



Optimal stocking density for broilers – optimal for whom?

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Abstract

Stocking density is not the sole crucial factor for broiler (*Gallus gallus domesticus*) welfare; management and environmental factors are certainly also very important. When talking about optimal stocking density it is vital to realise that the birds have no choice in this, as in practice economical factors play the most important role in the producer's decision making process. We must acknowledge that from the producer's perspective the ethical reasoning behind these choices are based on a view that animals may be used by humans for our purposes as long as they are properly cared for, i.e. fed, given water and are kept in good health. For the general public, good animal welfare may be defined as 'animals kept happy and healthy'. Ethical decisions are complex and ethical arguments may weigh differently for different stakeholders, leading them to very different conclusions regarding optimal stocking density and broiler welfare.

Keywords: animal ethics, bird density, broiler, management, stocking density, welfare

Introduction

In this paper we will describe some aspects of broiler (*Gallus gallus domesticus*) needs and set them into perspective of the commercial situation. We will then discuss the decision making process, for various stakeholders, when deciding or influencing what is the optimal stocking density for housing broilers.

Maximum stocking density may be defined as number of birds or weight per floor surface area. Both definitions have their pros and cons and we will therefore use them both in different contexts. Depending on how well the birds meet growth rate goals, weight per floor surface area is optimized - from a production perspective - if it is reached just before slaughter. If, instead, number of birds is used as a measurement the individual body weight at which the birds are slaughtered will be of great importance both for bird welfare and optimal use of the buildings and other facilities.

The modern broiler in comparison with its ancestor the red jungle fowl (*Gallus gallus*) and its close relative, the laying hen (*Gallus gallus domesticus*)

Standard commercial broiler stocking density increased rapidly mainly during the 70'ies and has since then been fairly stable, at least in countries where the rearing methods have not changed appreciably. The commercial stocking density for broilers is approaching 50 kg/m² (Shanawany, 1988; Grashorn & Kutritz, 1991) in some regions, which is roughly equivalent to 20 birds/m² if slaughtered at 2.5 kg of individual body weight. As a comparison the population density and group size in the natural situation is 1-0,2 birds/hectare and a group size of on average 5 birds (Collias & Collias, 1967), whereas a flock of medium egg hybrid hens housed under semi-natural conditions choose an individual distance of approximately 0,5 m when ground pecking (Keeling & Duncan, 1991). This corresponds to approximately 4 birds per square metre.

Comparing broilers with closely related bird types such as laying hens or older breeds of chickens or hens, in fact of the same species, will give a perspective on broiler physical abilities and provide a basis for a discussion on broiler motivation for

particular behavioural patterns. A comparison with the wild ancestor, the red jungle fowl, is relevant since the broiler and the jungle fowl share most of their genetical background and most of their innate behaviours (Hocking, 2009). Evolution has had millions of years to shape chicken motivation through natural selection, and domestication has had very little impact on this. However, we are often misled to believe that domesticated birds are very different from their wild ancestors, since their physical appearance is so dramatically different.

Broilers show extreme levels of sitting and lying; 75-90% of their time during a five week long development (Bessei 1992). Krujt (1964) describes the behaviour sitting in Burmese Jungle fowl (*Gallus gallus spadiceus*) only in connection with dustbathing and sexual behaviour, which both constitute very minor parts of a bird's time budget. A study by Mishra and co-workers (2005) described the behaviour "still", which included sitting. The laying hens in the study by Mishra and co-workers (2005) spent 13% of their day still. Furthermore, the performance of scratching behaviour (scratching and ground-pecking is part of foraging behaviour in *Gallus gallus*) is very different in broilers compared to laying hens. Bessei (1992) found that scratching behaviour constituted less than 0.5% of the broilers' time and walking less than 5% at five weeks of age. Jungle fowl may spend 90% of their time foraging (including scratching) (Dawkins, 1989) and laying hens have been shown to show similar levels of foraging (Schütz & Jensen, 2001).

