SMARTER

SMAll RuminanTs breeding for Efficiency and Resilience

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First batch of practice abstracts for end-users.

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About the SMARTER research project

SMARTER will develop and deploy innovative strategies to improve Resilience and Efficiency (R&E) related traits in sheep and goats. SMARTER will find these strategies by: i) generating and validating novel R&E related traits at a phenotypic and genetic level ii) improving and developing new genome-based solutions and tools relevant for the data structure and size of small ruminant populations, iii) establishing new breeding and selection strategies for various breeds and environments that consider R&E traits.

SMARTER with help from stakeholders chose several key R&E traits including feed efficiency, health (resistance to disease, survival) and welfare. Experimental populations will be used to identify and dissect new predictors of these R&E traits and the trade-off between animal ability to overcome external challenges. SMARTER will estimate the underlying genetic and genomic variability governing these R&E related traits. This variability will be related to performance in different environments including genotype-by-environment interactions (conventional, agro-ecological and organic systems) in commercial populations. The outcome will be accurate genomic predictions for R&E traits in different environments across different breeds and populations. SMARTER will also create a new cooperative European and international initiative that will use genomic selection across countries. This initiative will make selection for R&E traits faster and more efficient. SMARTER will also characterize the phenotype and genome of traditional and underutilized breeds. Finally, SMARTER will propose new breeding strategies that utilise R&E traits and trade-offs and balance economic, social and environmental challenges.

The overall impact of the multi-actor SMARTER project will be ready-to-use effective and efficient tools to make small ruminant production resilient through improved profitability and efficiency.

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1 Summary

This first batch of practice abstracts for end-users produced by the partners of the EU project SMARTER (SMAll RuminanTs breeding for Efficiency and Resilience) gathers six abstracts related to the WPs 1, 5 and 6 of the project. At this stage of development of SMARTER it was not possible yet to have available practical contents for end-users in all the fields covered by the project. There will be much more at the second stage of collection, at month 48.

2 Introduction

D8.3 First batch of practice abstracts for end-users should have been submitted by the end of April, but a one-month delay was necessary because of the COVID19 pandemic. All partners have been involved in the production of this deliverable.

A practice abstract is a short summary, in easily understandable language, of re-usable results. The targets are practitioners and stakeholders. It focuses on results and recommendations that can be used in practice. "A short summary" means +/- 1500 characters. EAAP has produced a power point presentation, inspired from different documents of EIP Agri and EC, with concrete examples of practice abstracts and has sent it to the partners.

After a discussion during the ExCom meeting held on 14th April 2020, it has been decided that different WPs could provide a practical abstract for this first batch:

- WP1 has submitted three abstracts, two on the automate available to measure feed efficiency, and gas emission, and one on biomarkers:

  (1) Phenotyping of feed intake in small ruminants – How to do in practice?

  (2) Greenhouse gases measurement in sheep using Portable Accumulation Chambers (PACs)

  (3) Predicting feed intake in small ruminants – How to do in practice?
- WP5 has submitted two abstracts:

  (4) Compute Realized reliabilities of predictions from consecutive genetic evaluations using method LR

  (5) Inferring challenges from frequently collected data
- WP6 has submitted one abstract:

  (6) Setting up across country genetic evaluations in sheep and goats requires international cooperation and the establishment of harmonised tools

WP2 was almost ready for producing practice abstracts, but for several reasons (due mostly to pandemic) it was not possible to gather them on time (but they will be collected for the second batch), WP3, WP4 and WP7 had nothing ready yet for this first batch, but will propose something for the second batch at month 48.

The role of EAAP in the dissemination of these practice abstracts, is to contact the partners, to gather the abstracts, and process the documents by integrating them in a single deliverable. But it will mostly consist also to give visibility to the abstracts, with a focus on EIP (European Innovation Partnership).

3 Practice Abstracts

1st abstract: Phenotyping of feed intake in small ruminants – How to do in practice?

