REVIEW

# EFFECT OF HOUSING SYSTEM ON PERFORMANCE AND EGG QUALITY CHARACTERISTICS IN LAYING HENS

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The housing system plays an important role in the hens' welfare, performance and egg quality characteristics. The alternative systems (litter floor systems) provide a more comfortable environment for laying hens and consequently hens can enjoy comfort behaviors, head shaking, head scratching, ruffling, trail wagging, wing flapping, wing and leg stretching, ground scratching and dust-bathing, more freely than in battery cages. Although the data related to laying performance are conflicting, however, it is generally recommended that, egg production, egg weight and feed conversion efficiency are mostly better in caged hens than in alternative systems. In contrast, body weight and mortality rates in alternative systems are higher than in cages. A lot of studies have reported an improvement in eggs that graded A in caged birds rather than in birds reared in alternative systems and this is due to the highest proportion of dirty, cracked and broken eggs in the alternative systems. Moreover, eggshell thickness, shape index, albumen height, Haugh units, shell color score and yolk index have been higher in birds housed in cages than birds on deep litter. Thus, there is no system currently under consideration as ideal.

cages; alternative system; hens' welfare; egg production; laying performance; egg quality; cholesterol

## Introduction

Many poultry flocks are kept in controlled environmental houses, which can give accurate control over light, and can also control temperature if outside temperatures are above or below those required inside the house. Different needs for weather protection, systems of waste handling and labor availability commonly dictate the type of housing utilization within a local industry by using local crews or materials. Generally, laying hens are commonly housed in the cage system or alternative systems (litter floor systems) depending on layers husbandry and local demand of egg.

In the 1930's, young chickens were kept in batteries and cages on commercial farms. The use of cages for commercial egg production has been become increasingly popular. It is estimated that over 75% of the world's commercial table-egg-production flocks are kept in cages (Bell, 1993, 2002a). During the last sixty years in the USA, over 95% of the layers are housed in cages. The alternative (free range and aviary) method of layer husbandry represents a major reversion back to practices utilized in the pre-1930's. Much of the trend seen today presents an attempt to go back to the natural way of doing things (non-cage) and is driven by local demand and higher prices received for chickens and eggs produced in this manner. Higher prices are necessary because of the higher production costs associated with these systems (Winstead, 1992; Bell, 2002b).

In recent years, both in Europe and the United States there has been a significant trend to develop and use litter-housing system rather than standard cages regarding the well being of animal utilized for food production. The aviary system could offer some distinct advantages over traditional battery cages with regard to the physical condition of laying hens (Wood-Gush et al., 1978; Tanaka, Hurnik, 1992; Taylor, Hurnik, 1994; Gunnarsson, 2000). Many studies have shown that egg numbers from hens kept in cages was more than the others kept in alternative systems (Hughes, Dun, 1986; McLean et al., 1986; Appleby et al., 1988). Also, the percentage of eggs that graded A was ($P < 0.001$) improved by 1.1% and the percentage of body checks eggs was reduced by 0.9 for hens reared in cages compared with hens reared in floor pens (Anderson, Adams, 1994). In contrast, Appleby and Hughes (1991) concluded that there is no evidence to show that egg number was clearly better either in cages or in litter systems. Reports concluded that feed consumption was higher in the floor systems than in conventional cages, therefore feed conversion efficiency in cages was better than in litter systems (Tauson et al., 1999; Abrahamsson, Tauson, 1998; Leyendecker et al., 2001a). The main objectives of this review are therefore to summarize a comparison of laying performance, egg quality and welfare of laying hens in cages and in alternative systems.

**Hens' welfare**

Animal welfare is one of the most important contemporary issues in animal agriculture. The public concern about the welfare of laying hens has increased during the last decades. If the egg production should avoid animal welfare criticism, the farming of laying hens should be carried out in a way that is acceptable to society as well as to the consumers (Gunnarsson, 2000). There is a widespread concern over the well being of farm animals and a wish to protect animals from abuse and neglect. Abuse is the deliberate causing of suffering. Neglect is the less systematic causing of suffering due to human idleness or ignorance (Rose, 1997). The Farm Animal Welfare Council in United Kingdom considered that there are five basic freedoms that should be given to farm animals, i.e., freedom from hunger and thirst; freedom from thermal and physical discomfort; freedom from pain, injury and disease; freedom from fear and distress; and freedom to exercise most natural patterns of behavior (Harrison, 1988; Appleby, 1991; Appleby, Hughes, 1991; Rose, 1997; Gunnarsson, 2000). Moreover, The Council of the European Union has introduced stricter legislative conditions for keeping hens in battery cages. As prescribed by the Council Directive 1999/74/EC, all the battery must comply with the requirements listed below, for 2012 onwards:

- Each hen has to have a minimum useable area of 600 $cm^2$.
- The cages have to be equipped with nests, perches and a littered area.
- The linear feeder space provided must be at least 12 cm/hen.

