EGGfocus

1. Global egg production trends

by Teun van de Braak, Product Manager Layers, Hendrix Genetics. www.hendrix-genetics.com

Global consumers continue to grow increasingly concerned about where their food comes from and how it is produced. This trend is especially influential on egg production and the housing systems in which laying hens are kept. Consumer concern for animal welfare has spurred on the cage-free movement, which is spreading rapidly around the world.

It all started in the EU, where a ban on conventional cages has been in place since 2012. In the United States, five states (Washington, Oregon, California, Rhode Island and Michigan) plan to enforce cage-free egg production by 2026.

Cage-free commitments are also becoming more common in Oceania, Asia and Latin America. Food industry leaders such as Nestlé, Heinz, Unilever, McDonalds, and Subway have all made commitments to exclusively source cage-free eggs by the year 2025.

The move from the relatively easy to manage conventional cages, to more complex cage-free aviary systems requires dramatic differences in the day-to-day management of laying hens. Birds kept in cage-free environments require more attention.

Additionally, in order to ensure a smooth transition from rearing to production facilities, housing facilities need to be similar so that birds can successfully find nests and can generally adapt to the production facility.

Another factor is that not all breeds are equally suited to alternative housing systems. Problems like hysteria, not being able to use the aviary system well, high mortality due to pecking, or large amounts of floor eggs are more likely to arise in some breeds than others.

This has caused some breeds that performed well in previous housing systems to lose their dominant position to birds purposely bred for alternative housing systems.

Table 1. Countries that have banned beak treatment.

Country	Year of ban
Norway	1974
Finland	1986
Sweden	1988
Austria	2000
Denmark	2013
Germany	2017
The Netherlands	2018

Animal welfare: beyond just housing systems

In Western Europe there is a growing move towards bans on beak treatment, as shown in Table 1.

In the countries that have recently banned beak treatment (Germany and the Netherlands), a clear trend is a shift from brown laying hens to white laying hens.

In cage-free housing systems, white laying hens with intact beaks are easier to manage than intact-beak brown hens. In these situations, white laying hens show less aggressive pecking behaviour and fewer negative social interactions, resulting in better livability and feather cover.

In scientific research there is a growing focus on the intrinsic needs and stress responses of laying hens, as exemplified by the recent launch of the ChickenStress European Training Network (ETN). The aim of this project is to provide information on the best welfare conditions, which will also enable optimum egg production. An international team of 14 PhD students, based over 12 European institutions, will engage in multidisciplinary projects under the supervision of world experts in their fields.

Focus on sustainability

Along with the trend for increased animal welfare, the egg industry has also become more focused on sustainability.

For decades, genetic selection has prioritised a reduced feed conversion ratio (less feed as input, with more egg mass as output).

In the last decade, there has also been a clear shift to keeping laying hens for a longer period without moulting. A laying cycle lasting 100 weeks is no longer the exception.

Keeping hens longer reduces the carbon footprint of egg production, as the cost of the non-productive period (rearing) can then be divided over a much longer production period.

The move to cage-free housing systems also presents sustainability challenges. Birds need to be much more robust in order to cope with the challenges presented by these environments. Robustness is gradually improved via breeding and selection: livability, longevity, proper bodyweight development profiles, the ability to recover and good feather cover are all key selection traits.

Pullets that are given the time and the resources to develop into robust laying hens will show better peak production and, most of all, will be much more persistent – which directly increases profits.

Retailers are also becoming more and more concerned about the GHG-emissions of the products that they offer in their portfolio. Lidl, one of the fastest growing worldwide retailers, is only offering white eggs in their Dutch retail stores as they have a lower carbon footprint compared to brown.

A report from Wageningen University showed that 1kg of brown eggs has on average a 4.1% higher CO_2 emission compared to 1kg of white eggs. Offering white eggs only in their product portfolio will help retailers like Lidl reach their sustainability commitments.

Growing demand for specialty eggs

The latest trend affecting egg production is an increased demand for the so-called 'specialty eggs'. Specialty eggs are eggs that have a different eggshell colour, such as olive, blue, or very dark brown. By creating a story around these eggs, retailers are able to market luxurious eggs (they even have their own Instagram page). This allows them to charge premium prices – more than 200% of the price of a regular egg.

