

## Identifying physical hazard for intensive pig and cattle breeding operators and defining prevention measures

Dioguardi L.<sup>1</sup>, Sangiorgi F.<sup>1</sup>, Ariano E.<sup>2</sup>

<sup>1</sup> University of Milan. Institute of Agricultural Engineering

Via Celoria, 2 – 20133 Milan, ITALY.

Tel +39 0250216857, Fax +39 0250316845, [loredana.dioguardi@unimi.it](mailto:loredana.dioguardi@unimi.it)

<sup>2</sup> ASL of Lodi, SPSAL, Piazza Ospitale 10 – 26900 Lodi, ITALY

### Abstract

This paper describes the results deriving from a survey, carried out at regional level about the implementation of safety prevention in agriculture. The main physical, chemical, and biological hazards connected to cattle and pig breeding, important zotechnical activities in Lombardy, were detected and quantified. In particular, the results related to the quantification of risks due to noise, lighting, and microclimate are considered here. The overall situation emerging from the study did not appear to be much critical.

Noise levels were generally lower than 80 decibels in dairy cattle farming, but they could increase on account of mechanized operations, a case where the quantification of the risk depended on the type of machinery implied (with or without cabin). During milking, noise values might range between 70 and 75 decibels. Exposure to noise in pig farms derived from the use of machinery and from stressed animals.

Lighting conditions showed very different in both types of breeding. Lighting levels were usually lower than the values in UNI EN 12464 standard; in some cases over measured lighting systems were found. Neither maintenance nor cleaning of bulbs resulted to be carried out on a regular basis, which decreased lighting levels.

Uncomfortable thermal conditions for milkers were found in dairy cattle farms in winter as all milking premises were not heated. In pig farms, the microclimate hazard concerned operators working in a very hot environment and having to withstand strong thermal shock in winter.

**Keywords:** animal husbandry, microclimate, lighting, noise.

### Introduction

The aim of this paper is to highlight the main objectives and achievements of the survey: "*Identifying chemical, physical and biological hazards for intensive pig and cattle breeding operators and defining prevention measures*", carried out by Lombardy Region with the scope of enhancing the effects of a programme called "preventive interventions in agriculture". This survey was perfectly in tune with a broader context of activities, providing essential information and contributing to the drafting of the guidelines on hygiene and safety in rural buildings (BURL of 10/02/2006, 3° special issue) and to the promotion of farm management systems taking into account prevention measures.

The project activities analysed all preliminary aspects necessary to describe the production, to provide a framework defining risk factors, and to identify a representative sample of the major breeding and production techniques with the final object of assessing, even by quantitative measures, chemical, physical, and biological risk factors. In particular, and to be concise, this work quantifies the main physical hazards (microclimate, lighting, noise) through detailed measurements and explains the main prevention measures put forward for intensive dairy cattle and pig farming.

## Material and methods

Sample premises were identified according to their being representative of animal productions and main breeding techniques in Lombardy region; productions and techniques whose physical, chemical, and biological risk factors were assessed even through quantitative measures. Zootechny is highly developed in Lombardy and among the various agricultural productions it excels economically with cattle and pig farming. Thus, this study focused on these two zootechnical productions. Cattle farms were chosen according to their milking parlour typology (stanchion barn, herringbone, parallel, robotic milking); while pig farms were chosen according to their breeding typology (farrow to finish, farrowing and fattening or farrowing only or fattening only).

The main features of the farms considered are shown in table 1.

**Table 1. Farms considered for quantitative analysis of physical risks**

Dairy cattle breeding			Pig breeding		
Farms	Typology	Nr. cow	Farms	Typology	Nr. pig
A	stanchion barn	30	A	farrow to finish	250
B	stanchion barn	70	B	farrow to finish	200
C	parallel 24+24	400	C	farrow to finish	250
D	herringbone 4+4	70	D	farrow to finish	250
E	herringbone 12+12	140	E	farrowing	350
F	herringbone 12+12	350	F	farrowing	400
G	robot	200	G	fattening	8.000

### Microclimate

Parameters related to microclimate were obtained by a microclimate recording instrument (Lambda Scientifica, mod. Helios), having a data logger permanently recording data and probes for environmental parameters (dry bulb temperature, wet bulb temperature, radiant temperature, relative humidity and air speed). Sampling was carried out seasonally, each session lasting at least a week for each farm; climate parameters were obtained according to a frequency of one data every ten minutes. The probes were placed at 1.5 metres above the floor (man-high). Obtained data were compared with standard animal welfare reported in literature and with technical standards UNI ISO 7730, 1997 and ASHRAE 55, 1992 about human microclimatic welfare.