The Directive foresees the banning of present conditions from 2012. During a transitional period from 2003 to 2012, the usable area is to be increased from 450 $cm^2$ to 550 $cm^2$/hen. Furthermore, claw-shortening devices will have to be provided (Wolffram et al., 2002).

Interest in alternative housing systems for laying hens has increased in recent years in Europe mainly because of public concern for the welfare of hens in battery cages. In free-range situations, domestic layers adopt social structures similar to those of wild jungle fowl. It lives in groups and individuals in groups tend to stay together and synchronize their activities, i.e., fly for few yards, forage, rest and preen at the same time (Webster, 2002). The aviary system could offer some distinct advantages over traditional battery cages with regard to the physical condition of laying hens, given a high level of management. Also, the aviary birds with foot lesions had only a single lesion, whereas one sixth of caged hens with lesions had more than one and also caged hens had poorer feather cover (Taylor, Hurnik, 1994). These results are in correspondence to the results of Tanaka and Hurnik (1992) which indicated that aviaries provide a more comfortable environment of birds and they observed that comfort behaviors (head shaking, head scratching, ruffling, trail wagging, wing flapping, wing and leg stretching, ground scratching and dust-bathing) were performed by aviary birds much more frequently than by the caged birds. At the same time, both Wood-Gush et al. (1978) and Gunnarsson (2000) concluded that caged laying hens cannot perform all behaviors that feral domestic birds perform under natural circumstances, such as wing flapping, roosting, dust bathing and nesting. Many studies have demonstrated that access to litter is essential to the hen for avoiding excessive feather pecking and feather damages because litter is used for pecking and scratching and it is related to behaviors, such as dust bathing (Simonsen et al., 1980; Blokhuis, Arkes, 1984; Blokhuis, 1989; Blokhuis, van der Haar, 1992; Vestergaard et al., 1997; Gunnarson, 2000). On the other hand, Appleby and Hughes (1991) concluded that no system currently under consideration is ideal. However, conventional cages are less likely than systems to provide freedom of movement, freedom from fear, comfort and shelter, suitable flooring and freedom to display most normal patterns of behavior. Litter systems, though, often expose birds to the danger of disease, to aggression from dominant birds and to the risk of cannibalism or beak trimming to avoid it. Cages also have positive effects on welfare in that provide a clean, disease-free environment and small group sizes.

Most of the environmental risks for injuries in battery cages have been reduced through refining of equipment. Solid partitioning walls between cages reduce the feather abrasion (Tauson, 1984). Reducing and refining construction details which trap the birds by their feet, head etc., has decreased the incidence of casualties (Tauson, 1985). Claw abrasive tape in the front part of the cage keeps the birds' claws short and few claws are then broken (Tauson, 1986). Cage floors that give support to the birds' feet and shallower slope of the floor have decreased the incidence of feet injuries (Svedberg, 1988). In spite of all these improvements, there are still health and welfare problems among battery hens, such as osteoporosis, which is mainly caused by the inactivity associated with battery housing (Fleming et al., 1994; Tauson, Abrahamsson, 1994; Newman, Lesson, 1998).

The criticism of conventional cages due to the lack of possibilities to natural behaviors and to restricted space, the furnished, comfortable, cages have gradually evolved. They provide birds with nests to lay eggs in, perches to rest on and litter material to manipulate and dust-bath in (Appleby et al., 1993; Craig, Swanson, 1994; Appleby, 1998; Wall, Tauson, 2002; Wall et al., 2002). However, according to a new EU-directive (CEC, 1999) conventional cages are banned from 2012 and from 2003 no new investment in cages will be allowed apart from those providing the facilities mentioned. The furnished cages try to combine advantages of small group size in cages and reduce disadvantages of poor air condition, and sometimes inferior hygiene, in floor-kept hens (Tauson, 2002).

