SMAll RuminanTs breeding for Efficiency and Resilience

March 27th, 2023

Module 1 - Traits and methods to compute phenotypes

Course description:

The module will cover basic principles for definition of traits related to resistance and resilience (RR) and traits related to feed efficiency (FE) in small ruminant, recording systems for these traits, together with relevant examples in different SMARTER's countries:

- Definition of resistance and resilience in small ruminant and for feed efficiency (theoretical and concepts)
- Traits and measures related to RR &FE traits (practical examples and genetic basis)
- Recording systems: examples in different countries and breeds.
- Statistical treatment of raw input data (R/R): transformation/normalization, repeated measures vs multi-trait, etc.

In addition to theoretical lecture, a large part of the module will use SMARTER partner data (INRAE, SRUC, UNILEON, INIA-UY) for a hands-on approach. For RR traits, the practical session will address gastrointestinal parasite resistance. For feed efficiency, participants will use several sheep data (ASSAF dairy sheep, Romane lambs, and cross bred lambs) to compute a comprehensive set of feed efficiency related traits.

Upon module completion, participants can expect to have a fundamental understanding of the purpose, have the basic knowledge to clean, manipulate and analyze RR &FE traits. They will be able to understand the assumptions and limitations of different types of traits, models and recording systems models, and will be able to interpret literature data.

Requisites:

Bring your own laptop. either Linux, Windows or Mac. The hands-on will use R. Data files and scripts will be provided.

Course teachers:

Rachel Rupp, Flavie Tortereau (INRAE), Elly Navajas (INIA-UY), Nicola Lambe (SRUC), Juan José Arranz (UNILEON).

Agenda

Session 1: General introduction to Resistance/Resilience and Feed Efficiency in small ruminants (theoretical and genetic basis)	
09:30 - 10:00	"Welcome, General presentation of the Course and of SMARTER" - Riccardo Bica (INRAE)
10:00 – 10:45	"Definition of resistance and resilience in small ruminant: concepts, traits and recording, and genetic basis" – Rachel Rupp (INRAE)
10:45 – 11:00	**Coffee Break**
11:00 – 12:00	"Definition of feed efficiency in small ruminant: concepts, traits and recording, and genetic basis" - Elly Navajas (INIA-UY)
12:00 – 13:00	**Lunch**
Session 2: Lecture & Tutorial: Presentation of SMARTER cases studies and manipulating traits and models for FE traits	
13:00 – 14:45	"Handling feed efficiency data in sheep: three examples in meat sheep lambs (cross bred lambs from SRUC and Romane lambs from INRAE) and adult dairy sheep (ASSAF from UNILEON) will be presented (recording and protocols), and datasets provided to handle trait construction, models and concepts with R" – Juan-José Arranz (UNILEON); Nicola Lambe (SRUC); Elly Navajas (INIA-UY); Flavie Tortereau (INRAE)
14:45 – 15:15	**Coffee Break**
Session 3: Lecture & Tutorial: Presentation of SMARTER cases studies and manipulating traits and models for RR traits	
15:15 – 17:00	"Handling gastrointestinal parasites RR data in sheep: one example from meat sheep (INIA-UY) will be used to analyze and interpret the "gold standard" FEC (fecal egg counts) at different ages, in farm or experimental stations, natural vs artificial infestation and other phenotypes such as FAMACHA and body condition score" - Elly Navajas, Gabriel Ciappesoni, Ignacio De Barbieri (INIA-UY)

March 28th, 2023

Module 2: Mechanistic and statistical modelling of resilience and feed efficiency

Course description:

Mathematical modelling has become a valuable tool in the analysis of resilience and feed efficiency and to support the development of control strategies. This module will introduce the conceptual ideas and mathematical tools needed for formulating and evaluating mathematical models for resilience and feed efficiency in farmed animals. A hands-on approach will be adopted in form of interactive lectures and tutorials. The module will cover fundamental principles of statistical and mechanistic resilience and feed efficiency models, together with relevant examples including

- General introduction to statistical and mechanistic mathematical models
- Mechanistic models of trade-offs determining variation in resilience and feed efficiency
- Statistical models of resilience trajectories
- Modelling resilience of sheep to gastro-intestinal parasite infections

The course will provide participants with the relevant theory of mathematical modelling of resilience as well as with hands-on experience with relevant modelling techniques. Upon course completion, participants can expect to have a basic understanding of the purpose, essential building-blocks, assumptions and limitations of different types of mathematical models, have the fundamental knowledge to build mathematical models from scratch and analyze the model behavior, and will be able to interpret published results from diverse modelling studies.