Dustbathing is a behaviour which is strongly motivated in *Gallus gallus* (Krujt, 1964) and therefore it has been intensively debated for laying hens, less so however for broilers. Broilers seem to dustbathe very rarely. According to a study by Arnould & Faure (2003) this behaviour was observed only very rarely and in a study by Murphy & Preston (1988) not at all. Dustbathing was further studied by Shields and co-workers (2004) who found that broilers have a strong preference to dustbathe in sand, whereas the litter provided in commercial poultry barns often is wood shavings, which the broilers in this study did not use for dustbathing to any considerable extent (Shields *et al.*, 2004). Vestergaard & Sanotra (1999) found that dustbathing decreased in broilers with leg disorders, presumably because of the level of pain that the leg problems caused the birds. The study by Shields and co-workers (2004) used broilers of an age of up to six weeks so it seems that dustbathing is a behaviour that broilers are physically able to perform, if suitable substrate is provided.

Welfare of commercial broilers

In this paper we will use the same welfare definition as Dawkins and co-workers (2004), who estimated welfare of broilers by measurements of mortality, physiology, behaviour and health, with an emphasis on leg health and walking ability. Production is a relevant factor, however good production does not necessarily mean good welfare, whereas decreased production may be a warning sign. In the view of the general public animals with good animal welfare may, quite simplified, be defined as 'healthy and happy' animals.

A large body of knowledge is available on welfare, or rather shortcomings in welfare, in broilers (Bessei, 2006) and broiler breeders. Several studies have found non-linear effects on mortality when increasing stocking density under experimental conditions (Algers & Svedberg, 1989, Dawkins *et al.*, 2004, Buis *et al.*, 2009, Guardia *et al.*, 2011), however under commercial conditions the situation may be very different. Estevez (2007) concluded that 'health and welfare' of broilers may be acceptable at densities ranging between 34-38 kg/m², while emphasising the importance of the quality of the management and environment provided for the birds. In the paper by Estevez (2007) 'health and welfare' indicators picked up from the literature available were e.g. prevalence of foot pad dermatitis, final body weight, mortality, carcass damage, breast blisters, scratches, time spent feeding, food consumed, gate score and tibial dyschondroplasia. Though all these indicators can be affected by stocking density, the management of the birds may be more important for bird welfare outcome than density *per se* (Dawkins *et al.*, 2004).

Negative effects on growth rate may be the most important economic argument for reducing stocking density. When comparing stocking densities of 38 kg/m² and 50 kg/m² a final body weight of around 2 kg was reduced to around 1,85 kg when applying the higher density (Grashorn & Kutritz 1991). Such a decrease may have a substantial impact on the monetary return, as well as being an indicator of reduced bird welfare. Grashorn & Kutritz (1991) found that the microclimate for the birds seemed to explain a large part of the decrease in weight gain. When Grashorn & Kutritz (1991) increased the ventilation rate weight gain differences were less pronounced. Reiter & Bessei (2000) investigated floor and air temperature at bird level, in flocks with

densities of 20-40 kg/m². At the lowest density of 20 kg/m² the floor temperature was 23 °C and temperature at bird height was 22 °C. However at the highest density, 40 kg/m², floor temperature was 31 °C and air temperature at bird level 26 °C, implying that birds at the highest density experienced heat stress. Worth noting is that temperature at a height of 1 m was 22 °C for all densities, which means that unless temperature sensors are placed at bird height or caretakers bend down to bird level the increased temperature may not be detected and adjusted. Furthermore, this may actually mean that older, heavy birds may demand a higher space allowance, i.e. lower stocking density, measured in kg per surface area than young, light birds (Bessei, 2004). The conclusion is that the stocking density will affect the birds differently at different stages of their lives, whether it is limited as number of individuals per surface area or weight unit per surface area.

The examples given above indicate that stocking density is indeed important for bird welfare, but within a wide range of densities management and environmental factors are also highly relevant to the welfare of the birds.

