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ECONOMIC ASPECTS OF REDUCING STOCKING DENSITY IN BROILER CHICKEN PRODUCTION USING THE EXAMPLE OF FARMS IN SOUTHERN POLAND*

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Abstract

The purpose of this paper was to assess the impact of reducing stocking density to the level recommended by Council Directive 2007/43/EC on broiler production profitability. The study was carried out using the example of three broiler-only farms located in southern Poland. The farms with production area of 950 m^2, 3 400 m^2 and 5 040 m^2, had fully automated systems for feeding, watering and ventilation. In total, the research covered 54 production rounds in the years 2009–2011. Research material included data concerning production costs and achieved production results, as well as income obtained in individual rounds. Net income from broiler production was calculated for three variants differing in stocking density: variant 1 – actual stocking density in farms in 2009 (47–45 kg m^{-2}), variant 2 – stocking density of 42 kg m^{-2}, variant 3 – stocking density of 33 kg m^{-2}. The study results indicate that reducing stocking density increases total production costs, and decreases broiler production income. Production profitability depended primarily on the relation between prices of broiler livestock and feed. Reducing stocking density to the level recommended by the European Commission (33 kg m^{-2}) in 2009 would result in decrease of income from €2.40 to 0.77 per m^{-2}, whereas in 2011 production carried out at this stocking density would result in losses. To maintain the current income level of farmers, it would require an increase of 5–6% in meat prices.

Key words: broiler, stocking density, broiler production income

Development of animal production technology allowed production of animals on growing production scale in modern, fully equipped houses. Due to the climatic conditions of Poland, broiler chickens are kept in poultry houses, which should provide animals with optimal welfare and living conditions. Currently, the systems used to

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keep farm animals depend mainly on economic and organisational factors (Lay et al., 2011), and their proper selection directly affects the welfare of animals (Dawkins et al., 2004; van Horne et al., 2008).

Farmers aim to keep production costs on a low level, which together with low food prices makes their production more competitive. In the current market conditions consumers attach great significance to farm product quality and prices (Vanhonacker and Verbeke, 2009; Napolitano et al., 2013). Animal welfare is affected first of all by environmental conditions: temperature, humidity, content of harmful gases, and litter quality. Animal-based measures such as corticosteroid metabolites, leg health, bursa weight or dermatitis (Buijs et al., 2009) are of importance. However, in practice these indicators are difficult to assess. In industrial broiler production, the most important technical indicators specifying welfare levels are rearing duration and stocking density (Gallot and Champagne, 2010). Stocking density affects welfare, but reducing it without guaranteed optimal environmental conditions is of minor significance (Dawkins et al., 2004; Estevez, 2007; Jones et al., 2005). Studies were conducted on the impact of stocking density on unfavourable changes in health of broiler chickens, their production results (Tong et al., 2012), feed and water consumption, and carcass quality. High stocking density results in an increase of foot pad dermatitis, hock and breast lesions (Buijs et al., 2009; Ventura, 2010) as broilers grow, in particular for stocking density above 30 kg of livestock per m^2 (Bessei, 2006). There are differing opinions if stocking density affects feed consumption, mortality rate and carcass quality (Feddes et al., 2002), but high stocking density reduces access to feed and water (Sikder et al., 2010).

The researchers still look for answers regarding best housing systems for rearing of broiler and laying poultry (Estevez et al., 1997; Sosnówka-Czajka et al., 2010; Lay et al., 2011). Good Production Practice is the essential component of best available technique in intensive poultry production (Mihułka et al., 2003).

Currently, according to the European Commission recommendations, broiler chickens may be kept at stocking density below 30 to 33 kg m^{-2} provided that Good Production Practice rules are followed, and not exceeding 40 to 42 kg m^{-2}. The EC decision regarding the reduction in stocking density will cause its decrease in production practice, although farmers would prefer a higher stocking density in order to obtain better production results per unit of area and higher incomes (Meluzzi et al., 2008; Verspecht et al., 2011).

The purpose of the research was to assess the impact of the reduction in broiler stocking density on the net income from broiler production.

Material and methods

Economic evaluation of the reduction in stocking density was carried out using the example of three broiler farms located in southern Poland in the Opolskie and Małopolskie Voivodeships. These farms had similar equipment and fully automated systems for feeding, drinking and ventilation, but differed in production

area size: farm A – 950 m^2, farm B – 3 400 m^2, farm C – 5 040 m^2. Broiler production was carried out in a closed system, on deep straw litter, in houses without windows. In total, the research covered 54 production rounds carried out in the years 2009–2011. Account books of the farms provided detailed information (separately for each round) concerning: the number of nestlings, mortality, fattening period, amount of consumed feed, and average body weight. Total production costs incurred in each round were distributed according to their place of occurrence (Skarżyńska, 2007). Final production output was determined quantitatively (in birds and kilograms) and according to value – actual price obtained from broiler sale. General characteristics of the farms and the production indices obtained in 2009 are shown in Table 1. Six production rounds per year were carried out in each farm.

