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National Evaluation for Animal Housing Systems

Assessment of Environmental Impacts

The goal of the national evaluation for animal housing systems was the development and application of a method which allowed the impacts of animal housing systems on the environment and animal welfare as two equally important criteria to be evaluated. Below, the evaluation of the environmental impacts of animal housing systems, which was developed together with the KTBL working group "Environmental and Process Engineering", is described.

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Keywords

Assessment, environmental impact, animal production facilities, environmental indicators

Literature

The results of the "National Evaluation for Animal Housing Systems" have been published in KTBL publication 446. Every housing system is shown in the form of a data sheet with a short description, management tips, as well as the evaluation with regard to the environment and animal welfare along with tables which explain the assessment. More detailed information about the husbandry systems is available via a separate internet access.

The term "environmental impacts" as defined for the project describes the emission potential of primarily airborne emissions of a housing system. Therefore, the emission potential of animal housing systems which must theoretically be expected is estimated in the national evaluation frame for animal housing systems. The actual environmental impacts can only be estimated and assessed in the concrete case given the conditions at the individual location.

The Method

The environmental evaluation of the housing systems is divided into five steps:

1st step: determination of production-specific parameters

After the husbandry systems had been chosen and a detailed constructional and housing-technological description as well as resulting management tips had been given, production-specific parameters (emissions, consumption values for energy, water, ...) for environmental evaluation were determined.

2nd step: determination of the environmental indicators

For the evaluation of the housing systems with regard to their environmental impacts,

the most important environmental indicators which seem appropriate for evaluation were determined parallel in cooperation with the working group "Environmental and Process Engineering". These are the emissions of ammonia, odour, dust, methane, and laughing gas, locally limited nutrient inputs of nitrogen and phosphorus into the soil, as well as the technical energy requirements in the housing and process water demand.

3rd step: determination of the evaluation schemes

Based on expert's knowledge and literature research, quantitative and qualitative evaluation schemes were developed separately for each indicator and each animal species to be assessed.

4th step: evaluation

The actual evaluation of the housing systems was carried out based on the quantitative and qualitative evaluation schemes using a five-step range of evaluations from "very low" to "very high".

The selected environmental indicators were evaluated individually with regard to their potential. If data for quantitative evaluation were available, this assessment was carried out based on a set of data. If no data were available, a qualitative evaluation scheme was used as a basis of evaluation.

Table 1: Quantitative evaluation scheme of the environmental indicators using laying hens as an example

indicators	unit	grading				
		very low	low	middel	high	very high
emission (air)						
NH ₃ from housing	kg TP ⁻¹ a ⁻¹	< 0,05	0,05-0,1	0,1-0,15	0,15-0,2	> 0,2
NH ₃ from manure storage	kg TP ⁻¹ a ⁻¹	k. A.				
odour from housing	GE GV ⁻¹ s ⁻¹	< 20	20-30	30-40	40-50	> 50
odour from manure storage	GE GV ⁻¹ s ⁻¹	k. A.				
dust from housing	kg TP ⁻¹ a ⁻¹	< 0,01	0,01-0,04	0,04-0,07	0,07-0,10	> 0,10
N ₂ O from housing and manure storage	kg TP ⁻¹ a ⁻¹	0,005- 0,35 ¹⁾				
CH ₄ from housing and manure storage	kg TP ⁻¹ a ⁻¹	0,05- 0,4 ¹⁾				
emissions (soil) locally nutrient inputs into the soil						
N ²⁾	kg ha ⁻¹ a ⁻¹	< 100	100-200	200-300	300-400	>500
P ²⁾	kg ha ⁻¹ a ⁻¹	< 25	25-50	50-75	75-100	>100
energy- and water requirements						
technical energy requirements in the housing	kWh TP ⁻¹ a ⁻¹	2,6-3,8 ¹⁾				
process water	l TP ⁻¹ a ⁻¹	k. A.				

1) range of available test results; reliable grading impossible.

2) N-value calculated based on g m⁻², P-value derived from N with the factor 3.9. k. A.: no data

TP = animal place; GV = livestock unit, 500 kg. GE = odour units.

place of emission/ influencing factor	emission potential NH ₃			
	low		high	
	measures and variations			
Housing	Open climate housing/naturally ventilated		closed housing /forced ventilation; housing with outlet openings/forced ventilation	
Building structure/ ventilation principle				
place of defecation	Dung area with under-floor demanuring/ventilated dung belt	dung area with under-floor demanuring/ dung belt	dung area with under-floor demanuring/ slide etc.	dung area with mobile demanuring
room temperature/ humidity	low		high	
installation of resting-, drinking-, and feeding equipment	above the perforated dung area		above the littered area	
dung remains in the housing for	< 1 week		> 1 week	
N/P-reduced feeding phase feeding	available		not available	
wintergarden (outdoor scratching area)	multi-phase-feeding available/ no additional indoor scratching area	2-phase-feeding not available/ only indoor scratching area	available/additional indoor scratching area	
store				
dung storage outside housing	covered or direct dung removal	covered	unprotected	
yard	available		not available	

Table 2: Qualitative valuation of the emission potential for ammonia (NH₃) using the example of laying hens

Afterwards, the individual evaluations of the environmental indicators were summarized in an overall environmental evaluation of the individual housing system. Overall evaluation was carried out in three categories (A, B, C).