Authors: F. Tortereau[1], J.-L. Weisbecker[1], C. Huau[1], J.-F. Bompa[1,2], D. Marcon[3], L. Estivalet[3], C. Marie-Etancelin[1], D. François[1], E. Ricard[1,2]

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Feed efficiency is a trait of major interest because breeding efficient animals is not only cost-saving but also leads to a decrease of environmental impacts. The genetic improvement of this trait requires feed intakes to be recorded individually. Sheep and goats are gregarious animals that are reared in group so either several individual devices are available (one for each individual) or one device can handle the feeding of several animals. Automated concentrate feeders (ACF) exist for small dairy ruminants. They deliver concentrate in the milking parlour, but the hypothesis is that all the delivered concentrate is eaten by the animal. Other ACF have been developed, mainly for research purposes. Very few devices enable the recording of forage intakes (AFF) when animals are reared in groups whereas small ruminants are mainly fed with forage. At INRAE, we developed ACF that can be used in ad libitum or restricted version, AFF and automated water dispensers. These three feeders return data for each visit (quantity and duration). This high-throughput recording is of high value. In combination with other biological data, feed intakes can be analysed to study feed efficiency but also responses to nutritional or infectious challenges. The succession of visits between animals gives hints for social interactions' studies. The duration of visits is also included in behavioural analyses. These large datasets can also help in identifying major events (technical, meteorological, health …) and then to test the resilience of animals under these stressful events. Current research programs aim at identifying proxies for feed intakes automated feeders, remain expensive devices.

2nd abstract: Greenhouse gases measurement in sheep using Portable Accumulation Chambers (PACs)

Author: Ignacio de Barbieri, Elly Navajas, José Ignacio Velazco y Gabriel Ciappesoni

INIA-Uruguay

This abstract is focused on practical and relevant aspects of measuring greenhouse gases emissions from sheep, based on short-term measurements using portable static accumulation chambers with an internal volume of 870 L (Goopy et al., 2011; Hegarty., 2013). This method allows measuring (and ranking) large groups of animals in a fast and inexpensive way. After weaning, animals are placed two to three times (one week between rounds) in sealed chambers for 40-50 minutes, after three weeks of constant feeding in terms of quantity and type of feed. On the measurement day with the animal placed into the chamber, CH4, CO2, and O2 are recorded using a portable multi-gas detector (in parallel with a background estimation) every ten or twenty minutes. Air temperature and pressure are also registered for the calculation of methane emission at standardized conditions. Multi-gas detector calibration, bump tests and chambers leak tests are performed routinely. Sealing of the chamber is mandatory to guarantee isolation, which is highly recommended. Transparent chambers are used to reduce stress, accounting for animal welfare. Records of bodyweight are necessary to estimate actual gas volume in the chamber and to estimate methane intensity. Also, dry matter intake on the measurement day and previous days are required to assess methane yield.

Goopy, J. P., Woodgate, R., Donaldson, A., Robinson, D. L., & Hegarty, R. S. (2011). Validation of a short-term methane measurement using portable static chambers to estimate daily methane production in sheep. Animal Feed Science and Technology, 166, 219-226.

Hegarty, R. S. (2013). Applicability of short-term emission measurements for on-farm quantification of enteric methane. Animal, 7(s2), 401-408.

3rd abstract: Predicting feed intake in small ruminants – How to do in practice?

Authors: F. Tortereau[1], C. Marie-Etancelin[1]

[1]: INRAE, INPT-ENVT, INPT-ENSAT, GenPhySE – Castanet-Tolosan, France

Feed efficiency is a trait whose selection meets both economic and agri-environmental challenges. The objective of farmers is to breed animals that consume less feed while maintaining their production level. Genetic selection of efficient animals is possible but requires the recording of individual feed intakes by means of automatic feeders, which remain very expensive devices. Most of the breed cannot afford to invest in these automates. The identification of proxies for feed intake is therefore a challenge we have to overcome in order to enable breeding companies to include feed efficiency in their breeding objectives. The proxies we proposed to consider in the SMARTER project are to be easily and non-invasively sampled and analysed at a reasonable cost. Among these proxies, we will first try to benefit from already recorded traits such as body weights and average daily gains. We will also focus on biological markers that can be measured in fluids that breeders are used to sample: blood and faeces. From blood, we will get genotypes and metabolites (either through specific determination or through NMR spectra). From faeces, we will get NIRS spectra that will be analysed in comparison with NIRS spectra obtained from the food itself. All these proxies can be considered separately to predict feed intake but also combined with data integration methods to benefit from all these proxies. For research purpose, additional proxies such as ruminal data (microbiota, volatil fatty acids…) will be considered because of their direct link with feed efficiency, but it is currently difficult to include them in the proposed proxies to sample routinely