Table 1. Characteristics and production indices of farms included in the study in 2009

Technical data	Farm		
	A	B	C
Production area (m^2)	950	3400	5040
Fattening period (days)	42	43	44
Stocking density (kg m^{-2}/birds m^{-2})	46.8/19.7	45.3/18.7	44.7/18.0
Feed consumption (kg kg^{-1})	1.81	1.82	1.84
Mortality (%)	4.0	3.9	4.2
Average body weight (kg)	2.41	2.52	2.62
European Efficiency Index	302.8	316.4	306.0

Source: own calculations.

In farm A, initial stocking density of nestlings was 19.7 chicks m^{-2}, fattening period 42 days, average weight 2.41 kg, and final stocking density reached 46.8 kg m^{-2}. In farm B, initial stocking density was lower (18.7 chicks m^{-2}), with more days of fattening (43 days), average broiler weight of 2.52 kg, and final stocking density of 45.3 kg m^{-2}. Lowest initial stocking density was applied in farm C (18.0 chicks m^{-2}), average production period was 44 days, average weight was 2.62 kg, and final stocking density reached 44.7 kg m^{-2}. In order to evaluate the impact of the reduction in stocking density on the income from broiler production, the costs were divided into two groups: fixed costs, which were not changing with the reduction in stocking density (ranging from 33 to 48 kg/m^2) during single production round, and variable costs, directly depending on the size of production resulting from assumed stocking density. Fixed costs included: production preparation (dung removal, washing, disinfection), litter, heating, permanent hired labour, repairs and overhauls, depreciation of buildings and production machines, and other. Fixed costs were recalculated per one production round and area unit (m^2). Variable costs included: purchase of nestlings, feed, water, veterinary care and vaccination, and temporary labour involving, among other things, catching and loading of birds.

Depreciation of fixed assets was calculated by linear method of amortization. This method is most frequently used in agriculture (Sobczyk, 2004).

Calculations were made for three variants differing in final stocking density given in kg m^{-2}. Variant 1 assumed actual final stocking density calculated as the ratio of sold livestock volume and production area of farms. Average stocking density from 6 production rounds in 2009 was taken for each farm. Variant 2 assumed stocking density of 42 kg m^{-2} approved by the EU directive under the following conditions: production is consistent with Good Production Practice; farms are provided with proper equipment, and data on feeding, heating, ventilation, disinfection and mortality monitoring are recorded. Variant 3 assumed introducing in all farms stocking density of 33 kg m^{-2} as recommended by the EU in Council Directive 2007/43/EC from June 2010. Sales revenue in variant 1 was real value of sold broilers, while in variants 2 and 3 it was defined as the result of stocking density assumed in a given variant and farm production area. Net income (I_N) (per m^2 of production area) for each variant was calculated as the difference between sales revenue (R_s) for a given stocking density and incurred fixed costs (C_F) and variable costs (C_V), according to the following formula:

$$I_N = R_s - C_F - C_V \tag{1}$$

Sale's revenue was calculated as a production volume (in kg) and current price for broiler meat, obtained by producers on selling. Because fixed costs are constant for specific farm and do not depend on stocking density, they were recalculated per m^2 of production area and per production round. Variable costs are strictly connected with stocking density and production volume, so they were recalculated per kg of produced broilers.

Keeping net income at the same level in spite of the reduction in stocking density is possible for example at adequate increase in prices for broiler livestock. According to formula (1) and demonstrated assumptions, income equivalence for different stocking density values is defined by the following relation:

$$D_A * P_{LA} - C_V * D_A = D_B * P_{LB} - C_V * D_B \tag{2}$$

where:

D_A – current stocking density used by producers, in kg m^{-2},
P_{LA} – current price for broilers obtained by producers, in € kg^{-1},
D_B – reduced stocking density, in kg m^{-2},
P_{LB} – hypothetical price for broilers for stocking density DB in € kg^{-1}.

Transformation of equation (2) allowed determining the price level for broilers (P_{LB}), so as to keep the net income obtained at the same level in spite of the reduction in stocking density.

Stocking density impact on net income was also examined with regression analysis. To develop the regression model, several variables including prices of livestock and production means as well as production indices were examined. Finally, price of livestock and feed prices as well as final stocking density were statistically sig-

nificant and chosen as independent variables (explaining the income). Computations were performed using the Statistica 10 program.