5th step: listing of the results

The results of each housing system are listed in a data sheet together with the evaluation of animal welfare.

Quantitative Evaluation Scheme

After an analysis of the most recent literature, the evaluation was graded from “very low” to “very high” based on the range of the available results for the determined indicators. If the quantity of data was insufficient, only the range was indicated without any grading. If no data were available, no evaluation was provided. Table 1 shows examples of the quantitative evaluation scheme for the assessment of laying hens housing systems.

Qualitative Evaluation Scheme

Due to the gaps in the data, quantitative evaluation schemes were supplemented with qualitative assessment schemes (Table 2), which were used as a supplement or an alternative in the evaluation of the housing systems.

Based on the different factors which exert an influence on the emission potential of the selected indicator within a housing system, numerous schemes were developed which were adapted to the animal species and the direction of production. In these schemes, the most important influencing factors were listed, whose different variations with regard to possible emission- and input potential or their requirement were classified.

In laying hens husbandry, for example, the installation of resting-, drinking-, and feeding equipment above the littered surface in-

creases the potential for ammonia emissions as compared with a perforated dung area. If all measures and technical variants which were assumed in the housing systems are classified, the emission potential can be derived with the aid of experts.

Together with the members of the working group “Environmental and Process Technology”, the emission potential or the requirement values of each environmental indicator were classified either based on production-specific parameters according to the quantitative evaluation scheme or the experts’ evaluation on the basis of the qualitative data set.

Since no well-founded data basis was available for many of the indicators to be evaluated, qualitative criteria had to be used to derive results in order to be able to carry out an evaluation at all. Otherwise, virtually all housing could not have been assessed.

The interdisciplinary composition of the working groups, which included renowned

experts and representatives of interest groups, guaranteed a well-founded, balanced evaluation. The emission- and yield potential as well as the potential of the demand for energy and water were listed in an overview for each housing system (Table 3). Since ammonia and odour were used as indicators in the permit procedure for stall facilities, they were chosen as leading indicators for evaluation.

Categories A to C are defined as follows:

The housing system provides the constructional-technical conditions for an animal housing system which according to current knowledge is evaluated as follows with regard to the environmental criteria considered:

- Category A: particularly advantageous
 - Category B: satisfactory
 - Category C: sufficient for existing facilities. For new facilities and alterations, other housing systems are recommended.
- Of the 139 housing systems to be evaluated, 87.8% were considered satisfactory (B) with regard to their environmental impact. 5.8% were evaluated as particularly advantageous (A), and 6.4% were regarded as sufficient (Table 4).

For many of the housing systems which were classified in categories B or C with regard to their emission potential, constructional-technical measures provide the possibility to reduce the emission potential. These measures are listed in the individual data sheets and directly refer to the housing system described there. However, one must consider that the realization of constructional-technical measures for the reduction of the emission potential might lead to a new housing system.

Table 3: Emission potentials of all evaluated environmental indicators using the example of selected laying hens housing systems

housing systems laying hens	emission (air)					emission (soil)	requirement		category
	NH ₃	odour	dust	N ₂ O	CH ₄	N and P	energy	water	
Deep litter housing with a wintergarden and additional indoor scratching area, dung pit	very high	high	high	middel	middel	n. v.	middel	low	C
Deep litter housing with a wintergarden and additional indoor scratching area, dung belt	High	middel	high	high	high	n. v.	middel	middel	C
Deep litter housing with a wintergarden, no additional indoor scratching area, dung belt	Middel	middel	middel	middel	middel	n. v.	middel	middel	B
n. v. = not available									

Table 4: Allocation of the selected housing systems to the environmental categories A, B, C

Animal	Number of housing systems in environmental category [n]			Total
	A	B	C	
Cattle	5	40	5	50
Pigs	1	43	-	44
Laying hens	1	14	4	19
Turkey	-	7	-	7
Peking duck	-	3	-	3
Horses	1	15	-	16
Total	8	122	9	139
%	5,8	87,8	6,4	100