The disadvantage of these specialty breeds is that they have not been part of intensive selection processes, creating a gap in performance with the commercial brown and white laying breeds. But the higher selling price can clearly compensate for this higher cost of production. Housing systems, beak treatment, sustainability, and consumer preferences are all factors in the changing global egg industry.

By taking a broad view of the industry and collaborating together, we can stay ahead of the curve to find solutions and deliver products that fit the needs of the future. ■

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2. Multi-tier aviaries

by Frank Luttels, Poultry Equipment, Chore-Time. www.choretime.com

Cage-free facilities remain a dominant trend in egg production, driven by the growing demands of consumers, supermarkets, restaurants and others in the food supply chain. When transitioning from conventional egg production to cage-free, producers have choices, including multi-tier aviaries, combination aviaries (sometimes called 'combi' or winchable platform) and floor systems.

	Egg quality	Bird density	Short-term expense	Return on investment
Multi-tier aviaries	Better	Higher	Higher	Better
Floor systems	Good	Much lower	Lower	Lower
Combi systems	Lower	Higher	Higher	Lower

Table 1. Advantages/disadvantages of the different types of cage-free solutions. Individual results may vary depending on a variety of factors.

While each solution offers a unique set of benefits and challenges, many leading industry experts see multi-tier aviaries, also known as European-style or open aviaries, as the superior approach due to several key advantages of these systems:

- High bird performance.
- Reduced labour requirements.
- Excellent bird welfare.
- Positive public perception.
- Strong return on investment.

What are multi-tier aviaries?

Today, producers may find a few types of multi-tier aviaries, but they all apply the same principles, based on a concept that originated in Switzerland in the 1980s. The main features include a bottom level, a separate nest level with water, and a top level with perches, where most birds prefer to sleep.

Wire mesh floors and manure belts are located on all levels to help maintain a clean environment, while reducing the labour requirements of cleaning the aviaries. In some aviary configurations the top level is the same width as the bottom, while other configurations use a stepped design with a narrower top level.

A combination of configurations within a house is often ideal, since some birds naturally jump up within the system, while others prefer to jump across the aisle to move up to the top level.

Advantages and challenges

The success of multi-tier aviaries in cage-free egg production is largely attributed to the way they support natural bird behaviour. For instance, the layout encourages birds to jump, move and naturally distribute themselves around the house, resulting in minimum management.

Additionally, multi-tier aviaries have 50% of the floor area available for scratching, which meets or exceeds current cage-free standards in both the United States and the European Union. Providing ample floor space encourages birds to scratch in the afternoon after laying eggs, rather than engaging in undesired behaviours, such as feather pecking.

Producers benefit by being able to stock more birds per square foot in multi-tier aviaries than other cage-free system styles allow. Two-storey houses can also be configured to increase the number of birds per house, which can further enhance return on investment, so long as producers take care not to overcrowd the houses.

Well-trained birds placed in a multi-tier aviary system at an appropriate density have shown good performance, even without moulting – just a single cycle through 94-96 weeks of age. This results in more eggs per bird, a lower cost per egg, and a higher return on investment than other system types. Over a period of 10 years, for instance, producers may be able to purchase one or two flocks less than they would with under-achieving birds that are taken out after only 74-76 weeks of age.

Egg quality is also optimised in multi-tier aviaries. Nests and eggs are kept cleaner in these systems, and a gentle collection system minimises cracking, helping producers achieve the most grade-A eggs per hen.

Other systems

The two main alternatives to multi-tier aviaries are floor and 'combi' systems. Floor systems are often chosen for existing poultry houses with low ceilings or other space constraints, and some consider these systems to provide the most bird freedom. Also, one great appeal of converting to a floor configuration is the typically lower short-term expense.

However, multi-tier aviaries offer much higher bird density without sacrificing bird welfare, providing producers with a better return over floor systems. Additionally, the multiple low-profile configurations available in multi-tier aviaries can often solve the issues of small houses and low clearances just as well as floor systems.

What may be a short-term gain in cost savings with a floor system is quickly outweighed by the higher long-term performance and density benefits of a multi-tier system.

Combi systems were developed with the goal of creating a superior alternative to multi-tier aviaries. They feature nests, feed and water on each level, based on the idea of placing less importance on training birds to move within the system.

