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Achieving sustainable production of eggs

Volume 2: Animal welfare and sustainability

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Introduction

The welfare of laying hens is dependent on the provision of appropriate housing, excellent management, high-quality feed, and prevention and appropriate treatment of diseases. This volume, 'Achieving sustainable production of eggs Volume 2: Animal welfare and sustainability', provides a detailed account of laying hens' nutritional requirements and a practical guide to maintaining their health. The welfare of hens is addressed by examining their welfare standards, identifying and discussing welfare issues affecting free-range laying hens, reviewing the welfare costs and benefits of beak trimming, and investigating the management of laying hen flocks with intact beaks. The sustainability of the egg industry is addressed from two perspectives: waste management in egg production and an assessment of the sustainability of organic egg production.

Part 1 Animal health and welfare

The major economic cost in commercial egg production is the provision of an appropriate diet for hens both during the rearing and during the laying stages. The scientifically formulated diets of hens should meet all their nutritional requirements, at the same time making use of cost-effective feed ingredients. Chapters 1 and 2 provide a detailed account of the nutritional requirements of laying hens, with an emphasis on how to meet the industry goal of keeping flocks in production for a longer period – up to 100 weeks of age. **Chapter 1** reviews ways of optimising energy intake to achieve high production and the desired egg size and weight. The importance of nutrition during the rearing period is stressed as this has a lasting impact on subsequent hen performance. Egg production commences when the pullet is still undergoing its final stages of growth, including the development of the gastrointestinal tract. This competition for energy expenditure between growth and egg production requires careful balancing of the hens' diet. Breeder company's recommendations should be followed for the different phases during rearing, pre-lay and production, in order to optimise egg production, persistency and longevity. Attention must be paid to body weight and its uniformity at all hen ages. Modern hens tend to eat too little at the onset of lay but can be trained to eat more by including 5–6% crude fibre in the developer diet and by varying particle size. During the laying period, and in particular in extended production cycles, the challenge is to supply feed adjusted to energy and protein requirements to optimise egg production, and in particular egg weight, for commercial profitability, without increasing body weight and fatness. During the laying period, feed intake can be manipulated by adjusting energy concentration, particle size and diet texture. Egg weight is influenced by energy concentration, as well as dietary lipids, proteins and amino acids. Hens' diet can be based on a range of cereals and other protein sources including corn, soya bean, wheat, barley, sorghum, dried distiller's grains and solubles, peas, faba beans, white lupin, sunflower meal, cottonseed meal, rapeseed and even insects. Alternative, non-cage production systems, including organic production, pose particular requirements with respect to diet.

Chapter 2 concentrates on optimising hen's performance, bone quality and eggshell quality, with particular attention being paid to calcium, phosphorus, vitamins and minerals, fatty acids and yolk pigments, as well as dietary means of reducing the incidence of metabolic diseases (hepatic steatosis, osteoporosis, keel bone disorders, feather picking).

Calcium and phosphorus are critical requirements in the diets of laying hens, and the ratio of these two minerals is also of importance. Eggshells contain a high percentage of calcium, and bone contains both calcium and phosphorus. Providing sufficient phosphorus in diets devoid of meat/bone or fishmeal can be enhanced by the use of phytase enzymes, which make available more of the phosphorus contained in plant ingredients. The size of calcium particles is a critical factor during egg production, with at least two-thirds of large particles (1–2.5 mm for low solubility particles, 2–4 mm for highly soluble particles) being recommended in the diet. Vitamin D is important in calcium metabolism, and the use of these metabolites may enhance shell quality. Vitamins K, E, C and A also play vital roles. Magnesium and trace minerals such as copper, zinc, manganese and boron are required for optimal performance. Proprietary additives may, under some circumstances, provide beneficial effects. As birds cannot synthesise carotenoids, yolk colouration depends directly on the level of carotenoids consumed by the hen, its intestinal transfer efficacy, and the chemical composition of the carotenoid source, which determines its colouring capacity. In commercial production, carotenoids, natural or synthetic, are commonly added to the feed. The role of nutrition in the occurrence and prevention of metabolic diseases such as hepatic steatosis, osteoporosis, keel bone disorders and feather picking is discussed.

