Effect of light intensity and stocking density on performance of broilers and cost-effectiveness

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Abbreviated title: broilers: light and stocking density

Summary

The council directive 2007/43/EG states minimum standards for chickens kept for meat production.

The effect of the stocking density on performances and cost-effectiveness was evaluated during six production cycles, in which two stocking densities (13 versus 20 birds / m²) were applied in two compartments of 300 m² per stocking density.

In the first four production cycles, additionally two light intensities (20 lux versus low light intensity) where tested.

The light intensity had no effect on growth performance (2516 vs. 2523 g). There was no interaction between the light intensity and stocking density observed.

The lower stocking density resulted in a better growth performance (2605 vs. 2436 g on day 39, $p < 0,001$), and less foot pad lesions (0,0 vs. 10,6 % with severe lesions on day 39, multinomial regression: $p<0,001$), lower mortality (3,04 vs. 3,64 %, $p < 0,02$) and higher return over feed.

Based on these results the effect of the stocking density on the cost-effectiveness of the poultry farm was calculated. These calculations show that the stocking density, as well as the meat price and the feed cost, has a huge impact on the farm cost-effectiveness.

Keywords: broiler, welfare, stocking density, light intensity

Introduction

The council directive 2007/43/EG states new minimum standards for chickens kept for meat production. The stocking density may not exceed 33 kg/m². A higher stocking density can only be allowed when the farmer complies with specific requirements. The maximum density might not exceed 42 kg/m². The directive states further that intensity of light must be at least 20 lux.

On Belgian farms the common density at age of slaughter can be higher than 46 kg/m² and the used light intensity is much lower than 20 lux.

In an experiment that was performed from 2008 till 2009, the effect of stocking density and light intensity on the performance of broilers and the cost-effectiveness was evaluated.

Material en method

The effect of the stocking density on the growth performances and cost-effectiveness was evaluated during 6 production cycles, in which 2 stocking densities (13 versus 20 birds / m²) were compared. The density of 13 birds / m² was set to obtain about 33 kg/m² at day 40. The density of 20 birds / m² corresponds with a commonly used density on commercial farms and resulted in 45 kg / m² at day 40.

In the first 4 of these production cycles, additionally 2 light intensities (20 lux versus low light intensity) to the stocking densities (13 versus 20 birds / m²) were compared. The experimental group with the low light intensity had a light intensity of 20 lux on the first 2 days, 15 lux from day 3 until day 10, then 5 lux until day 35 and 10 lux during the last 4 days.

The experiments were performed in 2 houses. Each house has 2 compartments of 300 m² where climate and light intensity can be controlled independently from the other compartment.. Each compartment has 4 pens of 75 m² where feed- and water distribution can be controlled independently. In 2 of the 4 pens, Ross 308® birds were placed. In the other pens different commercial breeds were placed. The effects of breeds are not in the scope of this paper.

All the birds got "ad libitum" feed and water. The climate control in each compartment was adapted to the stocking density; set point for environmental temperature was in each compartment the same, set point for minimum and maximum ventilation was expressed in kg live weight per bird and was the same in each compartment.

The birds where slaughtered at the age of 40 days

Live weight was measured each week (sample of 50 birds/pen and 75 birds/pen at slaughter age). Mortality rate, consumption of feed and water were recorded on a daily base.

At the age of 27, 34 and 39 days, 50 birds per pen were evaluated for cleanliness of the chest, the presence of hock-burn and food pad lesions. For this evaluation birds were classified in 4 classes where class 0 stands for good a condition and class 3 for a very bad condition.

The continuous data were analysed with a variance analyses (General Lineair Model, Mixed Model, (SPSS®)), the class-variables were analysed with a Multinomial Regression (Generalized linear models / ordinal logistic regression (SPSS®))

To calculate the cost-effectiveness of flock density a simulation of financial revenue per m² and per year was calculated with 2 densities (13 birds/m² and 20 birds/m²), 2 prices for meat (0,78 euro/ kg live weight and 0,84 euro/kg live weight) and a range of feed prices from 260 euro/1.000 kg to 340 euro/1.000 kg. To calculate this revenue all the variable costs and fixed costs for depreciation of the house and the equipment and assurances, were taken into account. However: costs for labour of the farmer were excluded.

Results.

There was no interaction between the stocking density and light intensity for cumulative mortality rate, live weight, feed consumption and water consumption at slaughter age. Neither on cleanliness of the chest, the prevalence of hock burn or food pad lesions, any interaction was found.

The effect of light intensity on the performance of the birds was not significant. The estimated means of the General Lineair Model of the two treatments are presented in table 1.

Table 1: effect of intensity of light on the performance at slaughter age (day 39).

	intensity of light		
	20 lux	low	sig.
cum. mortality %	2,51	2,82	n.s.
live weight (g)	2516	2523	n.s.
cumulative water consumption per bird housed (liter)	6,90	6,74	n.s.
cumulative feed consumption per bird housed (kg)	4,01	3,95	n.s.
feedconversion	1,67	1,64	n.s.

The effect of light intensity on the prevalence of hockburn and foot pad lesions was only significant on measurements at the age of 27 days. At day 34 and day 39, there was no significant effect anymore. The results are listed in table 2.