While this design offers some advantages, such as lower installation costs and decreased feed consumption due to less bird movement, it also has considerable drawbacks that may cause management issues and reduced bird performance, even though it was originally conceptualised as a low-management solution.

A greater concern with combi systems, however, is the loss of egg quality. These systems require more egg belts in places that tend to collect dirt, dust and other contaminants. Additionally, the combi design often leads to an unbalanced distribution of eggs.

Because of these problems, producers frequently experience dirtier eggs, more cracked eggs, and lower egg quality in general. Some trials have shown that combi systems result in 10-30 fewer grade-A eggs per bird over the total production cycle than multi-tier aviaries.

Perhaps the biggest issue with combi systems has nothing to do with production, egg quality or labour, but rather public perception. Though these are 'cage-free' systems, they still resemble traditional caged systems. In fact, many retailers, food producers and chain restaurants are putting in their contracts that they want cage-free eggs from multi-tier style aviaries, not combi systems. For this reason alone, combi systems are already rejected by many European producers today.

The advantages of multi-tier aviaries in cage-free egg production are that they offer long-term viability and the greatest potential for long-term profitability. Not only do these systems benefit bird welfare by encouraging natural bird behaviours and movement throughout the house, but producers also benefit from reduced labour requirements, lower cost per egg and increased number of grade-A eggs per bird. The positive experiences in Europe will continue to drive acceptance around the world, and it is only a matter of time before this new multi-tier approach becomes the standard. ■

A Chore-Time multi-tiered aviary.

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3. The role of micro-nutrition

by Dr Fernando Cisneros, Senior Director Carotenoids Specialties Global, DSM Nutritional Products. www.dsm.com

Eggs are part of healthy, balanced nutrition and particularly important for vulnerable populations like children, the elderly and pregnant women due to the fact that eggs are a good source of vitamin A, E, D niacin, and folate, while containing 6g of protein and only 70 calories per egg.

However, in the USA, it is estimated that 3-12% of the eggs are lost due to breakages and in other countries the number can be even higher due to poor packing, inefficient transportation and/or poor transport infrastructure. Improving the robustness of the egg can help alleviate these losses and this is achieved through improving the micro-nutrition of the hen.

Hens produce one egg per day and part of this biological process requires the mobilisation of mineral reserves within the bird for the formation of the egg shell – its thickness, strength and durability rely on this process.

Mineral nutrition plays a key role in this along with vitamin D. Without sufficient vitamin D, the process of mineral metabolism and subsequent egg shell development is impaired.

Optimum Vitamin Nutrition (OVN) with particular focus on vitamin D and its active form 25-hydroxy-calciferol (Hy-D).

Feeding Hy-D to the pullet and the hen through their lifetime leads to a 4% increase in egg shell thickness and reduced egg breakages by 15%. Such gains are an important contribution to help reduce food loss and waste, one of the main issues to achieve more sustainable food systems. Considering the nutritional value of the egg for so many, such innovation in vitamin D nutrition is an important technology that should be widely adopted by the egg value chain and one that DSM advocates.

The environmental cost of producing eggs

With increasing affluence, especially in Asia, the demand for animal protein has been growing well ahead of the population.

Over the last 50 years, the population grew two-fold, while the demand for animal protein in the form of eggs grew almost five-fold. This means that eggs are recognised as a highly affordable source of protein and a crucial part of a healthy diet. In the same period, the environmental footprint per egg in industrialised countries like Canada and the USA, has decreased by 70%. This reduction can be attributed to improved genetics, farm infrastructure, sanitary conditions and more importantly, to the advances in feed technology (especially feed efficiency).

However, this important reduction in the environmental impact per egg, has been outweighed by the growth of the egg industry.

Consequently, the absolute environmental footprint today is actually higher than 50 years ago and the greater use of compound feed is the main reason behind this.

Further reductions in greenhouse gases, phosphorus and nitrogen excretion are possible only if healthy animals are fed with optimised diets consisting of essential nutrients (amino acids, vitamins, minerals and essential fatty acids) and the latest micro-nutrition technology such as feed enzymes and eubiotics (to promote microbiota functionality), used in the feed industry to describe a healthy balance of the microbiota in the gastrointestinal tract.

