

# GASEOUS EMISSIONS FROM ALTERNATIVE HOUSING SYSTEMS FOR LAYING HENS

*F. da Borso, A. Chiumenti, T. Rodar*

*Dipartimento di Scienze Agrarie e Ambientali, Università degli Studi di Udine, via delle scienze, 208, 33100 Udine, Italy. daborso@uniud.it*

## ABSTRACT

Laying hen housing systems imposed by the 99/74/CE Directive are conceived to improve welfare of laying hens, so they could express natural behaviours, such as bitter-scratching, dust-bathing, egg-laying on nests. However, recent researches on enriched cage systems and deep-litter systems pointed out some negative aspects, like a worse egg quality, because a lot of eggs are laid out of the nest and are frequently broken.

The Department of Agricultural Science and Environment, University of Udine, in the frame of a research project co-financed by the Ministry of University and Research, carried out several experimental trials in alternative houses with deep-litter system in order to assess the environmental impact. Egg production from alternative houses was similar to that generally obtained from conventional cage systems, but hygienic, behavioural and management problems were pointed out. In alternative houses, higher ammonia and dusts concentrations were found, distressing hens, workers and environment.

Ammonia emissions, calculated from gaseous concentrations and ventilation rate, ranged from 0.239 and 0.427 kg unit<sup>-1</sup> year<sup>-1</sup>. According to the Best Available Techniques reference document of the IPPC EC Directive (ILF BREF, 2003), the deep litter systems for non-cage housing of laying hens could not be classified as BAT, due to the high emission levels.

## INTRODUCTION

In Italy the poultry sector is subject to several laws which involve environment protection (water and air pollution), welfare and sanitary aspects. In particular D.lgs 29/7/2003 n.267, adopts directives 99/74/CE and 2002/4/CE, about laying hens welfare, and D.lgs 4/8/1999 n.372 partially adopts the directive on Integrated Pollution Prevention and Control (IPPC).

The present study aims to point out some results obtained from experimental trials on alternative deep-litter systems for laying hens, conformed to 99/74/CE, in order to assess their gaseous emissions and environmental impact.

In the frame of the National Project “*Innovazione tecnologica degli allevamenti zootecnici*” co-financed by the Italian Ministry of University and Research (MIUR), a preliminary investigation was carried out in order to focus on the Italian situation about alternative housing systems. Up to now, in Italy only one livestock unit adopted furnished cages, but the deep litter systems are more diffused. However, the interest for the deep-litter systems is more related to the eggs’ marketing rules (1274/91/CE) and to the organic production rules, than to the obligations from 99/74/CE directive. Several experimental trials were carried out in alternative houses in order to record constructive, management, productive and sanitary data and to deep on environmental impact. The present paper aims to focus on this last aspect.

## MATERIALS AND METHODS

Two units were selected, fulfilling the requirements of directive 99/74/CE as regards deep-litter systems: more than 1/3 of the floor area was covered with litter material and the remaining

area had a raised and slatted floor, with two central tiers of collective nests. Poultry manure was stored under the slatted floor. Chain feeders with built-in percherics and nipples were placed above the slatted floor. In the following table 1, main characteristics of the two units are resumed, in comparison with some of the requirements of 99/74/CE Directive.

**Table 1.** Description of the 2 units and limiting parameters of the 1999/74/CE Directive.

	Unit 1	Unit 2	Dir. 1999/74/CE
<b>Total area</b> (m <sup>2</sup> )	696	600	-
<b>Number of animals</b>	3828	4200	-
<b>Date of housing</b>	2003 February 5th	2002 November 20th	-
<b>Animal density</b> (hens/m <sup>2</sup> )	5.5	7.0	< 9.0
<b>Ventilation</b> (type)	Natural	Natural	-
<b>Litter</b> (material)	Wood-shavings	Wood-shavings	-
(% useful area)	48	48	> 33
(cm <sup>2</sup> /hen)	757	595	> 250
<b>Nest</b> (type)	Collective	Collective	-
(hens/m <sup>2</sup> )	60.0	76.4	< 120
<b>Slatted floor</b>	Polypropylene slats	Polypropylene slats	-
<b>Percherics</b> (type)	Built-in with feeders	Built-in with feeders	-
(cm/hen)	6.1	4.8	> 15
<b>Feeders</b> (type)	Linear chain	Linear chain	-
(cm/hen)	12.2	9.6	> 10
<b>Drinkers</b> (type)	Nipple	Nipple	-
(hens/drinker)	6.6	8.4	< 10

Both units adopted natural ventilation and wood-shavings as litter material, but they were characterised by different animal density (5.5 and 7.0 hens m<sup>-2</sup>) and different start of productive cycle (February 2003 and November 2002).

Ammonia concentration was continuously monitored during 4 days in July and October 2003 by the photoacoustic multigas monitor Bruel&Kjaer 1302. Sampling points were 1.2 m high from the slatted floor.

Ammonia emission levels were calculated from the internal ammonia concentrations and the airflow rates, which were estimated through the CO<sub>2</sub> balance method, as suggested by Pedersen et al. (1998) and by CIGR (1984).