Table 2: effect of intensity of light on the prevalence of hockburn and foot pad lesions. score 0: % of birds that are in a very good condition; score 3: % of birds that are in a extreme bad condition

		hockburn				
age (days)	intensity of light	score 0	score 1	score 2	score 3	sig.
27	20 lux	85,8%	13,6%	0,5%	0,2%	**0,000**
	low	75,0%	24,4%	0,6%	0,0%	
39	20 lux	31,9%	56,4%	11,6%	0,2%	n.s.
	low	39,5%	45,6%	11,9%	3,0%	
		foot pad lesions				
age (days)	intensity of light	score 0	score 1	score 2	score 3	sig.
27	20 lux	85,8%	14,1%	0,2%		**0,000**
	low	76,7%	22,7%	0,6%		
39	20 lux	40,6%	37,3%	21,1%	0,9%	n.s.
	low	39,7%	43,9%	6,7%	9,7%	

The effect of density on the performance of the birds, the prevalence of hockburn and foot pad lesions was highly significant. The results are presented in table 3 and table 4.

Table 3: effect of flock density on the performance at slaughter age (day 39)

	stocking density		
	13 birds/m²	20 birds/m²	sig.
cum. mortality %	2,27	3,14	0,017
live weight (g)	2605	2436	< 0,001
cumulative water consumption per bird housed (liter)	6,94	6,74	0,074
cumulative feed consumption per bird housed (kg)	4,11	3,85	< 0,001
water/feed ratio	1,69	1,75	0,004
feedconversion	1,65	1,67	n.s.

Table 4: effect of intensity of light on the prevalence of hockburn and foot pad lesions. Score 0: % of birds that are in a very good condition; Score 3: % of birds that are in a extreme bad condition

		hockburn				
age (days)	density	score 0	score 1	score 2	score 3	sig.
27	13 birds/m²	84,5%	15,3%	0,2%	0,0%	**< 0,001**
	20 birds/m²	76,3%	22,7%	0,9%	0,2%	
39	13 birds/m²	45,0%	48,0%	6,6%	0,5%	**< 0,001**
	20 birds/m²	26,4%	54,1%	16,9%	2,7%	
		foot pad lesions				
age (days)	density	score 0	score 1	score 2	score 3	sig.
27	13 birds/m²	93,6%	6,4%	0,0%		**< 0,001**
	20 birds/m²	68,9%	30,3%	0,8%		

39	13 birds/m²	57,8%	40,2%	2,0%	0,0%	**< 0,001**
	20 birds/m²	22,5%	41,1%	25,8%	10,6%	

The cost-effectiveness of the two evaluated densities are presented in figure 1. In normal conditions for prices for live birds at slaughter and for feed, the revenue for a farmer is higher when the stocking density is high. When prices of feed increase, the difference in financial revenues between high and low stocking densities decreases. With very high feed prices, the financial revenues are better with low stocking density, but this occurs only in a situation when there are financial losses.

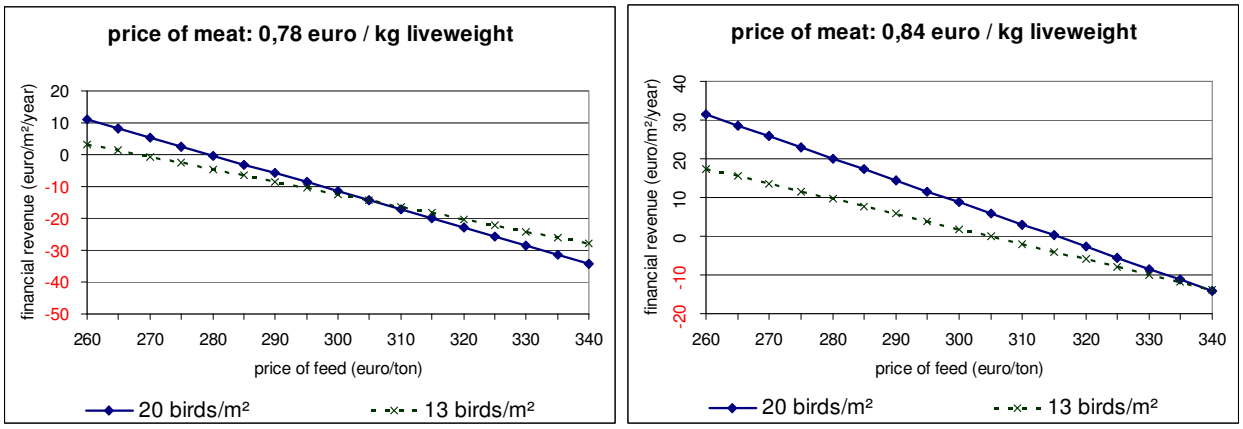

Figure 1: revenu per m² per year based on 2 prices for meat, a range of feed prices and 2 flock densities.

Discussion

The effect of light intensity on the performance of broilers, the prevalence of hockburn and food pad lesions is not significant. This is confirmed by other authors that investigated light intensities in the range from 5 lux to 20 lux. (Blatchford RA et al., 2009)

The effect of flock density on the performance of broilers and the prevalence of hockburn and food pad lesions was in this experiment more pronounced than in previous experiments. Till the age of 34 days there was not a significant difference between both densities for mortality (2,57 % at 13 birds/m² vs. 2,60 % at 20 birds/m²), while there was already a significant difference for liveweight on the age of 27 days (1514 g at 13 birds/m² vs. 1464 g at 20 birds/m²).

The financial consequences of flock density on farm level are important. To maximise the income it's important to use high flock densities as legally allowed if there is no extra value payed for birds raised in lower densities.

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References

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