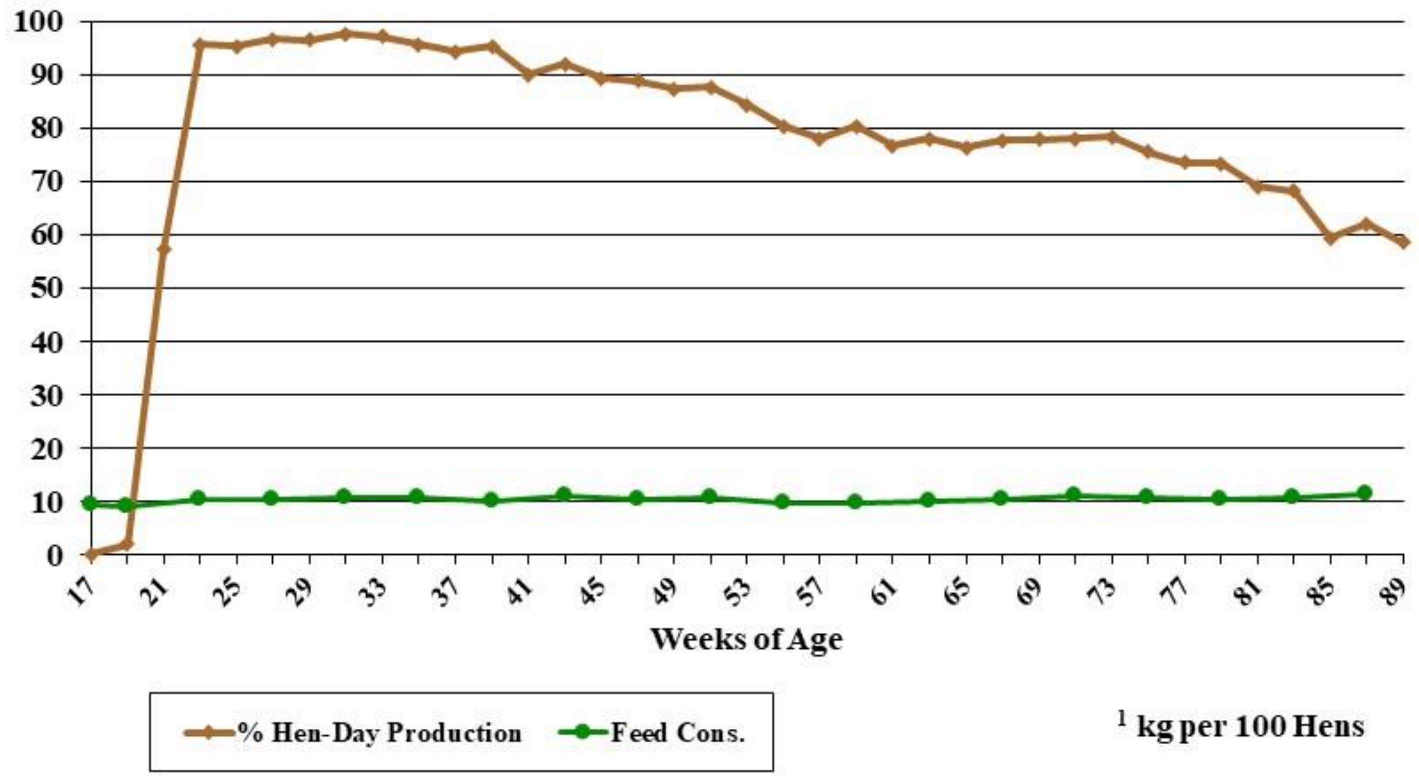
[1] kg per 100 Hens

Figure 14. Hy-Line Silver Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in Conventional Cages (80 in^2). 40th NCLP & MT.



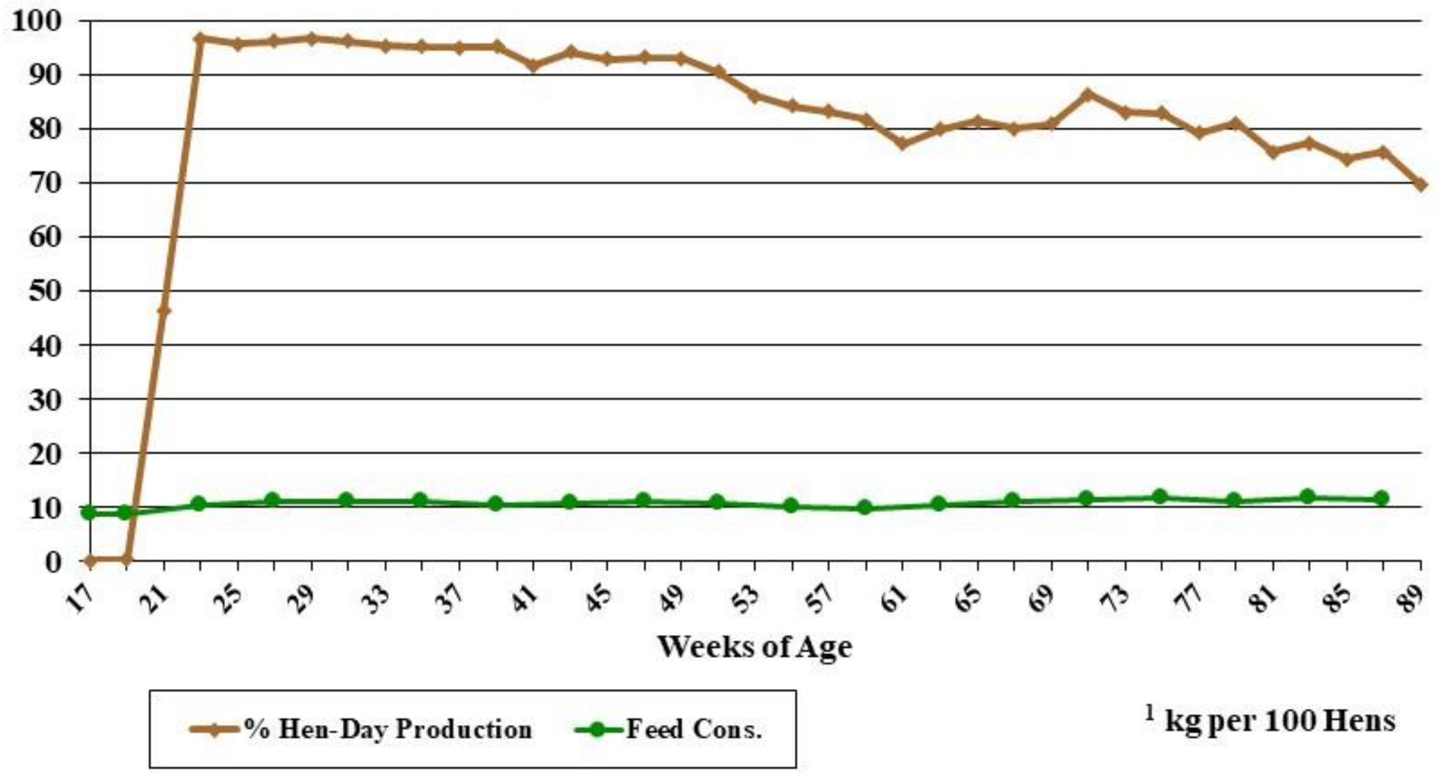
[1] kg per 100 Hens

Figure 15. Lohmann "LB-Lite", Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in Conventional Cages (80 in²). 40th NCLP & MT.



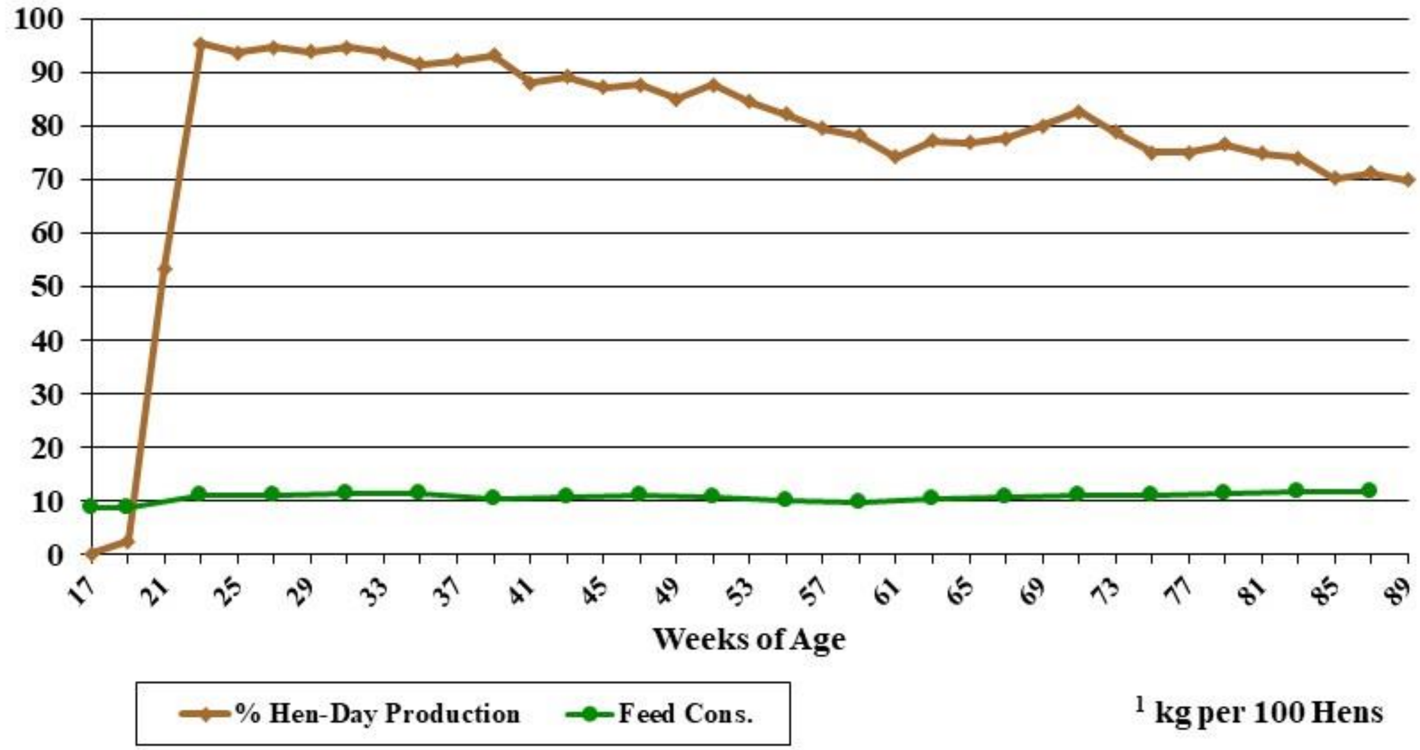
[1] kg per 100 Hens

Figure 16. Novogen Novobrown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in Conventional Cages (80 in^2). 40th NCLP & MT.



[1] kg per 100 Hens

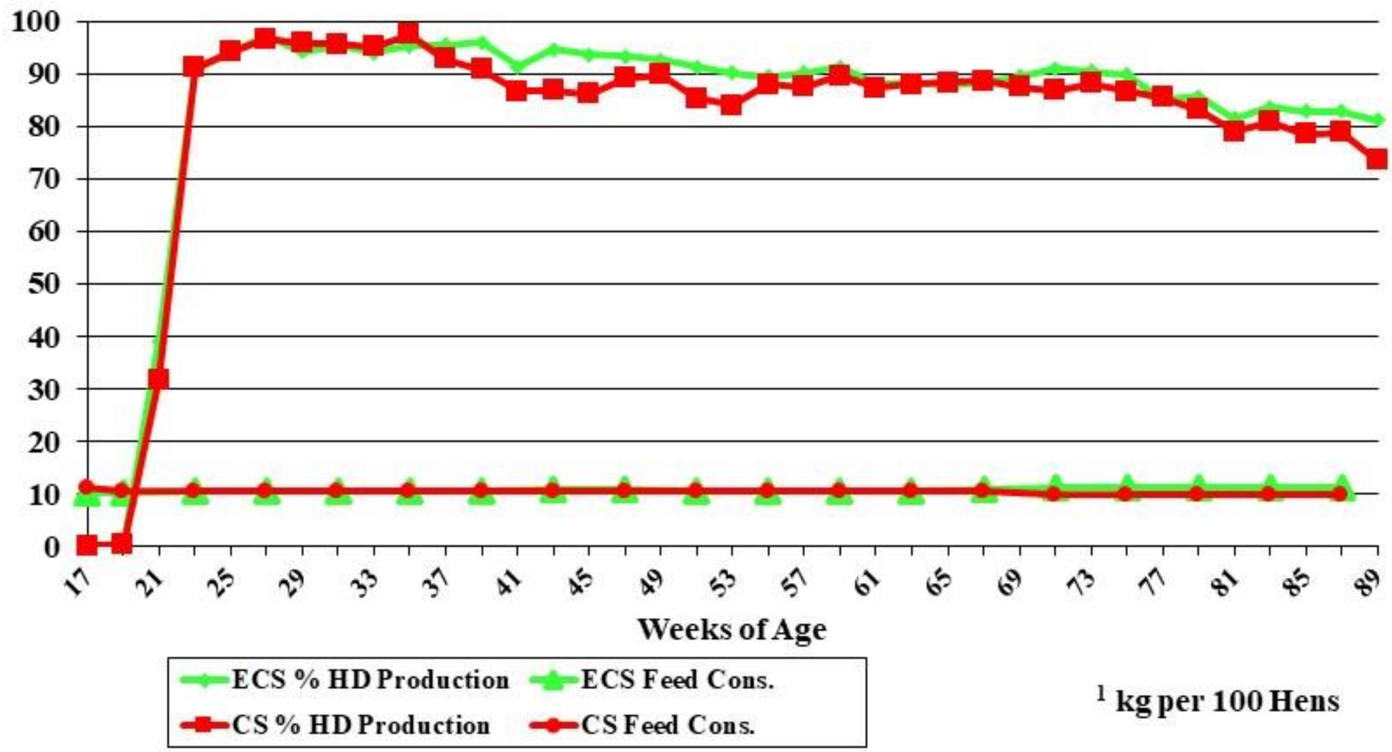
Figure 17. TETRA Americana Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in Conventional Cages (80 in^2). 40th NCLP & MT.



[1] kg per 100 Hens

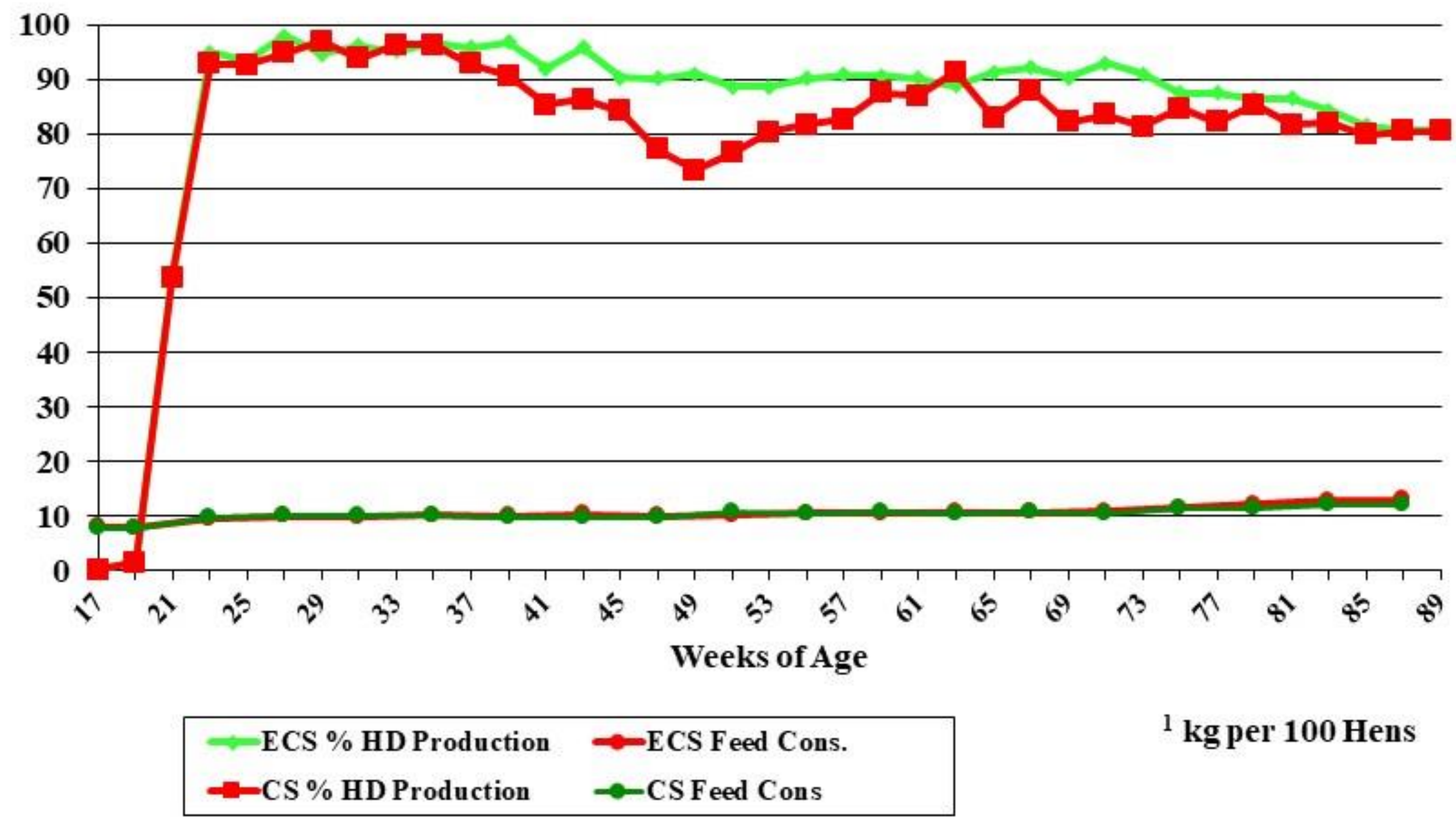
Production Figures for Laying Hens in a Colony Housing System and an Enriched Colony Housing System: White-egg Strains 69 in^2 per hen (445 cm^2) Brown-egg Strains 80 in^2 per hen (516 cm^2)

Figure 18. Bovans White, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in a Colony Housing System (CS) and an Enriched Colony Housing System (ECS) (69 in^2). 40th NCLP & MT.



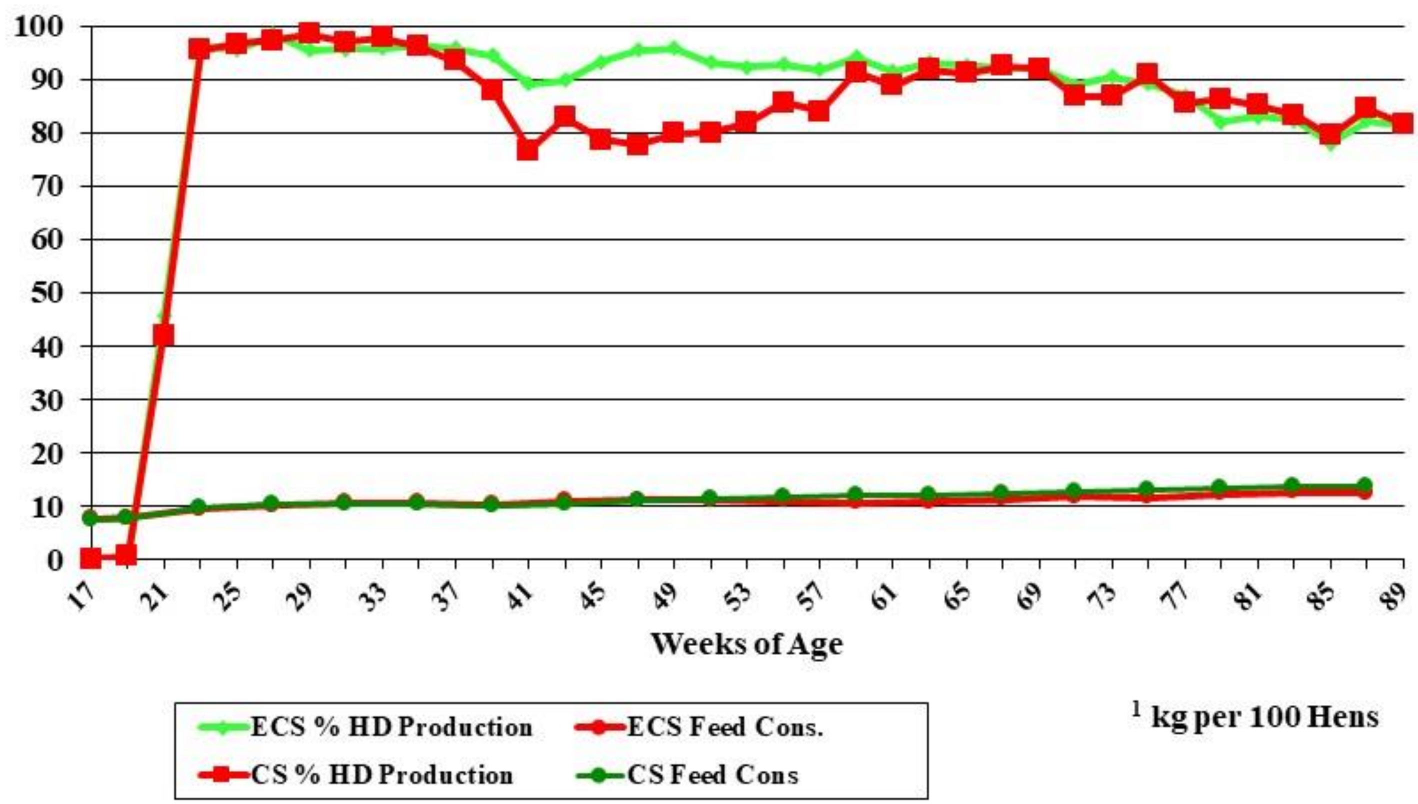
[1] kg per 100 Hens

Figure 19. Shaver, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in a Colony Housing System (CS) and an Enriched Colony Housing System (ECS) (69 in²). 40th NCLP & MT.



