Phenotyping tools and data collection for the agroecological transition

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Introduction

Livestock phenotyping (LiPh) has made significant progress in the recent years through the increasing use of **digital technologies**. When used appropriately, LiPh tools can be a significant lever for the **agroecological transition (AET)**.

The aim of this work was to carry out a **multi-species review of recent advances in LiPh** and of their **potential contribution these to AET**, with a focus on key traits (related to environmental impact, efficient use of feed and water resources, animal behaviour, welfare and health).

New methods to improve the measurement of more standard phenotypes are also considered. Strengths and weaknesses of the different phenotyping technologies and tools are discussed.

Material and methods

The review was carried out based on :

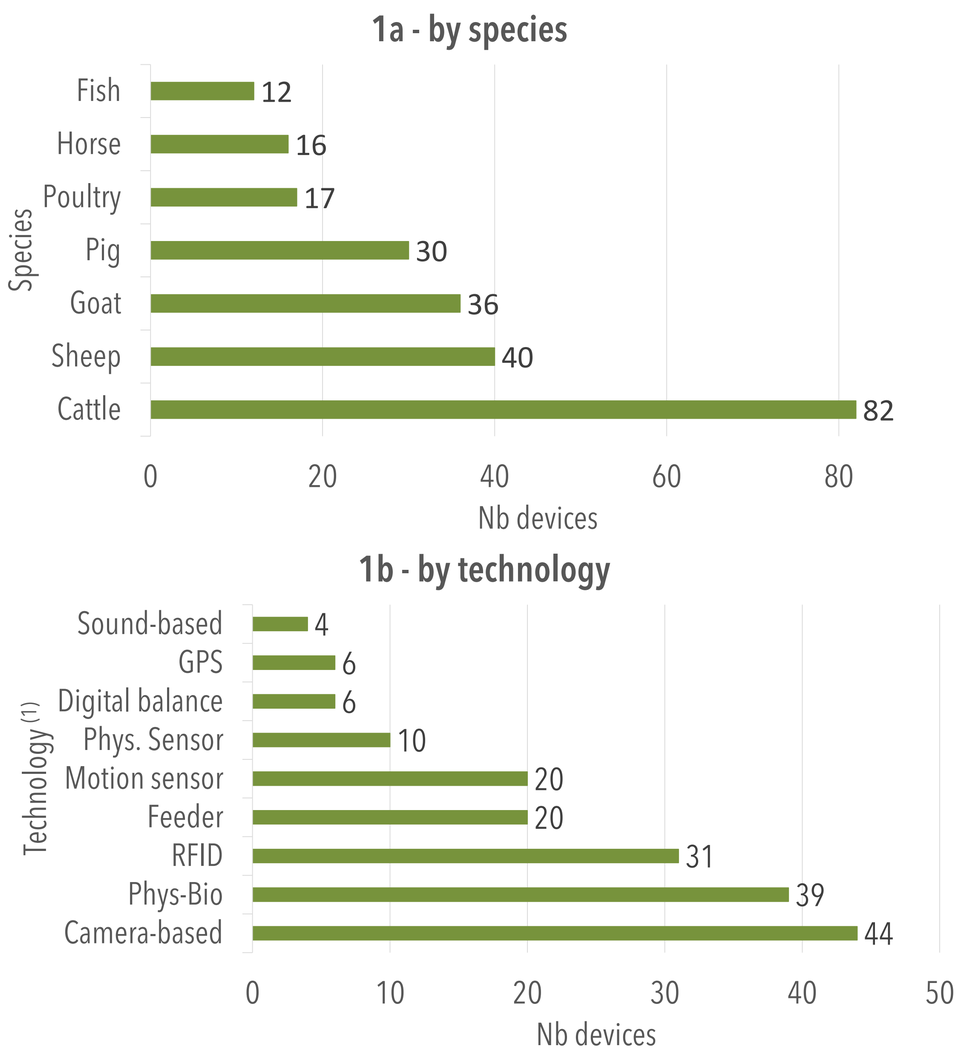
- **Visits** to experimental units
- **Interviews** with LiPh experts
- **Bibliographic research** primarily through Web of Science.
- Various webinars and **seminars on LiPh**.

The aim was not to be exhaustive, but to capture the major trends.

Main results : database included in PHENOTOOL

A database containing essential information on LiPh tools and a web-based access tool were created.

Figure 1 – Distribution of equipment in the Database



(1)Phys-bio : physical/biological analyses ; Phys. Sensor : physiological sensor

Figure 1 shows some features of the Database:

- A total of 144 registered devices at various stages of development (from experimental to commercial). Cattle devices are the most represented.
- Devices can be multi-species in ruminants, but are specific in other species.
- The most represented technologies : Camera-based, physical/biological analyses and Radio-identification (RFID)

Main recent advances

Overall trends:

Important advances of diverse technologies, which are increasingly wearable, less invasive, often more precise and automatically provide dynamic measurements. Increasing use of Artificial Intelligence for capturing and analysing data.

Computer vision technologies:

- Access of new phenotypes such as behavior traits .
- New ways to measure standard traits (body weight , NEC,…)
- Major advances in automation through the use of AI.

Spectrometry technologies:

- Allow for the detailed analysis of very diverse biological samples.
- Access to new traits such as methane production, digestibility, …

Sound-based phenotyping:

- Vocalization and other sounds analyzed using Artificial Intelligence (AI).
- Early detection of issues such as respiratory problems, distress calls or changes in behaviour.

Localization technologies:

- Geotracking (GPS, ...) for outdoor systems); RFID for indoor systems. Allow real-time access to livestock localization and activity.

Omics technologies:

- Transcriptomics, proteomics, metabolomics, …
- Offer access to different biomarkers which can be used as proxies for various traits such as feed efficiency, health, …

Opportunities for the agroecological transition

- Access to new traits that could not be measured before (health, behaviour...)
- Dynamic tracking of indicators with no human interference and under normal animal living conditions.
- Potential access to previously unavailable reference data (and visualise potential improvements).
- Deal with ethical aspects (improve animal & human welfare, reduce environmental impact ...).

Main challenges

Development /improvement of specific technologies:

- Computer vision
- Increasing use of Artificial Intelligence (AI)
- Combined technologies …

Data quality features:

- Quality control of high-throughput data and metadata

Data interoperability:

- Standardize and facilitate access to data and procedures

Efficient use of heterogeneous data:

- Increasing use of AI …

Economic issues:

- Reducing the cost for large-scale use
- Data storage, computing cost, …

Acceptability by end-users:

- Users need to be convinced and to know how to use it

Digital security:

- The risk of informatic attack, picture theft, fakes …
- Importance of regulatory aspects

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