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# Patterns of heat tolerance in different sheep breeds in Brazil

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ABSTRACT

Respiration rate and eye temperature were collected on 80 sheep from 11 breeds (Australian Merino, Polwarth/Ideal, Corriedale, Romney Marsh, Crioula, Hampshire Down, Texel, Ile de France, Suffolk, Santa Inês and Dorper) during 5 days, giving a total of 1071 observations. All sheep were adult and non-lactating. Data were analysed using SAS® procedure NLIN, using broken line regression to determine temperature humidity index (THI), air temperature and relative humidity limits by breed for respiration rate and eye temperature. These inflexion points were then used to determine regions suitable for sheep rearing by breed, using mean THI by municipality which were then plotted using ARCGIS v.9.3. Clear boundaries were found for sheep breeds, with wool breeds mainly limited to the south and southeast as well as coastal areas. Not all breeds are indicated to be reared in all areas of the country and some regions are unsuitable for any breed. Breed adaptation is in line with their natural history of territorially occupation.


## 1. Introduction

The maintenance of body temperature within physiological limits is necessary for the animal to remain healthy and maintain its productivity and longevity (Marai et al., 2007). Thus, animals should cope with their environment in order to produce more and better. Farmers can positively influence this relationship between the animal and environment by selecting animals able to produce efficiently in these environments (Starling et al., 2002), but heat stress impairs their performance (Silanikove, 2000). Severity of heat stress can be measured using both ambient temperature and relative humidity, termed as the temperature–humidity index (THI) (LPHSI, 1990; Marai et al., 2001).

Tropical regions can be characterized by higher levels of solar radiation and temperature compared with temperate zones (McManus et al., 2009a), often vastly different from the local of the origin of the breed (McManus et al., 2011). Breed differences have been seen for responses to environmental stressors. An animal is considered to be stressed when it has to alter its physiology and behavior to adapt to adverse environmental and management conditions (Marai et al., 2007). Quesada et al. (2001) showed that it was necessary to know the tolerance and adaptive capacity of various breeds as a technical basis for sheep exploration in a certain region, including direction of crossbreeding programs. Heat tolerance is generally measured based on respiration rate and rectal temperature among others traits (Castanheira et al., 2010; Correa et al., 2012). However, these measurements require direct intervention with the animals, which may influence their physiological responses. Overcoming this obstacle, Paim et al. (2013) studied the use of infrared thermography to measure heat tolerance in lambs of different genetic groups and found the method to be efficient in differentiating between them. Other way to minimize the stress

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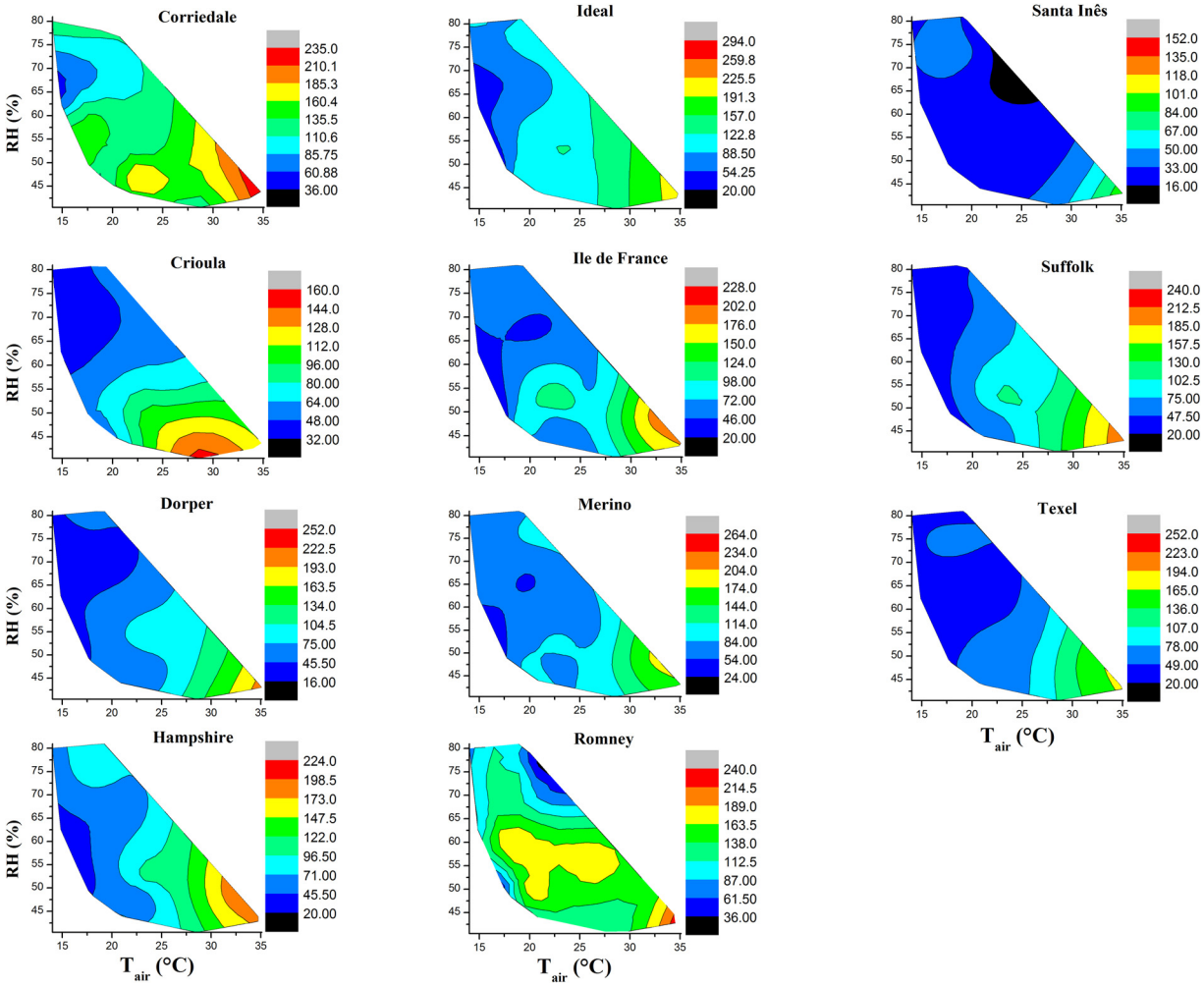