4th abstract: Setting up across country genetic evaluations in sheep and goats requires international cooperation and the establishment of harmonised tools

Author: Donagh Berry (TEAGASC) and Jean-Michel Astruc (IDELE)

In sheep and goats, compared to cattle, smaller within-country populations in selection and higher relative cost of genotyping and performance recording are among the main hindrances to the development of genomic selection. An international cooperation leading to across-country genetic evaluations and conception of an optimised and affordable genomic platform might generate great benefits for stakeholders in terms of genetic progress on resilience and efficiency traits.

The essential tools required for establishing an international evaluation and identifying the best panel of genomic markers across breeds have been put in place and are expected to be used widely beyond the project.

A template of agreement for sharing and pooling data was proposed and signed by 10 organisations. As performance recording and models of genetic evaluation for similar traits are somehow different across country, a survey on the situation in each partner country was undertaken. Harmonised formats of files for exchanging pedigree, phenotypes and genotypes were adopted by the 10 involved organisations. A codification of breeds was set up. Allele frequency information acquired from 14 meat and dairy sheep breeds were used to detect the more informative SNP markers across populations. Connectedness between countries was assessed on a first batch of populations, underlining the relevance of implementing across country evaluation.

As a main outcome of these first achievements, case studies of international evaluations will be developed for determining the best technical options and highlighting the benefits for breeders.

5th abstract: Compute Realized reliabilities of predictions from consecutive genetic evaluations using method LR

Author: Andres Legarra (INRAE), Fernando Macedo (INRAE)

Accuracies of genomic prediction are important to predict future genetic progress and to choose the adoption of different selection schemes, e.g. pedigree-based versus genomic ones. A method frequently used requires careful analysis of data involving cross-validation (e.g. hiding records and trying to predict them). Such methods for sheep and goats are very cumbersome and require access to raw data from genetic evaluation. We are essentially interested in accuracy at birth, when selection decisions are more important.

The "LR" method (from Linear Regression) estimates these accuracies from sets of consecutive proofs. Pick a set of "focal" animals with same age and information - for instance, young rams or young females. The set has to consist on at least 50 animals for the results to be reliable. We compare genetic proofs (genetic evaluations) of these "focal" animals, at birth ("old" proofs), versus "more recent" proofs of the same animals, one (or more) years later, when they have more information (progeny records or own phenotype). The correlation between "old" and "most recent" proofs across the set of animals (r(w,p)) is the ratio of initial and final accuracy such that the increase in accuracy from initial to final is (1/r(w,p)) - 1. For instance if r(w,p) is 0.8 it means that the accuracy increases by relative 25% from birth to the most recent evaluation. Thus high values of r(w,p) imply high accuracies at birth, and very low values imply that proofs at birth are little accurate.

6th abstract: Inferring challenges from frequently collected data

Author: Carolina Garcia-Baccino (INRAE), Andres Legarra (INRAE)

Under real productive rearing conditions, challenge events in sheep and goats are sometimes unrecorded and from unknown source. However, frequent recording allows to observe anomalous patterns in the flock showing up as additional variability on recorded traits.

To detect an unrecorded challenge, you need a series of daily recordings (milk yield, feed intake, growth) spanning at least one season. Then, challenges manifest as extra variation among individuals. To avoid the scale effect of increasing trait (growth, milk yield), analyse the natural logarithm of the daily coefficient of variation, log(CV). The daily log(CV) is analyzed using a mixture model with two components, one is “normal” variation and the other one is “extra” variation. Analysis may be done in R, for instance with package normalmixEM. On output there is an indicator variable from 0 to 1 tells the probability of a day being a “challenge”. These values can be used as indicators of “challenge” days or can be directly used in norm reaction models.

4 Deviations or delays

This deliverable is submitted with a delay of one month which is due to the COVID19 pandemic.