

# PhD School on Agriculture, Environment and Bioenergy

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(XXXVII cycle, 2021-24)

## Project draft

### 1. Field of interest

*AGR/19 - Animal husbandry, INF/01 - Informatics*

### 2. Project title

Multidisciplinary approach for setting up a continuous monitoring system in goat farms by means of vocalization analysis

### 3. Tutor (membro del Collegio dei Docenti) Silvana Mattiello

- **Co-tutor/s:** Stavros Ntalampiras, Monica Battini

### 4. Relevance of the topic and state of the art:

Animals use acoustic communication to transmit information about several specific situations (e.g. alarm, reproductive and social status) and the characteristics of acoustic signals depend on valence (positive and negative) and arousal (high and low) of a specific emotional state. In general, it has been observed that, regardless of the species, positive emotional states are usually characterised by a short duration and low fundamental frequency ( $F_0$ ), whereas in situations of high arousal, vocalizations are high-pitched and last longer (Briefer, 2012; Baciadonna et al., 2019). Despite the difference in the sound generating apparatus of different animals, the sound patterns can be handled in a common manner. The similarity among the various sound recognition schemes comes from the fact that a sound source that emits consistent acoustic patterns has a very distinctive and characteristic way to distribute its energy over time on its composing frequencies, which constitutes its so-called spectral signature. Preliminary research suggests that vocalization of farm animals can be successfully used as a measure of welfare (McCloughlin et al., 2019), and that emotional states in goats are characterised by different vocal traits and behavioural profiles (Briefer et al., 2015). This supports the importance of further research in this field, especially on ruminants, using recent methodologies that allow a more rigorous and detailed sound analysis (Potamitis, 2014). The aim of the project is to identify the characteristics of the sounds that better describe the specific emotional states and emission contexts and, on the basis of these results, to develop and test a practical tool for sound automatic identification of the different types of vocalizations associated to specific emotions elicited by stressful situations in farmed goats. This will allow continuous automatic monitoring to help farmers and technicians to intervene promptly in case of problems, thus improving farm profitability and animal welfare.

### 5. Layout of the project

#### 5.1. Materials & Methods:

Data collection will be carried out in three goat farms. Acoustic (by Autonomous Recording Units) and behavioural (using Full HD Network cameras with real-time recording and day/night mode that will send the transmission to a specifically dedicated computer via a wireless receiver) data will be simultaneously and continuously recorded in goats housed in their home pen. A threshold will be set for the activation of the audio recording system.

All audio and video recordings will be processed and synchronized, in order to be able to contextualise each vocalization into a specific context and to associate it to specific behaviours and emotional states, either positive (e.g. anticipation of food, waiting for milking) or negative (e.g. occurrence of disease), that may occur during the recording period. The vocalizations will be processed using specific programs (e.g. MATLAB), in order to determine sounds characteristics (e.g. intensity, frequency, duration) emitted in specific contexts that will be identified from video analysis or from information provided by the farmer (e.g. occurrence of health problems) whereas videos will be analysed using specific software for behavioural observations (e.g. Boris). The videos will be analysed in the time frame corresponding to the activation of sound recording (i.e. above the set threshold), in order to better understand animals' emotional state and to associate it to vocalizations' characteristics.

On the basis of bioacoustic results, in collaboration with the Dept. of Informatics of the University of Milan (where the co-tutor is working) a specific tool will be developed to help farmers and technicians to identify the emotional state of farm animals, based on the classification of vocal signals. This software will constitute an integrated framework which will have several levels of services and a graphic user interface enabling visualization of the collected information. The software will also implement data retrieval and automatic recognition and categorization of animal vocalizations. Once the main building blocks of the system are developed, integration of all constituent parts and evaluation of the integrated system will be performed in five goat farms. At this stage, system tuning and adjustment of the interactions between the constituent blocks may take place. Finally, we will investigate the performance of the tool in identifying the emotional states of animals.

### **5.2. Schedule and major steps (3 years):**

*Months 1-3:* literature update, training for collection of acoustic and behavioural data

*Months 4-16:* collection of acoustic and behavioural data;

*Months 6-18:* video analysis (including a training period);

*Months 8-20:* audio analysis (including a training period);

*Months 21-28:* tool development;

*Months 29-32:* tool testing;

*Months 33-36:* thesis writing.

Dissemination of results will take place as soon as the first results will be available (probably around month 18) and will last until the end of the project.

### **6. Available funds (source and amount)**

Project VOCAPRA (RL\_DG-AGR19SMATT\_01); ~ 400.000 €

### **6. Literature:**

Baciadonna L., Briefer E.F. (2019) Goat distinguish between positive and negative emotion-linked vocalisations. *Front Zool*, 16.1: 1-11.

Briefer E.F. (2012) Vocal expression of emotions in mammals: mechanisms of production and evidence. *J Zool*, 288: 1–20.

Briefer E.F., Tettamanti F., McElligott A.G. (2015) Emotions in goats: mapping physiological, behavioural and vocal profiles. *Anim Behav*, 99: 131-143

Manteuffel G., Puppe B., Schön P.C. (2004) Vocalization of farm animals as a measure of welfare. *Appl Anim Behav Sci*, 88: 163-182.

Mcloughlin M.P., Stewart R., McElligott A.G. (2019). Automated bioacoustics: methods in ecology and conservation and their potential for animal welfare monitoring. *J R Soc Interface* 16: 20190225.

Potamitis I. (2014) Automatic classification of a taxon-rich community recorded in the wild. *PLoS ONE*, 9: 1-11.