The course is aimed at animal scientists (post-graduate level or above) and professionals in the field of livestock production or health with good numeracy skill and an interest in quantitative approaches to study infectious diseases. The course is not aimed at researchers with advanced modelling skills.

Course teachers:

Masoud Ghaderi-Zefreh (UEDIN), Nicolas Friggens (INRAE), Laurence Puillet (INRAE), Frédéric Douhard (INRAE)

Agenda

Session 1: General introduction to mathematical modelling	
09:00 - 10:00	"General introduction to statistical and mechanistic mathematical models" – Masoud Ghaderi-Zefreh (UEDIN)
Session 2: Statistical models of resilience trajectories	
10:00 – 10:45	"Lecture: Statistical models of resilience trajectories from a biologist's perspective" - Nicolas Friggens (INRAE)
10:45 – 11:00	**Coffee Break**
11:00 – 12:00	"Statistical modelling tutorial" - Nicolas Friggens (INRAE)
12:00 – 13:00	**Lunch**
Session 3: Mechanistic models of trade-offs determining variation in resilience and feed efficiency	
13:00 – 13:30	"Lecture: Allocation theory in farm animals: from concepts to code" – Laurence Pulliet (INRAE)
13:30 – 15:00	"Lecture & Tutorial: Manipulating acquisition and allocation parameters to generate variability in production trajectories" - Laurence Pulliet (INRAE)
15:00 – 15:15	**Coffee Break**
Session 4: Modelling resilience to infections	
15:15 – 17:00	"Lecture and tutorial: Modelling resilience of sheep to gastr-intestinal parasite infections" – Frédéric Douhard (INRAE)

March 29th, 2023

Module 3 - Detecting Stress and evaluating ability to cope with stress

Course description:

Animals are exposed to stresses such as heat or management problems that may be measured or not. These stresses can be quantified and used in a norm reaction model to evaluate animal's ability to cope with stress. In addition, using frequent (e.g. daily) longitudinal data on traits, it is possible to infer the occurrence of unrecorded stresses based on deviations from the trajectory - either individual or group based.

The objectives of the module are:

- to present the norm reaction model to evaluate how animals deal with stresses when stresses are directly measured
- when stresses are not measured, how to infer and quantify their existence using deviation from trajectories, either of a group or of an individual
- how to include these inferred stresses into the norm reaction model for resistance to stress

In addition to some lecture, we will use INRAE data and UNEDIN simulation for a hands-on approach.

Requisites:

Bring your own laptop. either Linux, Windows or Mac. The hands-on will use R, the blupf90 suite, text editors, and command line ("Terminal" in the Linux & Mac jargon and "Command shell" or "PowerShell" in Windows). Another option for Windows users is Ubuntu's "Windows Subsystem for Linux". Data files and scripts will be provided.

Course teachers:

Andres Legarra (CDCB), Carolina Garcia-Baccino (NUCLEUS), Masoud Ghaderi-Zefreh, Oswald Matika, Ricardo Pong-Wong (UEDIN)

Agenda

Session 1: Theory	
09:30 - 11:00	"Measures of stresses (THI, bacterial load, farm effect...)" - TBD "Norm reaction model, and how can be used to model reaction at the genetic level to stresses" - Andres Legarra (CDCB); Ricardo Pong-Wong (UEDIN)
11:00 – 11:15	**Coffee Break**
Session 2: Hands-on with blupf90 and R	
11:15 – 12:30	"A norm reaction model with observed covariates (e.g.THI)" - Andres Legarra (CDCB); Oswald Matika (UEDIN) "Writing the model" - TBD "Estimating genetic parameters" - TBD "Interpreting EBVs" - TBD
12:30 – 14:00	**Lunch**
Session 3: Theory	
14:00 – 15:30	"Inferring stresses from farm effects" - Masoud Ghaderi-Zefreh (UEDIN) "Inferring stresses from perturbation of group data" - Carolina Garcia-Baccino (NUCLEUS)
15:30 – 15:45	**Coffee Break**
Session 4: Hands-on	
15:45 – 17:00	"Inferring herd effects" - Masoud Ghaderi-Zefreh (UEDIN) "Inferring stresses from daily data" - Carolina Garcia-Baccino (NUCLEUS)
Session 5: Challenge session	
17:00 – 18:00	"Analysis on non-yet analysed SMARTER datasets (e.g ruminal temperatures)" – Riccardo Bica (INRAE) "Test the model and assess its outcome" – Riccardo Bica (INRAE)