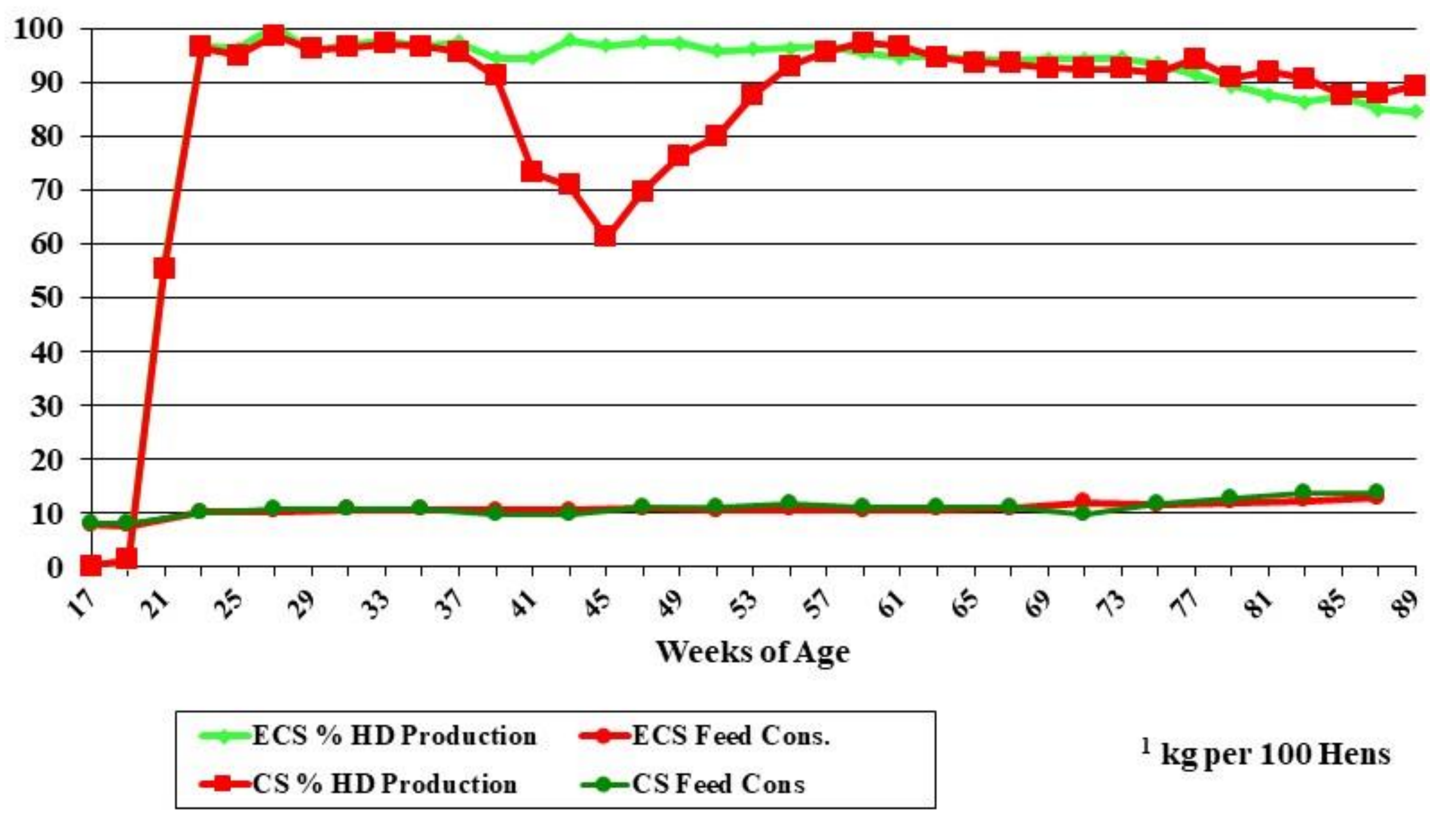
[1] kg per 100 Hens

Figure 20. Dekalb, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in a Colony Housing System (CS) and an Enriched Colony Housing System (ECS) (69 in^2). 40th NCLP & MT.



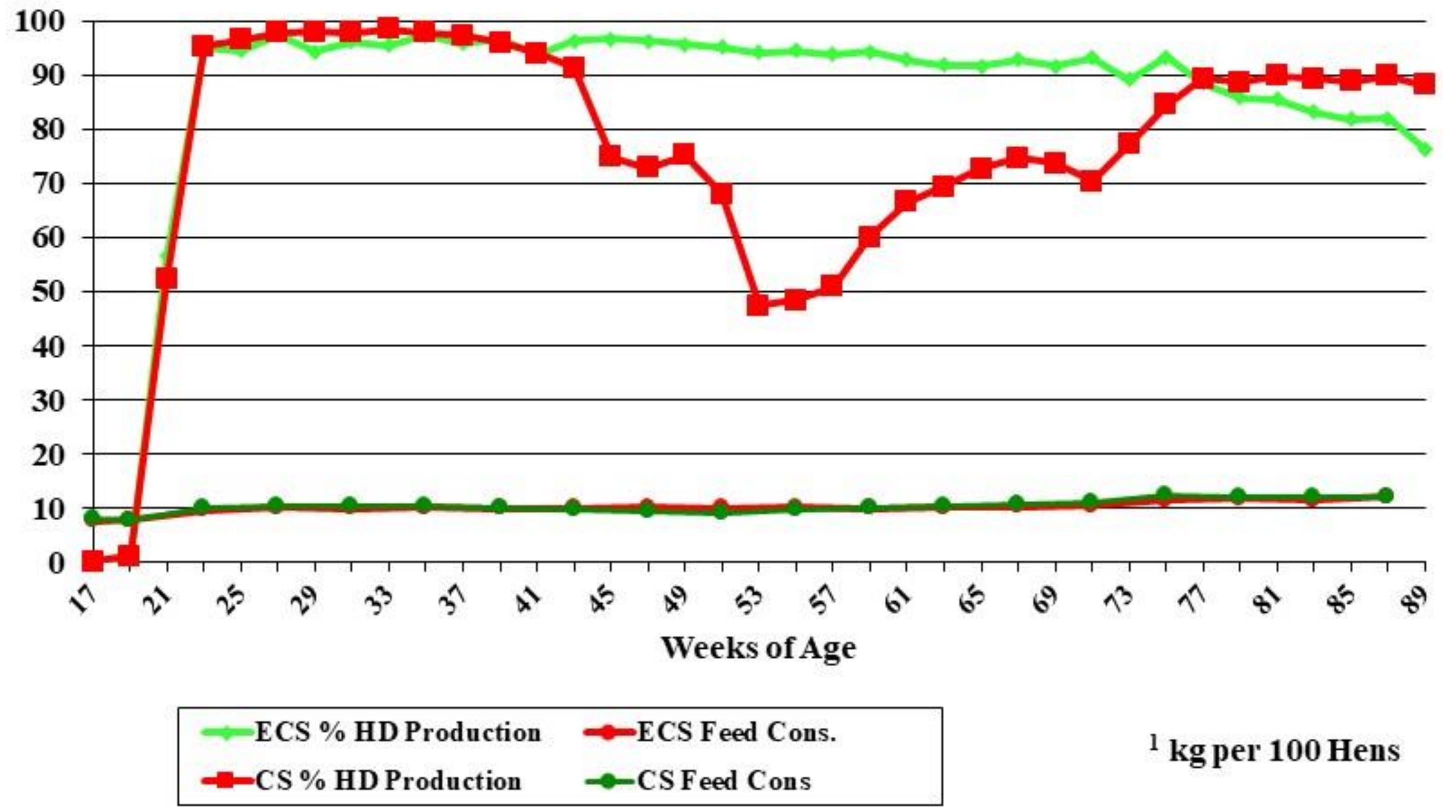
[1] kg per 100 Hens

Figure 21. Babcock, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in a Colony Housing System (CS) and an Enriched Colony Housing System (ECS) (69 in^2). 40th NCLP & MT.



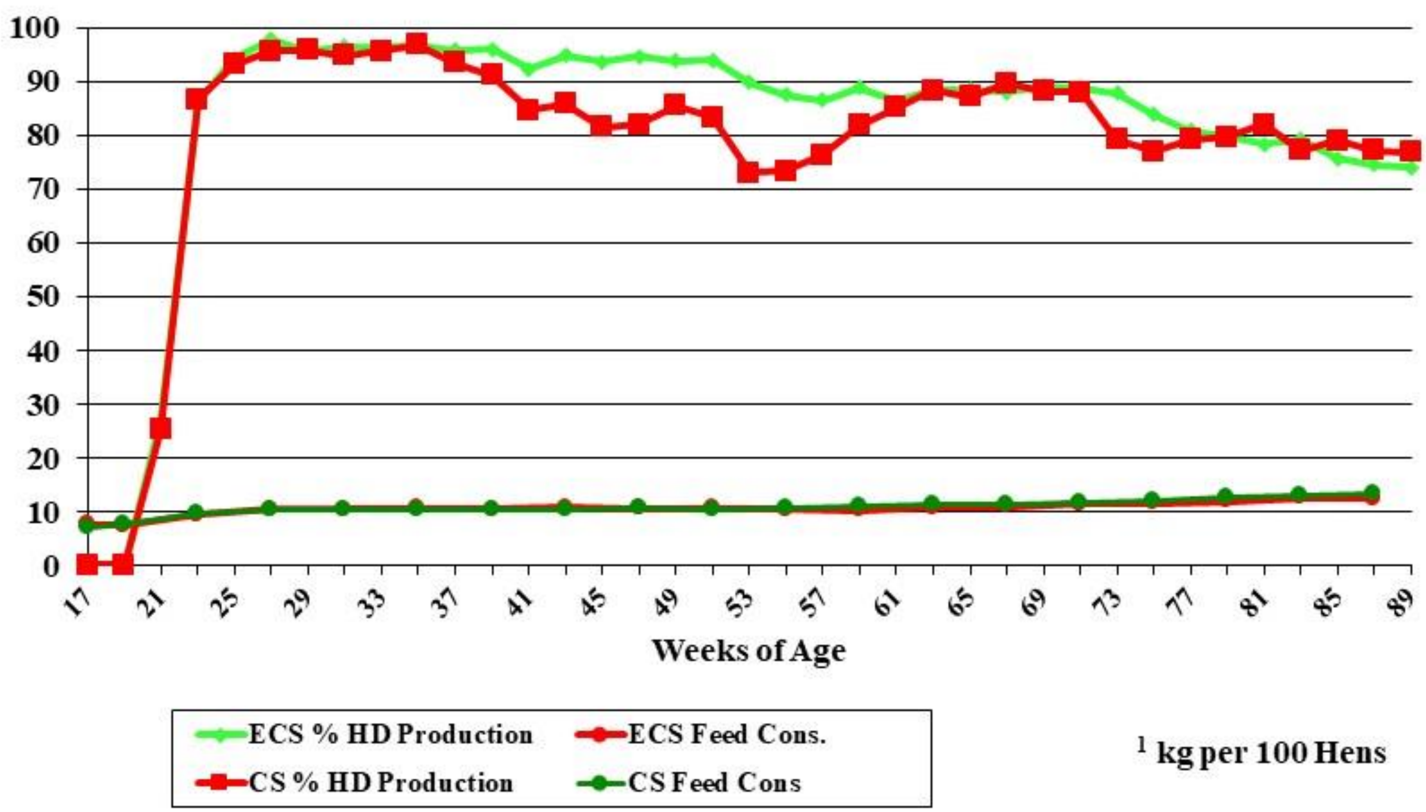
[1] kg per 100 Hens

Figure 22. B-400, Bi-weekly Hen-day Egg Production and Period Feed for White Egg Hens in a Colony Housing System (CS) and an Enriched Colony Housing System (ECS) (69 in²). 40th NCLP & MT.



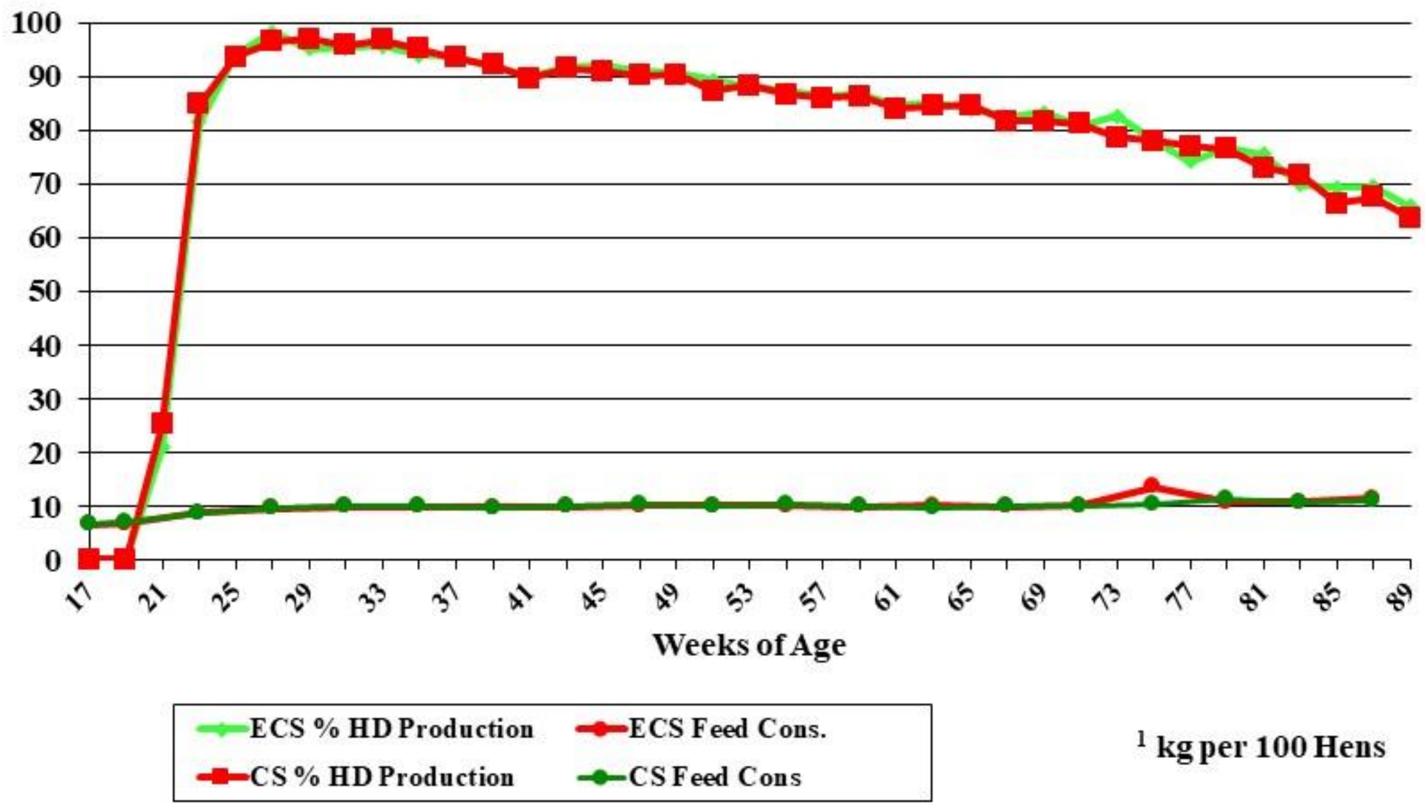
[1] kg per 100 Hens

Figure 23. Hy-Line W-80, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in a Colony Housing System (CS) and an Enriched Colony Housing System (ECS) (69 in^2). 40th NCLP & MT.



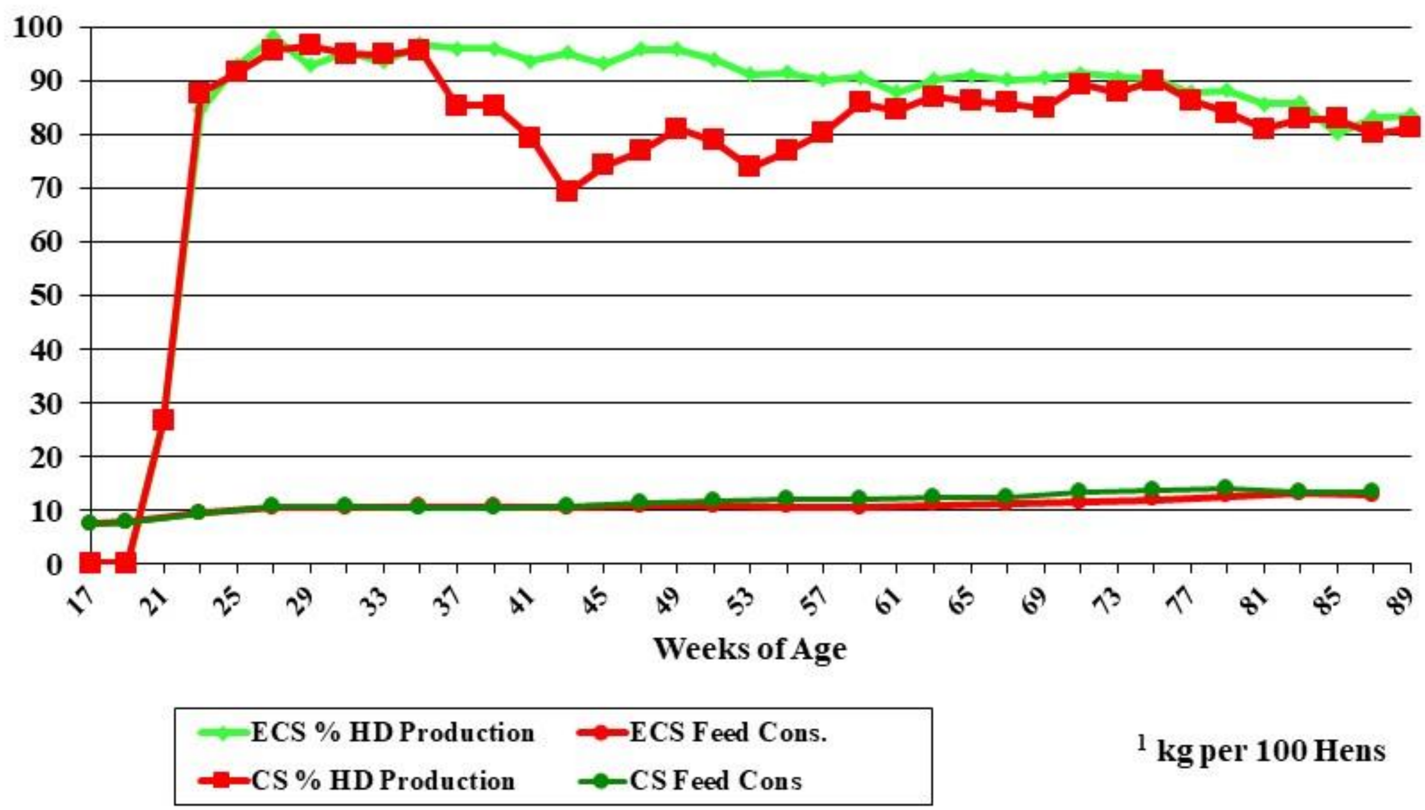
[1] kg per 100 Hens

Figure 24. Hy-Line W-36, Bi-weekly Hen-day Egg Production and Period Feed for White Egg Hens in a Colony Housing System (CS) and an Enriched Colony Housing System (ECS) (69 in^2). 40th NCLP & MT.