Therefore, it is clear that the alternative systems provide a more comfortable environment for laying hens and consequently, the laying hens can enjoy comfort behaviors more freely than in battery cages.

**Laying performance**

Overall egg production is a major indication of the performance of commercial layers and contributes to a reasonable of income in egg-production farms. The authors, who investigated the relationship between the egg numbers and housing system, concluded that the egg numbers from hens kept in cages were more than the others, which were kept in alternative systems (Hughes, Dun, 1986; McLean et al., 1986; Appleby et al., 1988). Moreover, Appleby et al. (1988) proved that egg numbers within the period 20 to 64 weeks of age for ISA Brown layers reared in cages and deep litter were 242 and 224 eggs, respectively. Similar results were reported by Hughes and Dun (1986), who indicated that egg numbers from ISA Brown hens during 20 to 68 weeks of age were 251 and 245 in cages and free range, respectively. In addition, Mostert et al. (1995) and Al-Awadi et al. (1995) indicated that the battery system was better than floor house and free-range system, yielding a significantly higher hen day egg production. These results agree with Tauson (1995) who proved that egg production of hens housed in the aviary was 3–5% lower than that of hens housed in traditional cages. Furthermore, Tiller (2001) showed that the field studies confirmed that biological results of non-cages egg production systems could not compete with results of cages units. Number of egg production in cages system was 332 eggs and it was 257 eggs in free-range system. On the other hand, Sütô et al. (1994) proved that with the aviary system, there was a 1% increase for Leghorns and a 14% decrease for brown-egg birds in hen-housed egg production. Similar results were reported by Chabo et al. (2000) who noted that the mean egg production was 88.8% in sawdust litter houses. On the other side, Appleby and Hughes (1991) concluded that there is no evidence to show that results were clearly better either in cages or in litter systems, especially when it is taken into account that more eggs are likely to remain uncollected in litter systems. These findings are consistent with those of Stockland, Blaylock (1974), Mench et al. (1986), Jin, Craig (1988), Anderson, Adams (1994) and Abrahamsson et al. (1996) who found that no effects on egg production were observed in both cages and aviary systems. In addition, Tanaka and Hurnik (1992) concluded that in both battery cages and aviary system, the production performance of hens was similar and relatively high. The mean value of hen-day egg production from 27 to 63 wk of age in cages and aviary was 89.2% and 86.9%, respectively.

Egg weight is one of most important measurements of laying hens performance. Mostert et al. (1995) postulated that the battery system was better than floor house and free range, yielding a significantly higher egg mass. These results are coincident with Anderson and Adams (1994) who investigated that hens reared in cages produced ($P < 0.001$) heavier eggs than those reared in floor pens, 57.0 and 56.3 g, respectively. Moreover, Pavlovski et al. (1994a) showed that in cages, deep litter and free range, egg weight averaged 64.10, 62.26 and 61.33 g, respectively. On the other hand, Chabo et al. (2000) showed that in sawdust litter houses, the mean egg weight was 57 g. The proportion of eggs laid in each weight category (small, medium, large) was influenced by the type of roof. The highest proportion of large and medium eggs size was recorded in the houses that was roofed with corrugated iron sheets and insulated with grass. Contradictory results were reported by both Mench et al. (1986) and Tanaka and Hurnik (1992) who concluded that the mean value of egg weight from 27 to 63 wk of age in cages and aviary was similar and it was 59.2 g.

Regarding to feed intake, it was 10% higher in the floor systems than in cages, this attributed to poor feather insulation of the body as a result of feather pecking and cannibalism (Tauson et al., 1999). This result is in correspondence to Abrahamsson, Tauson (1998) and Leyendecker et al. (2001a) who revealed that feed consumption increased in the intensive free range as compared to the other housing systems (battery cages and aviary system). Pavlovski and Masic (1991) reported that daily feed consumption in cages was 118 to 125 g/hen/day. Furthermore, many workers recommended that the battery system was better than floor house and free range, yielding a significantly better feed conversion efficiency (Dutta, 1993; Tauson, 1995; Mostert et al., 1995; Tiller, 2001). Moreover, Tiller (2001) reported that feed conversion was 2.00 and 2.45 kg feed/kg egg in cages and free-range system, respectively. Also, Dutta (1993) observed that the feed consumed for each dozen eggs was 5.32, 4.01 and 5.0 g in cages, deep litter and free-range, respectively. In addition, Carey et al. (1995) investigated that feed consumption was significantly influenced by cage population size and it was significantly greater for hens housed at 12 and 24 birds per cage (120.3 g/hen/day) compared with those at 6 to 8 birds per cage (108.7 g/hen/day), respectively. On the other side, Mench et al. (1986) and Anderson, Adams (1994) recommended that no differences were apparent for feed consumption due to the housing system and daily consumption in cages and floor pen was 120.4 and 120.6 g, respectively. This result agrees with Tanaka and Hurnik (1992) who found that the mean value of daily feed consumption from 27 to 63 wk of age in cages and aviary was similar and it was 127.8 g for both.

