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25 ■ The Challenges Ahead for Animal Buildings Faced with the Emergence of Hot Climate Conditions in Portugal

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Portugal has a Mediterranean climate characterized by hot, dry summers. According to data from the Portuguese IM (Instituto de Meteorologia), over the last decade, summer temperatures have tended to be higher, with a greater incidence of heat waves, temperatures above 40 ºC, and periods of consecutive warm nights (daily minimum air temperature above 20ºC).

During the summer, very high temperatures and heat waves are becoming increasingly common in Portugal. The summers of 2003, 2004, 2005 and 2006 were among the hottest ever recorded.

These frequently hot climatic conditions can cause problems in intensive animal production, or even to livestock in extensive systems. In most cases, livestock buildings are not designed for animal production under high temperatures and most of them do not have environmental control equipment suitable for controlling the indoor climate under such conditions.

An analysis of climatic data revealed the existence of two regions (Alentejo and Trás-os-Montes) where high temperatures are more usual and summers tend to be hot. In these two regions, livestock numbers are high and play a major role in the regional economy. The occurrence of hot climate conditions was identified and its impact on the environmental conditions in animal housing discussed.

Introduction

Portugal is located in south-western Europe (37º to 42º N and 9.5º to 6.5º W). Despite the fact that it has a large Atlantic coast, its climate is mainly Mediterranean. In general, summers are hot and dry; winters are cold and wet. In littoral areas, the climate is milder and the rain is more frequent. The climate varies significantly from region to region, which has an effect on agricultural activity and also on animal production. In addition to other factors, these climatic conditions have a major influence on the geographical distribution of domestic animal species. Briefly, dairy cattle are more common in the littoral north, and beef cattle are more common in the Alentejo region, in the south. Pigs are mainly raised in the central littoral areas of the country and in Alentejo. Sheep and goats are more common in Alentejo, and in the inland regions of the centre and north (INE, 2005).

Based on developments over the last few decades, it is now possible to identify the emergence of hot climate conditions in Portugal, which may be having a gradual impact on animal production, especially in summer. According to data from IM (2006) over the last decade, summer temperatures tend to be high (mainly in June, July and August) and have tended to be

above the average of the reference period 1961-1990, according to the Climatological Standard Normals (WMO, 1983). Likewise, days with significantly high temperatures have become more frequent; there has also been an increase in the number of days with a minimum air temperature (generally at night) of over 20 ºC; and the incidence of heat waves (several consecutive days of high temperatures) in recent years.

These frequently hot climate conditions (very high temperatures, warm nights and heat waves) can cause problems in animal housing production. It is recognized that these adverse hot climate conditions, primarily heat stress, have a number of negative effects on animal behaviour and production, causing livestock damage with losses to the farmer. Heat stress decreases voluntary feed intake (Fuquay, 1997; Nienaber et al, 2004); retards animal growth (Cruz et al, 2000); affects carcass composition and meat quality (Nienaber et al, 1987); decreases milk production while reducing milk quality (West et al, 2003; Perissinotto et al, 2005); and disturbs animal activity and interactive social behaviour (Frazzi et al, 1998; Hahn, 1989).

In Portugal, emerging hot climate conditions are posing a new challenge to animal housing and also to livestock in extensive systems. Breeders are not usually familiar with this situation and they have difficulties dealing with this problem. In addition, in most cases, buildings for livestock are not suitable for animal housing under high temperatures and they lack appropriate equipment to control the indoor environment under such conditions.

High temperatures combined with a lack of necessary equipment to control environmental conditions inside buildings and deficient acclimatization of animal housing can increase this problem. In addition, livestock in extensive systems, or raised outdoors, can be affected by high temperatures associated with humidity, as well as by the absence of shade, airflow or wind. The risk increases when these conditions persist for several consecutive days (Nienaber et al, 2004).

A review of climatic data from recent years assumes that, periodically, problems related with hot climate conditions have affected animal production in some regions.