Chapter 3 provides an overview of the welfare of laying hens. Societal concerns about hen welfare have resulted in a trend away from conventional cage systems towards enriched cages and non-cage production systems in many countries. This has been driven mainly by concerns about confinement of hens and about the ability of hens to carry out natural behaviours such as nesting and dust bathing. However, all types of production systems represent a trade-off between welfare costs and benefits. Evaluation of the welfare of laying hens requires definitions and methods of measuring welfare. The authors point out that the scientific assessment of animal welfare involves multiple measures that capture different viewpoints on what constitutes a good quality of life for animals. These include measures of health and biological fitness (e.g. physical condition, mortality, production and indicators of stress), the emotional or subjective experiences of animals (e.g. conditions leading to pain, fear, discomfort, reward and pleasure) and the ability to perform natural or species-typical behaviour patterns. Conceptual frameworks for animal welfare are continuously evolving. The welfare trade-offs inherent in the different types of production systems are discussed. Conventional cages result in high levels of health and hygiene and low levels of mortality, but prevent birds from moving around freely and engaging in some natural behaviours. Non-cage systems permit birds to move around more freely, but increase the risks of injury and poorer health. Behavioural requirements of laying hens are assessed in a range of ways including preferences, strength of motivation and the extent to which a hen exhibits signs of negative mental state if she cannot access a resource or perform a behaviour. Four commonly agreed-upon behavioural needs of laying hens are nesting, foraging, dust bathing and perching. Injurious pecking can be influenced by environmental factors, nutrition, genetic predisposition, physiological states and rearing environments. Once it occurs, it can be controlled by two main means – beak trimming and dim lighting. However, beak trimming has its own welfare concerns, as discussed in Chapter 6. Poor skeletal health is a serious welfare issue for laying hens. The high rate of egg production means that laying hens have one of the highest rates of calcium turnover of any animal. Optimising calcium availability and metabolism and facilitating load-bearing exercise, as well as genetic selection, are key to prevention of osteoporosis in hens.

Chapter 4 focuses on welfare standards for laying hens. Laying hen production systems are categorised differently in different countries. In the European Union (EU), Council Directive 1999/74/EC categorises the common laying hen systems into three groups: alternative, un-enriched cage and enriched cage systems. This directive required the adoption of enriched or colony cages ('colony' cages in the United Kingdom house between 40 and 80 birds) in place of conventional cages. The European Food Safety Authority Scientific Opinion Statement reports on animal-based measures to assess the welfare of animals. In the United Kingdom, welfare standards include the Farm Animal Welfare Council, the British Egg Industry Council 'Lion Code', the Royal Society for the Prevention of Cruelty to Animals Freedom Foods Laying Hen Standard and AssureWel and Welfare Quality®. Global standards include the World Organisation for Animal Health (OIE) (Office International des Epizooties) Terrestrial Animal Health Code. Different mechanisms are in place to enforce implementation of the welfare standards. Consumers and supermarket chains have considerable influence in determining welfare standards. However, consumers are not always consistent in making purchases in line with the welfare standards they say that they support. AssureWel has identified the following as important indicators of hen welfare: feather loss, bird dirtiness, beak trimming, antagonistic behaviours, flightiness, birds needing further care and mortality. Welfare Quality® collects welfare data under the headings: good feeding (absence of prolonged hunger and absence of prolonged thirst); good housing (comfort around resting, thermal comfort and ease of movement); good health (absence of injuries, absence of disease and absence of pain induced by management procedures); appropriate behaviour (expression of social behaviours, expression of other behaviours, good human–animal relationship and positive emotional state); and classifies these categories as excellent, enhanced, acceptable and not classified. Welfare Quality® specifies what indicators need to be used and the order in which they are assessed on-farm.

Chapter 5 reviews welfare issues affecting free-range laying hens. Definitions of 'free range' vary among and within countries. They may involve static sheds with an outdoor area or mobile sheds that are rotated around pasture. Regulations or guidelines vary between countries in relation to indoor/outdoor stocking density, flock size, age of first access, daily hours of available access and so on, and in some cases, independent auditing bodies will have further stipulations (e.g. shelter on range) for certification labels. However, the international consensus is that free-range hens need daily access to outdoor open-air runs. The areas of major welfare concern for free-range laying hens reviewed in this chapter include individual differences in range use, behavioural expression on the range, correlations between ranging and health variables, parasite loads, adequate nutrition, grass impaction, feather pecking and cannibalism, and predation. Each of these issues were addressed in detail and, where possible, preventative measures suggested.