The use of feed enzymes and eubiotics improve the digestibility of the feed and subsequent absorption of nutrients resulting in a lower feed requirement or enabling the greater use of alternative feed raw materials and by-products.

This leads to significant efficiency gains in egg production and reduces the environmental footprint per egg.

If the entire global egg industry were to use optimised feed enzyme technology across the 149 million tons of layer feed, the reduction in feed use due to improved digestibility of the feed (and therefore less needed by the hen) would lead to a reduction in greenhouse gas emissions of 12.4 million tons of CO_2 equivalents. This is enormous and equates to a 7% reduction in greenhouse gas emissions for the industry and is equivalent to removing 5.2 million cars from the roads. This example clearly demonstrates the importance of feed on overall industry sustainability and how the influence of feed enzyme technology makes a highly significant contribution to more sustainable production. It is the use of such micro-nutrition that holds the keys to reducing the environmental footprint of egg production in the face of continued, strong consumer demand.

The welfare concern

If welfare is defined by the well-being of a group of animals, the first step is to ensure their good health.

The hens' health is dependent on proper accommodation, light, air quality, dry litter, clean water and most importantly, access to a nutritious and balanced diet composed of grains, vegetable sources of protein, vitamins, oils and minerals. Attention to optimised vitamin D nutrition and the use of Hy-D in the diet, will promote skeletal integrity by increasing the bones' cortical tissue volume (Fig. 1) and therefore reducing the possibility of osteoporosis. As a consequence, hens can live longer, suffer fewer skeletal disorders while continuing to lay and therefore produce more eggs over their lifetime (Fig. 2).

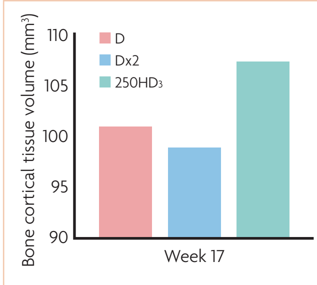


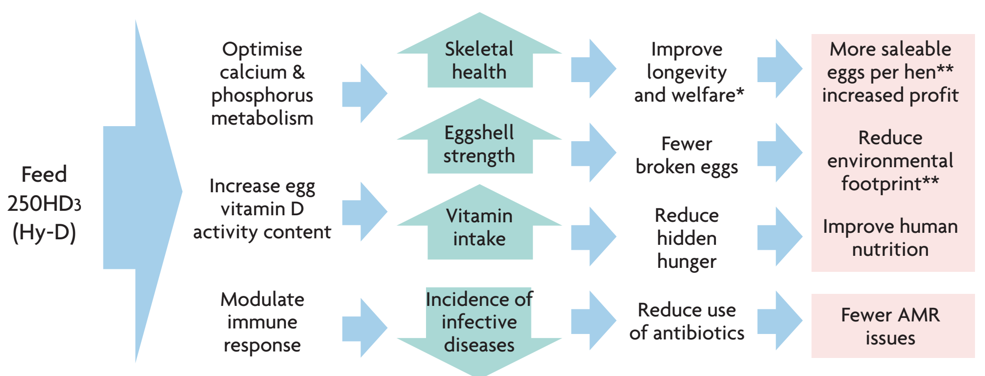
Fig. 1. Bone cortical tissue volume (mm³) (Kim, 2018. Univ. of Georgia).

Improved welfare through attention to micro-nutrition means a more productive bird and less need for replacements, reducing the need to raise more pullets and the consequential environmental footprint of doing so. Optimum vitamin levels (through OVN) are key to not only skeletal health, but also enhancing the immune system of the hen to ensure the welfare of the bird is maintained over its lifetime.

Conclusions

The environmental footprint of eggs has increased over the last decades. Feed is the single most important contributor to the environmental footprint of egg production. DSM has developed over many years nutritional solutions and innovations based on the combination of vitamins, eubiotics and enzymes to enhance the health of the hen, enable the efficient utilisation of feed and ensure improved productivity over the lifetime of the bird. The further success of the layers industry is strongly linked to sustainability. ■

Fig. 2. The triple role of Hy-D on the sustainability of the egg industry.



