MANAGEMENT AND NUTRITION OF LAYING HENS BRED FOR EFFICIENT FEED CONVERSION

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Introduction

For many years, breeders of commercial laying hens have selected for increased egg output and lower feed intake. As a result, we find the expected improvement of feed efficiency in random sample tests and well managed flocks in the field. If egg producers find it difficult to achieve target early egg weights, we are reminded that 'appetite' has to be optimized, not minimized. Fortunately, laying hens have a remarkable ability to adapt their nutrient intake to requirements - provided, we help them with a combination of lighting programs, feed composition, feed structure and feeding techniques.

Communication among specialists

The **geneticist** responsible for the saleability of future generations of his company's products has to determine targets for genetic progress. This requires reasonably accurate prediction of:

- egg prices and preferred egg weight,
- feed cost and feed quality,
- age at depletion,
- marketing channels of major producers,
- changes in performance profile of competitor products.

A general breeding goal is an 'easy-to-manage' type of chicken, with a genetic appetite close to requirements under average conditions.

The **nutritionist** responsible for feed formulation typically has the prices for all available raw materials, average figures for nutrient contents of feed ingredients and 'production standards' for a flock of laying hens. To do the best possible job, he should also know and take into consideration:

- age of the flock,
- daily feed intake,
- daily egg mass output,
- body weight (relative to standard),
- actual and desired egg weight.

The **pullet grower** has more influence on the productivity of laying hens than many people realize. He or she should be experienced and dedicated, spend enough time in the growing unit to see (and smell) problems before they become critical. Essential are:

- enough feeder and drinker space,
- adequate air quality (temperature, humidity, levels of ammonia and other noxious gases),
- suitable lighting program (day length and light intensity),
- no feather pecking and cannibalism,
- normal body weight development (average and uniformity),
- adequate feather development.

Changes in day length and feed composition should be guided more by body weight than age. Seasonal effects should be balanced by specific lighting and feeding programs.

To maximize egg income over feed cost, the **egg producer** should resist the temptation to buy pullets at the lowest possible price whenever the market is oversupplied. Instead, he should buy day-old chicks of defined quality and keep in contact with the pullet grower during the rearing period to insure best possible pullet quality. The lighting program should be adapted to the specific needs of the egg producer.

Through appropriate channels, which include the service team of the franchize hatcheries, it is becoming more and more important to **communicate** between geneticists, nutritionists and farm managers. Specific management tools, lighting programs and feeding regimes must be applied to maximize egg income over feed cost in the current generation of layers.

Trends in feed efficiency

Since representative field data are not available, we use the annual reports of one of the German random sample tests, Kalkriese, to demonstrate how feed efficiency has improved as a result of higher egg output and lower maintenance requirements. As shown in table 1, the feed efficiency improved more dramatically in the brown-egg layers than in the white-egg layers as a consequence of three factors:

- selection within and between strains in both types (inefficient strains dropped out),
- relatively more selection response in the brown-egg layers for higher egg output,
- about twice as much reduction in body weight in the brown-egg layers.

Table 1: Trends for egg production, body weight and feed efficiency as documented in random sample test Kalkriese, Germany

Test-ending:	Egg Mass g/day		Body Weight kg		Feed Conversion kg/kg	
	white	brown	white	brown	white	brown
1968 - 77*	44.6	41.8	2.12	2.79	2.82	3.17
1978 - 87*	49.4	49.5	1.90	2.40	2.42	2.56
1988 - 97*	53.4	54.2	1.80	2.12	2.24	2.31
1996 / 97:						
LSL	56.1		1.70		2.11	
LB		54.9		2.06		2.13

*10-year averages for all white-egg and all brown-egg entries, respectively

The changes in net efficiency can be seen more clearly in terms of 'residual' feed consumption, i.e. the difference between actual feed consumption and calculated energy needs. Energy demand (in kcal) was calculated as follows:

for white-egg layers: $118 * BW^{.75} + 2.2 * EM/day$
for brown-egg layers: $115 * BW^{.75} + 2.2 * EM/day$

BW = body weight EM = egg mass

If we assume that the energy content of the feed was the same throughout the 30-year period as published for 1996/97 at 11.4 MJ = 2723 kcal per kg and that maintenance requirements for brown-egg layers 2.5 % lower per kg metabolic body weight (due to calmer temperament), then we can show that the improvement of feed conversion in white-egg layers and brown-egg layers involves different contributions of 'residual' feed consumption. Different selection history for different strains may support this interpretation.