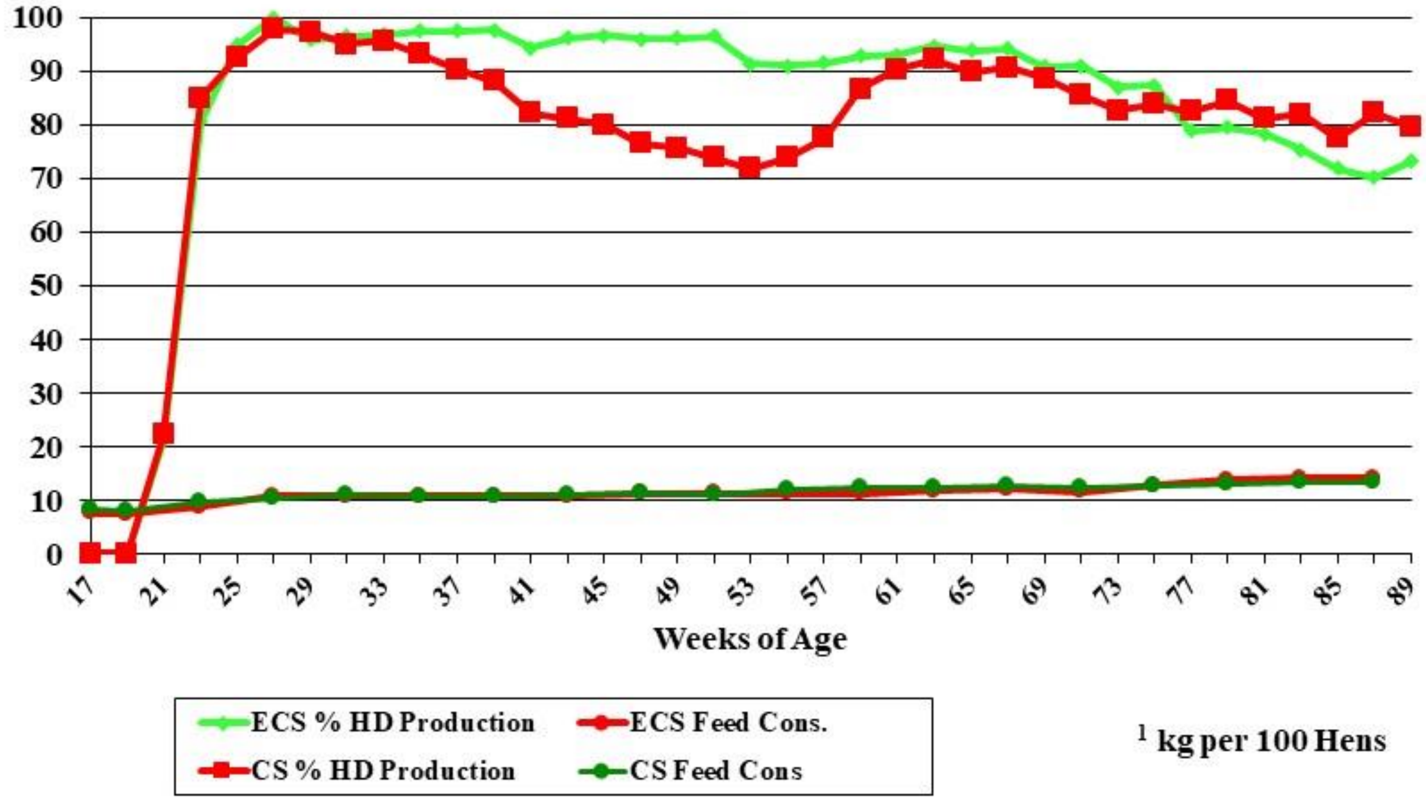
[1] kg per 100 Hens

Figure 25. Lohmann LSL-Lite, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in a Colony Housing System (CS) and an Enriched Colony Housing System (ECS) (69 in^2). 40th NCLP & MT.



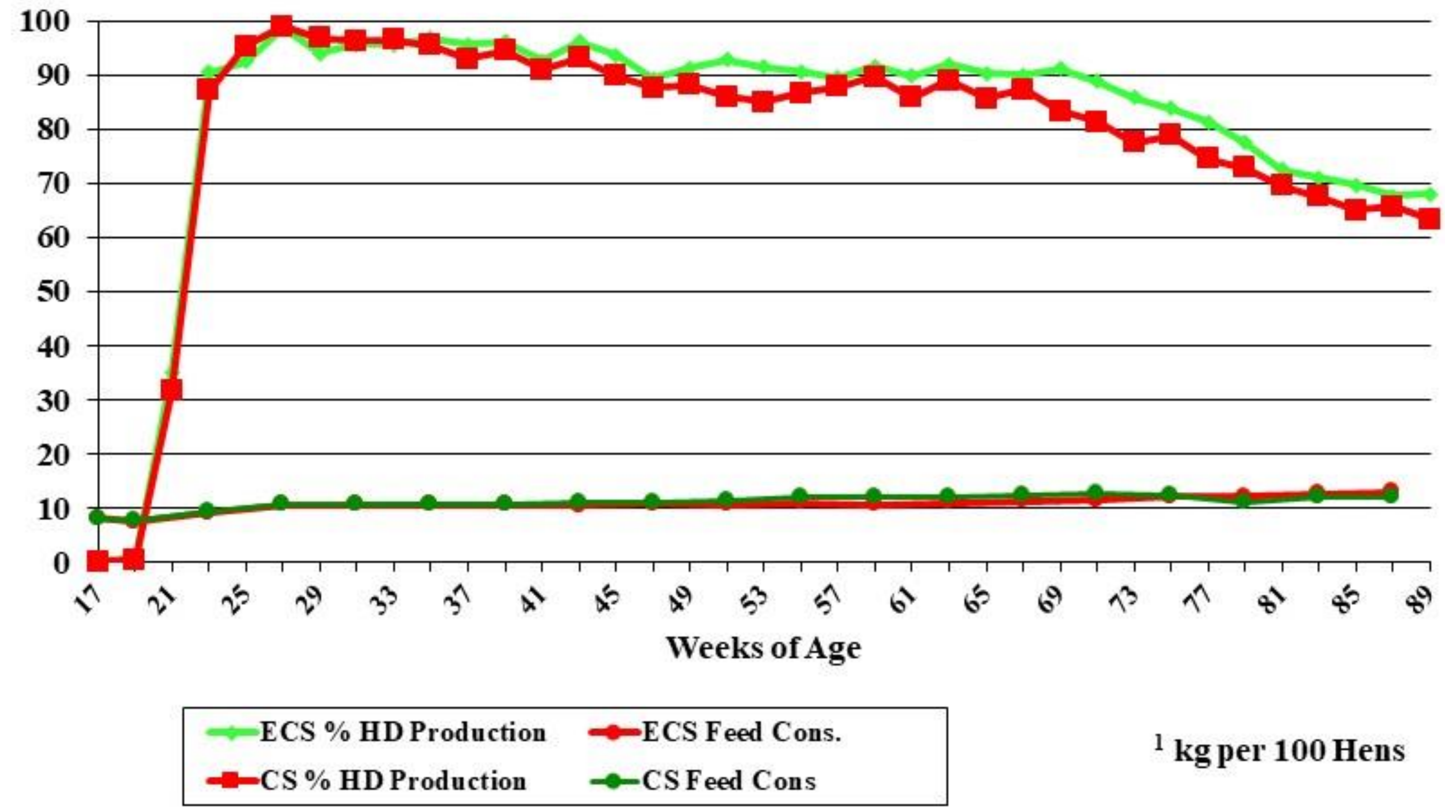
[1] kg per 100 Hens

Figure 26. H&N "Nick Chick", Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in a Colony Housing System (CS) and an Enriched Colony Housing System (ECS) (69 in^2). 40^{th} NCLP & MT.



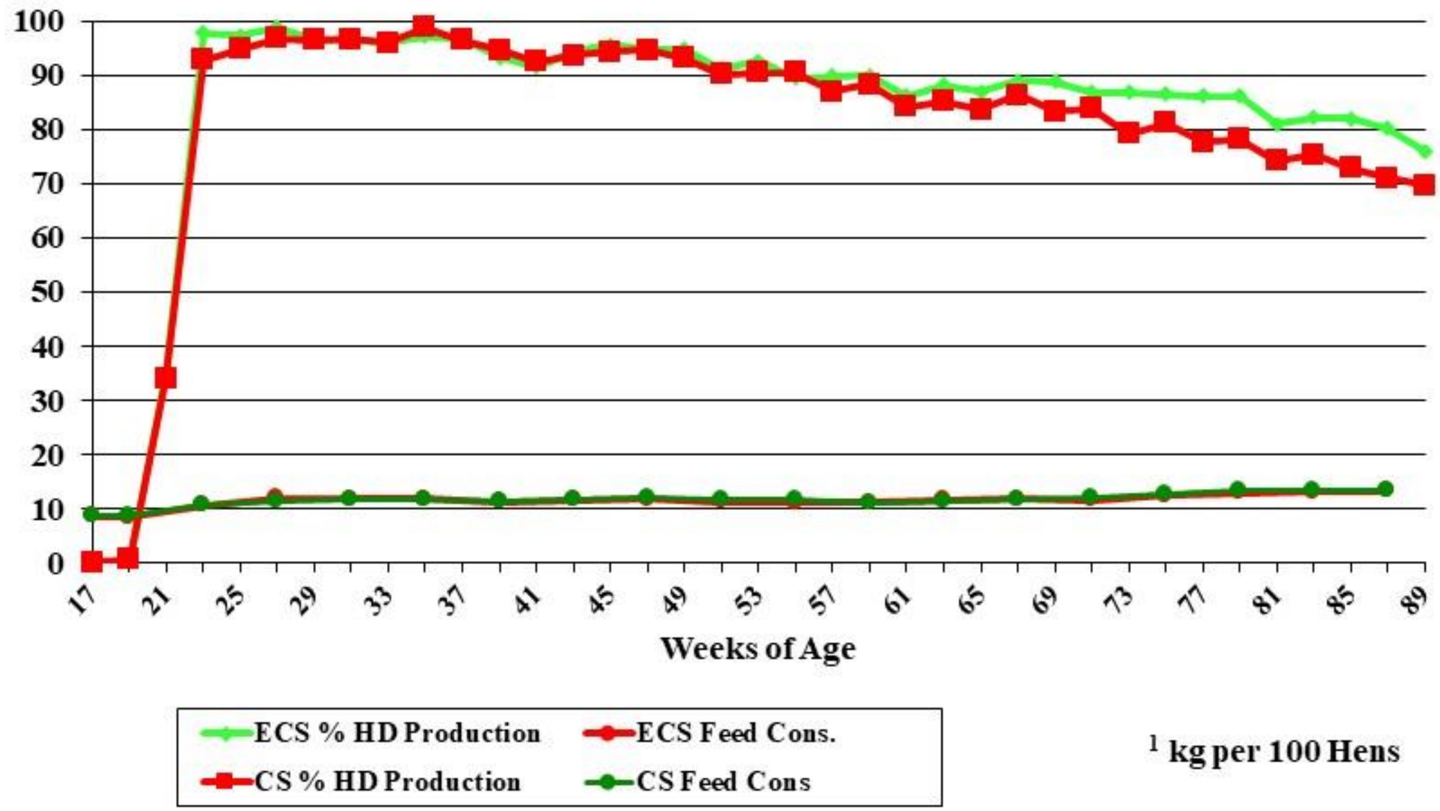
[1] kg per 100 Hens

Figure 27. Novogen Novowhite, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in a Colony Housing System (CS) and an Enriched Colony Housing System (ECS) (69 in^2). 40th NCLP & MT.



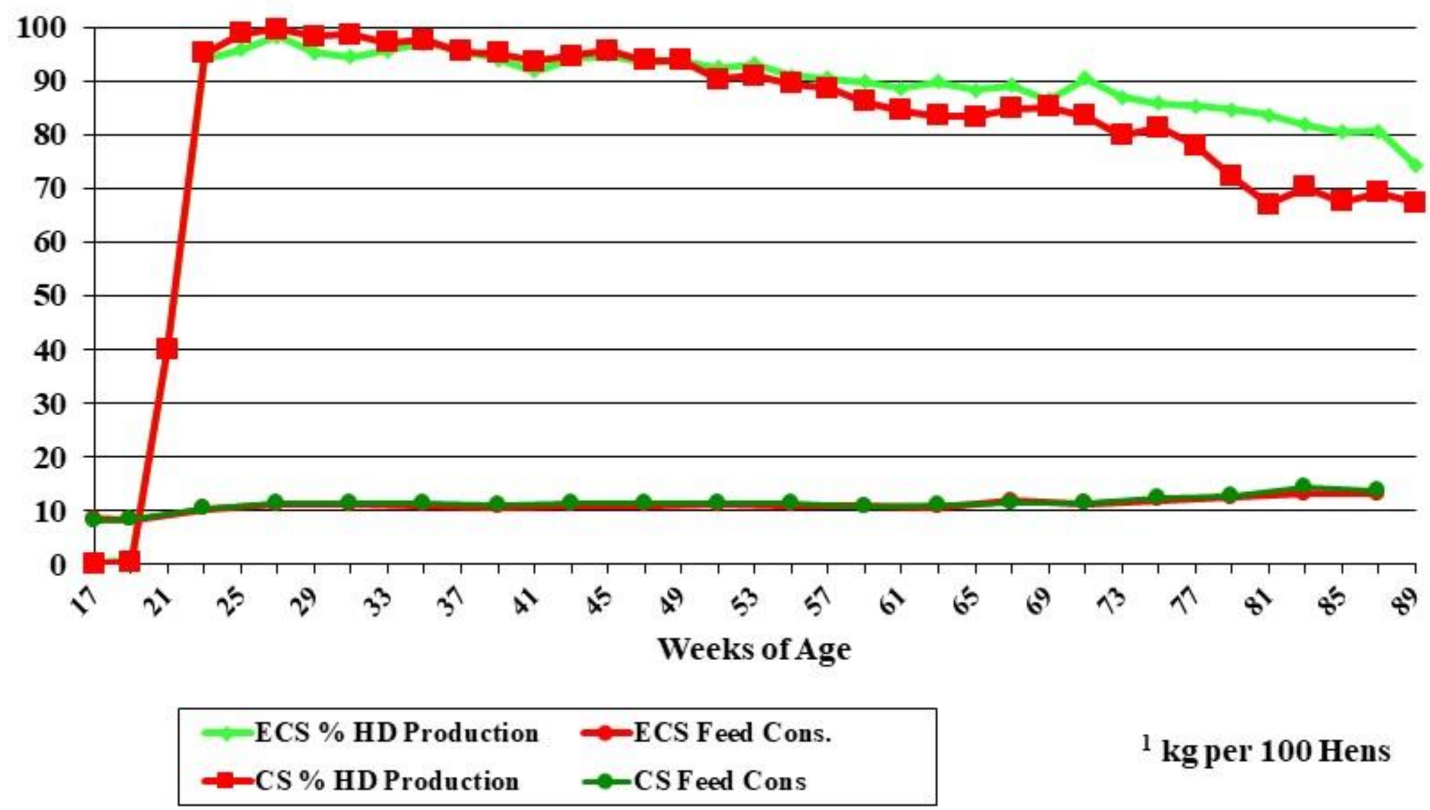
[1] kg per 100 Hens

Figure 28. Bovans Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in a Colony Housing System (CS) and an Enriched Colony Housing System (ECS) (80 in^2). 40th NCLP & MT.



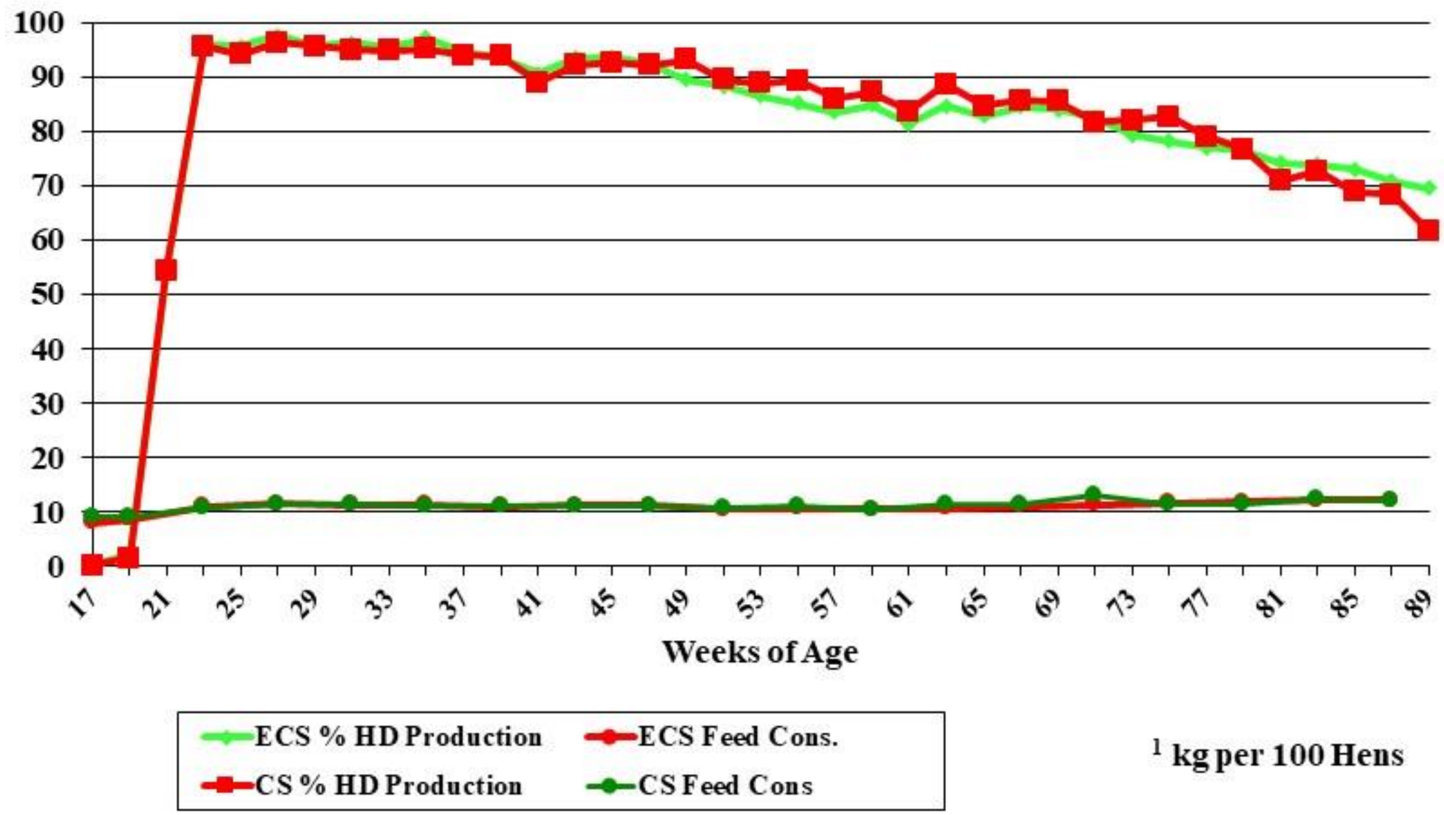
[1] kg per 100 Hens

Figure 29. ISA Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in a Colony Housing System (CS) and an Enriched Colony Housing System (ECS) (80 in^2). 40th NCLP & MT.



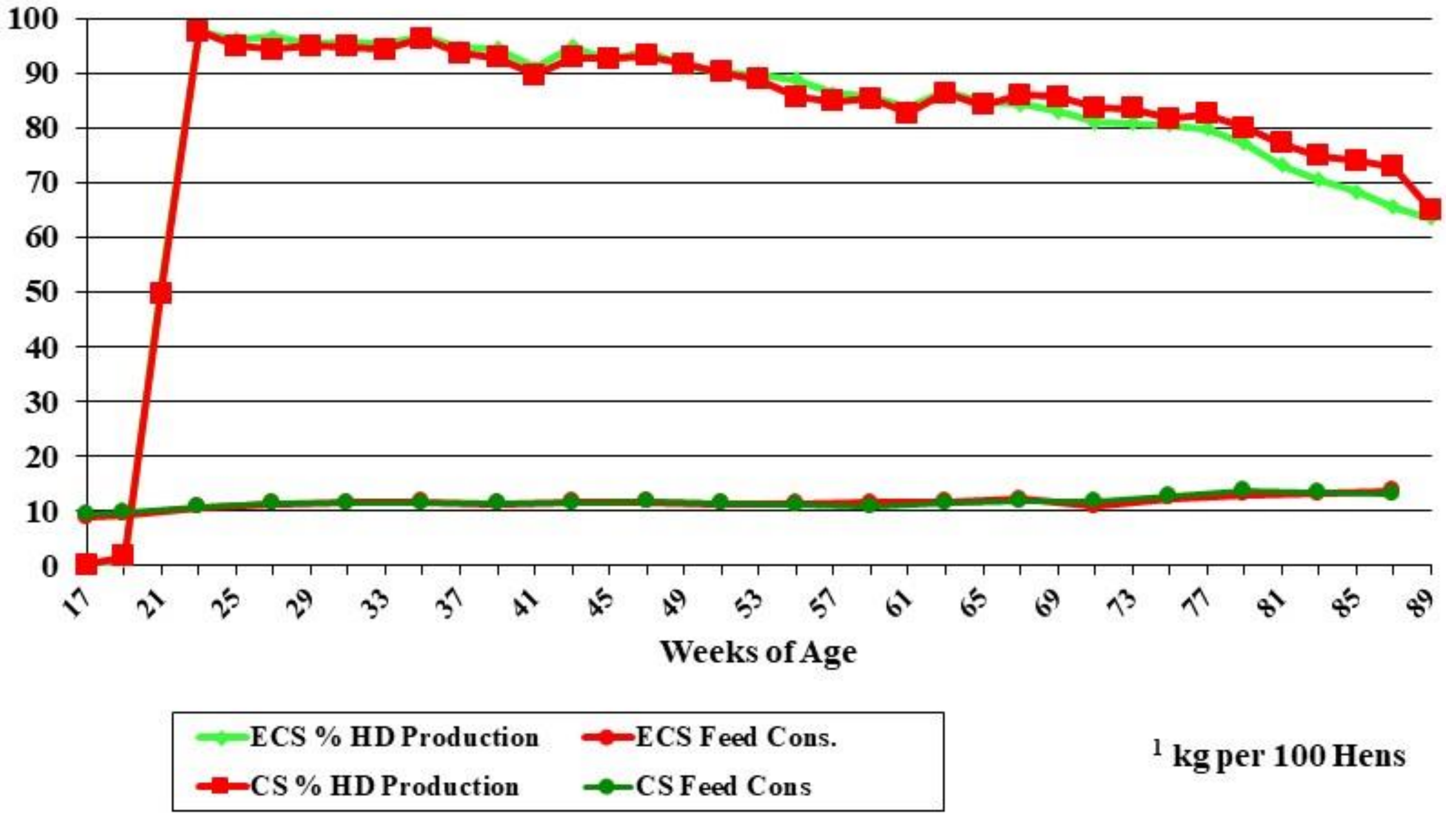
[1] kg per 100 Hens

Figure 30. Hy-Line Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in a Colony Housing System (CS) and an Enriched Colony Housing System (ECS) (80 in²). 40th NCLP & MT.



