Environmentally Relevant Criteria in Brother Rooster Rearing

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Poor Climate Balance

Germany is restructuring its animal husbandry. Starting in 2022, male day-old chicks will no longer be allowed to be culled - one alternative will be the rearing of these brother roosters. Until now, there were no studies on the environmental impact of this branch of production. Our author Prof. Dr. Werner Bessei has closed this gap.

In a Nutshell

A legal ban on chick culling will come into effect in Germany at the beginning of 2022. This calculation will examine the environmental impact of rearing brother roosters. The ratio of maintenance requirements to growth over the extended fattening period will be determined. Greenhouse gas emissions almost double when the same amount of carcasses is produced. This is accompanied by significantly increased emissions contributing to acidification and eutrophication, as well as increased land and water consumption.

The practice of culling male chicks from laying breeds has been criticized from various quarters in recent years. According to the current animal welfare law, the culling of animals is only permitted if there is a "reasonable reason" for it. The argument that male birds of laying breeds are not suitable for fattening because they have a poorer feed conversion ratio compared to fattening breeds is now seen more as an economic aspect and is no longer recognized as a "reasonable reason" in the sense of the law.

One alternative is the so-called brother rooster fattening. Due to their genetic predisposition, their ability to convert feed into body mass is limited compared to broilers that have been selectively bred for fattening performance. Generally, 90 days are required to produce a marketable carcass. In addition to the high feed input, the less developed valuable cuts, such as breast and thigh, oppose the economic utilization of the rooster chicks. Typically, this is balanced out by adding a surcharge to the price of the eggs of the "sister hens."

The environmental consequences of brother rooster fattening have not played a role in public discussion so far. However, the government has set ambitious goals to limit global warming. According to the Climate Protection Plan 2050, agriculture is expected to reduce greenhouse gas emissions by 31 to 34% by 2030. Animal production will also have to contribute to this. Therefore, it is expected that individual sectors will be assessed in terms of their environmental impact. So far, there has been no knowledge in this regard concerning brother rooster fattening. The aim of this study is to close this gap with the help of a Life Cycle Analysis.

TABLE 1: Basic data comparing brother roosters (Bruderhähnen) and conventional broilers

Characteristics	Broiler	Brother Rooster
Fattening duration, days	32	90
Final weight (LW), g	1755	1750
Slaughter weight (SW), %	72	58
Whole-body crude protein, %	19.6	22.5
Feed conversion ratio, kg/kg	1.56	3.43
Feed consumption, g/animal	2737.8	6000
Starter feed consumption, g/animal	1218.8	250
Grower I feed consumption, g/animal	1519	1500
Grower II feed consumption, g/animal	0	4250
Crude protein in starter, %	22.5	20.5
Crude protein in Grower I, %	20.5	19.5
Crude protein in Grower II, %	-	18.5
Stocking density, kg/m²	39	35
Fattening cycles/year	9	3.6
Number of animals per m² per year	198	72

LW = Live weight

Source: Bessei

Ammonia Emissions Vary

In the fattening of brother roosters, there are 48 g of NH_2 and 0.3 g of N_2O per animal per cycle. The values for broilers were significantly lower for both gasses (14.39 g NH3 and 0.09 g N_2O). The NH_2 emissions for fattening chickens documented in the literature vary greatly. Comparing with the current data is challenging because these values relate to different fattening durations and body weights. When adjusted approximately to the same conditions as in the present study, values range between 6 and 31 g NH_2 per animal. The current calculation is in the mid-range.

Increased CO_2 Equivalent

The brother roosters' NH_2 emission per animal is 3 to 4 times higher than that of broilers. There's less information available about N_2O emissions than NH_2 emissions. Nielsen et al. (2011) reported N_2O values of 0.24 g per animal. According to MacLeod et al. (2013), 0.5% N_2O-N arises from the nitrogen excretions of broilers. Based on the nitrogen excretion in the different fattening systems, this would result in 0.19 g N_2O per animal for brother roosters and 0.06 g for broilers. The emission values of N_2O for brother roosters, which are three times higher than broilers, like the higher NH_2 values, are mainly due to the slow growth and the relatively high nitrogen excretions this causes.

As expected, the CO_2 emission values for broilers were in the ranges also reported by Henn et al. (2015): 1.32 kg per animal for respiration and 0.23 kg per animal for litter. The corresponding values for brother roosters were 5.00 and 1.17 kg. Based on body weight, brother roosters produce 3.23 kg CO_2 (respiration and litter), and broilers produce 1.15 kg. This shows that the extended fattening duration of the brother roosters, in order to achieve an acceptable weight, results in a disproportionate increase in CO_2 emissions from respiration and litter. CO_2eq resulting from CH_2 amounts to 16 g CO_2eq for brother roosters and 4 g CO_2eq for broilers. Since both N_2O and methane account for less than 1% of the total CO_2eq, they are often not considered in the environmental balance for poultry.