* Bain et al, 2016. "25 more eggs per hen could potentially reduce the UK flock, including breeding hens, by 2.5 million birds per annum"
** Bain et al, 2016. "around 1g of nitrogen could be saved per dozen eggs for an increase of 10 weeks in production"

4. Resilience for laying persistence

by Gwendolyn Jones, Anco Animal Nutrition Competence GmbH. www.anco.net

Longer laying cycles can help to cut costs, so they are a promising solution in a tough economic climate. Plus, they can reduce the environmental impact of egg production. Therefore, there is an increasing focus on improving laying persistence and egg quality at the end of the laying cycle.

However, due to increasingly intensive metabolism for egg formation, laying hens are more susceptible to diseases, which requires a shift in breeding and nutrition towards greater resilience of birds to improve laying persistence for longer laying cycles.

There is a fast decline in egg production after the hens reach 480 days of age leading to reduced commercial value of laying hens. Understanding the mechanisms of the deterioration of the laying performance can help to slow down the process.

The ovary and the liver are key organs involved in egg production of the laying hen, which is why knowing how to support them effectively by nutritional means can make a difference to laying persistence.

Oxidative stress in ageing organs

Ovarian ageing is one of the highest risk factors that lead to the decline of ovarian functions and hence a reduction in egg production. Studies have shown that oxidative stress plays a driving role in ovarian ageing.

The antioxidant status of the ovary decreases with age (Fig. 2) as a result of a reduction in antioxidant enzymes and antioxidants in the hen's own defence mechanisms.

Oxidative stress is initiated by the gradual accumulation of reactive oxygen species (ROS) in the ovary and a reduction of the antioxidative capacity during the ageing process. This will be exacerbated through stressors, such as heat, mycotoxins, endotoxins and others, which increase the production of ROS in the hen on a cellular level. A growing body of evidence suggests that oxidative stress is involved in most commercially relevant stresses in poultry production.

Oxidative stress is defined as an imbalance between production of ROS and their elimination by protective mechanisms.

This imbalance leads to damage of important biomolecules and cells, with potential impact on the whole organism. It can also lead to inflammatory responses which can affect energy efficiency of the laying hen.

Age-related changes in the antioxidative capacity of the hen's liver, is an important factor that influences liver function. Studies have demonstrated that the total antioxidant capacity of the liver declines as the hen ages (Fig. 2) and this has also been linked to a decrease in egg production and in the ability of yolk precursor formation.

Feeding for resilience

To extend the laying cycle of commercial flocks, long-term maintenance of organs involved in producing eggs is required. Feeding for antioxidative capacity in laying hens has been shown to retard the antioxidant decline of ageing ovaries and can thus help to maintain functioning ovaries for longer. It is also known to maintain a healthy liver for longer.

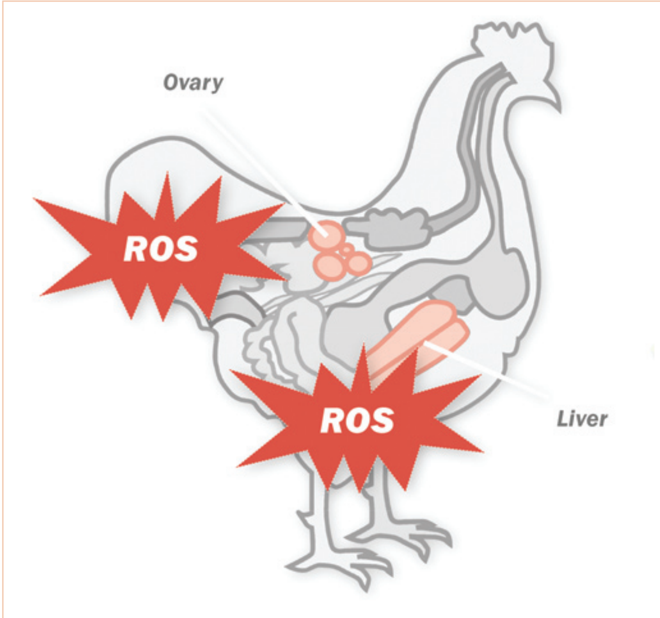


Fig. 1. Stressors affect vital organs and defence declines with age.

However, feeding to improve the adaptive capacity of birds to stressors helps to minimise stress reactions, such as oxidative stress, as well as inflammatory responses and reduced feed intake, which can further increase resilience in birds and reduce the potential for stressors to diminish the chances for producers to successfully extend the laying period.