As to cattle farms, milking was specifically monitored; in fact, a worker here occupies a fixed area for several hours a day. Instruments were placed in the centre of the milkers' pit.

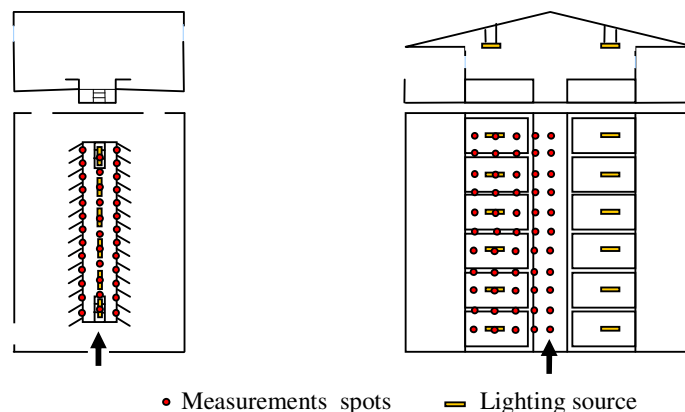
As to pig farms, the following production units were monitored: farrowing, weaning, storing and fattening rooms; the worker, in fact, continuously moves when on duty for animal inspection, animal feed or animal cleaning. Where possible, the probe was located in the centre of the farrowing room and of the weaning rooms. In the storing and fattening units, giving their large dimensions, additional portable microclimate probes (Delta Ohm, mod. HD 226-1) were placed in different spots of the units.

### Lighting

Lighting level was measured by a luxmetre (Minolta, mod. T-10), adapted to catch both natural and artificial light. Accurate measures of horizontal lighting were taken at 80 cm above the floor or at a visual field corresponding to the working location. In the milking parlour, lighting level was measured near the small ladder leading to the milkers' pit, near the control board, and at the height of cows' teats.

In pig farms measures were taken in different points of the units (farrowing, weaning, storing and fattening rooms) as indicated in UNI EN 12464 standard (Fig. 1); measurements took place in autumn/winter and spring/summer as well as in different periods of a day, under natural or artificial lighting. Then, obtained figures were compared to what recommended both in UNI EN 12464 standard - that is an average lighting of 200 lux in farrowing areas, and 50 lux in animal shelters - and in decree 53/2004 concerning pig welfare, estimating as necessary at least 40 lux for eight hours a day.

Lighting homogeneity, shadowing, lamp and window cleaning were also considered.



**Figure 1. Location of the spots where to measure lighting level inside a herringbone milking parlour 12+12 and within a pen for fattening pigs**

### Noise

As to noise levels, measures were performed by a class I phonometer integrator (Larson Davis, mod. DSP 82) in keeping with IEC 651 and 804 standards, yearly adjusted and calibrated before and after any survey referring to 114 dB(A) as noise source. Survey methodology is compliant with decree 195/2006, recently included in the act about safety 81/2008, and with UNI 9432 standard concerning good techniques.

As to cattle farms, exposition level by milkers was examined; in pig farms measurements were taken in every production unit where the animals behaved either quietly or stressed (before being fed). Different spots were involved in the measurement as workers can not stay in fixed locations while inspecting animals. Where possible, noise from mills while grinding feedstuff was quantified; the workers' exposure to noise was then compared with the highest values in the regulation.

## **Results**

### Dairy cattle farms

None of the temperatures measured in seven sample farms in winter during morning and evening milking (Table 2), were higher than 12°C, in the presence of almost high relative humidity rates offering a stronger subjective feeling of coldness; a situation particularly inconvenient during morning milking, becoming worse as current water was continuously needed by the processing.