How to make ethical decisions

We argue that research will never give the “right” answer to what is optimal stocking density. Even if considering only bird welfare factors there is no clear-cut answer (Dawkins, 2004). Under commercial conditions bird welfare is not the only basis for decision. It is the society, through the politicians, who make the decision about where to set the standards for animal housing, if this is at all regulated by law. Consumers and consumer interest organisations, public opinion, retailer chains and breeding companies, producers’ organizations etcetera will affect the setting of private standards. Furthermore, farmer economy and consumer interests will be of varying importance depending on the strength of the respective lobbying organisations. For countries with a large export or a large low income population of the possibilities of sufficient protein supply may be a factor of political consideration.

It is not necessarily the interests of the animals that come first when making decisions on animal housing; in fact we argue that it is very rare that animal interests come first. In countries where poverty is common, animal welfare clearly is

secondary to human welfare. In the industrialized world, where the human population have their nutritional needs fulfilled - often excessively - animal welfare may receive increased weight in decision making, but is still balanced against other interests.

Hence, farmers’ possibility to make a living, environmental aspects, consumer preferences and choices, difficulty or ease to alter routines in the chain of producer – retailer – consumer, and many other factors effectively have an impact on stocking density as well as bird welfare.

How does one decide what is most important? Professional ethics may help us in sorting out the arguments. Below, we will describe a number of ethical views often used (Sandøe & Christiansen, 2008) when discussing argumentation around animal ethics.

Utilitarian argumentation is based on a view that the sum of good should be maximised. Broiler and human welfare both matters and are weighted against each other before making a moral decision. This means, very simply put, if human poverty and child protein deficiency is alleviated due to a cheap source of protein this might outweigh the possible suffering of broilers. Just because we know that broilers may suffer this does not per se lead to the conclusion that we should ban or change broiler production.

However, if taking an animal rights ethical standpoint, feeding humans in the third world will not be a valid argument for letting broilers suffer, let alone farmer economy in the wealthier parts of the world. With this standpoint all sentient beings have rights, which cannot be violated. Taken to its extremes radical people with this view may damage property and people to safeguard the rights of animals.

Yet another ethical standpoint identified is the ‘respect for nature’ standpoint. Arguments used may be that broiler production should be banned since the broilers have been bred to a degree where their inherent growth rate forces them to lead a very unnatural life. According to this view, it is the unnaturalness that makes it wrong. On the other hand it may also be argued that it is natural for humans to eat meat in general and bird meat in particular and therefore this type of production is something that should be continued.

A fourth type of ethical reasoning is the contractarian ethical view. This implies that farmers

have an obligation to safeguard broiler welfare because their consumers trust in them to do so. This may be seen as a contract between farmer and consumer giving the farmer moral obligations to do what he or she has 'promised' to do. In this case animal welfare is not mainly focused on the animals themselves but may be relevant for the people who will consume the products.

The fifth and last type of moral reasoning that we will mention here is the relational standpoint, based on the relations between humans and animals and between humans and humans. Since we have a relation with e.g. pets we are obligated to take care of them. The closer the relation is the stronger the ethical obligation to take care of the individual is. If using this type argumentation a farmer will have stronger moral obligations to his or her back yard broilers than the broilers in a huge, modern poultry barn with large flock size and high stocking density. However, the relation to the consumers might be more important. A farmer having a small shop on his farm will have a closer relation to the consumers than if a farmer who is just sending the broilers to the slaughter plant and never faces the consumers personally. This situation varies across the world and different situation will give different weight to the factors affecting decision making (**Figure 1**).

Farm animal welfare in the perspective of farmers, consumers and other stake holders

A number of authors have investigated the attitudes of farmers towards animals and related these attitudes to what type of production the farmers' are managing. Lauwere and co-workers (2007) were able to divide their interviewed pig and dairy farmers into five value categories as regards to animal welfare. Most conventional pig and large dairy farmers shared the view that "economic and commercial values are central both in the discussion about and the

treatment of animals." Broiler farmers may differ in their views as compared to pig and dairy farmers, however this has to our knowledge not been studied explicitly, and the arguments for broiler farmers not differing substantially from pig and dairy farmers may be stronger.