As shown in table 2, actual feed consumption decreased by about 8 g in both, white-egg and brown-egg strains, whereas calculated demand remained similar in the white-egg layers and decreased by 5 g in the brown-egg layers.

Table 2: Actual feed consumption, calculated requirements and 'residual' feed consumption (g/day) corresponding to the data in table 1

Test	Actual -		Calculated =		Residual	
ending	white	brown	white	brown	white	brown
1968 - 77*	127.6	132.4	107.0	117.5	20.6	14.9
1978 - 87*	121.0	126.6	106.1	115.1	14.9	11.5
1988 - 97*	119.8	124.9	106.5	112.8	13.3	12.1
1996 / 97:						
LSL	118.4		106.3		12.1	
LB		116.7		112.7		4.0

*10-year averages for all white-egg and all brown-egg entries, respectively

The changes in residual feed consumption are even more dramatic if we look at individual strains in the last test year, 1996/97: LOHMANN BROWN (LB) consumed 4 g more than calculated requirements, whereas LOHMANN WHITE-LSL (LSL) still had a 'safety margin' of 12 g.

Without further speculation to what extent feed quality remained constant over the 30-year period and whether the prediction equations for energy demand are realistic for today's highly efficient layers, it seems reasonable to conclude that the 'safety margins' for adequate nutrition generally have become narrower as a result of reduced genetic appetite. Consequently, efforts to optimize feed quality, in terms of balanced composition and structure, have to be intensified.

Priorities in case of nutrient deficits - pullet management

When we investigate possible deficits in the nutrition of laying hens, we should not only know flock average consumption, but keep in mind variation between individual hens. Although we seldom know the individual feed intake, we can assume that there is considerable variation around the mean: some hens will eat more than they 'need', others not enough. In case of insufficient nutrient intake, we can observe the following reactions:

- **egg weight** does not increase according to age-related standard and may be more variable than normal,
- **body weight** does not develop according to age-related standard,
- hens may appear nervous, frequently in combination with poor feather cover (feather pecking),
- in extreme cases, a percentage of hens will pause production until requirements are met.

Efforts to stimulate feed intake of laying hens with genetically reduced appetite has to start from the beginning of pullet growing:

- individual weights should be recorded at least every two weeks to monitor the growth curve and uniformity,
- lighting program according to season, desired sexual maturity, feather development and body weight of individual flock,
- change of rations (from chick starter to grower to pullet developer to pre-lay) according to body weight and uniformity, not simply on age,
- vaccination program adapted to local conditions and expected disease pressure in laying farm.

A slow step-down lighting program delays sexual maturity and supports higher early egg weight. Feed intake towards the last weeks of rearing is usually higher if the feed trough is empty for at least one hour per day. If necessary, remove left-over feed with fine structure and supply fresh feed with desired coarse structure to support gizzard development. A uniform flock of pullets on 'standard' body weight at point of lay will seldom develop problems with insufficient appetite during the laying period.

Nutrition during the laying period

To minimize the stress connected with moving pullets to the laying unit they should be transferred before the first eggs are laid. Many egg producers in Germany with multiple age farms still prefer pullets to be housed as late as possible, i.e. at about 19 weeks of age. In other European countries, pullets are mostly housed at about 17 weeks of age. We recommend to change to “pre-lay” feed as soon as the first eggs are found in a flock and continue with it until about 5 % production are reached in the laying farm. It is part of good flock management to plan feed deliveries carefully depending on flock development. During the most critical period of start of lay the feed bin should never contain feed for more than a 5 to 6 days. This helps to switch from developer to pre-lay to “start-lay” feed at the optimum stage of development.

