Housing systems for laying hens and their effect on egg quality

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Summary
Housing systems for laying hens have changed a lot in the last decade. Reasons for this were mainly focussed on animal welfare issues. In Council Directive 1999/74/EC, laying down minimum standards for housing of laying hens, directions are given for housing systems of laying hens. In this Directive three categories of housing are defined: alternative systems, unenriched cage systems and enriched cage systems. There is a wide variety of systems within these three categories, all affecting egg quality differently. It is therefore hard to draw any conclusions on egg quality in relation to the category of housing system. When looking at housing systems in more detail, a further categorisation is possible. For alternative systems, more correctly called non-cage systems, important aspects in relation to egg quality are: number of levels in the house and positioning of the nest boxes in relation to these levels, presence of free range and/or covered veranda and type of lighting. Further also the presence or absence of a beak treatment may be of influence on egg quality. Effects of the various housing systems and their components on egg quality are discussed.

Introduction
Housing systems for laying hens have changed a lot in the last decade. Reasons for this were mainly focussed on animal welfare issues. As conventional battery cages do not guarantee minimum needs of laying hens for expression of their natural behaviour, other systems have been developed. The first new design was floor housing, which actually is a slightly modernized version of the earliest system for keeping hens. To refer to their difference with the cage system, these new systems were referred to as alternative housing systems.

As eggs from alternative systems usually have a higher cost price, new systems were developed. The aim was to combine the technical results and high economic efficiency of the cage system with the higher possibilities to express their behaviour as was realised in the alternative systems. In the early 80s aviary systems were developed (Ehlhardt et. al., 1984, Hill, 1981). About the same time furnished cages were developed. First they were called Get-Away Cage (Elson, 1976). Since then many new variations of systems were developed, mainly based on the principles of aviary housing. Council Directive 88/166/EEC (EU, 1988) was adopted to set minimum standards for the protection of laying hens kept in cages. The minimum requirements for alternative systems were set in national legislation and through Commission Regulations setting detailed rules for marketing of eggs (EU, 1991). In 1999 new legislation for the keeping of laying hens became into force. This Council Directive 1999/74/EC (EU, 1999), laying down minimum standards for housing of laying hens, three categories of housing are defined: alternative systems, unenriched cage systems and enriched cage systems.

As there is a wide variety of systems within these three categories, it is hard to draw any conclusions on egg quality in relation to the category of housing system. When looking at housing systems in more detail, a further categorisation is possible. In a recently published EFSA-report (EFSA, 2005) a detailed description of the various housing systems for laying hens is given. In this report more categories are defined and also slightly different terminology is used. In this paper egg quality in 4 different systems are discussed:

- traditional cages
- non-cage systems (in the mentioned Directive these fall into the category Alternatives)
- In addition to the non-cage system free range area can be provided.
Traditional cages

Traditional cages have been developed and improved for almost 50 years. Major factors influencing egg quality are cage dimensions, cage floors (material and slope) and egg transport (Oosterwoud, 1987, Alvey & Tucker, 1993). Feeding, ventilation and lighting also contribute to optimal egg quality (Brake & Peebles, 1992). Influence of these factors and their interaction is known to a great detail and fine-tuning of these factors resulted in the highest possible level of egg quality. Problems with egg quality almost always can be traced down to mechanical problems in the system, health problems or mismanagement.