The Welfare Quality® project (an EU-funded integrated project to systematically assessing farm animal welfare, www.welfarequality.net) has defined four principles for animal welfare: "Good feeding", "Good housing", "Good health" and "Appropriate behaviour" (Welfare Quality®). In a Belgian study Tuytens and co-workers (2010) investigated the attitudes to farm animal welfare in the groups Farmers, Representative Citizens and Vegetarians. Farmers saw natural behaviour as less important than vegetarians (Tuytens *et al.*, 2010). The most important welfare criterion to Belgian farmers was health and good feeding, i.e. factors influencing welfare as well as economy. As another example, one of the major breeding companies supplying the producers with broilers defines "bird welfare traits such as leg health, cardiovascular fitness and robustness" (Ross manual, 2009).

In a study by Vanhonacker *et al.*, (2007) comparing consumers' and farmers' views on animal welfare, it was found that consumers overall scored animal welfare higher than what farmers did. However, even though scoring differed there were large similarities in how the relative importance of factors such as feed and water, animal health and human-animal relationship was rated. The large difference between farmers and consumers lay in the importance the two groups gave to "expression of natural behaviour". Expressed bluntly, animal health is of great importance to farmers; however natural behaviour is of relatively low importance.

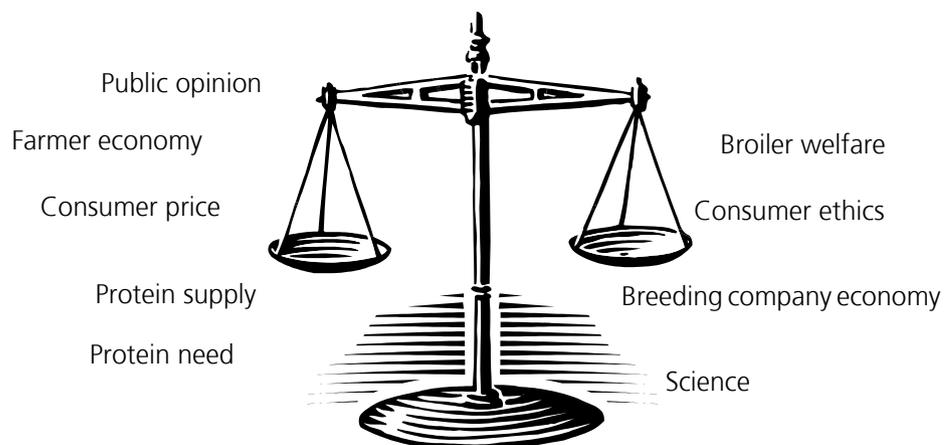


Figure 1 - The factors put into the scale bowls are given different weight by different stake-holders.

Having said that, it is important to be aware of how the poultry production chain is designed. The first link in this chain is the breeding companies. In the world today there are basically three major, international companies producing all modern broilers. These companies supply breeders with grandparent and parent stock, which produce eggs. The eggs are delivered to the hatcheries which hatch birds on demand from broiler producers. The broiler producers rear broilers and deliver them to the slaughter companies, the fourth link in this chain. In many cases all parts of the production chain are integrated in one single company or by a contracting system. After slaughter and processing the meat is delivered to retailers who sell the meat to the consumers, the last link in this chain. All of these have interests, some in common and some that differ (**Figure 2**).

The consumers may have a large impact on broiler welfare, but this is under two assumptions. Firstly the consumers need to have knowledge and awareness about what animal welfare is in general, and secondly they need to be aware of the normal rearing conditions for commercial broilers. If the consumers are not well informed, any price increasing action - taken by farmers or legislators - to improve broiler welfare will be pointless since the consumers will not choose to buy the more expensive product. Actions taken to increase consumer awareness will aid the effectiveness of welfare increasing actions (Algers, 2011).