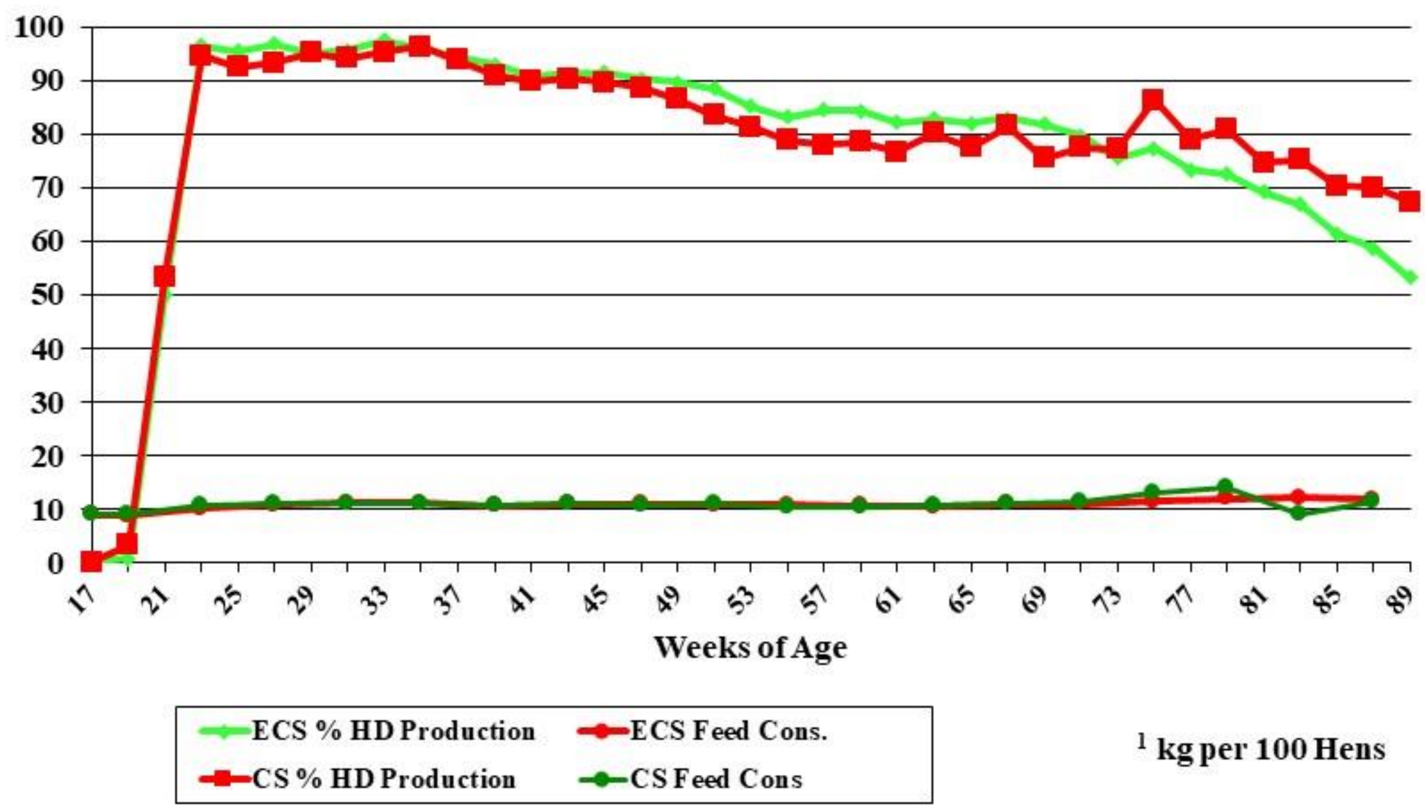
[1] kg per 100 Hens

Figure 31. Hy-Line Silver Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in a Colony Housing System (CS) and an Enriched Colony Housing System (ECS) (80 in^2). 40th NCLP & MT.



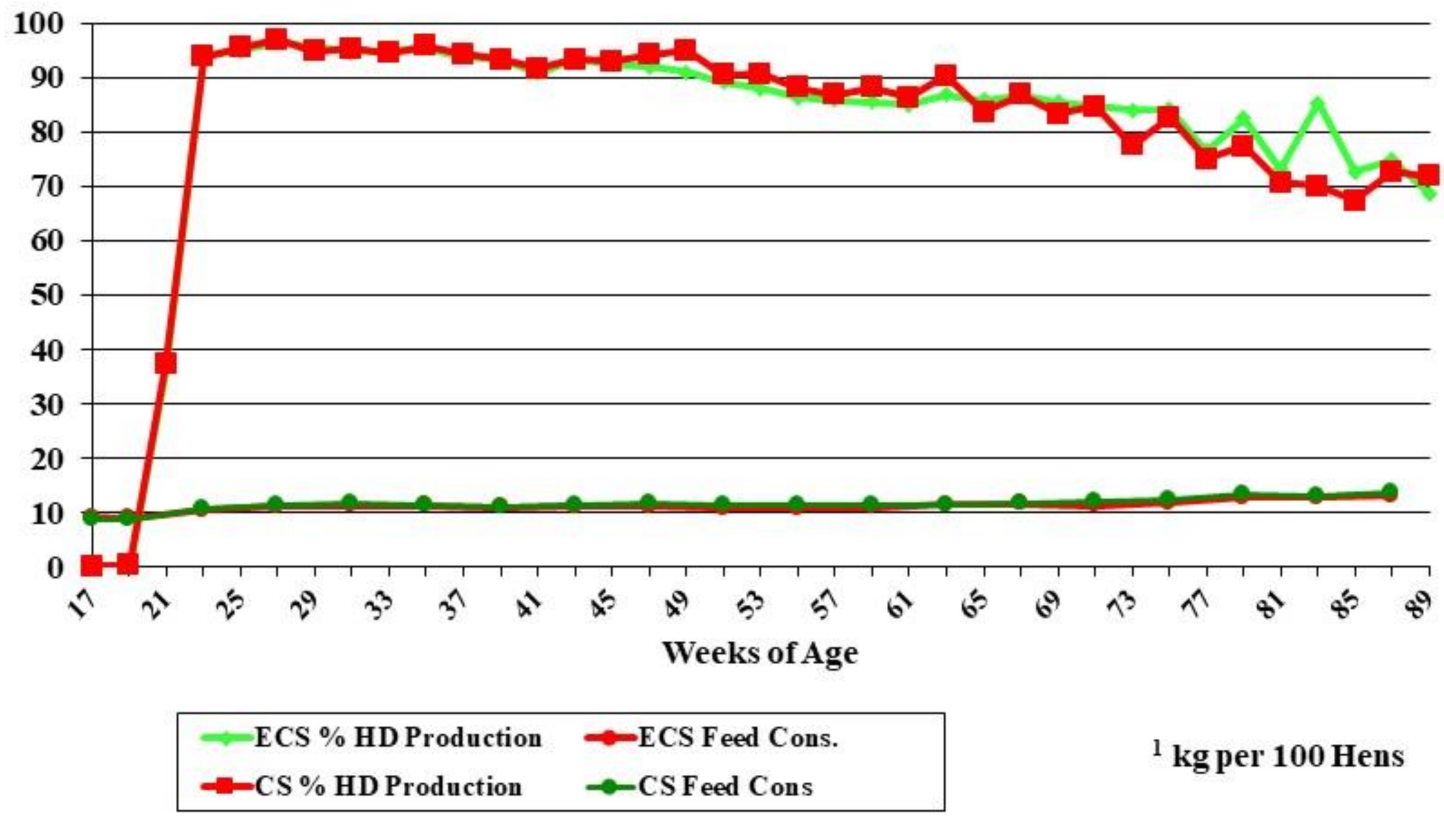
[1] kg per 100 Hens

Figure 32. Lohmann LB-Lite, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in a Colony Housing System (CS) and an Enriched Colony Housing System (ECS) (80 in^2). 40th NCLP & MT.



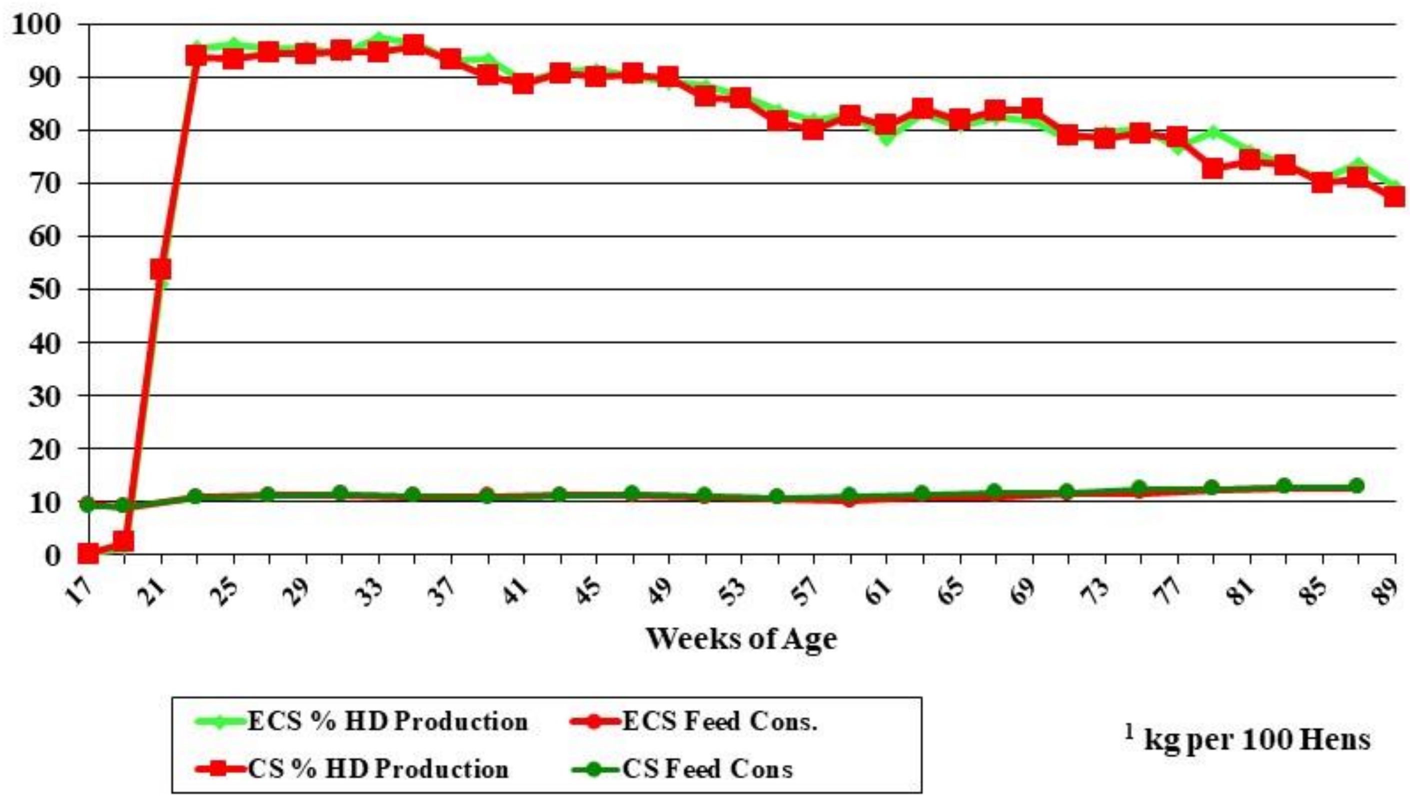
[1] kg per 100 Hens

Figure 33. Novogen Novobrown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in a Colony Housing System (CS) and an Enriched Colony Housing System (ECS) (80 in^2). 40th NCLP & MT.



[1] kg per 100 Hens

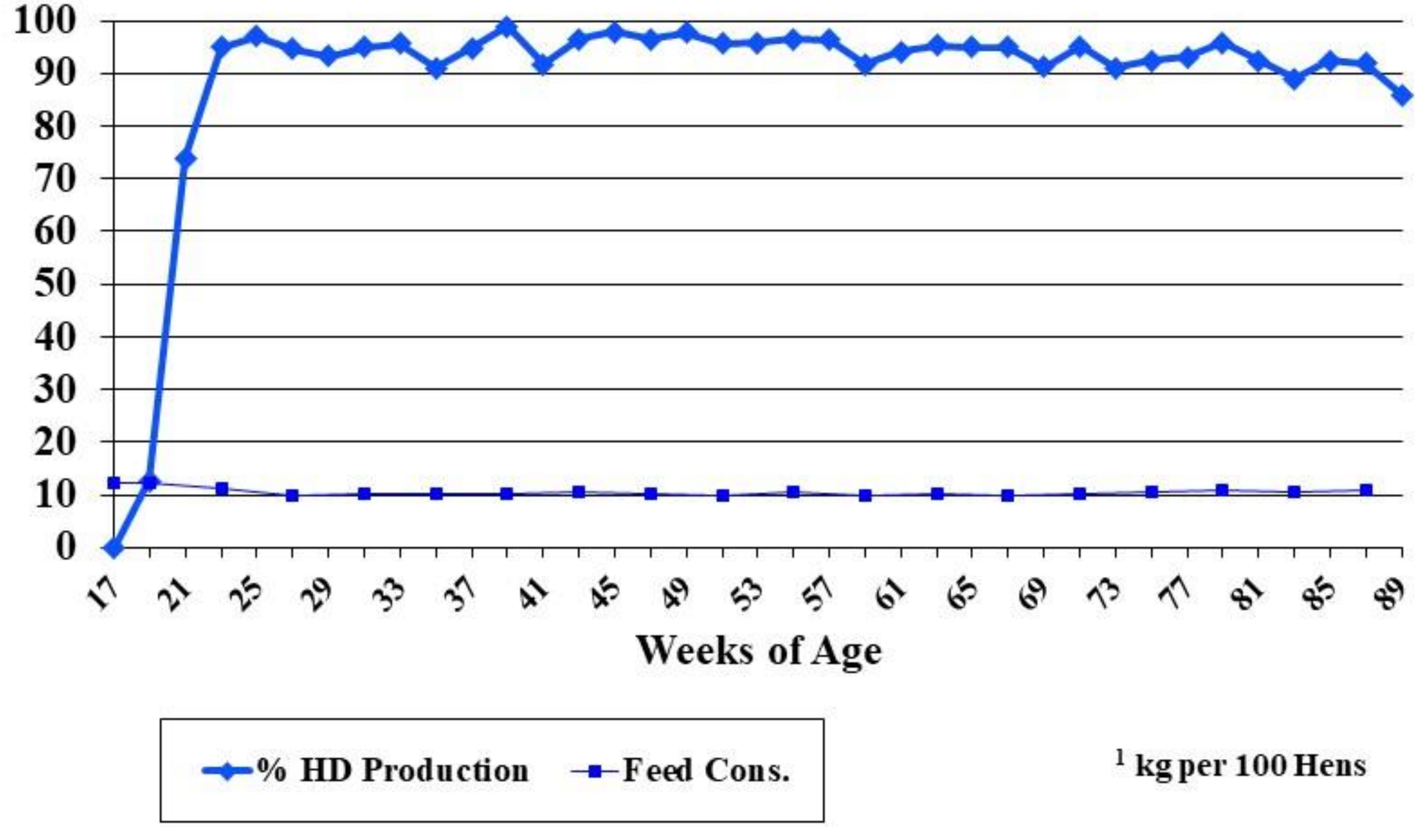
Figure 34. TETRA Americana Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in a Colony Housing System (CS) and an Enriched Colony Housing System (ECS) (80 in²). 40th NCLP & MT.



[1] kg per 100 Hens

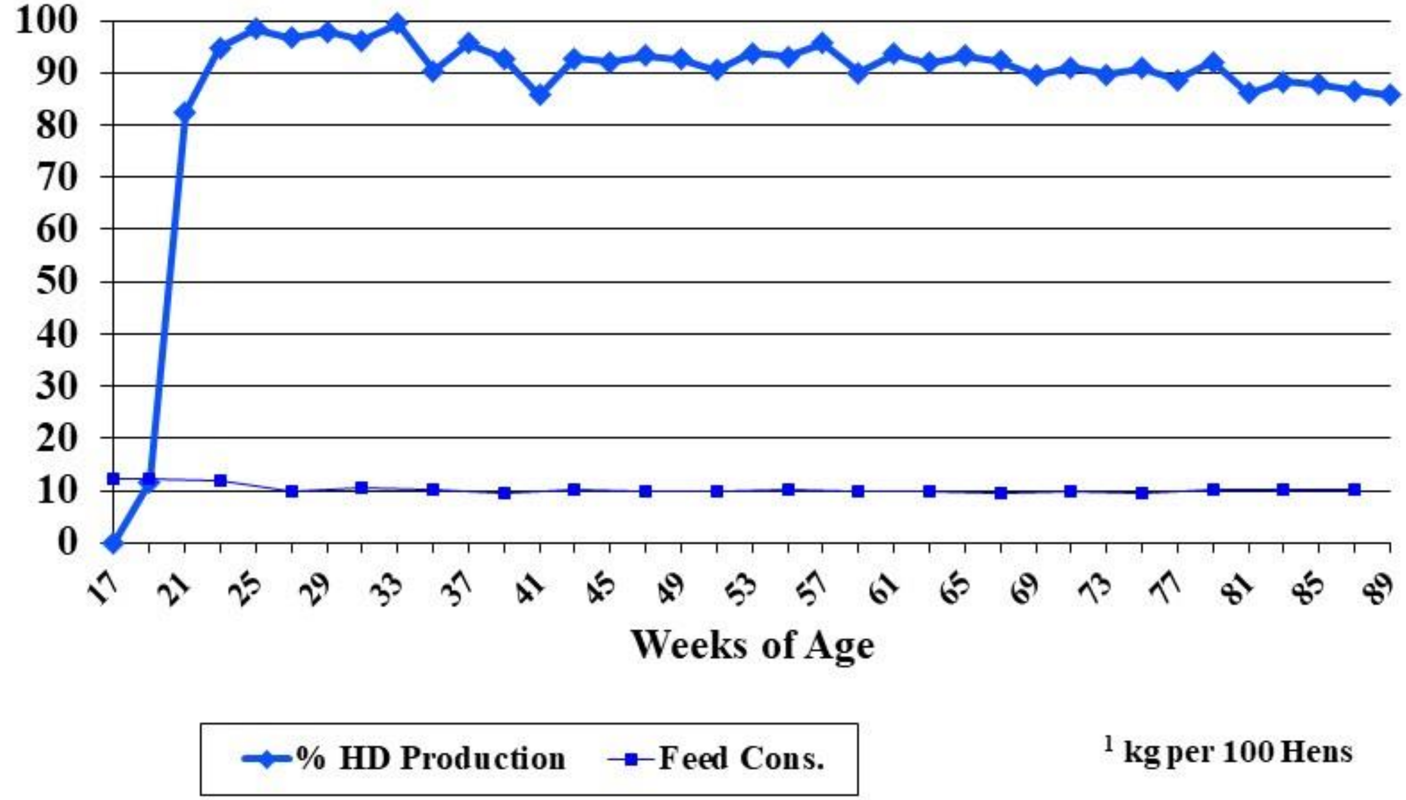
Production Figures for Laying Hens in a Cage-free system which was ½ slat and ½ litter: White- and Brown-egg Strains 177 in^2 per hen (1141 cm^2 per hen)

Figure 35. Dekalb, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in a Cage-free System (177 in²). 40th NCLP & MT.