The CO_2 production in the barn from respiration, litter, and feed, as well as the CO_2eq from the CH_2 and N_2O emission from the litter and the feed, are summarized in Table 2. The CO_2eq caused by the feed, after respiration, account for the largest proportion of the total CO_2eq. Since the CO_2eq of the different rations do not differ significantly, they largely follow feed consumption. With 3.09 kg CO_2eq, brother roosters are significantly higher than broilers at 1.22 kg. Based on respiration, litter, and feed, brother roosters emit 9.60 kg, which is three times the CO_2eq compared to broilers with 2.96 kg per kg of slaughter weight (SW).

TABLE 2: CO_2 and CO_2eq (kg per kg slaughter weight)

Source	**Broiler**	**Brother Rooster**
Respiration	1.32	5.00
Bedding/Litter	0.23	1.15
Feed	1.22	3.09
Electricity	0.04	0.15
Gas	0.15	0.20
Total per kg slaughter weight	2.96	9.60

Energy Expenditures are Similar

The power requirement for broilers in short-fattening, according to KTBL, is 1.6 kWh per animal space per year. Of this, 1.2 kWh is attributed to ventilation, 0.3 kWh to lighting, and 0.1 kWh to other factors. As Table 2 shows, the power requirement for lighting in brother roosters is significantly higher than in broilers. This is primarily because only 72 animals per m^2 of barn area are fattened per year for brother roosters, compared to 198 animals for broilers. However, the ventilation power requirement is highest for the broilers, as ventilation is primarily dependent on CO_2 and water vapor production and thus on live weight (LG).

The CO_2eq resulting from the power consumption per kg of slaughter weight (SW) is 150g for brother roosters and 40g for broilers, which is of minor importance compared to other emissions. The values often listed in Life Cycle Assessments (LCAs) for barn construction and furnishings are also in a range that does not influence the overall balance, so they were not considered in this LCA. According to KTBL (2021), the energy requirement for heating per animal and barn space per year in short-fattening of broilers is 6.5 kWh. Due to the longer fattening duration and fewer fattening cycles per year, brother roosters consume only half as much heating energy per animal space per year. However, the CO_2eq per animal is higher for brother roosters than for broilers due to the smaller number of fattened animals per year. Like with power consumption, the CO_2eq per kg SW is minor in relation to the total emissions, with 200 g for the brother rooster and 150 g for the broiler.

Table 4 lists land and water consumption per animal, as well as the contribution to acidification and freshwater eutrophication from feed production. It shows a space requirement of 17.4 m² for brother roosters and 6.5 m² for broilers per animal.

TABLE 3: Environmentally relevant criteria from cultivation, transport, and processing of feed according to Feedprint

Parameter	Broiler	Brother Rooster
Area, m²/Animal[1]	6.52	17.40
Water, L/Animal[2]	116	199
Acidification, g SO2/Animal	6.22	20.18
Eutrophication, g PO_4/Animal	7.03	21.79

[1] To the area from feed production, 0.114 m² stable area for Brother Roosters and 0.005 m² for Broilers were added.
[2] For water consumption for feed production, 121L for Brother Roosters and 5.5L for Broilers were added.
Source: Werner Bessel, University of Hohenheim

TABLE 4: Increased CO_2eq emissions, increased land and water consumption, as well as increased acidification and eutrophication through the fattening of Brother Roosters

Parameter	Amount
CO_2eq, t	334,078
Area, ha	60,254
Water, m³	4,691,000
Acidification, t SO_2eq	760
Eutrophication, t PO_4eq	807

Source: Bessei

Three Times the Land Requirement

Relative to the SW, the land consumption of the brother roosters at 17.14 m² is three times higher than that of the broilers (5.16 m²). The water consumption per animal is 199 liters for brother roosters and 116 liters per broiler. Based on SW, brother roosters require twice the amount of water (196 liters and 92 liters). The direct water consumption is about twice the feed consumption. This includes not just drinking water, but also cleaning water and losses from drinking systems, amounting to approximately 12 liters for the brother rooster and 5.5 liters for the broiler. These values were added to the aforementioned water consumption. The high values for the brother roosters are still below those found by Séguin et al. (2011) for extensively kept, slow-growing broilers. Here, the water consumption values varied from 199 to 343 liters per kg of live weight.

