INFRARED THERMOGRAPHY TO DIAGNOSE BIOCLIMATIC CONDITIONS IN LIVESTOCK SYSTEMS IN THE AMAZON BIOME

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In Brazilian agriculture, the adoption of technologies capable of expanding the evaluation of variable-responses is being expanded, to consider processes in the soil-plant-animal-atmospheric system. Using infrared thermography makes it possible to diagnose, in real time, different thermal patterns regarding targets of technical and scientific interest. In livestock production system (McMANUS *et al.,* 2016), thermograms have supported evaluations capable of pointing out indicators of animal thermal comfort, herd health, quality standards in pastures (PILATO *et al.*, 2018b), animal behavior and thermoregulation associated with bioclimatic conditions (PERISSINOTTO *et al.,* 2006; MALAMA *et al.*, 2013; KOTRBA *et al.*, 2007; SOUZA *et al.*, 2008; MEDEIROS *et al.*, 2001; AGGARWAL; SINGH, 2008; MARAI; HAEEB, 2010; SILVA *et al.,* 2010, MENEGASSI *et al.,* 2015). This is a non invasive method (ROBERTO; SOUZA, 2014) and has a high potential for use in rapid diagnostics in decision making, especially in strategies for improving thermal conditions, in open and controlled environments. Making it possible to measure the temperatures of buildings (PLEŞU *et al.*, 2012), including zootechnical installations.

RESULTS IN THE AMAZON BIOME

- Financial support for projects such as the PECUS Network, accessing funds to finance master's, doctoral and postdoctoral fellowship (CAPES/ Embrapa edital) and acquisition of equipment such as a thermographic camera (CTINFRA/CNPq) allowed the achievement of innovative research results. The availability of scholarships to support the training of new professionals in the region (undergraduate, master's, doctorate and post-doctorate) and the expansion of opportunities for new scientific investigations by the teams involved in these projects were decisive in achieving results such as:

- Different anatomical regions showed thermal correlations with bioclimatological indexes of thermal comfort in buffaloes in the Eastern Amazon (BARROS et al., 2015);

- The maximum temperature of the eye orbit was the response variable most correlated to the rectal temperature. Temperature oscillations of the eye orbit, right flank, left flank and scrotum were measured in buffaloes, based on thermographic data (BARROS et al., 2016);

- Climatic variables in the dry season on the Ilha de Marajó pointed out that buffaloes are prone to present thermal stress, especially between 10 am and 2 pm (JOSET et al., 2018);

- The thermal comfort indexes for buffaloes indicated a high level of efficiency in evaluating the status of thermal comfort under environmental conditions in the research area (PANTOJA et al., 2018);

- Thermal patterns were higher in areas with pastures undergoing degradation with exposed soil than in areas of secondary vegetation and targets in female adult bovines (PILATO et al., 2018b);

- In a silvopastoral system in Belém-PA, it was observed that Murrah buffaloes with access to the shade of trees, whose microclimate presents lower values of air temperature, orbit temperature index and relative air humidity, were in better conditions of thermal comfort (SILVA et al., 2011);

- The thermoregulation capacity, scrotal thermal patterns and the semen quality of male buffaloes were efficient in dissipating heat on days with high temperatures and high levels of humidity in the air (SILVA et al., 2018);

- During the hottest periods of the day in an extensive livestock system, without trees in the pastures, the animals spent a long period in idleness (AMARAL JÚNIOR et al., 2016), reinforcing the importance of thermal comfort for animals in production systems;

- Degraded pastures with extensive areas with exposed soil showed higher temperatures when compared to areas with secondary vegetation and animal targets at times of higher radiation intensity in western Pará (PILATO et al., 2018b); and

- Thermal patterns in production systems pointed to successful responses that strengthen the wide application of near infrared thermography, in the

soil-plant-animal-atmosphere-system analyses (BARROS et al., 2016; BARROS et al., 2015; BRCKO et al., 2020; PANTOJA et al., 2018; PIRES et al., 2017; SANTOS et al., 2016a; SILVA et al., 2020; SILVA et al., 2018a; SILVA et al., 2018b; PIRES et al., 2019; SILVA et al., 2018; BARROS et al., 2015; MONTEIRO et al., 2016; ROCHA et al., 2018; SILVA et al., 2016; SANTOS et al., 2016b; SOUSA et al., 2016).

Results were also presented in a lecture at AMAZONVET and at the National Congress of Wild Animals (MARTORANO, 2019), at the invitation of the organizing committee. In Figure 1, it is possible to identify images of thermal patterns, based on thermographic diagnostics, in the Amazon biome.

NEXT STEPS AND RECOMMENDATIONS

The projects have all been completed. However, as the research networks have been consolidated over the period and duration of these projects, it is emphasized that new scientific investigations have been carried out due to the high potential of diagnosing thermal patterns in different targets with infrared thermography in the Amazon.

PROJECT COORDINATORS

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Continued in Annex

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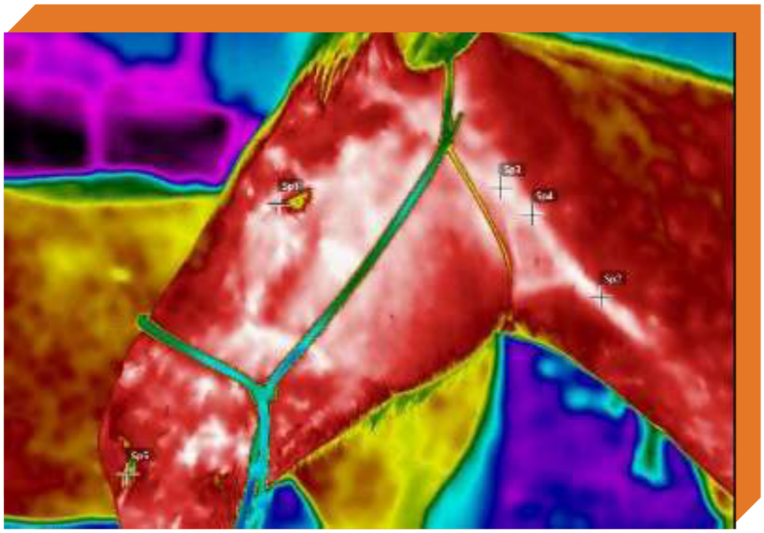
Continued in Annex

Figure 1: Thermographic image in a livestock production system on a field monitoring date of 09/16/2017, in the Amazon



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