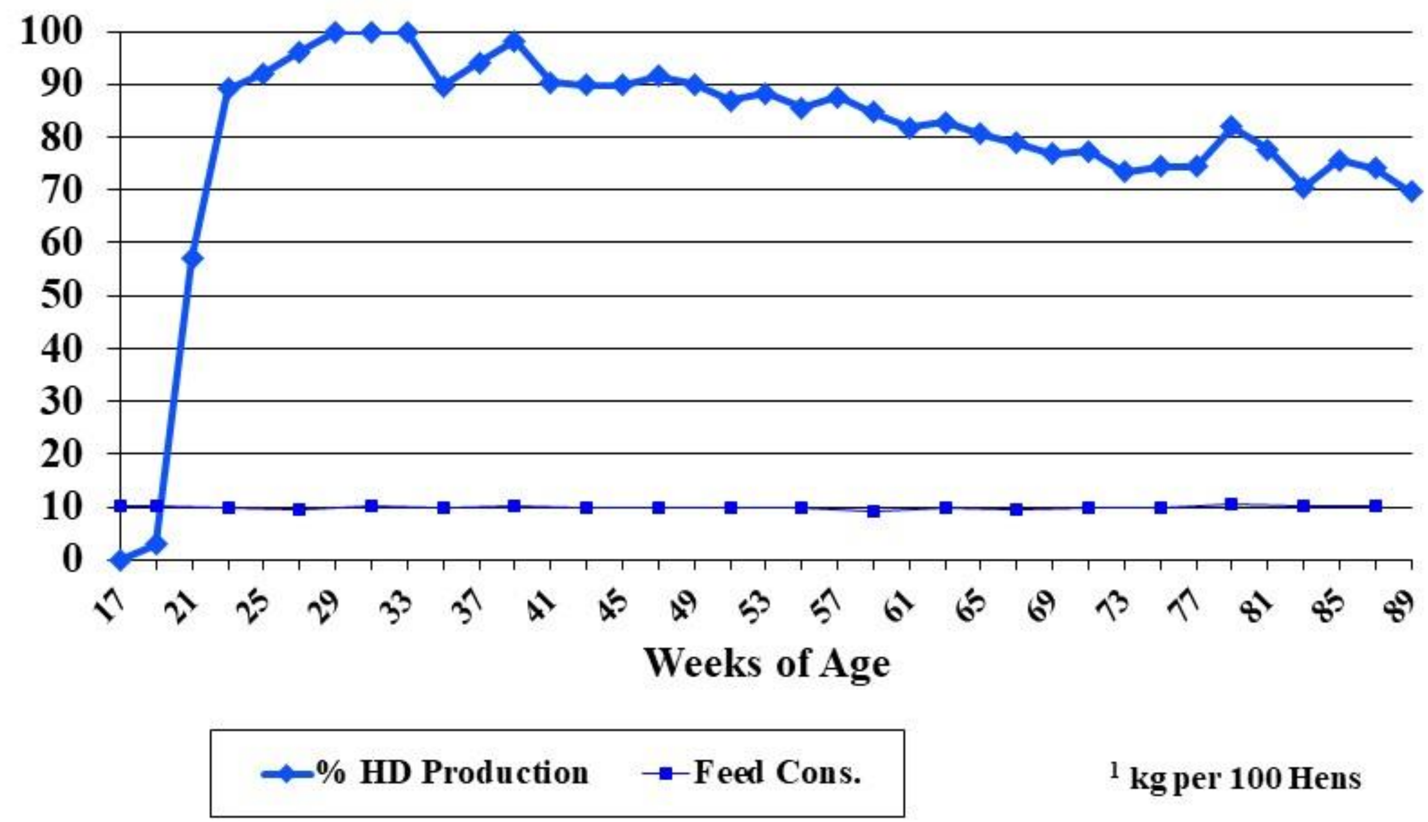
[1] kg per 100 Hens

Figure 36. Babcock, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in a Cage-free System (177 in^2). 40th NCLP & MT.



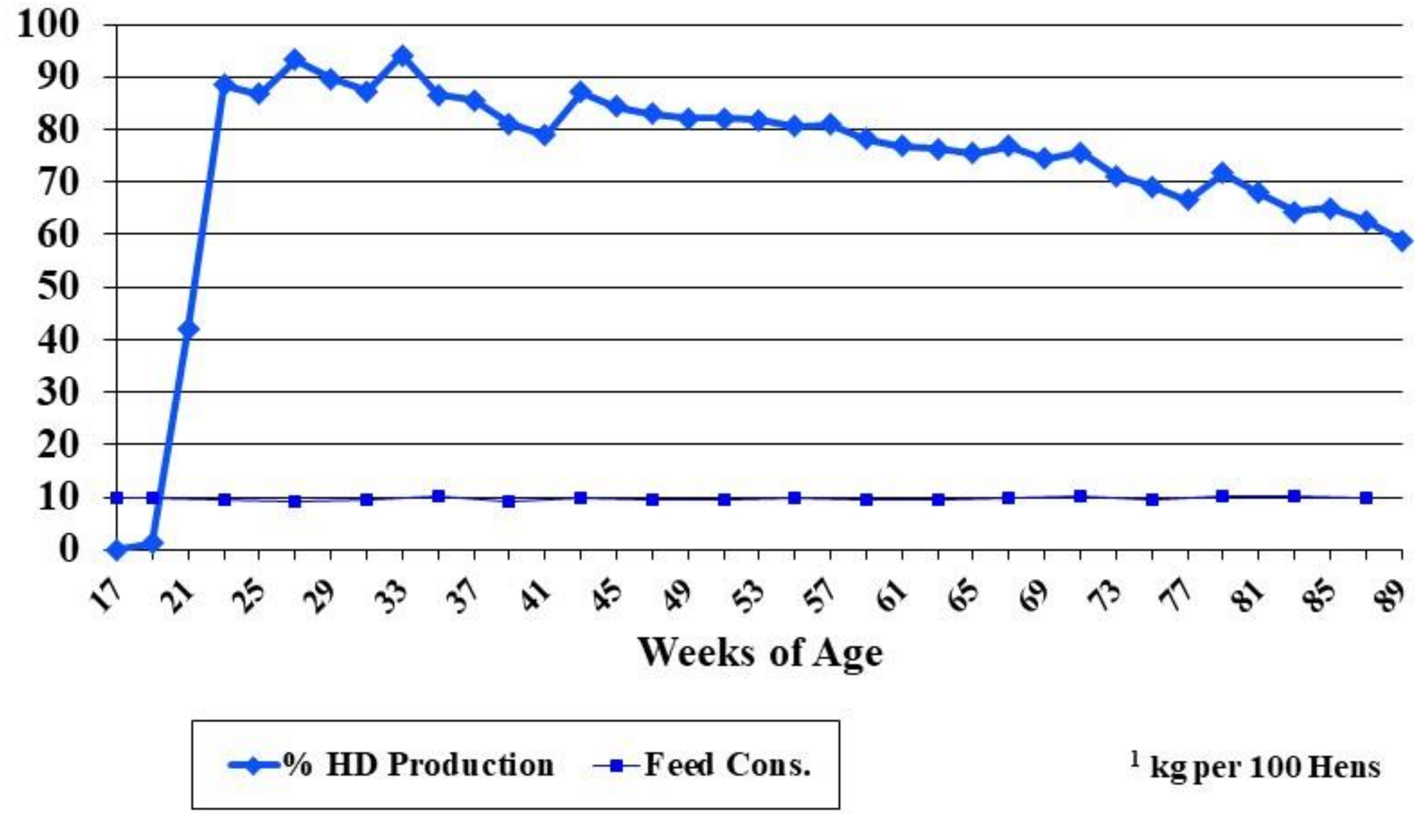
[1] kg per 100 Hens

Figure 37. Hy-Line W-80, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in a Cage-free System (177 in^2). 40th NCLP & MT.



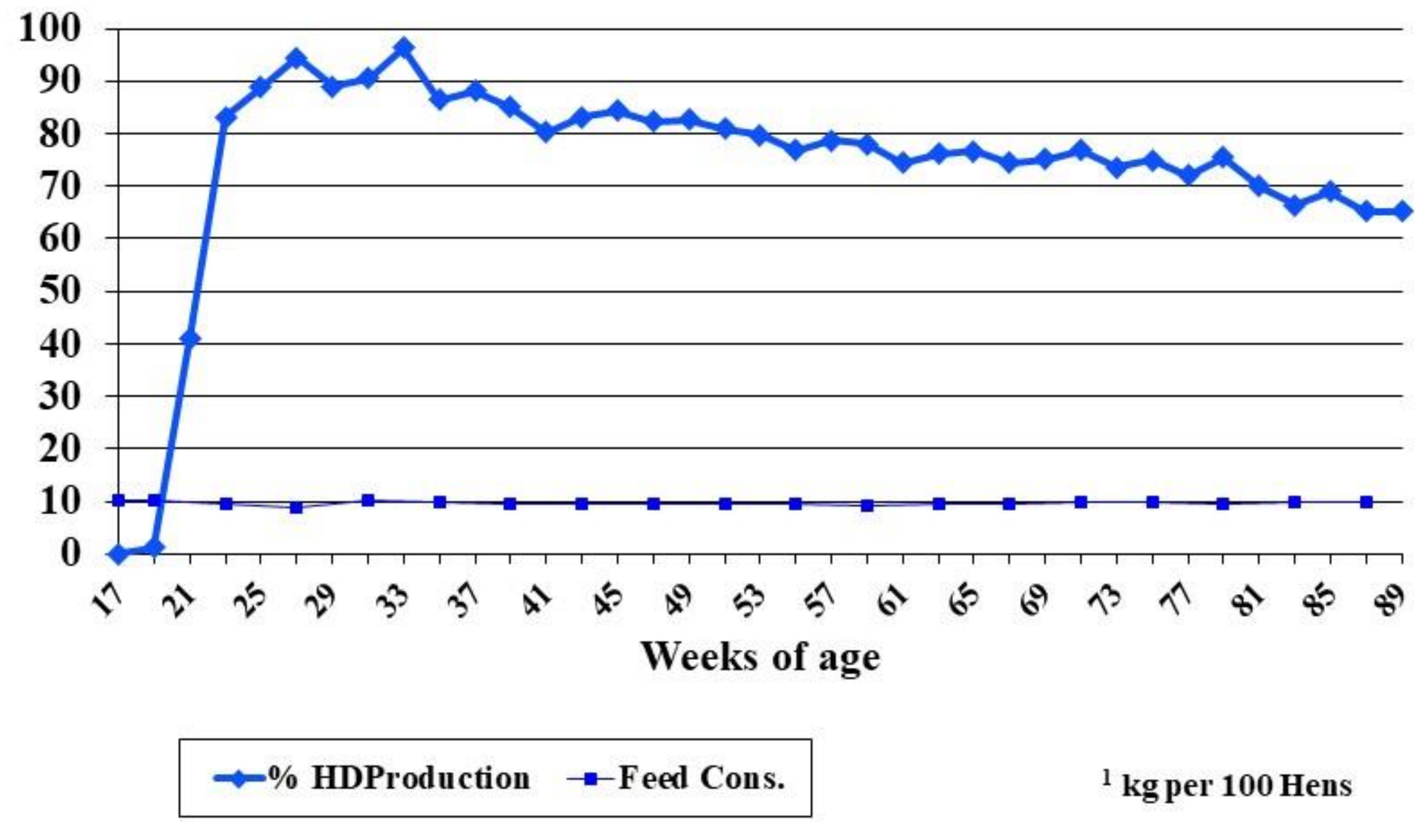
[1] kg per 100 Hens

Figure 38. Hy-Line W-36, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in a Cage-free System (177 in^2). 40th NCLP & MT.



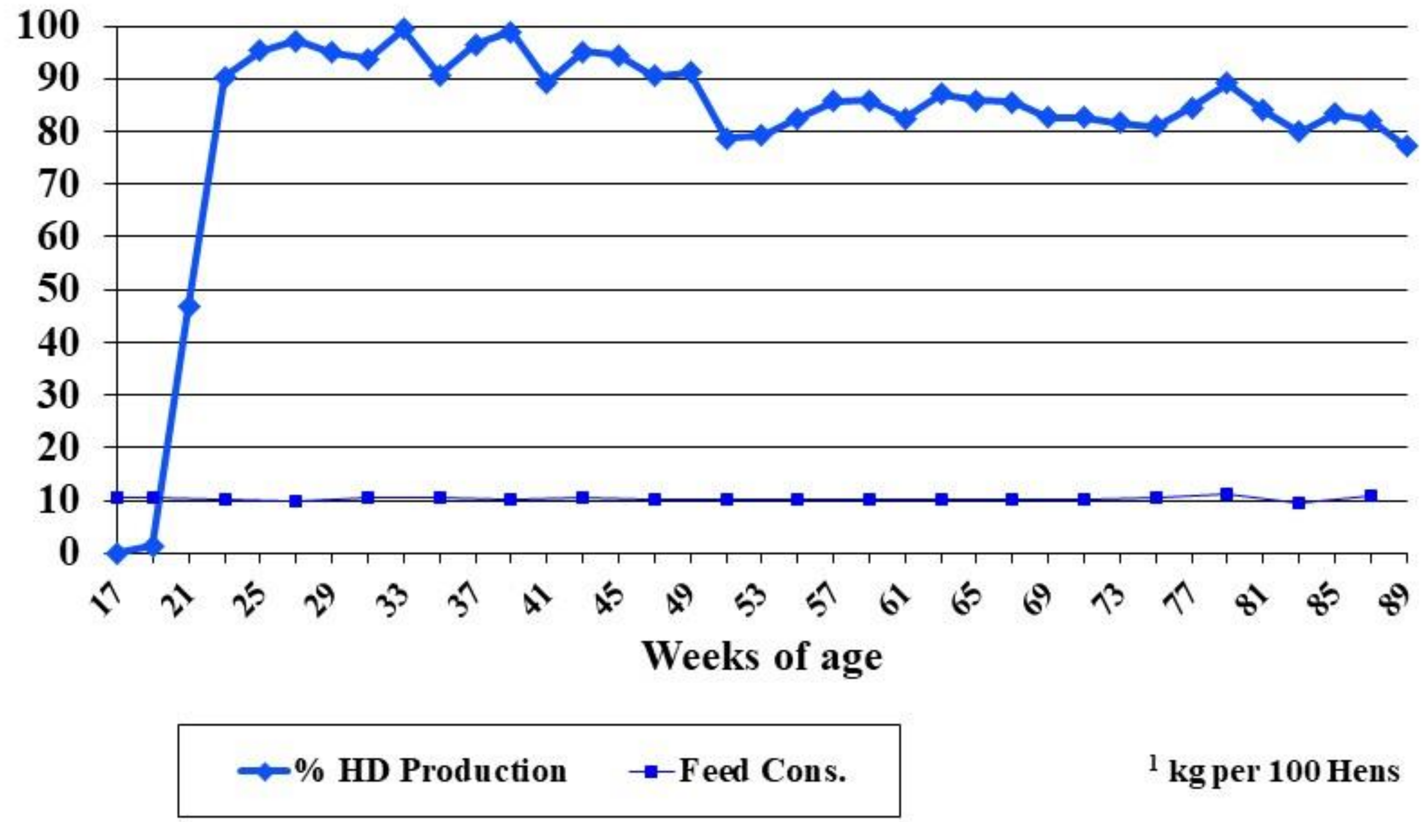
[1] kg per 100 Hens

Figure 39. Hy-Line White Experimental, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in a Cage-free System (177 in^2). 40th NCLP & MT.



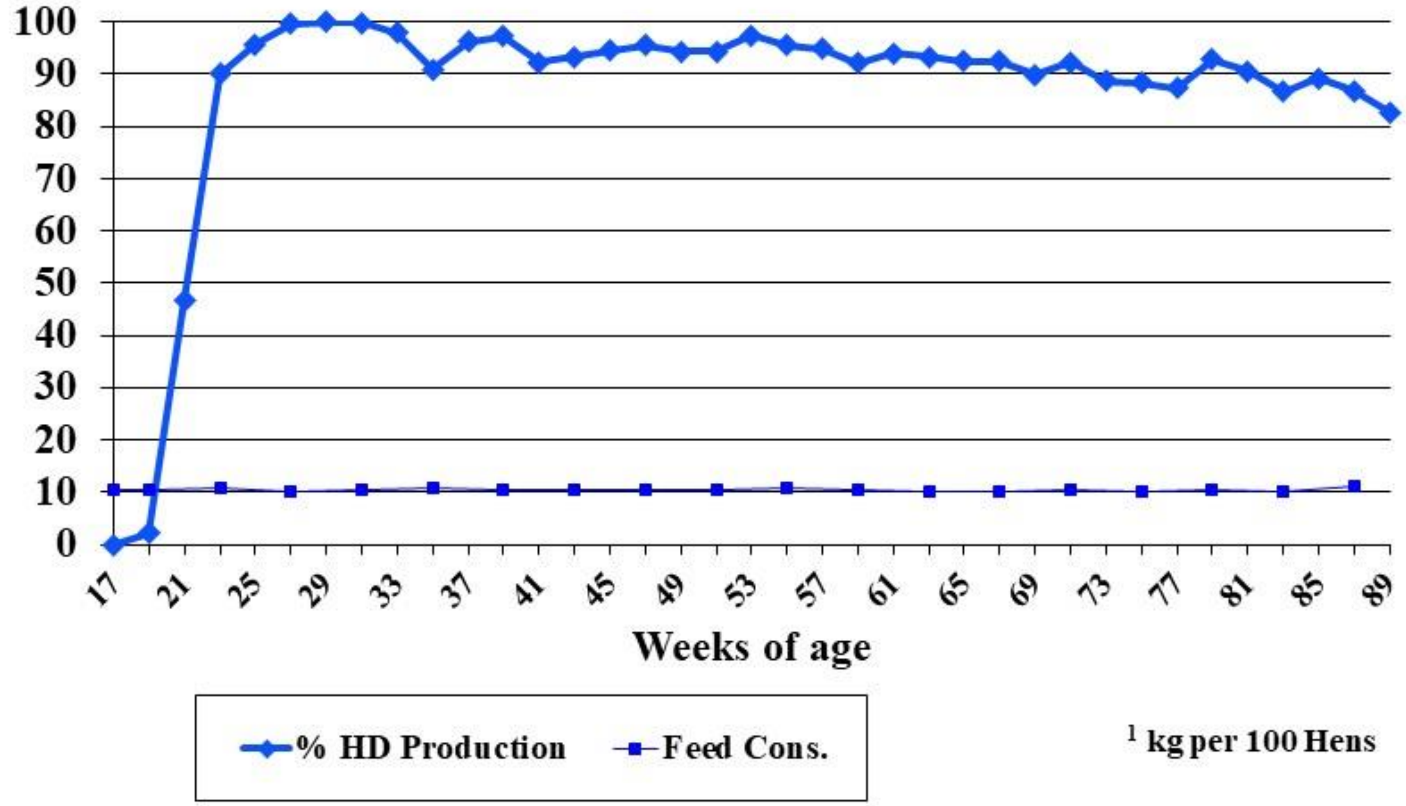
[1] kg per 100 Hens

Figure 40. Lohmann LSL-Lite, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in a Cage-free System (177 in²). 40th NCLP & MT.



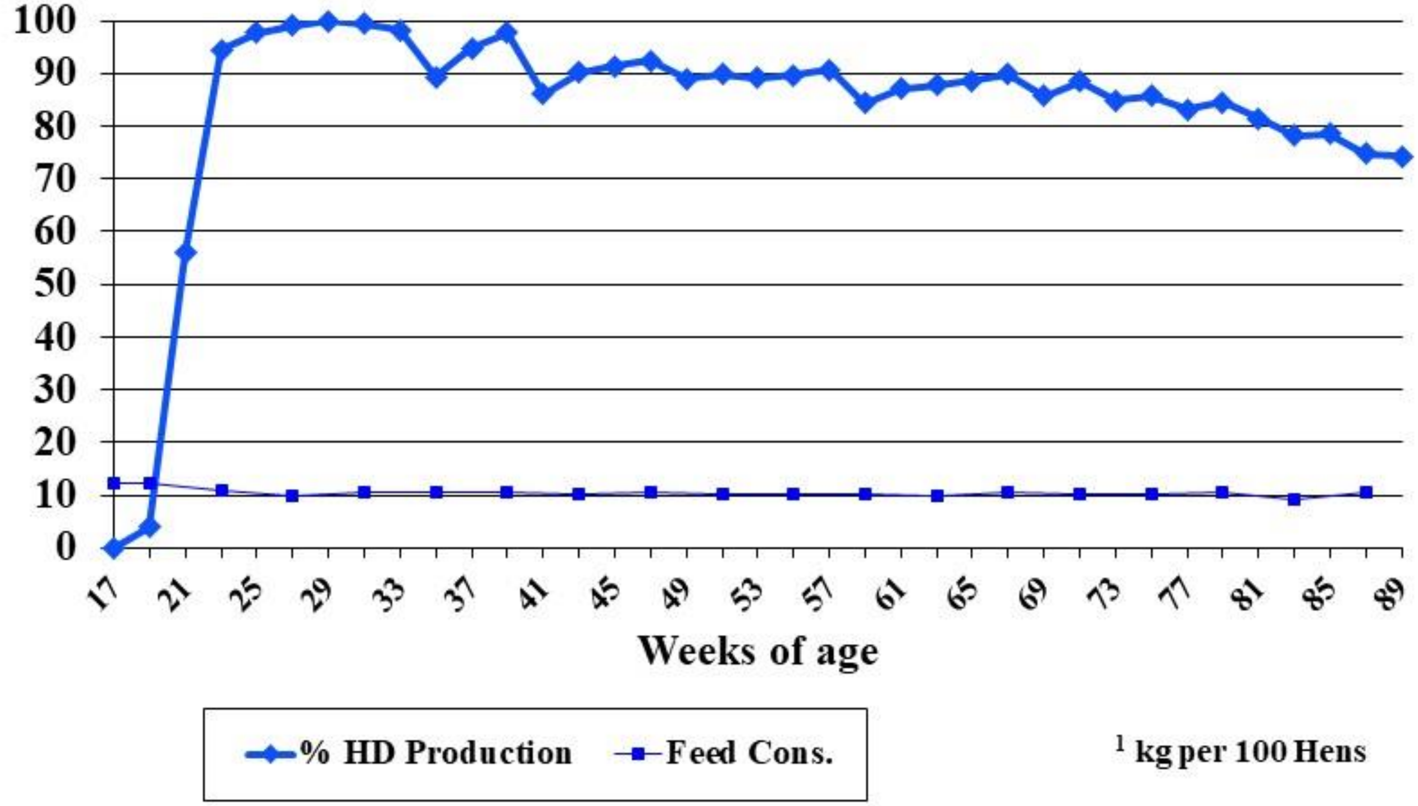
[1] kg per 100 Hens

Figure 41. H&N "Nick Chick", Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in a Cage-free System (177 in^2). 40th NCLP & MT.