Animal resilience has been defined as 'the capacity of the animal to be minimally affected by challenges or to rapidly return to the state pertained before exposure to a challenge'.

The gut agility concept in Anco FIT Poultry was specifically developed to increase the capacity of the bird to adapt to challenges more efficiently and to reduces stress reactions that would otherwise reduce the hens' performance and potential to sustain longer laying cycles.

A trial carried out in a commercial laying hen flock in Brazil, demonstrates how Anco FIT Poultry improves the resilience of birds to stressors compared to birds on a control diet (Fig. 3).

The impact of stressors was smaller on egg production and birds recovered quicker from stressors leading to greater laying persistency and more eggs produced per hen over the trial period. ■

Fig. 2. Total antioxidant capacity in key organs of ageing laying hens (Liu et al 2018).

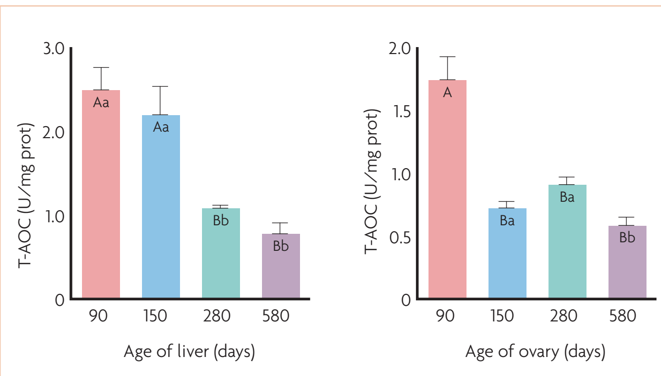
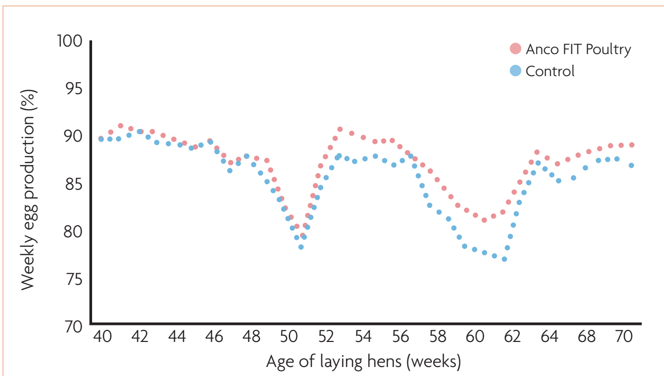


Fig. 3. Improved resilience with Anco FIT Poultry in the late laying period, commercial trial Brazil.



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5. Low pathogenic avian influenza

by The Technical Team, Hy-Line International, USA. www.hyline.com

Avian influenza (AI) is caused by a type A influenza virus and is distributed worldwide in birds. There are two important classifications: high pathogenicity avian influenza (HPAI) and low pathogenicity avian influenza (LPAI). Waterfowl naturally carry many LPAIs and are the primary reservoir for transfer to commercial poultry.

As LPAIs replicate and spread in commercial poultry, they may cause disease production losses. Without proper control programmes, LPAI infections can become endemic in areas of concentrated commercial poultry production.

When significant, LPAI infections in laying chickens cause acute respiratory disease and egg production losses. Circulation over time increases the possibility of mutation to HPAI. This occurs most commonly with H5 and H7 subtypes, and causes an acute, severe disease resulting in high mortality. HPAI is a designation made by the Office International des Epizooties (OIE) and specifically refers to H5 and H7 subtypes.

Although HPAI strains cause significant damage, there are several examples of non-H5 or H7 viruses officially classified by the OIE as LPAI which cause significant disease in poultry.

Virus susceptibility to disinfectants and environmental conditions

AIV are enveloped viruses, which refers to the presence of a lipid membrane surrounding the virus, and as such are inactivated by most detergents and disinfectants commonly used in poultry facilities.

Heat and dryness are also effective for inactivation. The virus can survive outside the bird when the environment is cool and moist, or contained in organic matter (nasal secretions, faeces, dust, bird carcases).

Transmission

Transmission of LPAI occurs easily among susceptible birds that encounter nasal secretions, aerosols, or faeces from infected birds.

Important sources of infectious particles are contact with wild birds, people, vehicles, equipment, clothing, and footwear.