March 30th, 2023

Module 4: How can resilience and efficiency traits impact system performances and modify farmers' breeding choices?

Course description:

In the animal breeding process, the system level is very important because different aspects can be modified by the availability of new resilience and efficiency traits: economic results, environmental impacts, farmer choice and farming practices. This course module focuses on two different methods: modelling and surveys, with different approaches.

Redesign of farming systems to switch towards more sustainable and resilient sheep and goat production using modelling.

The first approach is based on the development of **a farm-scale mathematical simulation model**. This linear programming model is implemented for sheep and goat farms and its outcomes will be presented. This whole-farm model simulates economic performance under new resilient and efficient traits that counteract presence of infectious and non-infectious diseases. The model provides scenarios of how changes towards optimizing one farm component (e.g. genetics at animal level) could affect other components of the farm or the overall system (e.g. gross margin, labor, land use, grazing, profit etc.), in terms of sustainability. The model constitutes a very useful tool for policy-makers to identify innovative strategies that can be proposed to re-design sheep and goat farming systems. The structure and the main features of the model as well as the required data for its implementation will be described in detail and the results of the implementation of the model using real-farm data from ***Chios sheep breed*** will be analyzed.

The second approach uses OSIRIS, **a bio-economic model**, that allows to define an economic breeding goal for ruminants by estimating the economic values of traits for a particular system and breed in today's context. The very detailed description of the functioning of the system (replacement and culling policy, fertility rates, health costs, mortality rates, etc.) allow to model the profit for a typical herd management. The model includes equations of income and costs related to several traits that can be genetically improved for breeding and production and so be part of breeding objectives. Then, the economic values can be defined as the first derivative of the herd profit function regarding each individual trait. The architecture of the model as well as the main parameters required will be described. The results of the modelling for a system in the French ***Lacaune milk sheep breed*** will also be detailed.

Understand farmers' choice to use new breeding traits for more sustainable livestock production using surveys.

The approach is based on interviews about farmer's practices **to identify paragon of livestock farming system.** The interviews focus on farm features, breeding practices, and farmers' choice of traits to improve farm genetics. Based on the diversity of the case studies (10 different types of systems/intensification and different breeds), we will explore how farmer choice can be linked to various socio-technical systems and positively enable increased sustainability of agriculture.

Course teachers:

Alexandros Theodoridis (AUTH), Vincent Thénard (INRAE), Stéphanie Coppin (IDELE)

Agenda

Session 1: General introduction of resilience and efficiency traits approach in Sheep & Goat farming system	
09:30 - 10:00	"Presentation of the cases studies Livestock Farming System by countries" – Vincent Thénard (INRAE)
Session 2: Holistic models for designing efficient and resilient Sheep & Goat sector	
10:00 – 11:00	"A farm-scale mathematical model to simulate economic performance under infectious and non-infectious challenges" – Alexandros Theodoridis (AUTH)
11:00 – 11:15	**Coffee Break**
11:15 – 12:15	"OSIRIS, a bio-economic model, that allows to define an economic breeding goal for ruminants" – Stéphanie Coppin (INRAE)
12:15 – 13:15	**Lunch**
Session 3: Breeder's choices to use new breeding traits for sustainable livestock production	
13:15 – 14:15	SMARTER Survey - Stéphanie Coppin (INRAE)
14:15 – 15:30	Conduct interviews on farmers' practices to identify paragons of livestock selection management" – Vincent Thénard (INRAE)
15:30 – 15:45	**Coffee Break**
15:45 – 17:15	"How to imagine new select traits based on participatory approach using LEGO game" – Vincent Thénard (INRAE)
17:15 – 17:30	General discussion