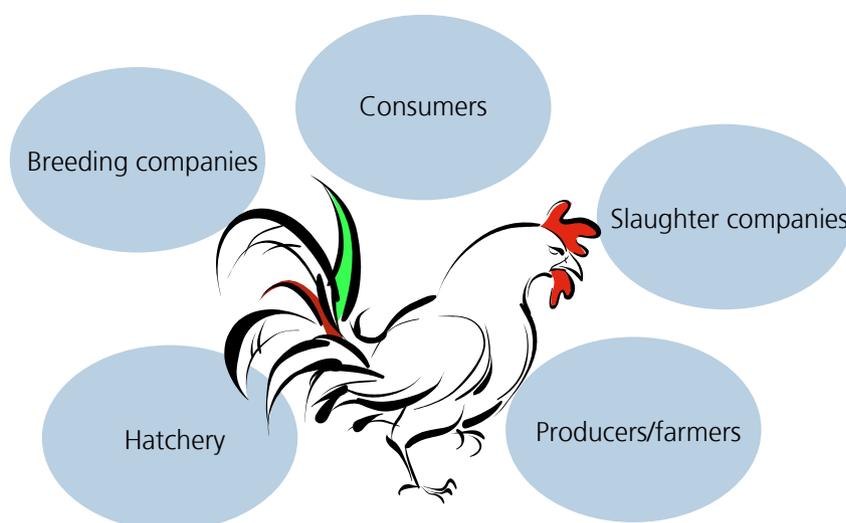


Figure 2 - Ethical decisions around broiler production depend on many interests, apart from the interests of the birds. It is important to take into consideration that none of these stakeholders solely has the power to change the situation for the birds.

Discussion

In the Welfare Quality® Assessment protocol for poultry the welfare principle is that welfare is associated with feeding, housing, health and behaviour (Welfare Quality®, 2009). In the protocol a number of criteria based on the five freedoms are mentioned, e.g. freedom from hunger and thirst. Furthermore, some behavioural measurements are taken: panting as a measurement of thermal discomfort, ease of movement (crowdedness) and freedom of fear, which is estimated by the percentage of birds within reach of a human observer.

Examples of welfare measurements for laying hens (Welfare Quality® 2009) are, apart from feeding, housing and health, expression of social behaviour, use of litter, freedom of fear estimated as distance from a human at which the bird turns away. Also, positive emotion estimation is carried out through a novel object test. No measurement of positive emotions for broilers is identified in the protocol; however play behaviour might be used as a measure of positive emotions in young broilers.

On farm measurements of animal welfare are fairly well developed for broilers. For example the Bristol gait scoring method (Kestin *et al.*, 1992) has been widely used and Berg & Sanotra (2003) have modified the LTL test so that it is feasible to use on commercial farms. However, these methods are not routinely used by the industry itself or by authorities controlling on farm animal welfare. This means that it should be possible to audit welfare in a more detailed way also for broilers.

The question “*What is the optimal broiler stocking density?*” cannot be resolved by science, as this is an ethical question. Science can certainly provide useful knowledge about how broilers are affected by stocking density, but the final decision will inevitably be a trade-off between many different aspects. We encourage stakeholders as legislators, the public, consumers, producers, breeding companies, retailer chains etc to communicate with each other and discuss

what moral reasoning they are using and possibly share. Legislation will only give a minimum level of protection from suffering, but animal welfare is so much more. Higher standards of animal housing and management may be achieved if stakeholders can agree.

Conclusions

Legislation is based on ethical decisions and the policy makers should be as well informed about science, economy and other factors, as possible.

Information to the society and to the politicians is the responsibility of both researchers and producers.

Farmers alone cannot change modern broiler production and it is important for the society to realize this. If change is to be achieved, all parts of the production chain must be involved.

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