**Table 2. Average temperature and humidity values obtained during morning and evening milking in winter**

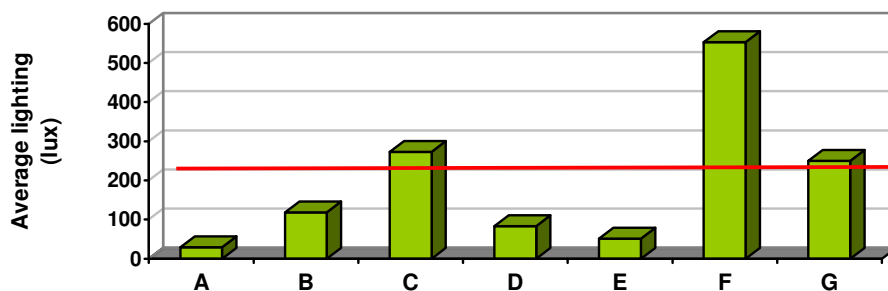
Farms	Milking time	T <sub>ex</sub> (°C)	T <sub>av</sub> (°C)	Hu <sub>av</sub> (%)	Milking time	T <sub>ex</sub> (°C)	T <sub>av</sub> (°C)	Hu <sub>av</sub> (%)	S <sub>air</sub> (m/s)
A	5.30-6.30	-1,7	8,1	70,9	17.30-18.30	4,8	12,0	49,3	0,55
B	4.00-6.30	-1,5	10,8	79,3	16.00-18.30	5,5	12,1	67,8	0,60
C	4.30-7.30	-1,6	6,1	81,8	16.30-19.30	4,6	10,1	59,3	0,45
D	4.00-5.30	-1,5	2,5	84,0	16.00-17.30	6,1	6,0	63,8	0,47
E	4.30-5.30	-1,3	7,6	71,1	16.30-17.30	6,2	9,4	58,8	0,52
F	4.00-7.00	-1,5	4,8	76,7	16.00-19.00	5,7	8,1	50,4	0,44

Measures related to A and B farms (stanchion barns) obviously showed a higher thermal gradient between inside and outside; analogizing, situations C and F (a wide opening communicating with the waiting room) were more influenced by external climate. No heating system was found in the rooms checked contrary to data showing that milking parlour would need it, as anyway stated in the latest policy of Lombardy region dated 29.12.2005, "Hygiene and safety standards in rural building". A system that should be designed in conformity to the structural peculiarities of the room. As data collected in spring time confirmed, its microclimate is strongly affected by external microclimatic conditions. In fact, in recent building typologies processing rooms are as near as possible to the cattle or pig shed, clearly on the basis of organizational reasons that also require wide openings ( Fig. 2).



**Figure 2. Milking parlour connected to waiting room through a full opening**

As given in Fig. 3, optimal lighting, 200 lux as specified in UNI EN 12464 standard, was found in very few cases. This means a greater visual effort and a possible increase of accidents in extreme conditions, even if work is not stopped.



**Figure 3. Average lighting (expressed in lux) inside different typologies of milking parlours (recommended lighting level for milking parlour according to UNI EN 12464 standard is given in red)**

Cattle-sheds with permanent stalls, reasonably did not guarantee enough lighting where the milker was, as shaded by the cows themselves. At cow's teat level lighting showed to be 10-20 lux (Fig. 4). Notwithstanding such figures, hygienic and health assessment of the teat as well as milking can be easy if the shed is lighted homogenously and when the milker does not shade the body of the cow. Difference in lighting between the two sheds of the same typology are basically due to different heights of the lamps from the floor. In herringbone and parallel milking parlours the average lighting level was not always optimal, which was justified by the building typology. Wide and clean lateral windows, adequate orientation and large openings between the milking parlour and the waiting room permitted a better natural lighting (when there is natural light connected to milking time and to the season). Frequent cleaning and maintenance of the premises (walls painted in light colours) help with reflection from internal surfaces (frequently in raw concrete). When walls are finished, light coloured tiles are preferable and mat to avoid indirect dazzling, mainly occurring during morning milking in winter.



**Figure 4. Cow pen with fixed stall for bucket milking**

Noise measured during milking was not risky to the worker, less than 80 dB(A) according to the milking duration (according to act 81/2008).