Results

Broiler production costs are shown in Table 2. In 2009, fixed costs were €3.49 per m^{-2} on average. They were highest (€3.55 per m^{-2}) in farm A characterised by smallest production area and lowest (€3.42 per m^2) in farm C with highest production area. Variable costs were similar in individual farms, and ranged from €0.65 per kg^{-1} to €0.67 per kg^{-1} of broilers.

Table 2. Broiler production costs in selected farms in the years 2009–2011

Cost category	Year	Farms			
		A	B	C	average
Fixed costs	2009	3.55	3.49	3.42	3.49
€ m^{-2} $round^{-1}$	2010	4.03	3.98	3.99	4.00
	2011	3.96	3.92	3.91	3.93
Variable costs	2009	0.67	0.65	0.65	0.66
€ kg^{-1}	2010	0.73	0.69	0.71	0.71
	2011	0.81	0.80	0.81	0.80

Source: own calculations.

In 2010, fixed costs increased by approximately 15% to €4.00 per m^{-2} (primarily due to the increase in heating and labour costs). Variable costs increased by 7% on average, up to €0.71 per kg^{-1}. In 2011, fixed costs dropped by 2% compared to the level from previous year, while variable costs increased by approximately 13%, which resulted primarily from considerable increase in feed prices (Figure 1).

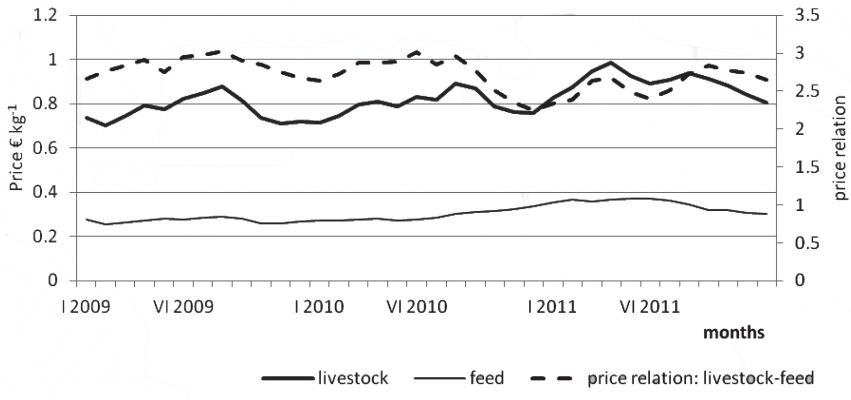

Figure 1. Prices of broilers and feed in the years 2009–2011

Broiler production in 2009 was profitable, and for actual stocking density (variant 1) it resulted in an average net income of €2.40 per m^{-2} (from €2.01 per m^{-2} in farm A to €2.66 per m^{-2} in farm C) (Table 3). In 2010 for the maintained base stocking density the income decreased to €1.73 per m^{-2} on average. Decrease of the income was primarily caused by unfavourable relation between the prices of broiler livestock and price of feed (from 1:2.95 in 2009 to 1:2.89 in 2010). The unfavourable tendency for faster growth of feed prices compared to meat prices intensified by 2011. The ratio between prices of meat and feed reached 1:2.66, which resulted in further income drop down to €1.35 per m^{-2} on average.

Table 3. Net income from broiler production in selected farms for varying final stocking density in the years 2009-2011, € m^{-2}

Stocking density variant	Year	Farms			Average
		A	B	C	
Base stocking density[1)]	2009	2.01	2.58	2.66	2.40
	2010	1.38	1.86	1.97	1.73
	2011	1.14	1.44	1.51	1.35
Stocking density of 42 kg m^{-2}	2009	1.44	2.14	2.29	1.94
	2010	0.98	1.43	1.61	1.08
	2011	0.61	1.05	1.19	0.93
Stocking density of 33 kg m^{-2}	2009	0.37	0.93	1.07	0.77
	2010	–0.72	0.28	0.41	–0.01
	2011	–0.37	–0.02	0.10	–0.11

Stocking density: farm A 46.8 kg m^{-2}; farm B 45.3 kg m^{-2}; farm C 44.7 kg m^{-2}.
Source: own calculations.

Assuming final stocking density at the level of 42 kg m^{-2} (variant 2) involves average reduction of production in one round by 4.8 kg m^{-2} in farm A, by 3.3 kg m^{-2} in farm B, and by 2.7 kg m^{-2} in farm C. This would also lead to a decrease in income. Given the market conditions in 2009, the net income would be reduced by €0.46 per m^{-2} on average (decrease of 19%) compared to base stocking density, and in individual farms by €0.57 per m^{-2} (28%) on farm A, by €0.44 per m^{-2} (17%) on farm B, and by €0.37 per m^{-2} (14%) on farm C. In 2010 reduction in stocking density to 42 kg/m^2 would lower the income by €0.65 per m^{-2} (37%) on average, and in 2011 – by €0.42 per m^{-2}, which is a 31% decrease compared to the income obtainable in that year for base stocking density. Maintaining the income at a constant level while reducing stocking density to 42 kg m^{-2} would require an increase in livestock prices by approximately 1.5%.