**Fig. 1.** Effect of $T_{air}$ (air temperature) and RH (relative humidity) on RR (respiration rate) in sheep reared in Brazil by breed. (For the interpretation of the references to colour in this figure legend, the reader is refered to the web versionof this article.)

caused by stressful landscape factors is, based in descriptors, to determine regions more suitable to rear one or other breed.

Both wool and hair sheep are found in Brazil. Sheep arrived in Brazil from the Iberian Peninsula and African continent with the settlers in the late 15th century (Primo, 2004). The possible Iberian breeds which came to Brazil early on include Merino, Manchega, Ojalado, Talayerana, Bordalera and Churra. Hair sheep were registered as early as 1640 (Villela et al., 2005). British Lincoln and Romney Marsh breeds were used to the end of the 19th century for mutton production for the European market. In the 1930s the decreasing demand for sheep meat and increasing wool prices led to the use Australian Merinos, Polwarths and Corriedales, imported from Australia and New Zealand (Cardellino, 2000) as well as Hampshire Down, in the south of the Country as well as Uruguay and Argentina. The importation of meat breeds (Ile-de-France, Suffolk and Texel) increased in the 1990s. It is known that wool sheep were mainly concentrated in the south and hair sheep remained in the northeast (Hermuche et al., 2012; McManus et al., 2014) of Brazil. The northeastern hair breeds were mainly reared in harsh environments by subsistence farmers, undergoing little selection, while commercial wool and meat sheep tended to be reared in the South. This led to different adaption traits of these breeds.

Physiological mechanisms which limit and adjust cold and heat tolerance are regaining interest due to global warming. Shifts in the geographical distribution of animals have also stimulated actions within the Food and Agricultural Organization of the United Nations (Pilling et al., 2008) to attempt to standardize descriptors for animals and their environments. However, farmers are increasingly using terminal sire breeds in diverse environments without taking their adaptation into account. This study aimed to determine differing regions of Brazil that could be more favorable for sheep breeds based in differences in heat adaptation.

## 2. Material and methods

Data from eye temperature ($T_{eye}$) and respiration rate (RR) were collected on 80 sheep from 11 breeds (ranging from 3 to 8 animals/breed) during 5 days, using a total of 1071 observations (not all sheep were collected at all times). Breeds included Australian Merino (ME), Polwarth/Ideal (ID), Corriedale (COR), Romney Marsh (RM) and Crioula (CRI) for wool sheep. Semi wool sheep included Hampshire Down (HD), Texel (TX), Ile de France (IL) and Suffolk (SU), while hair sheep included Santa Inês (SI) and Dorper (DR). All sheep were adult males (2 to 5 years old).

$T_{eye}$ were taken using a FLIR série-I Infrared InfraCAM™ (Wilsonville, USA). The recorded temperature corresponding to the point of maximum temperature observed in the eyeball. The temperature was measured in both eyes and average temperature calculated. The respiratory rate (RR) was assessed by remote inspection of animals by movement of the chest wall and abdomen during breathing and the movements performed in one minute counted. During the evaluation, the animals were at rest and