Chapter 6 reviews the costs and benefits of the commercial practice of beak trimming, which is a procedure routinely applied in the egg industry to prevent feather pecking and cannibalism. The traditional method of trimming by application of a hot blade (HB) has been superseded by infrared (IR) beak trimming. Both methods are associated with acute pain, but there is evidence that IR trimming has welfare advantages over HB trimming. In the past, HB beak trimming in early life was sometimes followed by a second trim in adulthood, but IR trimming is only applied to chicks. Bird-to-bird pecking has been categorised into five types: aggressive pecking, gentle feather pecking, severe feather pecking, tissue pecking and vent pecking. Although repeated aggressive pecks can cause feather and tissue damage, various studies have demonstrated that feather pecking and

aggressive pecking have different underlying mechanisms; however, there is evidence of a genetic correlation between the two. There is general agreement that damaging feather pecking is related to foraging. Injurious pecking in laying hens remains a complex and intractable problem, and unpredictable pecking outbreaks are more likely and more severe in intact beak flocks. Beak trimming is still the most effective preventative strategy available, while it remains the case that injurious pecking cannot be reliably controlled under commercial conditions, and the author concludes that the welfare costs imposed by IR beak trimming are probably justified. Considerable research has been conducted into the welfare impacts of beak trimming. HB trimming causes initial acute pain followed by a period of more chronic pain. It also results in the formation of scar tissue and neuromas, which may result in chronic pain. IR trimming is conducted by application of a localised, non-contact IR heat source, which results in necrosis of the affected area causing loss of the beak tip within 2–3 weeks following treatment. The author summarises the advantages of IR over HB as: the beak tip gradually erodes, giving the bird time to adjust to the new beak shape, which may improve pecking accuracy and feeding efficiency; the process eliminates the presence of open wounds following trimming, preventing bleeding and reducing the risk of inflammation and infection; the automation and standardisation of the process reduces variability and the risk of human error or inappropriate handling. The effects of HB or IR on production parameters are not always consistent. Beak trimming usually results in reductions in damaging pecking and improved plumage but may also increase feed wastage and reduce the effectiveness of preening in removing ectoparasites. Research is continuing into alternative strategies to reduce the need for beak trimming.

Chapter 7 provides an excellent practical guide to maintaining the health of laying hens. Biosecurity is a critical factor in maintaining healthy flocks and the author categorises factors into separation, people, traffic control, equipment and vehicles, air, feed and water. Where possible, hens of different ages should be housed separately from one another and this can be facilitated by having breaks or buffer zones between housing facilities. Staff should enter the 'dirty' side of the farm or building, shower and then enter the 'clean' side before changing into coveralls, boots and hair coverings that are specific to that location. Birds should be reared separately from pets and pests that may be capable of transmitting diseases. Keeping the areas around poultry houses free from overgrown vegetation and use of rodent bait stations are standard precautions. All movements of people and vehicles should be strictly controlled and disinfection procedures followed. Detection of disease within a flock can be challenging, so staff need to be familiar with the symptoms of possible diseases in the flock. Common poultry diseases are respiratory diseases (e.g. infectious bronchitis, Newcastle disease, infectious laryngotracheitis, *Mycoplasma gallisepticum*, collibacillosis and infectious coryza), diseases of the nervous system (e.g. Marek's disease and Newcastle disease) and gastrointestinal diseases (e.g. coccidiosis, focal duodenal necrosis and intestinal parasites such as tapeworms and nematode worms). Other diseases of concern are the skeletal system disorder osteomalacia, urogenital system diseases such as gout and urolithiasis, fatty liver syndrome, vent prolapse and cannibalism, mites and egg production drops caused by avian encephalomyelitis. Vaccination is a critical tool in preventing disease in layer flocks and can be applied by a variety of methods: spray, in drinking water or by subcutaneous injection.