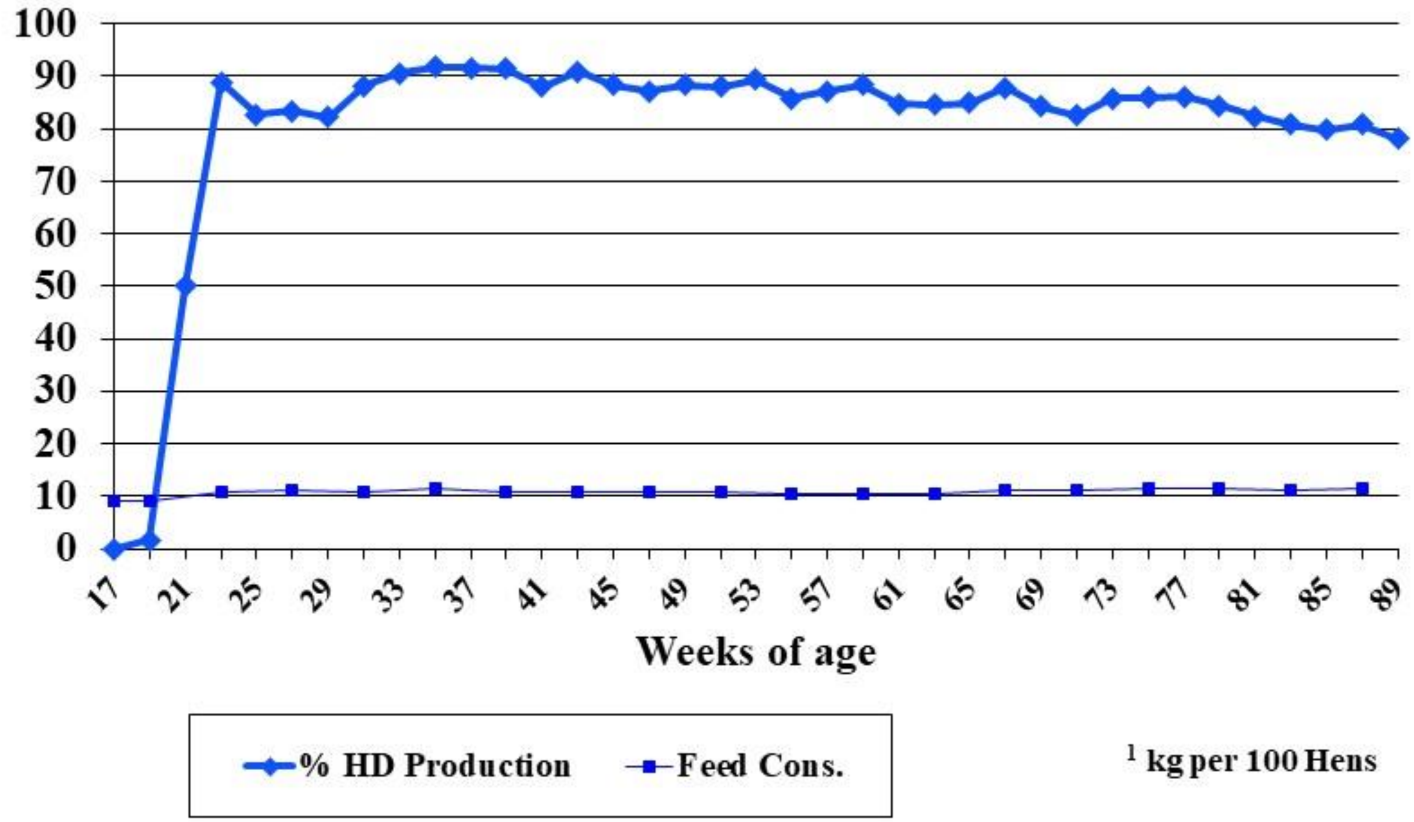
[1] kg per 100 Hens

Figure 42. Novogen Novowhite, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for White Egg Hens in a Cage-free System (177 in^2). 40th NCLP & MT.



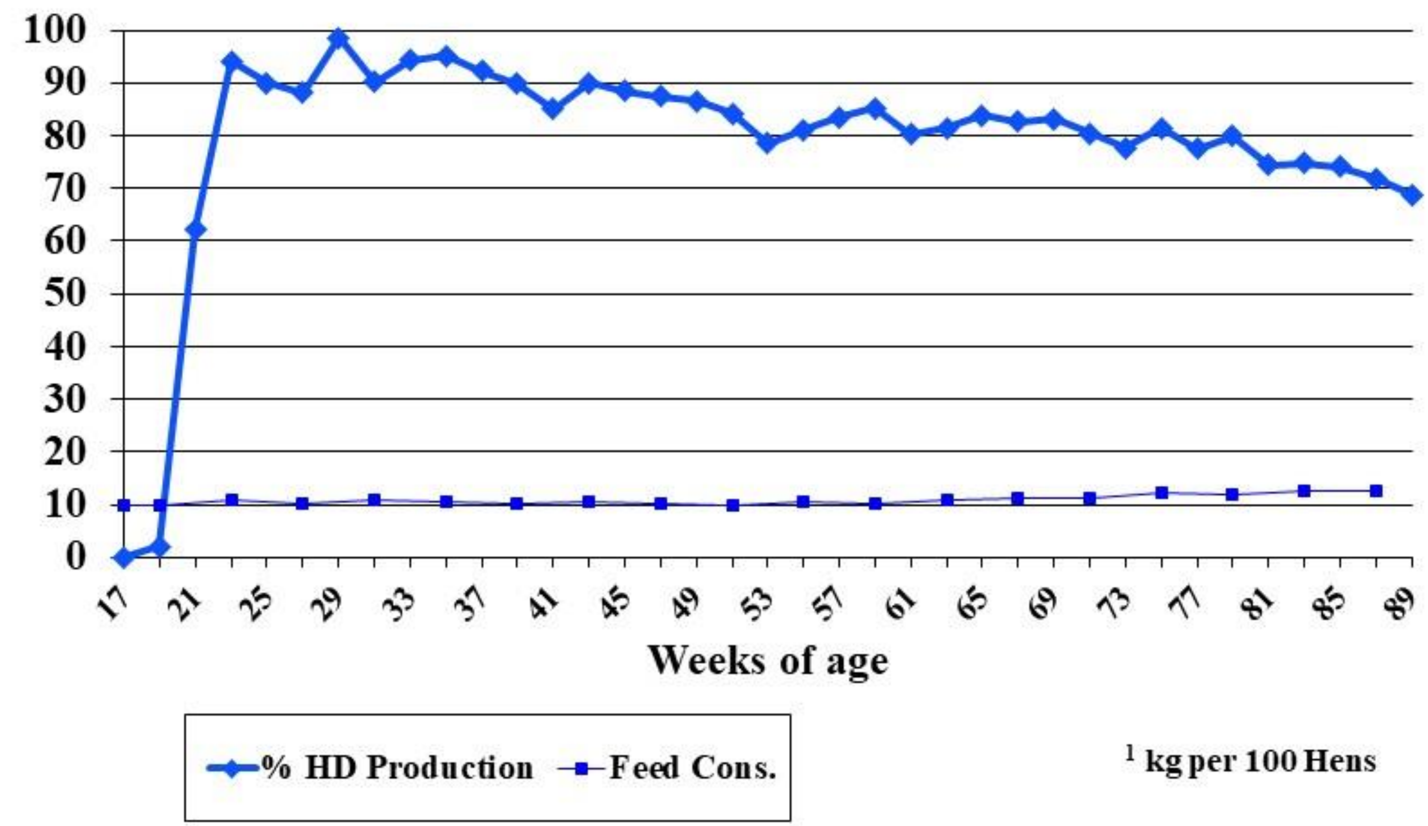
[1] kg per 100 Hens

Figure 43. Bovans Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in a Cage-free System (177 in^2). 40th NCLP & MT.



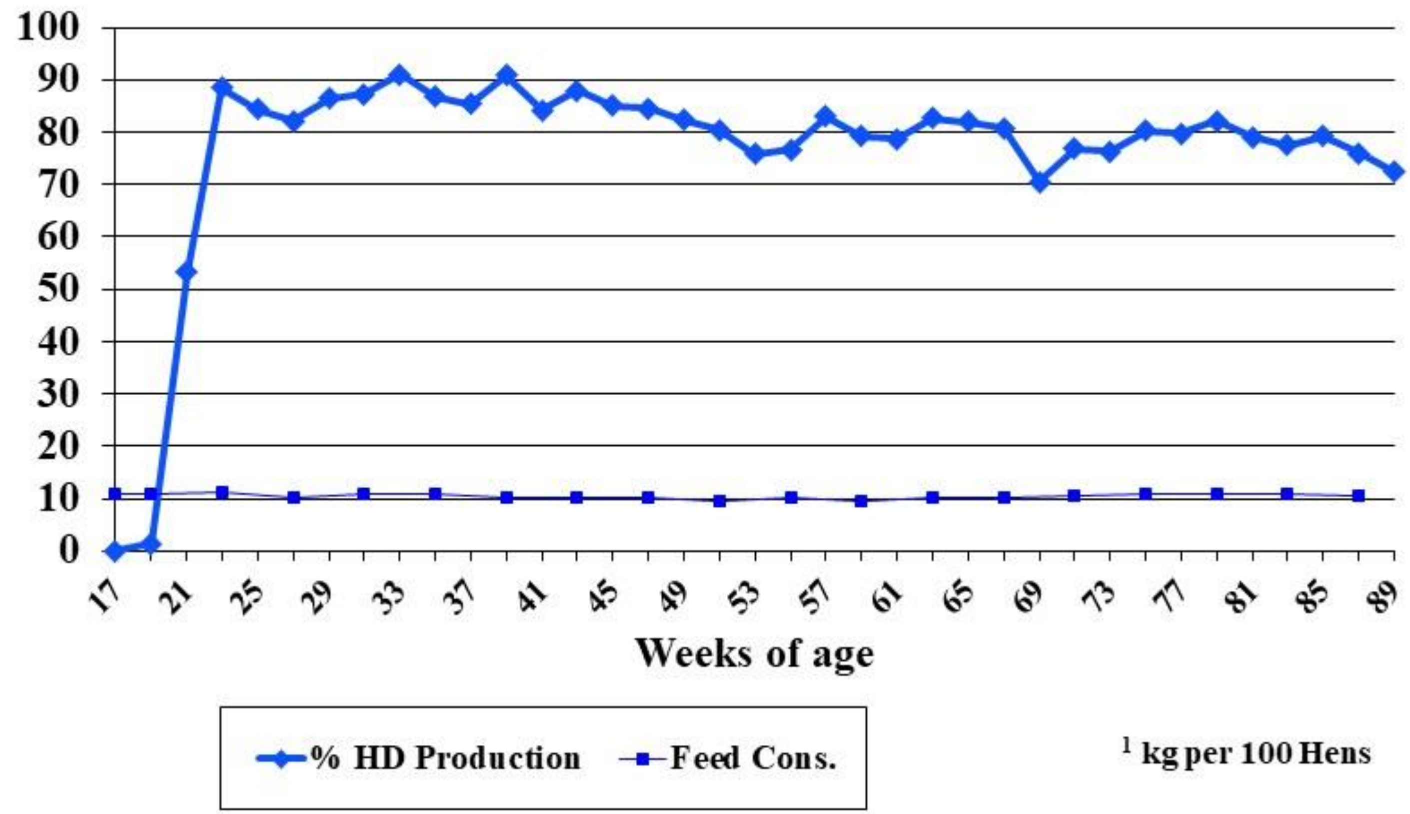
[1] kg per 100 Hens

Figure 44. ISA Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in a Cage-free System (177 in^2). 40th NCLP & MT.



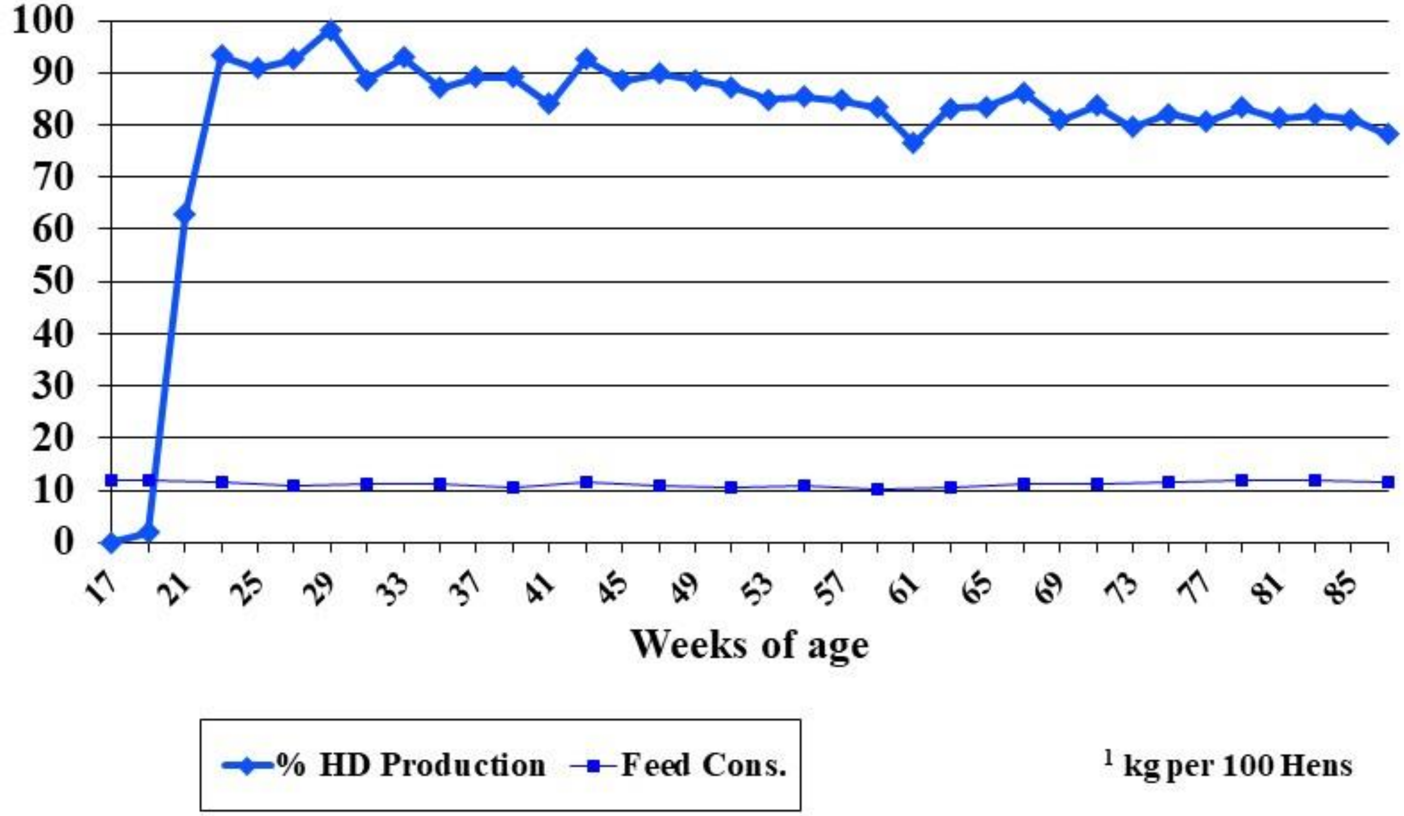
[1] kg per 100 Hens

Figure 45. Hy-Line Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in a Cage-free System (177 in^2). 40th NCLP & MT.



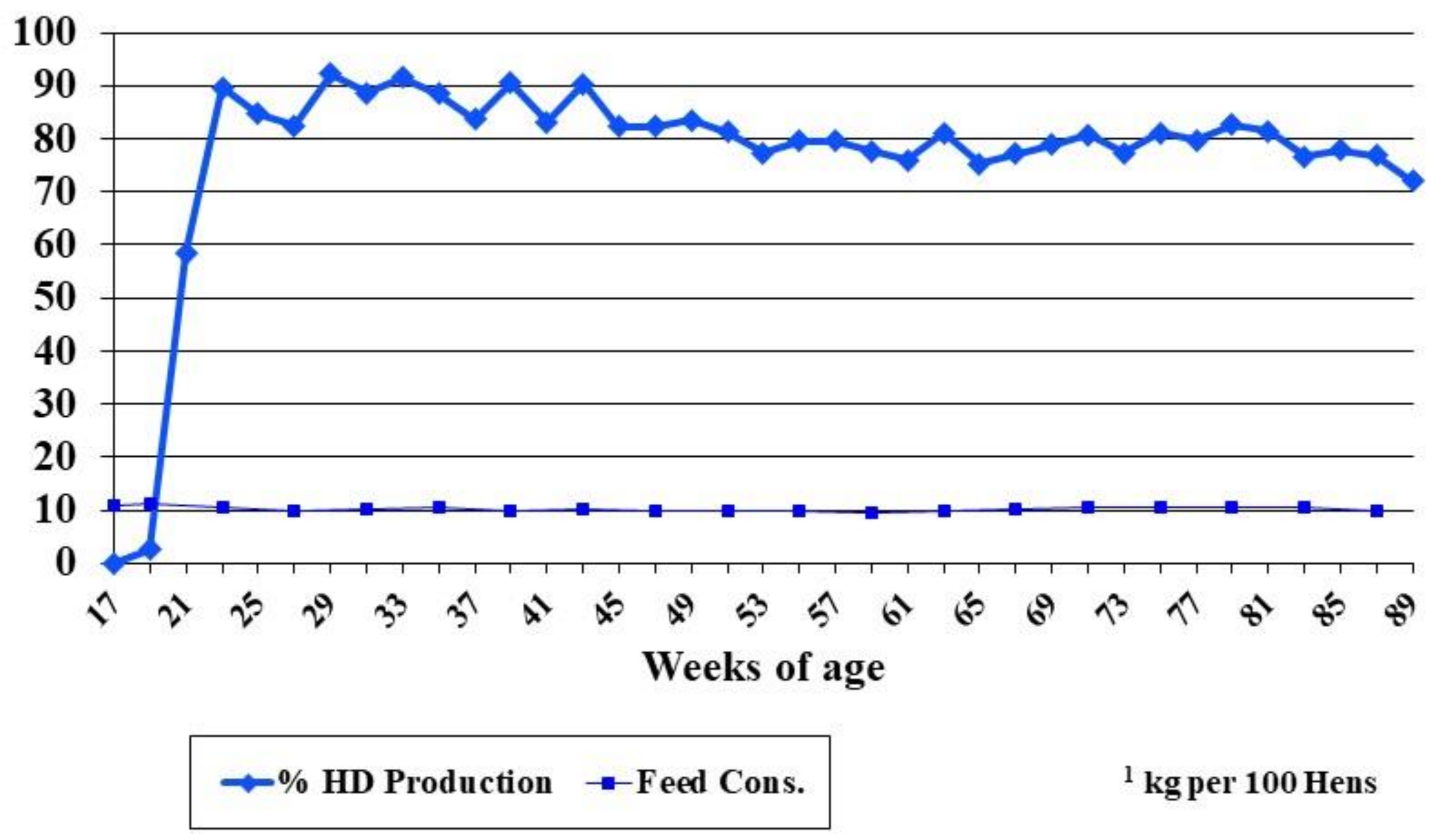
[1] kg per 100 Hens

Figure 46. Hy-Line Silver Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in a Cage-free System (177 in^2). 40th NCLP & MT.