### Pig breeding

Pigs are very sensitive to thermal stress, both as exceeding hot or as sudden change in temperature. Therefore, their optimal microclimatic conditions do not match with human requirements. During lactation and weaning, piglets need a warm environment (2-week suckling pigs: 30°C, 4-week: 20°C). During fattening, best temperature conditions for pigs are 18-23°C and 50% of relative humidity.

In summer, working conditions for operators are not particularly hard as the sudden change in temperature between inside/outside is not so high, while in winter the situation gets more critical (Table 3).

**Table 3. Average temperature and humidity values obtained in summer-autumn time in the analyzed piggens**

Productive sectors	Average temperature (°C)							Humidity (%)						
	A	B	C	D	E	F	G	A	B	C	D	E	F	G
Farrowing	29,2	27,9	28,9	23,7	26,7	27,5	-	59,3	60,2	60,4	77,2	69,2	66,8	-
Weaning	29,5	28,0	29,3	16,8 <sup>a</sup>	26,3	22,2	-	60,9	65,2	58,3	78,0 <sup>a</sup>	69,4	77,4	-
Storing	30,2	27,3	27,8	14,6 <sup>b</sup>	25,7	22,5	-	59,6	60,7	65,1	75,8 <sup>b</sup>	78,4	75,8	-
Fattening	-	-	27,8	21,3	-	-	23,6	-	-	61,9	73,4	-	-	76,9

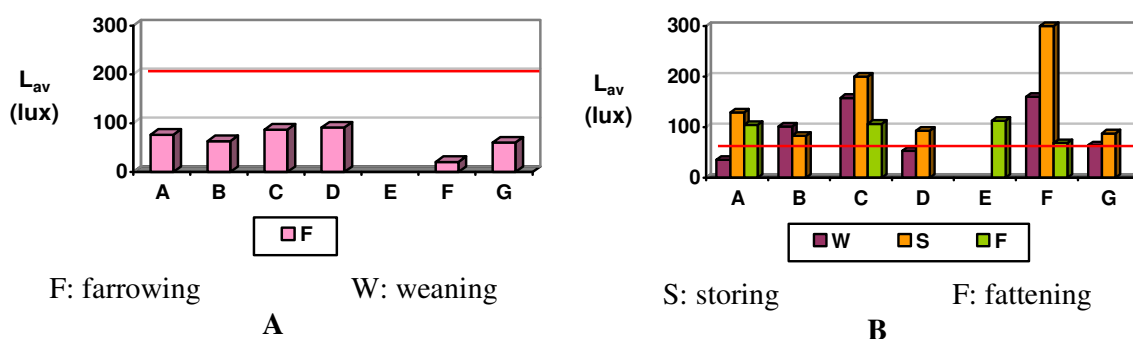
<sup>a</sup> Sheltered stalls with external pens, probe inside

<sup>b</sup> Tunnel with permanent straw litter, probe outside

The working environment can become more comfortable improving ventilation of the shelters just opening and closing the windows, by hand or by automatic systems, in order to keep constant internal temperature. This is needed to change air and avoid dangerous gases (CO<sub>2</sub> e NH<sub>3</sub>). Evaporating water from wet floor surface can get cooler air during summer hottest hours, and usually this system is the only one used in farrowing rooms. In winter operators should avoid sudden change in temperature by undergoing an acclimatization period when moving from a shed to another.

All farrowing rooms showed lighting figures inferior to what given in the standard, that is 200 lux (Fig. 5A). Such high value is needed for the operators safety in case they have to help the sow with farrow. Under common conditions, a lower lighting is suggested not to stress sows. Given such considerations, further lights should be placed nearby the farrowing cage, so avoiding strong total lighting.

Other areas, weaning, storing and fattening rooms (Fig. 5B), showed adequate and homogenous lighting with an average level of 50 lux. Considering the typology of the operations performed - i.e. inspection, distribution of feed, environmental control and cleaning – measured levels matched with them. Other procedures, such as vaccinations and gelding, were carried out in other rooms with better lighting or even outside.



**Figure 5. Average lighting ( $L_{av}$ ) in the piggeries (recommended lighting level according to UNI EN 12464 standard is given in red)**

Anyway, more care to and more frequent cleaning of the lamps, their due substitution as well as more attention to windows cleaning are suggested. Saving energy would be possible painting stables with light colours and using bulbs with lower power. As also standard highlight, before inspecting animals without stressing them portable devices should be used to light where necessary.