Applying final stocking density at the level of 33 kg m^{-2} (variant 3) resulted in reduction of production from 13.8 kg m^{-2} in farm A to 11.7 kg m^{-2} in farm C. Assuming current prices for means of production and broiler meat, production at this level

in 2009 would result in a decrease in income (compared to base stocking density) to €0.37 per m^{-2} in farm A (a drop of 82%), €0.93 per m^{-2} in farm B (a drop of 64%) and €1.07 per m^{-2} in farm C (a drop of 60%). In 2010, net income for stocking density of 33 kg m^{-2} would be negative in farm A (–€0.72 per m^{-2}), while in larger farms it would be €0.28 per m^{-2} (farm B) and €0.41 per m^{-2} (farm C). Broiler production in 2011 for stocking density of 33 kg m^{-2} in farms A and B would bring losses (–€0.37 per m^{-2} and – €0.02 per m^{-2}, respectively), whereas in farm C it would fluctuate near break-even point. It is possible to balance the economic results of the reduction in stocking density to 33 kg m^{-2} through the increase in prices of broiler meat from 5% to 6%.

Regression analysis results confirmed the impact of stocking density on the value of net income (Table 4). Prices of both broiler meat and broiler feed, as well as final stocking density proved to be statistically significant. The model obtained explains 80% of variability in net income (corrected R^2=0.798).

Table 4. Selected statistics of multiple regression function for net income from broiler production as a dependent variable

Independent variables	Parameter B[1)]	Student's t-test value
Intercept	–13.9659[2)] (1.2212)	–11.4357
Stocking density (kg m^{-2})	0.1079[2)] (0.0166)	6.5061
Broiler meat price (€ kg^{-1})	39.9578[2)] (1.7081)	23.3927
Feed price (€ kg^{-1})	–76.9381[2)] (3.5216)	–21.8477

[1)] Standard error values are given in brackets.
[2)] Significance: P<0.001.

Coefficient value of 0.1079 for "stocking density" variable indicates that the reduction in stocking density by 1 kg m^{-2} results in net income decrease of €0.11 per m^{-2}.

Discussion

The purpose of this work was to examine the impact of a reduction in broiler stocking density to the level indicated by the European Commission. In farms selected for the study in 2009, initial stocking density ranged from 17 to 20 nestlings per m^2 of production area. Mortality during the production period ranged from 3 to 4%, and average body weight was 2.40–2.65 kg. As a result, final stocking density ranged from 44 to 47 kg m^{-2}. According to Council Directive 2007/43/EC, since June 2010 final stocking density of broilers should not exceed 33 kg m^{-2}. If production is consistent with Good Production Practice, this stocking density may be increased up to 42 kg m^{-2}. The issue of adapting stocking density to the EE requirements concerns many countries. Versprecht et al. (2011) report that stocking density commonly used in Belgium reaches 48 kg m^{-2}. The reduction in stocking density with limited poultry house surface area directly lowers production volume. Average farm size in Poland

is about 3000 m^{-2}, but there are still many small farms with a size of about 1000 m^{-2}. In the analysed farms, the reduction in stocking density to the recommended level of 33 kg m^{-2} will result in a production volume drop of 25 to 30%, and maintaining production volume at the same level will require building of new houses. Moreover, reduction in stocking density increases production costs because of a growing share of fixed costs which are allocated to fewer animals. In small farms fixed costs per production area unit are higher than in large farms. In farm A sized 950 m^2 fixed costs were highest and constituted 10.7% of costs involved in producing 1 kg of livestock, and the reduction in stocking density to 33 kg m^{-2} would increase the share of these costs to 14.3%. Broiler production profitability depends on the production performance and the market conditions which determine the meat price and the price of the production inputs. For relatively stable production indicators (dependent on producer), production profitability depends primarily on the relation between prices of broiler and feed. In Poland, prices of broiler livestock and feed are subject to considerable fluctuations (Utnik-Banaś, 2012). In the course of 2009–2011, the relation between prices of broiler and feed decreased significantly. The reduction in stocking density to 33 kg m^{-2} in the market conditions of 2009 and with favourable relation between the prices caused a considerable decline in income, but production was still profitable. For prices of 2011, broiler production at this stocking density would result in losses.

Results of this work indicate unequivocally that the reduction in final stocking density will cause a drop in net income from broiler production in given market conditions. Maintaining the current income level of farmers while reducing stocking density from 45 kg m^{-2} to the value of 33 kg m^{-2} indicated by the EC, would require an increase of 5–6% in prices of broiler livestock.

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