The relationship between body weight and housing system is not self-evident. Differences between systems are usually small, though Hughes and Dun (1986) reported that hens from four successive flocks were con-

sistently heavier on free range (2.4, 2.6, 2.3, 2.4 kg) than in cages (2.2, 2.5, 2.2, 2.3 kg). Similarly, Anderson and Adams (1994) proved that hens reared in floor pens were significantly heavier than those reared in cages at 68 wk of age (1.576 g vs. 1.536 g). The similar observation was noted by Stockland and Blaylock (1974) who found a 30 g difference at 62 wk of age. At the same time, the differences between the pullets' growth in cages and litter systems as examined by Rowland, Harms (1970) and Deaton et al. (1985) indicated that pullet development was improved by floor rearing and these improvement were attributed to the differences in activity levels and movement capability and the fact that the birds had to access to the litter as a mineral and fiber source. On the other hand, body weights of birds in one deep litter house (2.36 kg at the end of lay) were not significantly different from those of cage birds (2.42 kg), but cage birds were fatter: lipid weight was proportionally 0.26 of empty weight compared with 0.21 for litter birds (Appleby et al., 1988).

In cases where flocks in litter systems have been compared directly with cages and no problems, such as cannibalism or disease occurred, mortality was generally similar (Appleby, Hughes, 1991). Contrarily, when cannibalism did occur, mortality could be disturbingly high (in some cases 25% even more). Craig, Lee (1990), Mou, Katle (1990), Abrahamsson, Tauson (1995), Abrahamsson et al. (1996, 1998), Moinared et al. (1998), Gunnarsson et al. (1999) and Leyendecker et al. (2001a) proved that the highest mortality rate was registered in litter systems and it is mainly caused by cannibalism. In experimental flocks, losses of 14.6% were recorded in one aviary and 13.3% in a straw yard (Gibson et al., 1988). In a deep litter house, mortality was 1–3% in a number of flocks over a 2-year period, compared with 2–3% in comparable birds in cages (Appleby et al., 1989). In addition, the mortality rates were 21–27% in floor systems while it was only 7% in cages (Tauson et al., 1999) and the incidence of aggressive behavior is generally higher in litter systems than in cages (Appleby, Hughes, 1991).

Several scientific reports stated that birds in furnished small group cages produce at similar levels to hens in conventional cages in European conditions (Abrahamsson et al., 1995; Abrahamsson, Tauson, 1997; Tauson, 2002). Moreover, Tauson (2002) concluded that production was similar to a conventional cage provided that misplaced eggs on the sand belt were included. Slightly lower egg weight have been registered but at very similar feed conversion ratios (Van Niekerk, 1999).

Based on a lot of observations, it may be suggested that caged hens appear more efficient than birds in alternative systems in the performance of laying hens because it produces more egg numbers and heavier egg weight. Moreover, caged birds consume feed less than birds reared in litter system, so the feed conversion efficiency of hens housed in the aviary will be poorer than that of hens housed in cages. Furthermore, the mortality rate in cages is less than in litter systems.

**Egg quality characteristics**

The avian egg is a highly integrated biological system, the structure and characteristics of which are interlinked by many relationships. Therefore, any abnormality in the physical character of the egg can lead to a breakdown in the interactions of these parameters and, as a consequence, a collapse in its main physiological function to provide the best conditions for the developing embryo. Shell breakage (6–8%) is of major concern because it continues to explain the origin of 80 to 90% of current downgrading and therefore has significant economic consequences for table egg production. Moreover, concern about the safety of egg consumption is growing, and since the eggshell is the first barrier against bacterial penetration it should be free from defects. The banning of the conventional cage system in Europe may increase load on eggshell because of hens reared in housing system with access to litter. The consequence will be a higher risk of human toxi-infection due to Salmonella, uncooked eggs being one of the most frequent origins of outbreak (Yves, 2001). So, eggshell integrity is the first condition contributing to the natural defense system of the egg.