The occurrence of hot climate conditions in Portugal is a concern that we have been analysing over the last few years and it was our intention to set up a project with several institutions in order to identify practical solutions designed to help and prepare breeders to deal with hot climate conditions and to minimize the impact on livestock. For several reasons this has not yet been possible (shortage of time and financial resources).

Objective

The main objectives of this work were, 1. to identify the occurrence of hot climate conditions in some regions of Portugal, 2. to discuss the impact of these conditions on livestock production, and 3. to outline our concerns about the procedures required to manage this problem.

Data, results and discussion

Climatic data over the last few decades show that hot climate conditions have been more frequent in recent years.

Table 1 shows the five hottest summers since 1931 considering the variation over the average of the reference period. The summer of 2005 was the hottest since 1931 and presents an anomaly of +2,4 ºC in mean air temperature. Between 2003 and 2006, four summers were exceptionally warm and among the hottest since 1931.

Table 1. The five hottest summers since 1931, in Portugal (source: IM, 2006).

Year	Variation in Mean Air Temperature (ºC)
1949	+ 2.0 ºC
2003	+ 1.9 ºC
2004	+ 1.9 ºC
2005	+ 2.4 ºC
2006	+ 1.8 ºC

As presented in Table 1, the years from 2003 to 2006 had very hot summers. In 2007 and 2008, summer temperatures were normal, according to the average of the reference period. Preliminary data from summer 2009 point to another very hot summer, with temperatures above the average of the reference period.

Another consequence of emerging hot climate conditions is the regular occurrence of heat waves. Considering a heat wave as defined by the Heat Wave Duration Index (WMO, 2001) the Portuguese IM registered heat waves in 1981 and 1991. In recent years, however, several heat waves have occurred in Portugal. During one heat wave in 2003, temperatures were over 40ºC for eleven day in some places and there were two heat waves in 2005 with temperatures over 40ºC degrees in several regions.

Similarly, in summer 2006, five heat waves occurred in the period from May to September. These five heat waves affected different regions for several days. It is interesting to note that the heat wave that began on 7 July had the greatest territorial extension ever registered and that from 27 August to 9 September marked the longest heat wave ever registered, with a duration of 14 days in some places.

Recently, during summer 2009, at least four heat waves occurred: from 2 to 8 May and from 27 May to 3 June (Fig. 1); and between 10 and 22 June. Again, during August several regions were affected by heat waves. Generally, the most intense heat waves affect mainly inland regions in the north and the south.

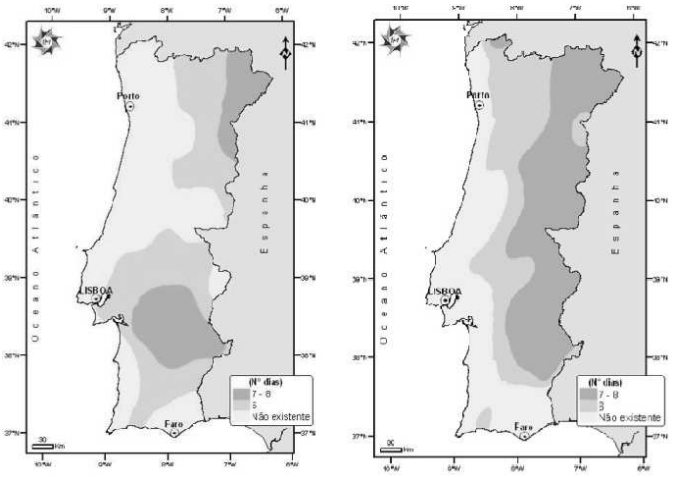

Figure 1. Heat waves that began in May 2009 (source: IM, 2009).

Another problem is the occurrence of high temperatures. Days with values higher than 40º C for maximum air temperature, sometimes associated with high values of minimum air temperature, above 20 ºC, increases the risk for animals since night time recovery is difficult. Again, the occurrence of high temperatures is more probable in some regions, generally in the south and inland regions.