Both in their impact on terrestrial acidification and freshwater eutrophication, brother roosters are more than three times higher than broilers. Both the SO_2eq and the PO_4eq for conventional broilers in this study are significantly lower than in other studies. In general, it can be said that the calculations in this study for the various environmental parameters cannot be directly compared with the values reported in the literature. This is because the husbandry conditions and calculation methods are inconsistent, and the used feed materials are evaluated differently.

Triple CO_2 Emissions

Per animal, the brother roosters contribute 9.082 kg CO_2eq to the greenhouse effect, and the broilers contribute 4.95 kg CO_2eq. The largest share is due to the animals' metabolism (respiration), followed by feed production, CO_2 development in the litter, and CO_2eq resulting from CH_4 and N_2O. The CO_2eq portions for electricity and heating are negligible.

Rearing 50 million brother roosters would produce 485,000 tons of CO_2eq. To substitute the slaughter weight (SW) produced from brother rooster production with broilers, 40.15 million animals would be required. The resulting CO_2eq would then amount to 151,000 tons. Therefore, rearing brother roosters would lead to an increased annual CO_2eq emission of 334,000 tons.

The additional need for land amounts to approximately 60,000 hectares, and for water, 4.69 million m^3. The production of brother roosters would contribute 760 tons of SO_2eq and 807 tons of PO_4eq to acidification and eutrophication. Not considered in this calculation are the additional buildings required due to the increased land needed for production. It must also be taken into account that specialized facilities would be needed for the slaughtering and processing of brother roosters.

Conclusion: Environmental Balance is Poor

The rearing of brother roosters is considered an alternative to the killing of male chicks from laying lines. The higher costs of this production compared to conventional broilers are known. They are covered by a surcharge on eggs, which come from the sisters of the brother roosters. The environmental costs caused by this production have not been quantified so far. If all the male chicks from laying lines that annually arise in Germany were fattened according to the brother rooster system, this would lead to an increase of 334,000 tons in CO_2 equivalents, a 60,000-hectare increase in land consumption, an increase in water consumption of 4.69 million m^3, an increase in acidification potential of 760 tons of SO_2eq, and an increase in eutrophication potential of 807 tons of PO_4eq.

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Basis of Calculation

The comparison of the environmental impacts of brother rooster and conventional broiler farming is based on the calculation of the emissions of carbon dioxide (CO_2), ammonia (NH_3), nitrous oxide (N_2O), and methane (CH_4) during fattening, storage, and application of the litter-manure mixture. It also considers the resulting CO_2 equivalents (CO_2eq), CO_2eq from feed production, acidification effects (SO_2 equivalents, SO_2eq), and eutrophication (PO_4 equivalents, PO_4eq), as well as land and water consumption. In brother rooster farming, a slaughter weight of 1,200 g and more is targeted. This requires a live weight of over 1,700 g. The base data for the rearing come from various sources. For conventional broiler farming, the performance data for Ross 308 were used. The basic data can be found in Table 1, page 41. The calculation of CO_2 production from animal respiration and litter during fattening was carried out according to equations from Henn et al. (2015). For the calculation of N-losses and the formation of NH_3 and N_2O, values from Nielsen et al. (2011) were used. For N_2O emissions, it was assumed that 0.1% of the N content in the litter appears as N_2O. To calculate the CH_4 development from the litter, measurements from Henn (2003) were used, suggesting that 0.15% of the C-emissions from the litter are emitted in the form of CH_4 and 99.85% as CO_2. The CO_2eq were calculated using the factors 1 (CO_2), 298 (N_2O), and 25 (CH_4). The environmentally relevant criteria from the feed were determined using the Feedprint (2021) program. Based on the individual components of the rations, CO_2eq, water consumption, land use, acidification values (H+), and eutrophication values (P) were calculated. The acidification values were converted into the more common SO_2 equivalents (SO_2eq) and the eutrophication values into PO_4 equivalents (PO_4eq) so that they were compatible with the values from fattening.

So far, there are no measurements of the energy consumption of brother roosters. As a basis, the data on the expenditure of electricity for lighting, ventilation, and other factors, as well as heating from the KTBL collection for short-term fattening of broilers, were used. A barn with 30,000 fattening places served as a model. Based on this, the energy consumption per animal in kWh for heating (gas) and electricity for brother rooster farming was calculated. For heating energy, it was assumed that the heating period in both production directions is the same. The NH_3 values go into the calculation of acidification, and the N_2O values into the calculation of CO_2eq. Due to the lower number of cycles in brother roosters, the heating energy consumption per *year is less than in broilers. Ventilation energy consumption per animal is determined by the removal of CO_2 and water and is higher in broilers than in brother roosters. The power requirement per animal for lighting is determined by the stocking density and the duration of fattening, which is why it is lower in broilers than in brother roosters. The power consumption for "miscellaneous" was rated the same.*