Results of a number of studies revealed that the proportion of dirty eggs was significantly higher in the aviaries than in cages system and higher proportion of dirty eggs dependent on the proportion of floor eggs (Pavlovski et al., 1994a; Tauson, 1995; Abrahamsson, Tauson, 1995, 1998). Floor eggs are a problem in non-cage systems for laying hens. Usually they are dirty, many are broken and it is laborious to gather them. A high percentage of the floor eggs also broken, destroyed or eaten, resulting in a direct loss (Cooper, Appleby, 1996; Bell, 2002b; Meijerhof, 2002). In contrary, Tauson et al. (1999) showed that the proportion of dirty eggs was lower in the traditional floor system than in cages for Light White Leghorn birds. In addition, Tauson et al. (1999) and Leyendecker et al. (2001a) reported that the highest proportion of cracked and broken eggs was registered in battery cages but Mostert et al. (1995) showed that the proportion of cracked and broken eggs was lower in cages system.

Regarding to egg quality traits, eggshell thickness, shape index, albumen height, Haugh units, shell color score and yolk index were higher in birds housed in cages than birds on deep litter (Mohan et al., 1991; Anderson, Adams, 1994; Pavlovski et al., 1994a, b; Roland et al., 1997; Moorthy et al., 2000). Moreover, Pavlovski et al. (1994b) concluded that in cages, deep litter and free-range, respectively, albumen height averaged 7.001, 6.411 and 6.619 mm, Haugh units 79.80, 75.96 and 78.24, yolk index 47.30, 47.46 and 47.38%, yolk color intensity score 9.94, 9.88 and 10.21 and shell thickness 0.355, 0.358 and

0.358 mm. Contrarily, Mohan et al. (1991) proved that shape index, yolk index and albumen percentage were significantly higher on deep litter than in cages. This result is coincident with Leyendecker et al. (2001b) who revealed that Haugh units were higher in the aviary system and eggshell thickness was higher in the intensive free-range system than in the battery cages. Also, eggshell thickness and yolk color were higher in the free-range system. Both Pavlovski et al. (1994b) and Leyendecker et al. (2001b) proved that the number of meat spots was significantly lower in eggs of the hens kept in the free-range system and the incidence of meat spots in cages and free-range was 12.95 and 13.51%, respectively. On the other side, both Abrahamsson and Tauson (1995) and Abrahamsson et al. (1996) postulated that there is no significant differences were found in egg quality traits in both aviary systems and cages. And these results agree with Moorthy et al. (2000) that concluded that albumen index, Haugh units, yolk index and yolk color were not significantly affected by housing type. Similar results were reported by Tanaka and Hurnik (1992) who noted that there were no significant differences between the cages and the aviary for eggshell deformation and the mean values were 25.2 and 25.8 μm, respectively.

Consumers are increasingly interested in food quality and animal welfare issues. This interest is resulting in increased demand for eggs from hens raised on a drug-free, animal fat-free, hormone-free diet or in a cage-free environment. Cherian et al. (2002) concluded that the total lipid content was lower in cage-free vegetarian diet brown eggs and the content of n-3 fatty acid in certified organic free-range eggs, cage-free vegetarian diet brown eggs and naturally nested uncaged eggs were similar. On the other hand, Akkan et al. (2002) proved that the highest yolk cholesterol contents were recorded in eggs of hens raised in free-range systems in villages.