Furnished cages

Enriched cages, more correctly called furnished cages, came into practice when Council Directive 1999/74 was adopted. This Directive bans traditional cages in the year 2012. From that moment onwards, only cages are allowed that are more equipped to meet behavioural needs of laying hens. The extra equipment provided are at least perches, nest boxes, litter and extra space per hen. These items have major influences on the design of the cage and consequently on egg quality. Part of the knowledge about cage design, as build up for traditional cages, can be used to optimise furnished cages. However, due to the complete new measures of the cage and the extra elements, new and unknown design problems arose. For instance, a well designed cage floor may give problems with egg quality the moment that cage depth is prolonged. With a nest box in the back of such a cage, the distance eggs have to roll over the cage bottom towards the egg belt is much longer than in a traditional cage. This influences speed of the eggs and thus the chance for breaking. Also on the way to the egg belt the risk of damaging or soiling is higher (e.g. hens stepping on eggs and eggs come into contact with manure). It is therefore not surprising that the early furnished cage models often had problems with egg quality (Fiks et al., 2002, 2003a, b). Due to improvements in both management and design, a much better egg quality can be realised in the latest models. Further improvement is expected as these systems are fully in development. There are some specific aspects of influence on egg quality in furnished cages. The better the acceptance of the nest, the less other cage elements will affect egg quality. The rolling distance for the eggs is already mentioned. In relation to this aspect a nest positioned in the back of the cage in combination with an egg belt along the front of the cage is a risk factor for egg quality. A litter box needs to be closed in the morning to prevent hens from laying eggs in the litter. Litter mats do not have this problem, but may have problems with soiling. Perches sometimes form an obstacle for the birds, preventing them from walking on certain areas of the cage floor. This may result in soiling of the floor and thus a higher risk for dirty eggs (Fiks et al., 2003b).

Non-cage systems

Alternative systems, more correctly called non-cage systems, have been on the market for a longer time than furnished cages and are thus further in their development. Compared to the earliest models major improvements have been made specifically with regards to floor eggs and nest usage. Floor eggs are important with regards to egg quality, because they are contaminated easier than nest eggs. Bosch and Van Niekerk (1996) reported an average of 3.5% floor eggs in the first 62 aviary flocks in The Netherlands. From these flocks, 52% produced less than 2% floor eggs. Still, in 8% of the flocks more than 10% floor eggs were collected.

In an inventory made by Emous et al. (2001) the highest percentage of floor eggs was 5.6%. This flock also had several disease problems that may have contributed to this high percentage. In total 68% of the flocks stayed below 2% floor eggs. The average number of floor eggs in older hen houses (used for 3 or more laying cycles) was on average 2.3% floor eggs, indicating an improvement compared to the earlier figures of Bosch and Van Niekerk (1996).

In the study of Emous et al. (2003) the average number of floor eggs in the newer hen houses (less than 3 laying cycles, 7 flocks) was only 1.2%. Figure 1 shows that there was actually only one flock with fairly high percentage of floor eggs. However, this high percentage was probably due to some management mistakes. The average percentage of floor eggs in the other 6 flocks in newer hen houses was only 0.6%. It is hard to distinguish between the effect of the system and the effect of management. Most likely they both contribute to the successful reduction of floor eggs in modern aviary housing systems.

Dutch experiences indicate that single tier non-cage systems are easier to manage than large hen houses with multi-floor non-cage systems. This relates to both minimising feather pecking and
cannibalism as well as reducing floor eggs. Also light programmes appear to be very effective in reducing floor eggs (Emous et al., 2003).

Egg quality of non-cage eggs as reported in the literature is very variable (EFSA, 2005). This can be explained by: 1. a much higher variation in environment, leading to more factors contributing to egg quality; 2. shorter experiences with aviaries then with cages and thus a less far developed system; 3. a much higher influence of bird behaviour, influencing the percentage of floor eggs. Also egg shell structure is found to be not as good as in cage eggs (Fraser et al., 1995). It is suggested that this may be caused by stress as a result of inter-bird conflicts. In these non-cage systems groups size in too large to enable individual recognition of birds. A stable pecking order therefore can not be realised, which may be the cause of stress in each inter-bird relation (Nicol et al., 1999).