Chapter 8 reviews ways of managing flocks with intact beaks and complements Chapter 6. Chapter 8 further discusses the nature and causes of feather pecking as a good understanding of the underlying causes that are critical to identification of ways to prevent this potentially damaging activity. The author points out that beak trimming will

not necessarily prevent pecking but rather reduces the amount of damage that pecking can inflict on other birds. Some clues can be obtained from observations of chickens in semi-wild situations. A genetic association appears to exist between fearfulness and feather pecking and there is evidence of an association for stress and feather damage between parents and offspring. Good management focuses on the prevention of the onset of feather pecking as, once it starts, it is very difficult to control. Rearing conditions are of vital importance with factors such as presence or absence of litter, stocking density, the complexity of the environment, climatic conditions, light intensity and feed (e.g. nutritional completeness and particle size). The transition period from the rearing facility to the layer house is also critical. Factors affecting feather pecking in the laying period are similar to those for rearing but the laying period is of a much longer duration. Type of housing, environmental enrichment, access to a free range, feed characteristics, management (particularly changes in management), light intensity, health status and ventilation all influence the incidence of negative pecking behaviours and need to be carefully controlled and monitored.

Part 2 Sustainability

Chapter 9 reviews waste management associated with commercial egg production. Wastes that need to be managed include manure, bird mortalities, egg washing and processing wastewater. Most of the nitrogen in poultry manure is contained in urea, uric acid and undigested protein; when these compounds are broken down, they release ammonia. Ammonia production from manure is influenced by strain, production system, ventilation, feed consumption, body weight, duration of egg production and egg size. Frequency of removal of manure from the housing system also plays a role. Manure may be stored for a period prior to distribution or further processing. Mortalities can occur as a result of diseases, accidents or natural disasters, and they need to be treated carefully in order to avoid spread of disease. Many countries practice egg washing, and different practices are reviewed and characteristics of waste wash water summarised in this chapter. Waste and wastewater can be treated by anaerobic digestion, or by aerobic processes such as composting and aerobic stabilisation of wastewater prior to use for irrigation. Thermochemical processes such as incineration, pyrolysis and gasification may also be used for treatment of waste. Dead hens may be burnt, composted or rendered. Land application of laying hen manure can be a controversial issue and it is important to consider the nutrient status of the land, possible run-off into water sources and the presence of contaminants such as antibiotics, pesticides, larvicides, endocrine-disrupting compounds and coccidiostats. An interesting case study is provided for anaerobic digestion of laying hen manure and mortalities. There is considerable scope for improved technologies for processing and utilisation of waste arising from egg production.

The last chapter, **Chapter 10**, assesses the sustainability of organic egg production. Organic food production has increased in popularity in the last few decades, although it still remains as a small portion of global food production. Because of concerns about animal welfare, there has been a movement away from the caged-rearing systems used in conventional egg production. Some would argue that organic production systems increase the welfare of the birds and, at the same time, reduce environmental impact. In the EU, organic farming regulations are set out under Council Resolution 2029/91 and

its amendments and organic poultry production is dictated by EC 834/2007. For organic egg production in the EUS, poultry must be housed in free-range systems with stipulated furnishing and stocking density for both the poultry house and range, and a maximum flock size of 3000 hens. The US regulations do not restrict the size of the flock. In the EU, synthetic amino acids cannot be used, and both the EU and the United States ban the use of synthetic medications such as antibiotics, dewormers, insecticides and coccidiostats. Some areas allow vaccinations if they were not produced biotechnologically. In all countries, organic regulations require the feeding of diets made with organic feedstuffs. The authors discuss the sustainability of organic production using a life cycle assessment approach. The authors point out that 75% of conventional crop producers in the United Kingdom believed that organic farming methods are better for the environment but only 13% thought that such techniques could produce sufficient food and fibre for society. Conversely, only 73% of organic crop producers in the United Kingdom interviewed believed that organic production systems could produce the necessary food and fibre for the growing world population. Organic egg production will most likely remain as a niche market.

Summary

The chapters contained in Part 1 of Volume 2 review the relevant aspects of animal health and welfare. Nutrition is of crucial importance to hen welfare and the profitability and sustainability of the commercial egg industry. Concerns about hen welfare centre on the type of housing system, the costs and benefits of beak trimming and the maintenance of good health in the flocks. As outlined in Part 2, the sustainability of the industry relies not only on the provision of housing and suitable feed ingredients but also on the management of waste arising from the industry. The final chapter reviews the sustainability of organic egg production and concludes that such production is likely to remain at a relatively small scale.

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