The nutrient requirement of a pullet during the first 6 to 8 weeks following the first egg is significantly lower than at peak egg mass production. Therefore it makes little sense to change from “pre-lay” feed immediately to a classical Phase I-feed which covers the requirements of peak egg mass production. We recommend to use a “start-lay” feed and switch to phase feeding when peak egg mass is reached (at about 28 weeks of age).

Feed intake is regulated by biochemical processes which can be visualized as a 'dialogue' between animal and feed. Endogenous control mechanisms like hormones and the nervous system are involved. When we try to overcome apparently insufficient appetite, we need to keep the following physiological facts in mind:

- the 'starvation' centre in the brain is suppressed by the 'satiety' centre,
- an excess of serotonin is produced by the pituitary; since tryptophan is a main component of this hormon, excessive tryptophan content of the feed might reduce

feed intake,

- overproduction of the digestive hormon Cholecystokinin (CCK) lowers appetite due to increased enzyme production of the pancreas,
- the plasma glucose level is a reliable indicator of satiety; diets high in starch and poor in fat quickly increase the glucose level and lower appetite,
- low-energy, low-fat rations lead to the depletion of body fat (catabolic metabolism), which is critical especially at point of lay,
- fine feed structure inhibits feed intake; chickens prefer a mix of different particle sizes so that they can 'select' what they need according to the present status of metabolism,
- **severe** imbalance of essential nutritients (energy, protein, amino acids, calcium etc.) is recognized by the hen and leads to reduced feed intake.

Recommendations for feed formulation

The nutritionist has to concentrate on the objective to meet the nutrient requirements of a specific flock of laying hens.

To support the genetic potential for high egg output, it is necessary to increase feed intake from the end of the growing period to peak production as fast as possible. The compound feed manufacturer has two main tools to design feed in the desired quality: choice of suitable feed stuffs and choice of the sieves. Corn and wheat are generally good sources of energy, their structure favours the development of young hens' appetite. Barley in mash diets causes an undesirable (fine) feed structure and should only be used in significant amounts where layer feeds are crumbled after pelleting. Feedstuffs with consumption depressing effects (e.g. field beans) should be excluded from diets for young layers.

A **"start-lay" feed** for the first 8 to 10 weeks of production should be designed as follows:

- coarse mash, with high grain content,
- at least 2.0 - 2.5 % **added** fat to bind fine particles,
- at least 11.6 MJ/kg energy,
- crude protein not higher than 18 %,
- sufficient levels of methionine/cystine, lysine, threonine and tryptophan,
- max. 3.5 % Ca, coarse structure,
- min. 2.0 % linoleic acid.

Phase feeding has been recommended by nutritionists since many years. In the USA, 6 to 8 different rations are not uncommon to maximize egg income minus feed cost. In other parts of the world, including Europe, phase feeding is progressing in well managed all-in, all-out farms. Multiple-age farms with currently only a single silo for one type of layer mash should review the benefits of fewer age groups and at least one silo for each age segment. The investment in an additional silo may pay back quickly as a result of higher egg income, lower feed cost and improved egg quality.

Summary and conclusion

Successful selection for higher egg output and lower feed intake calls for revised concepts of management and nutrition for growing pullets and laying hens.

In order to fully utilize the economic potential of current generation layers, the following points are stressed:

- step-down lighting program to delay sexual maturity (if higher egg weight is desired),
- pullets with good average body weight and uniformity before start of lay,
- "pre-lay" and "start-lay" feed to stimulate appetite in the critical period up to peak production,
- phase feeding during the laying period to meet nutritient requirements more precisely and support persistent shell quality.

Today's laying hens are not bred for recycling waste products, but to produce quality eggs for human consumption. Efficient transformation of quality feed to quality eggs remains a challenge for geneticists, nutritionists and egg producers. Close communication among them is necessary to keep up with changing market requirements.