Bacterial contamination is found to be higher in non-cage eggs. Surprisingly, the correlation of bacterial egg shell contamination with air contamination was much higher than with visual contamination of eggs, indicating that even a visually clean non-cage egg may have a higher bacterial load than a conventional cage egg (Protais et al., 2003). It also has been stated that the impaired shell structure of non-cage eggs may easier lead to penetration of bacteria into the egg (EFSA, 2005). One can conclude from this information that non-cage eggs will have a higher risk for bacterial contamination both on the shell and inside the egg. With regards to Salmonellae spp. many non-cage flock in the Netherlands, especially the ones with access to free range are vaccinated against Salmonella spp.

Dutch experiences indicate that problems with egg quality in aviary systems often relate to dust problems. This is in accordance with Dutch and French findings of higher dust levels in aviaries compared to cages (Drost et al., 1995; Michel and Huonnic, 2003). Litter areas combined with movement of hens lead to higher dust levels in the hen house compared to cage housing. Well designed nest boxes, placed in strategic positions in the hen house, in combination with proper ventilation systems can reduce dust problems.

One of the major factors to obtain a good egg quality in non-cage systems is a good nest design. Proper nest management will lead to clean nest bottom. Together with a correct slope of the nest bottom and a smooth transition to the egg belt this will contribute to a good egg quality.

In the inventory on commercial Dutch farms Emous et al. (2003) found that 17 out of 25 flocks had problems with worms. Worms are not found in cage systems. Treatments are allowed under strict conditions and often a withdrawal time for the eggs is required. In this aspect also contamination of eggs with Dioxine-like components needs to be mentioned. This seems to have a relation with free ranging of the hens (EC, 2004). Further research is needed to get a better understanding of this problem.

**Beak treatments**

In the mentioned inventory of Emous et al. (2003) 10 out of 25 flocks had problems with feather pecking and cannibalism, although they were mostly beak trimmed at 6 weeks of age. If beak treatments are not allowed or treatments are performed at an early (before 10 days of age) feather pecking incidence is expected to be higher.

Feather pecking can result in hens hiding in the nest boxes and thus defecating in them, leading to decreased egg quality. Also part of pecking problems is vent pecking, which leads to wounds at the cloacae and as a result blood on the eggs.

Bestman (2002) found a correlation between free ranging of hens and the extent of feather damage caused by feather pecking. She concluded than one of the major management measures to prevent feather pecking and cannibalism is providing the hens with an attractive free range area. Other measures are mentioned in the literature to reduce feather pecking. Most of them relate to keeping hens busy. This is well possible in non-cage systems, but limited in cages. On the other hand small group sizes usually give less problems with feather pecking and on this aspect cages have the advantage. Also in cages it is easier to dim the lights to reduce pecking. Dimming lights in non-cage systems will easily lead to floor eggs.

Feather pecking and cannibalism can have a major influence on the production results of a flock. A vast amount of research is conducted resulting in knowledge on several factors influencing pecking behaviour. Several management measures are known to reduce pecking behaviour, but they are not always effective. The problem is very complex and there is not enough known to eliminate this behaviour.

The extent in which feather pecking and cannibalism is a problem is different for the different housing systems. Also measures to reduce the problem are not the same for the various housing systems. Finally legislation with regards to beak treatments varies between European countries.
Conclusions

In conclusion, it can be stated that with the present state of the art, conventional cages still produce the best egg quality. Furnished cage systems are new and therefore not well developed. Egg quality needs improvement, but the newest models show that a good egg quality is very well possible. Non-cage systems are confronted with a variety of different factors influencing egg quality. Therefore a good egg quality is not easily to obtain. In the last years however non-cage systems have been improved largely and it is just a matter of time to obtain the same external egg quality as in cage systems. With regards to internal egg quality more research is needed to get a better understanding of the various influences and solutions to it. With the ban on beak treatment or more strict regulation of this treatment more problems with feather pecking and cannibalism are expected, leading to more downgraded eggs. The extent of the problem and possible measures to take differ for the various systems.

Figure 1  Relation between age of aviary and percentage of floor eggs (Emous et al., 2003).

References


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