Many recent studies have been interested in egg quality in furnished cages (Abrahamsson, Tauson, 1993, 1997; Abrahamsson et al., 1995; Wall, Tauson, 1999, 2002; Wall et al., 2002; Tauson 2002). Many results indicted that the introduction of a perch in conventional cages normally reduces egg quality in various ways, partly due to the position of the perch (Abrahamsson, Tauson, 1993). The reason for more dirty eggs is often that the cage floor is more defected due to less trampling of the manure through the floor under/besides the perch. Moreover, the proportion of cracked eggs may be higher than in a conventional cage (Wall, Tauson, 1999). In addition, Abrahamsson and Tauson (1997) recorded similar or lower proportions of dirty eggs but higher proportions of cracked eggs in small group-furnished cages compared with conventional cages. These results are in coincident with Abrahamsson et al., (1995) and Wall et al. (2002). Moreover, Wall and Tauson (2002) proved that egg saver wires and long nest curtains lowered the proportions of cracked eggs significantly by softly catching and reducing the speed of the eggs before entering the egg cradle in furnished cages. A study by Reed and Nicol (1992) showed that a strip of artificial grass, mounted on the rear wall of rollaway nests, encouraged nesting behavior, measured as time spent in the nest. Their findings indicated that covering only one part of the wire floor bottom of the nest with, e.g., artificial turf might be sufficient to encourage nesting behavior in laying hens. At the same time, Wall et al. (2002) found that nest floor partly covered (30 vs. 50%) with artificial turf resulted in lower proportions of eggs laid in the nests than fully lined nests.

It could be mentioned that, in most situations, egg quality characteristics are higher in birds housed in cages than birds housed in litter systems and this is because of the highest proportion of dirty, cracked and broken eggs in litter systems.

## Conclusions

It remains impossible to generalize regarding the welfare and husbandry status of birds in litter systems compared with cages. All housing systems offer a number of potential advantages and disadvantages; the advantages are not always achieved and the disadvantages are not always minimized. So, it is evident that no system currently under condition is ideal. All systems are likely to provide freedom from hunger and thirst, adequate lighting and the company of conspecifics. However, conventional cages are less likely than other systems to provide freedom of movement, freedom from fear, comfort and shelter, suitable flooring and freedom to display most normal patterns of behavior. Litter systems, though, often expose birds to the danger of disease, to aggression from dominant birds and to the risk of cannibalism or beak trimming to avoid it.

In most situations, egg production and egg quality characteristics are higher in birds housed in cages than birds housed in litter systems and this is due to the highest proportion of dirty, cracked and broken eggs in litter systems. But if the uncollected eggs in alternative systems are taken into account, there is no evidence to show that results were clearly better either in cages or in litter systems. Furthermore, the trend seen today presents an attempt to go back to the nature way of doing things (non-cage) and is driven by local demand and the higher prices received for eggs produced in this manner. Thus, it is evident that the relationship between the welfare and performance of laying hens and their environment is complex and that choices between husbandry systems are difficult, especially as economics have to be taken into account and it is too difficult to determine the ideal system for laying hens housing.

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**Vliv způsobu ustájení nosnic na jejich užitkovost a kvalitu vajec.**

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Způsob ustájení nosnic má význam z hlediska welfare, užitkovosti a kvality vajec. Alternativní systémy ustájení (např. na podestýlce) jsou pro nosnice výhodnější, protože slepicím poskytují vhodnější podmínky prostředí, zejména ve vztahu k přirozeným životním projevům chování. Na druhou stranu výsledky užitkovosti jsou v alternativních systémech většinou horší než v klecích. Údaje o užitkovosti jsou v některých pracích rozporuplné, ale obecně z literárních údajů vyplývá, že snáška, hmotnost vajec a spotřeba krmiva jsou lepší v klecích v porovnání s alternativními systémy ustájení. Dále živá hmotnost a úhyn jsou v alternativních systémech vyšší oproti klecím. Mnoho literárních pramenů uvádí, že počet vajec zařazených do vyšší kvality je v klecích v důsledku většího počtu špinavých vajec, vajec s poškozenou skořápkou nebo křapů nižší než v alternativních systémech. Mimoto vejce se silnější skořápkou, lepším indexem tvaru vejce, výškou bílku, vyšší kvalitou bílku vyjádřenou Haughovými jednotkami, lepší barvou skořápky a kvalitou žloutku jsou produkovány v klecích. Z literárního přehledu je zřejmé, že je poměrně složité rozhodnout, který systém ustájení je výhodnější, protože je těžké říci, co je důležitější, zda welfare, nebo ukazatele užitkovosti. Náklady na produkci vajec jsou v alternativních systémech vyšší, ale na druhou stranu jsou mezi spotřebiteli skupiny, které jsou ochotny zaplatit více za vejce pocházející z chovů, které respektují přirozený chov slepic.

klece; alternativní systémy; welfare; snáška; užitkovost; kvalita vajec; cholesterol

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