High risk factors for transmission between facilities also includes crews and equipment involved in vaccination, manure handling, and transporting pullets and end-of-lay hens. Most LPAI infections in waterfowl are subclinical and are transported over long distances by infected birds during their seasonal migrations. Spring migrations are a high risk, as waterfowl from all the major migratory flyways migrate to nesting areas near the arctic circle. This makes it possible for inter-continental spread of influenza.

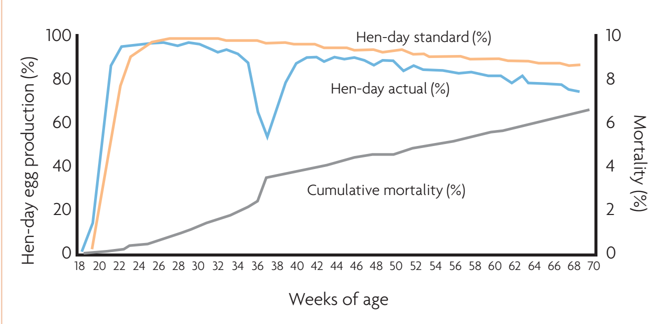

Fig. 1. Egg production and mortality in a laying flock infected with LPAI. The drop in egg production and mortality is highly variable depending on the strain of LPAI, immune status of the flock and the presence of other secondary pathogens.

Clinical signs

The incubation period of LPAI infection is highly variable and can range between 3-14 days in naturally infected birds. Many LPAI infections do not cause significant clinical signs in chickens and are only diagnosed through AI surveillance programmes. LPAI usually causes acute, mild to moderate disease with high morbidity and low mortality.

Typically, mortality does not exceed 5%, but high mortality has been recorded.

Clinical signs of infection vary greatly and include: decreased feed and water consumption, coughing, sneezing, respiratory rales, and facial swelling. Less common signs include: exudate from sinuses, diarrhoea, and subcutaneous haemorrhages of the feet and legs.

Affected flocks become quiet and listless. In laying hens, egg production and eggshell quality can decrease dramatically, and loss of shell pigmentation can occur in coloured eggs.

Necropsy lesions

Most pathology occurs in the respiratory, digestive, and reproductive tissues. The lining of the mouth, sinuses, and trachea may appear inflamed and oedematous with occasional haemorrhages. Tracheal exudates can form plugs that block airways causing suffocation.

Pneumonia and airsacculitis may occur, especially with complicating secondary pathogens. Haemorrhages in the proventriculus are a common necropsy finding in layers.

Some LPAI strains present with egg yolk peritonitis as a prominent finding. Complete regression of the ovary and oviduct with cessation of egg production is possible. Some LPAIs cause swollen kidneys resulting in visceral gout.

Differential diagnosis

Differential diagnoses for LPAI include infectious bronchitis, Newcastle disease, infectious laryngotracheitis, fowl cholera, and mycoplasmosis.

Diagnosis

Detection and confirmation of infection can be done via real time reverse transcriptase polymerase chain reaction (rRT-PCR), detection of viral antibodies 5-10 days post infection through ELISA, HI, or AGID; or virus isolation. Samples and tests should be done in accordance with local regulation and monitoring programmes.

Intervention strategies

- Strict, effective biosecurity programmes and procedure adherence.
- Rapid, early detection of infection through routine monitoring.
- Focused, effective vaccination programmes (where allowed).

Eradication strategy

Eradication of the virus is accomplished by depopulation of infected flocks and isolation of other flocks within an established quarantine area. Flocks are released from quarantine after repeated negative results.

This requires strict biosecurity programmes, controlled movement of poultry and poultry products, and extensive surveillance testing. Eradication has not been achievable in many countries due to the resources required. For many countries, the goal is to control AIV infections with vaccination programmes and limit the economic impact of the disease.

Vaccination

Avian influenza vaccines have been shown to provide antibody protection against AIV infections. While vaccination does not prevent infection, properly vaccinated birds are protected from the mortality, respiratory disease, and egg production losses associated with AIV infection.

Vaccinated birds are more resistant to infection, with less shedding and transmission of infected virus after a field challenge. ■

Commercial layer with LPAI exhibiting facial swelling, swollen sinuses and nasal exudate.