In pig farms, noise risk was mainly due to plant and equipment devoted to feed preparation and unit cleaning, as well as to animal sounds. Where dry feeding was used, a mill could be found; when working it could generate of the lamps noise of 80-85 dB(A) in the environment. An operator was exposed to noise only when operating on the device for on/off phase from a control board enough far from the plant or even inside a soundproof box. When moist feeding was used, the mash was prepared in a special room indicating 75-80 dB(A). The plant here was usually operated from a room soundproof as to the kitchen. The operator could be exposed to high noise levels in units where very stressed animals were to be fed. Cleaning of the units, including faeces removal and manger cleaning, occurred daily using low pressure hydrants or high pressure water cleaners after each pig cycles. According to the environmental reverberation and the impact between water jet and metallic equipment, this phase could generate 80-85 dB(A). The best safety here would be assured by regular use of ear protectors. Pregnant sows and adult swine showed to be the noisiest subjects when under particular conditions, i.e. before being fed or when any disturbing element inside their pen provoked anxiety and stress. Situations inducing sound pressure levels above 85 dB(A), while no risk was estimated in quiet conditions. Animals were particularly quiet in farrowing rooms, in weaning units, where feed was regularly given, and when they were low in number. If they were fed twice a day, they showed higher stress and anxiety just before being given it, which produced sound pressure levels of 85 dB(A). In such cases, operators should be more careful with connected risks by organizing their work:

- with a different conduct and adequate procedures to minimize animal stress;
- with entering their pens only after having fed them;
- with wearing proper ear protectors as suggested.

Sanitary procedures on piglets, i.e. gelding, tail/teeth cutting and vaccinations, exposed the operators to very high sound levels, above 90 decibels, due to the animals' howls, screams and cries. Ear protectors are highly recommended in such cases, as these operations are periodical.

The design of the premises, together with adequate building techniques and soundproof materials can also help with limiting noise propagation and reverberation inside animal pens.

## **Conclusions**

Much more has still to be done, notwithstanding improved conditions of work. Everybody working within public and private prevention institutions must be involved in the prevention measures. In particular, many critical points detected through measurements from this study can be solved thanks to a correct and progressive application of regional policy.

## **Acknowledgements**

*The Authors gratefully acknowledge the Local Health Unit of Lodi for coordinating the project, and extend special thanks to breeders for performing experiments and supporting them with useful information.*

## **References**

AA.VV. 1991. Manuale di agricoltura. HOEPLI.

Aghemo C., Piccoli B. 2004. Analisi delle condizioni illuminotecniche nei luoghi di lavoro. G Ital Med Lav Erg, 26:4, 395-400

ASHRAE 55:1992. Thermal Environmental Condition for Human Occupancy

AA.VV. 2003. Il benessere dei suini e delle bovine da latte: punti critici e valutazione in allevamento. Università degli Studi di Milano, Facoltà di Medicina Veterinaria, Istituto di zootecnica. Fondazione Iniziative Zooprofilattiche e Zootecniche.

Decreto Legislativo 10 aprile 2006, n. 195. Attuazione della direttiva 2003/10/CE relativa all'esposizione dei lavoratori ai rischi derivanti dagli agenti fisici (rumore). G.U. n. 124 del 30 maggio 2006

Knizkova I., Kunc P., Novak P., Prikryl M., Maloun J. 2005. Microclimatic condition in milking parlour during winter period. Proceedings on ICAR Technical Series N.10 Physiological and technical aspects of machine milking, Nitra, Slovak Republic, 26-28 april 2005.

Luymes J. 1990. Ventilation in milking complex. Resource Management Branch, Abbotsford, Canada, 1-3.

UNI 9432:2002. Acustica. Determinazione del livello di esposizione personale al rumore nell'ambiente di lavoro.

UNI EN 12464:2004. Luce e illuminazione. Illuminazione dei posti di lavoro. Parte 1: Posti di lavoro in interni.

UNI ISO 7730:1997. Ambienti termici moderati. Determinazione degli indici PMV e PPD e specifica delle condizioni di benessere termico.