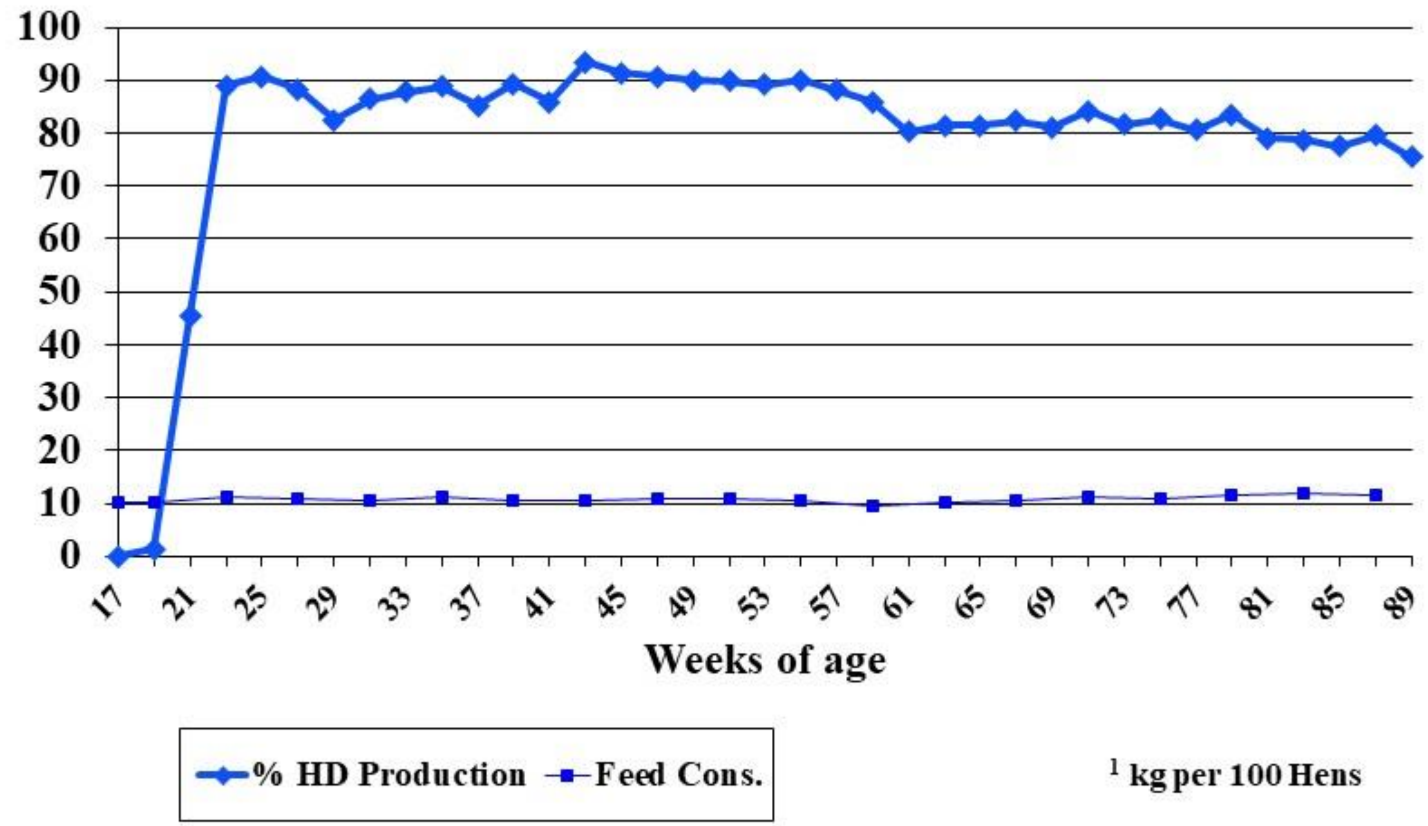
[1] kg per 100 Hens

Figure 47. Lohmann LB-Lite, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in a Cage-free System (177 in^2). 40th NCLP & MT.



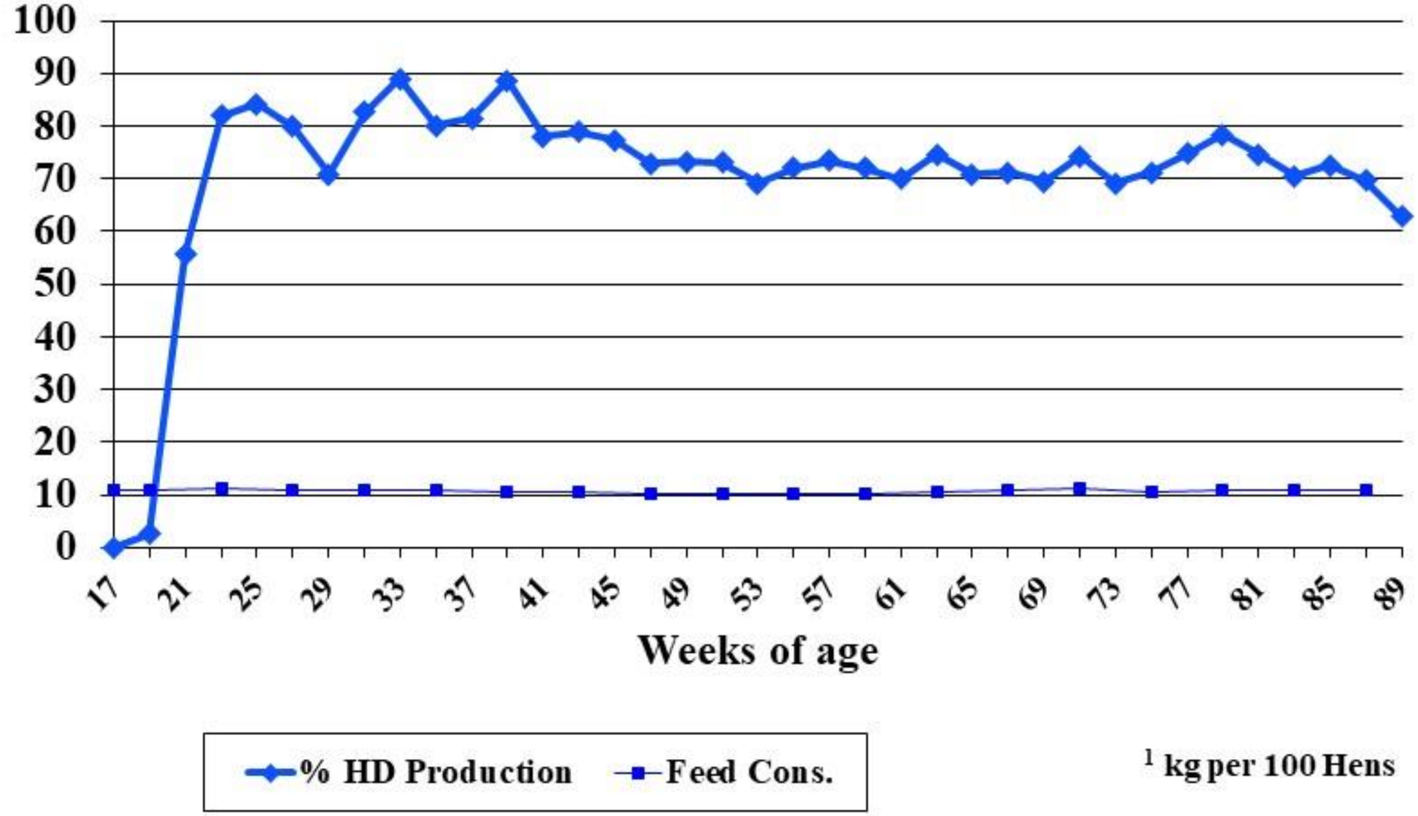
[1] kg per 100 Hens

Figure 48. Novogen Novobrown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in a Cage-free System (177 in^2). 40th NCLP & MT.



[1] kg per 100 Hens

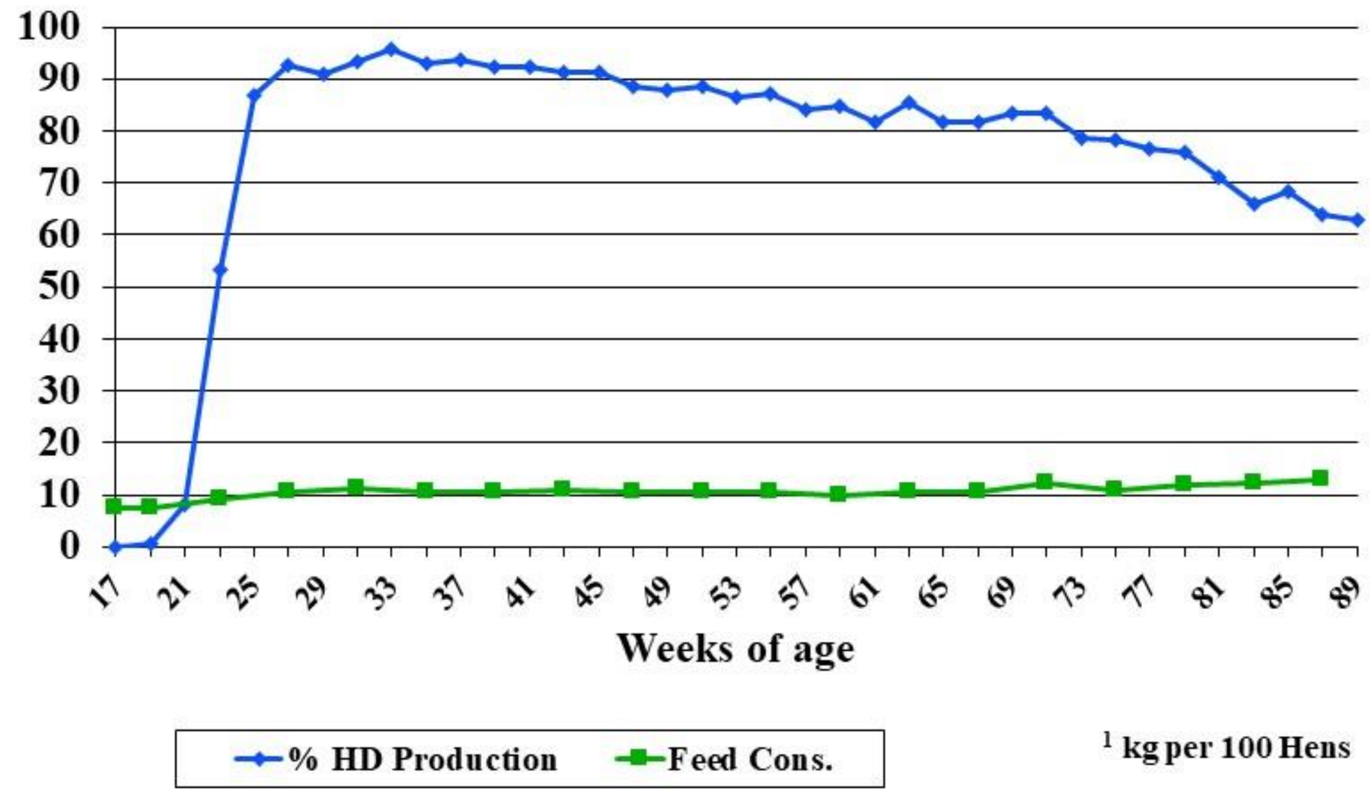
Figure 49. TETRA Americana Brown, Bi-weekly Hen-day Egg Production and Period Feed Consumption[1] for Brown Egg Hens in a Cage-free System (177 in²). 40th NCLP & MT.



[1] kg per 100 Hens

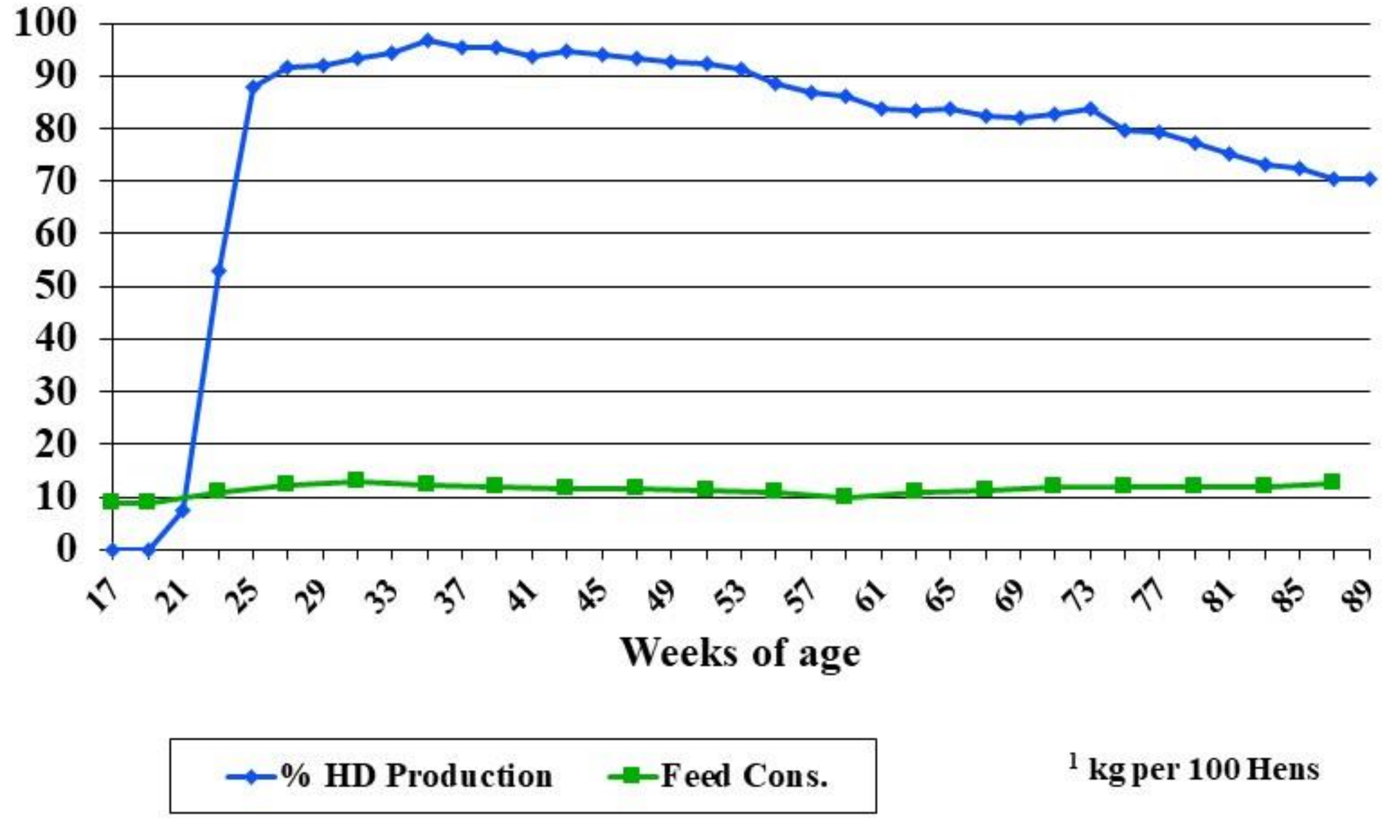
Production Figures for Laying Hens in a Free-range System: White- and Brown-egg Strains 177 in^2/hen pens (1142 cm^2/pen)

Figure 50. Hy-Line White Experimental, Bi-weekly Percent Egg Production and Period Feed Consumption[1] for White Egg Hens in a Free-range System (177 in^2). 40th NCLP & MT.



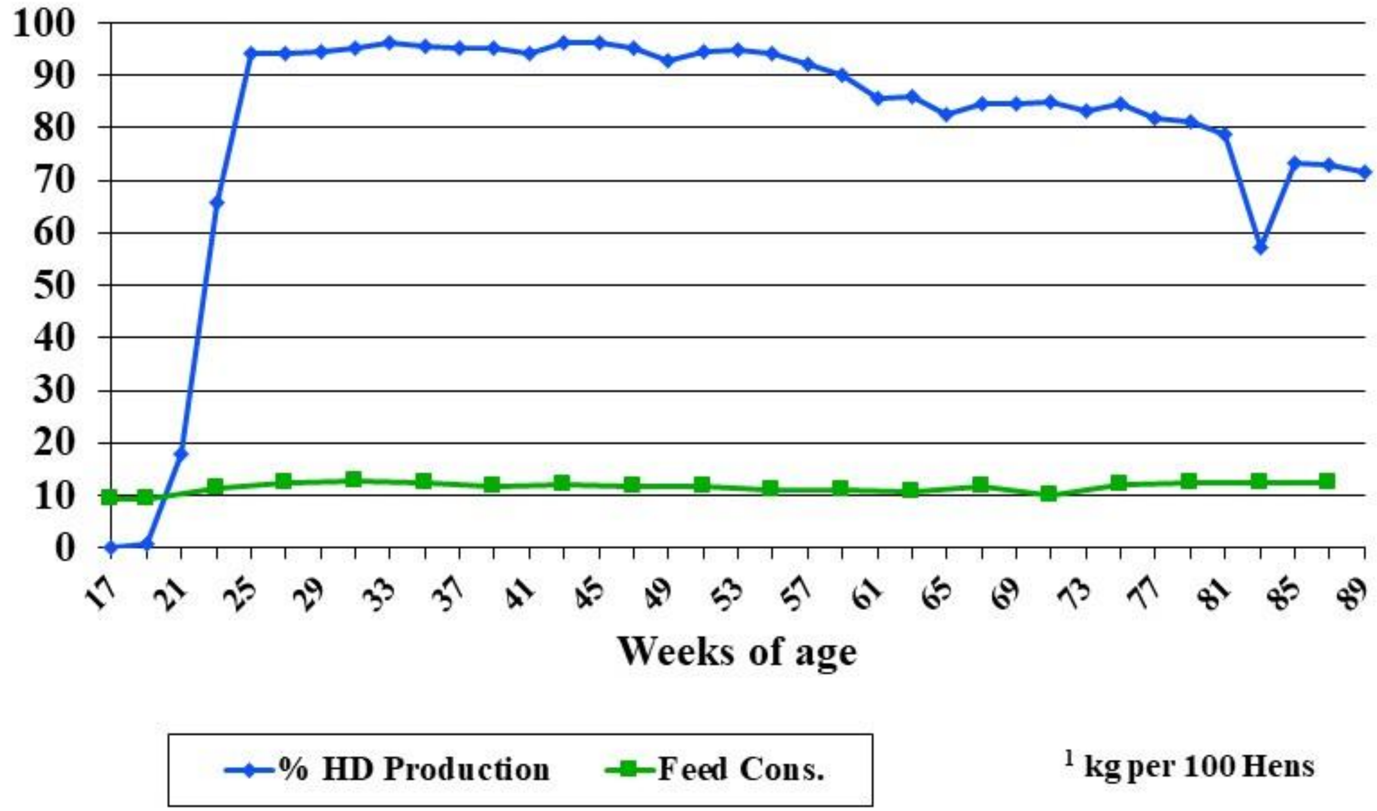
[1] kg per 100 Hens

Figure 51. Hy-Line Brown, Bi-weekly Percent Egg Production and Period Feed Consumption[1] for Brown Egg Hens in a Free-range System (177 in^2). 40th NCLP & MT.



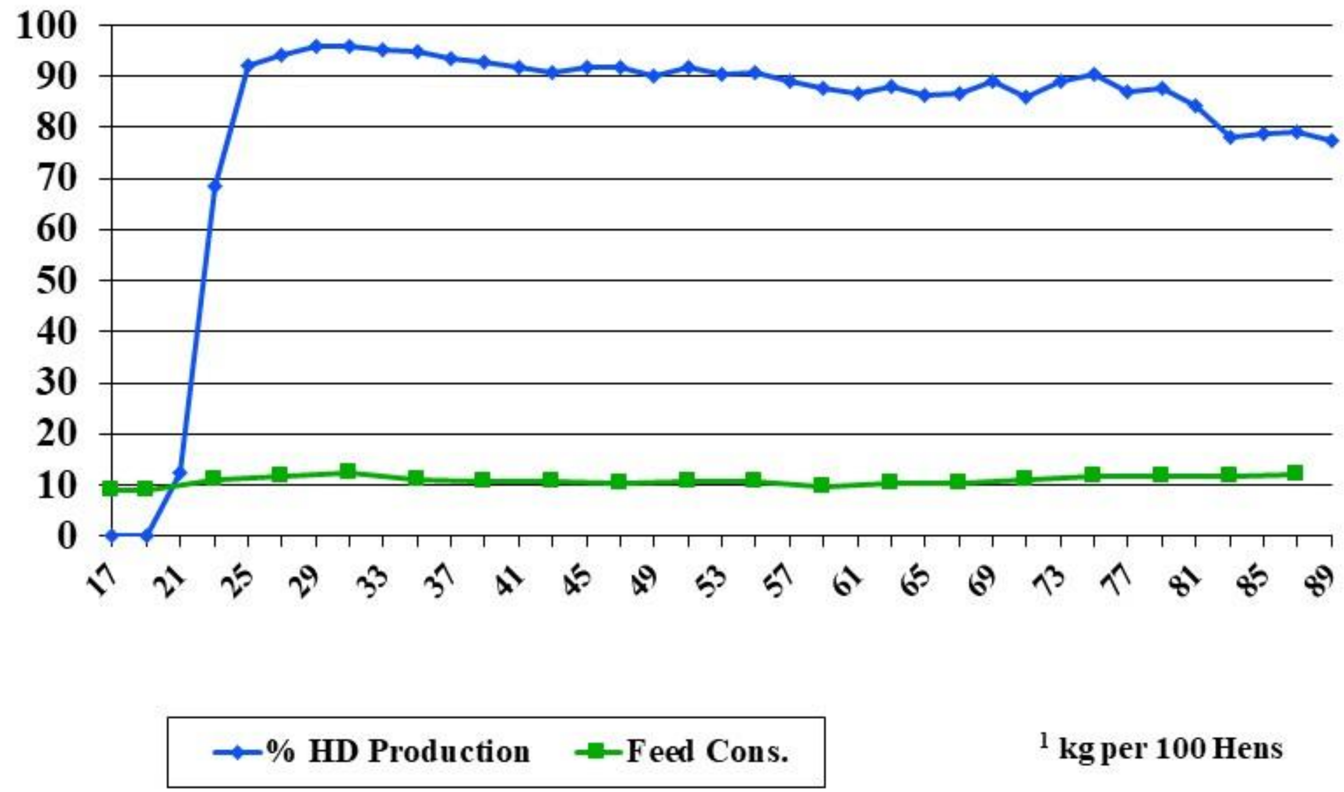
[1] kg per 100 Hens

Figure 52. Hy-Line Silver Brown, Bi-weekly Percent Egg Production and Period Feed Consumption[1] for Brown Egg Hens in a Free-range System (177 in²). 40th NCLP & MT.