According to data that we recorded in Vilariça (in the northeast of Portugal), during the summers of 2005, 2006 and 2007, some days presented very high temperatures, above 40 ºC. Table 2 shows the number of days with maximum air temperature (Tmax) ≥ 35 ºC; and the higher value of temperature recorded in this location.

Table 2. The hottest days (Tmax) registered in Vilariça, from 2005 to 2007

Year	No. days with Tmax ≥ 35 ºC	Tmax recorded
2005	58	42.1
2006	62	41.3
2007	21	41.8

In Vilariça, several periods of consecutive days with minimum air temperature (Tmin) ≥ 20 ºC were recorded, representing conditions of consecutive warm nights. Table 3 shows the longest period: twelve days in summer 2006, from 7 to 18 July.

Table 3. Longest period of consecutive days with Tmin ≥ 20ºC.

Date	Tmax	Tmin
2006.07.07	35.7	20.7
2006.07.08	37.8	20.5
2006.07.09	40.2	19.8
2006.07.10	39.6	21.5
2006.07.11	40.3	22.5
2006.07.12	40.1	23.1
2006.07.13	38.2	23.4
2006.07.14	37.8	20.9
2006.07.15	37.8	21.1
2006.07.16	39.9	22.2
2006.07.17	41.3	22.3
2006.07.18	30.1	20.4

This period of consecutive hot days (high values of Tmax and Tmin) coincided with one heat wave registered in July 2006. It is notable that, during this period, 10 days of Tmax higher than 37 ºC were recorded. Hot climate conditions, as shown in Table 3, could present risks that can affect animals mainly in intensive systems.

The regions of Alentejo (in the south) and Trás-os-Montes (in the northeast) have a higher risk of high temperatures or extended heat waves. In these two regions, livestock numbers are very high and animal production is fairly important to the regional economy. This suggests that farmers should be on alert for a significant number of days, since heat stress-related problems may occur and some measures should be implemented in order to minimise any negative effects.

In fact, consecutive days with high temperatures increase the difficulty of controlling animal heat stress, which is aggravated if cooling is not possible during nocturnal periods. These risks can be heightened due to the fact that most breeders are not familiar with these problems and most of the time buildings are not equipped with preventive and mitigatory systems. Evaporation cooling systems can be a solution for solving or at least minimising these problems. Also, in extensive production, some problems may occur due to heat only in nocturnal housing and again breeders should be prepared to solve the problem.

Final considerations

After analysing these climate data it is possible to conclude that:

- there seems to be a tendency for summers to be hotter than before;

- periods of consecutive days with temperatures higher than usual, classified as a heat wave, are now occurring;

- in Alentejo and Trás-os-Montes, where summer is usually hotter than in the rest of the country, temperatures higher than 40 ºC occur with relatively high frequency;

- in these regions there are consecutive days with minimum air temperature higher than 20 ºC;

- all these situations present heat-related risks for animals and it will be necessary to prepare animal housing and breeders to implement certain preventive and mitigatory measures.

It is our conviction that this problem could affect productivity indices/levels in the future and it will be necessary to alert farmers/breeders and to prepare them to deal with the problem and the impact of climate conditions on animal welfare and production.

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Within a context of major reorganisation and adaptation of livestock housing to meet tomorrow's issues, this forum provided an overview of recent and current research and extension initiatives, with the aim of creating together a coherent visualisation of what will be livestock housing of the future.

This forum was organised by "RMT Livestock housing of the future" which is co-presented by the Institut de l'Elevage (French Livestock Institute) and the Chamber of Agriculture of La Manche, in close collaboration with the Pig Breeding Technical Institute (IFIP) and Poultry Breeding Technical Institute (ITAVI), and also the French Chambers of Agriculture network. The ISA Lille (Life and Earth Engineering Institute) also supported this event.

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