## RESULTS AND DISCUSSION

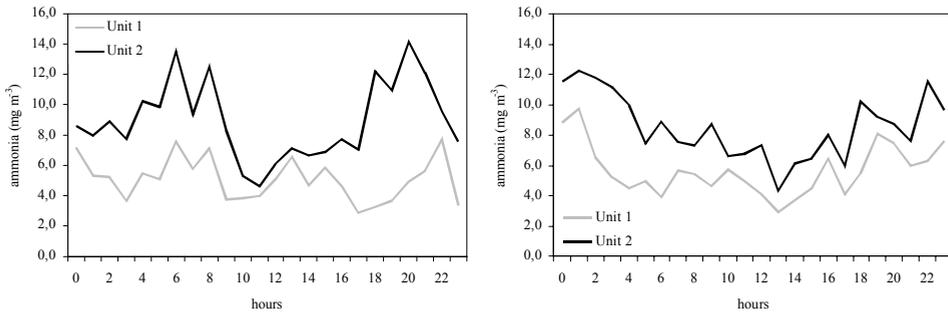
### Environmental parameters

Daily average values of external air temperature were 25.0°C in summer period (July) and 6.3°C in autumn period (October), whereas internal air temperature ranged from 20.3 to 31.9°C and 6.0 to 12.2°C, respectively in summer and in autumn period.

### Ammonia concentrations

Both in the summer and in the autumn period ammonia mean concentration was higher in Unit 2 (in which animals were housed in November 2002 with an higher animal density) than in Unit 1. However, into the same Unit, daily mean ammonia concentrations in the two periods were similar (5.7 – 5.1 mg m<sup>-3</sup> in Unit 1 and 8.5 – 8.9 mg m<sup>-3</sup> in Unit 2).

The lowest ammonia levels were reached from the 10 a.m. to the 18 p.m., while the highest levels during the night.

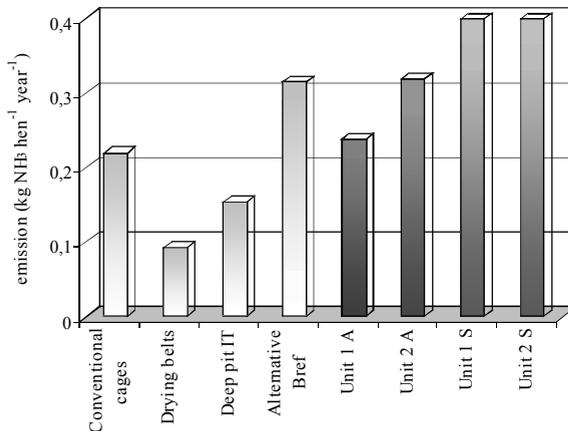


**Figure 1.** Ammonia concentration during 24 h in summer (left) and in autumn (right)

### Ammonia emissions

Airflow rates in summer were a bit higher in Unit 1 (9.3 m<sup>3</sup> hour<sup>-1</sup> hen<sup>-1</sup>) than in Unit 2 (5.4 m<sup>3</sup> hour<sup>-1</sup> hen<sup>-1</sup>), while they were similar in autumn (4.8 – 4.3 m<sup>3</sup> hour<sup>-1</sup> hen<sup>-1</sup> in Unit 1 and in Unit 2, respectively). Ammonia emission levels were calculated by these airflow rates and by the above mentioned mean ammonia concentrations.

Ammonia emissions were about 49 mg hour<sup>-1</sup> hen<sup>-1</sup> in both the units in summer, while in autumn they ranged from 27 mg hour<sup>-1</sup> hen<sup>-1</sup> (Unit 1) to 36 mg hour<sup>-1</sup> hen<sup>-1</sup> (Unit 2). Emissions levels from Unit 2 were higher than those reported by IPPC BREF for the reference techniques (0.43 kg NH<sub>3</sub> year<sup>-1</sup>hen<sup>-1</sup>) and they were considerably higher than those generally measured from conventional cage systems.



**Figure 2.** Ammonia emission factors from different housing systems calculated by IPPC ILF-BREF (light grey) and from alternative systems in Northern Italy (dark grey).

## CONCLUSIONS

During the last 20 years several housing systems for laying hens were developed in order to reach high productive performances and to improve environmental sustainability. Vertical tiered cages with manure belts and forced air drying, external drying tunnels and deep-pit systems were considered best available techniques (BAT) by the Bref document, fulfilling the IPPC requirements (Dir. 96/61/CE). Housing systems imposed by the 99/74/CE directive for the protection of laying hens (i.e. enriched cages, deep litter systems, aviary systems) were not so deeply studied from an environmental point of view. The IPPC's Bref document reported only data collected

from Northern Europe (i.e. the Netherlands), from which resulted that alternative-to-cage systems could not be considered as BAT, since ammonia emission is  $0.315 \text{ kg year}^{-1} \text{ hen}^{-1}$ .

The present paper dealt with the results of some experimental trials carried out in North Italy in deep litter systems for laying hens. Deep litter systems completely fulfilled the 99/74/CE directive requirements, and some parameters, such as animal density ( $5.5 - 7.0 \text{ hens m}^{-2}$ ), were considerably below the animal density provided by the directory itself ( $9 \text{ hens m}^{-2}$ ).

The high ammonia emission levels, ranging from  $0.24 \text{ kg year}^{-1} \text{ hen}^{-1}$  (in autumn) to  $0.43 \text{ kg year}^{-1} \text{ hen}^{-1}$  (in summer), demonstrated that, in Mediterranean Countries, these alternative systems do not allow to reach good environmental sustainability standards, even though animal density lower than standard for welfare are adopted. Further researches have to be carried out on these systems, focused on rapid manure removal from the houses and drying. In particular this last aspect appeared to be crucial in relation to the necessity of controlling the great number of flies which develop from these housing systems.

In conclusion, a closer integration between welfare and environmental regulations is desirable: many conflicts seem to arise from the fact that alternative systems suggested by welfare directive are not considered best available techniques from the environmental point of view.

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