[1] kg per 100 Hens

Figure 53. Lohmann LB-Lite, Bi-weekly Percent Egg Production and Period Feed Consumption[1] in Brown Egg Hens in a Free-range System (177 in^2). 40th NCLP & MT.



[1] kg per 100 Hens

Figure 54. Causes of Mortality for Layers in a Conventional Cage System as Determined by Postmortem Examination.

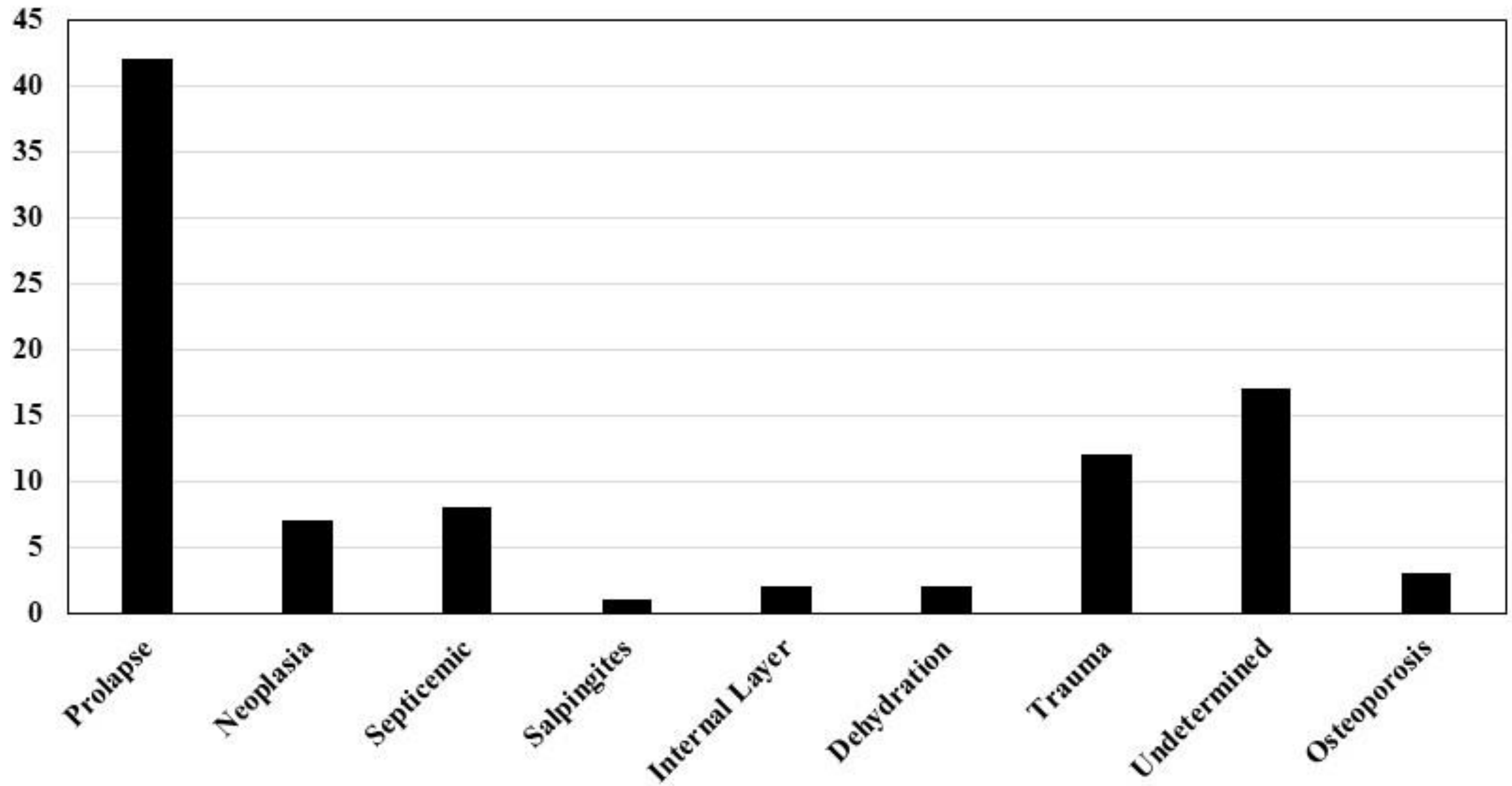


Figure 55. Causes of Mortality Combined for Layers in a Colony Housing System and an Enriched Colony Housing System as Determined by Postmortem Examination

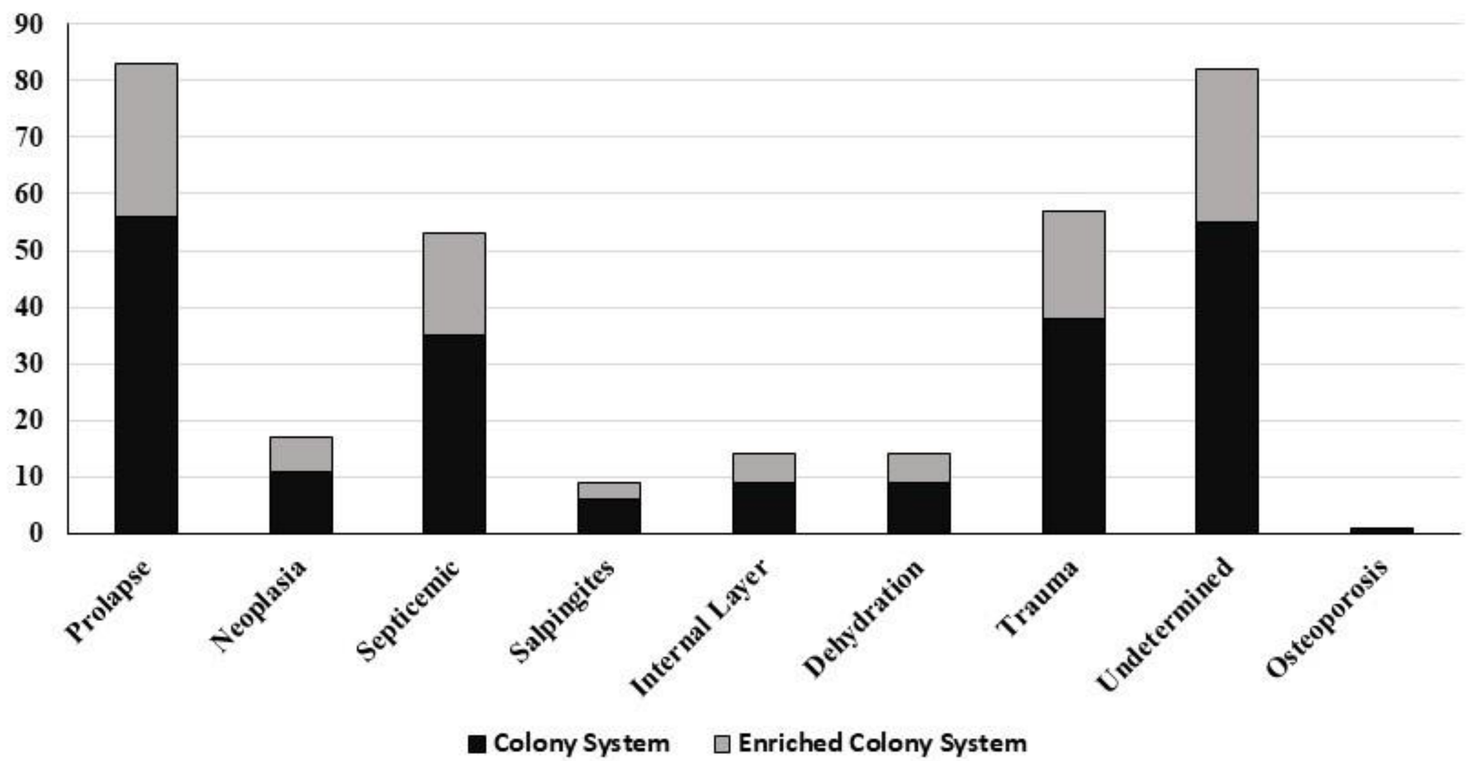


Figure 56. Causes of Mortality for Layers in a Cage-free System as Determined by Postmortem Examination

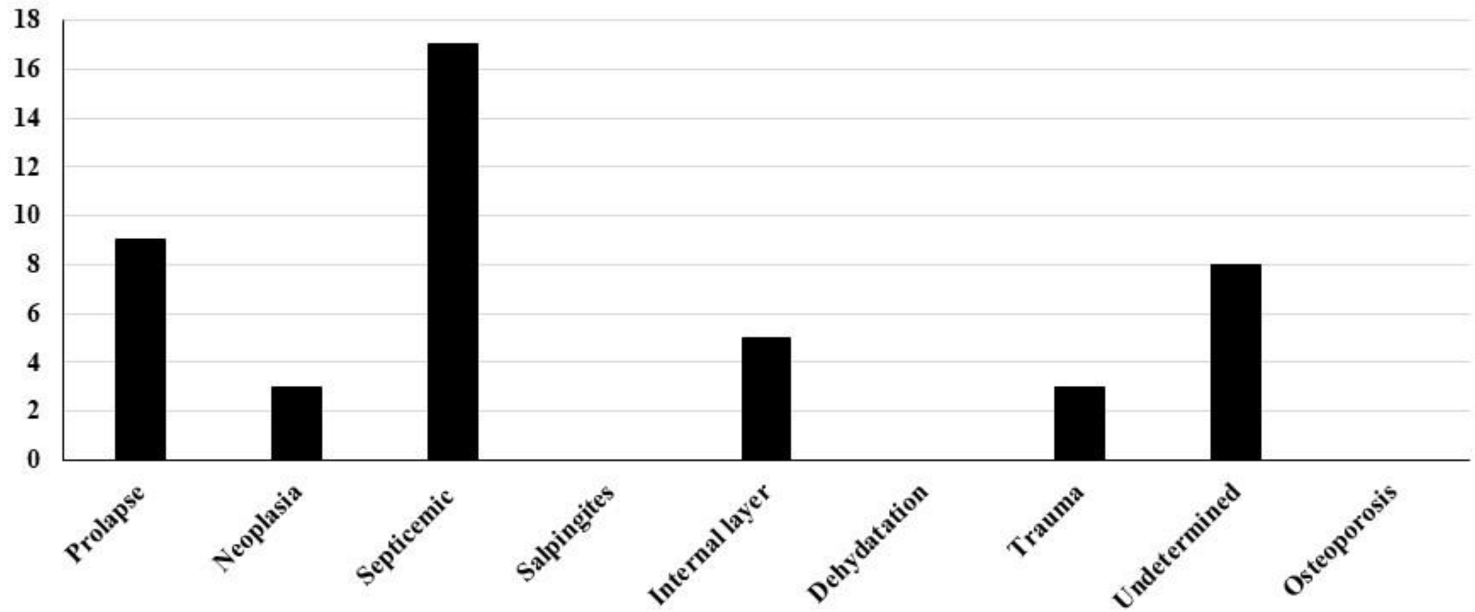


Figure 57. Causes of Mortality for Layers in a Free-range System as Determined by Postmortem Examination

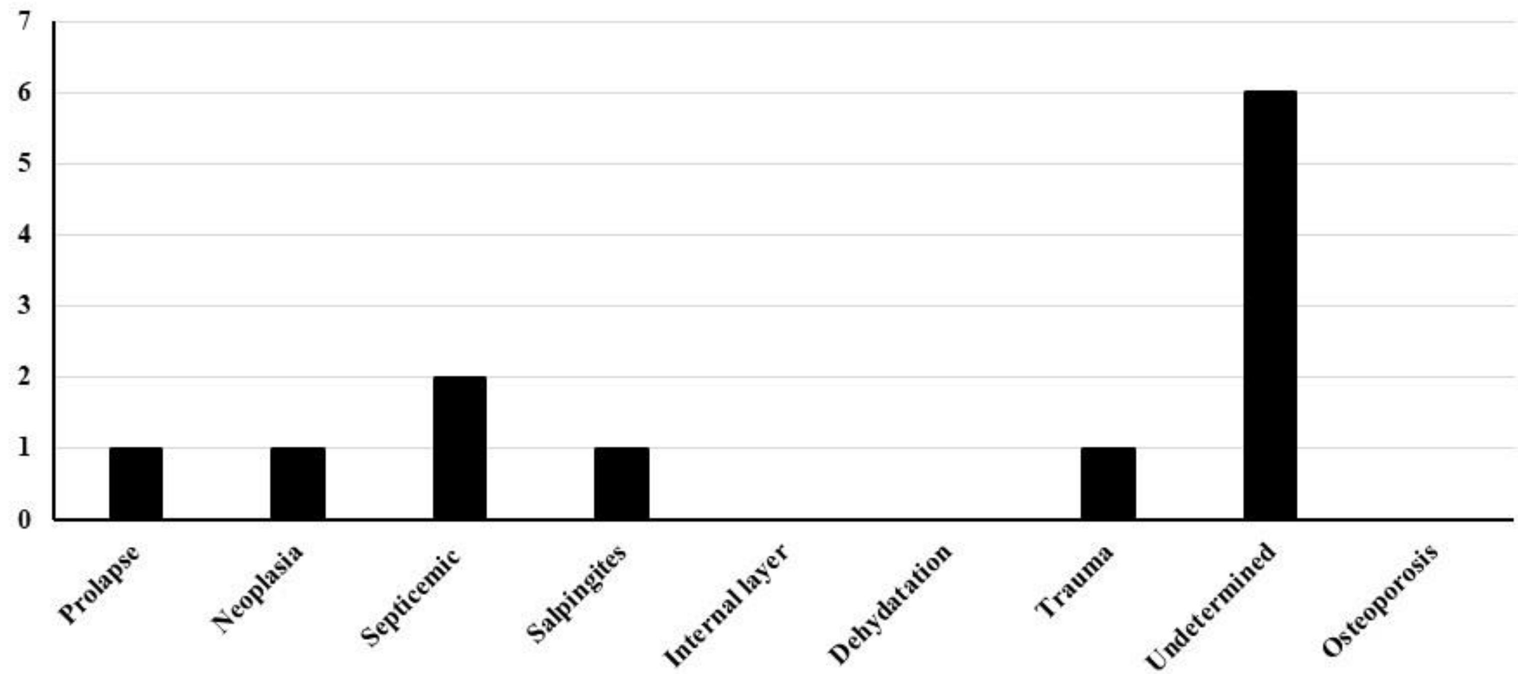


Figure 58. Summary of Causes of Mortality for Layers According to Housing System

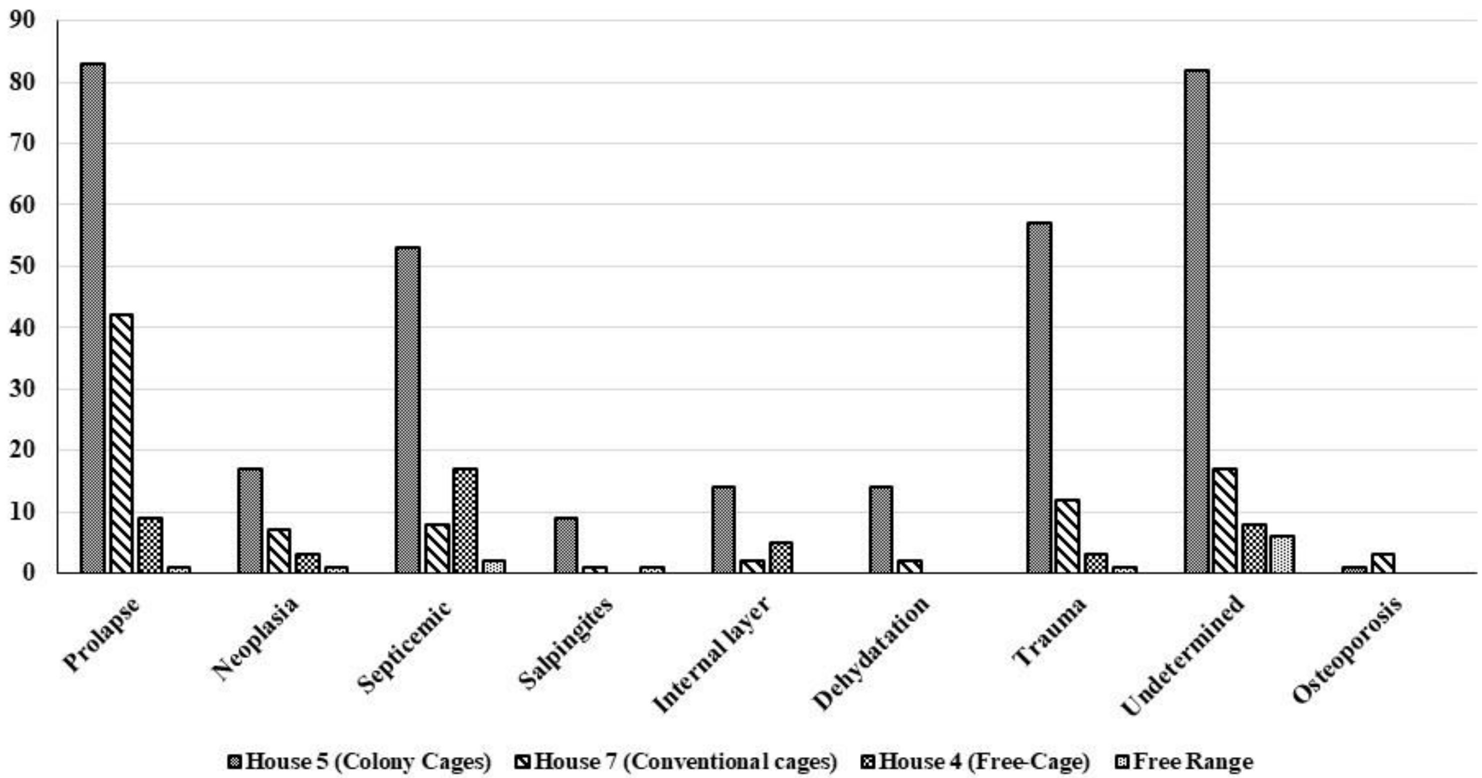


Table 39. Entries in the 40th NCLP&MT by Breeder, Stock Suppliers, and Categories

Breeder	Stock	Category[1]	Source
Hy-Line International 2583 240th Street Dallas Center, IA 50063	W-36	I-A	Hy-Line North America 4432 Highway 213, Box 309 Mansfield, GA 30255
	W-80	I-A	(Mansfield, PA)
	Hy-Line Brown	I-A	HyLine North America 79 Industrial Rd Elizabethtown, PA 17022
	Hy-Line Silver Brown	I-A	(Elizabethtown, PA)
	Hy-Line White Exp.	II-A	(Mansfield, PA)
Lohmann Tierzucht Gmbh Am Seedeich 9-11 . P.O.Box 460 D-27454 Cuxhaven, Germany	Lohmann LSL-Lite	I-A	Hy-Line North America 79 Industrial Rd Elizabethtown, PA 17022
	Lohmann LB-Lite	I-A	(Same)
H&N International 321 Burnett Ave South, Suite 300 Renton, Washington 98055	H&N "Nick Chick"	I-A	Feather Land Farms 32832 E. Peral Road Coberg, OR 97408
Institut de Selection Animale (A Hendrix Genetic Company) ISA North America 650 Riverbend Drive, Suite C Kitchener, Ontario N2K 3S2 Canada	Bovans White	I-A	Hendrix-ISA LLC 621 Stevens Rd Ephrata, PA 17522
	Dekalb White	I-A	(Ephrata, PA)
	Bovans Brown	I-A	(Ephrata, PA)
	Babcock White	I-A	Institute de Sélection Animale 50 Franklin Road Cambridge, Ontario N1R 8G6 Canada
	B 400	I-A	(Cambridge, Ontario)
	Shaver White	I-A	(Ephrata, PA)
	ISA Brown	I-A	(Ephrata, PA)
Tetra Americana, LLC 1105 Washington Road Lexington, GA 30648	TETRA Brown	II-A	BABOLNA TETRA KFT Babolna TETRA Korisvolgy1 Uraiujfalu, Hungary-EU
NOVOGEN S.A.S. Mauguérand – Le Foeil BP 265 22 800 QUINTIN - FRANCE	NOVOgen BROWN	I-A	Morris Hatchery 4090 Campbell Road Gillsville, GA
	NOVOgen WHITE	I-A	(Gillsville, GA)

[1] A = Entry requested, I = Extensive distribution in southeast United States, II = Little or no distribution in southeast United States