Smarter

SMAll RuminanTs breeding for Efficiency and Resilience

SMARTER: a European project on selection on efficiency and resilience in small ruminants with strong ICAR commitment and implication

INSTITUT DE L'ELEVAGE idele

Visit Interbull – Uppsala, Sweden,
27-28 May 2019

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement n°772787

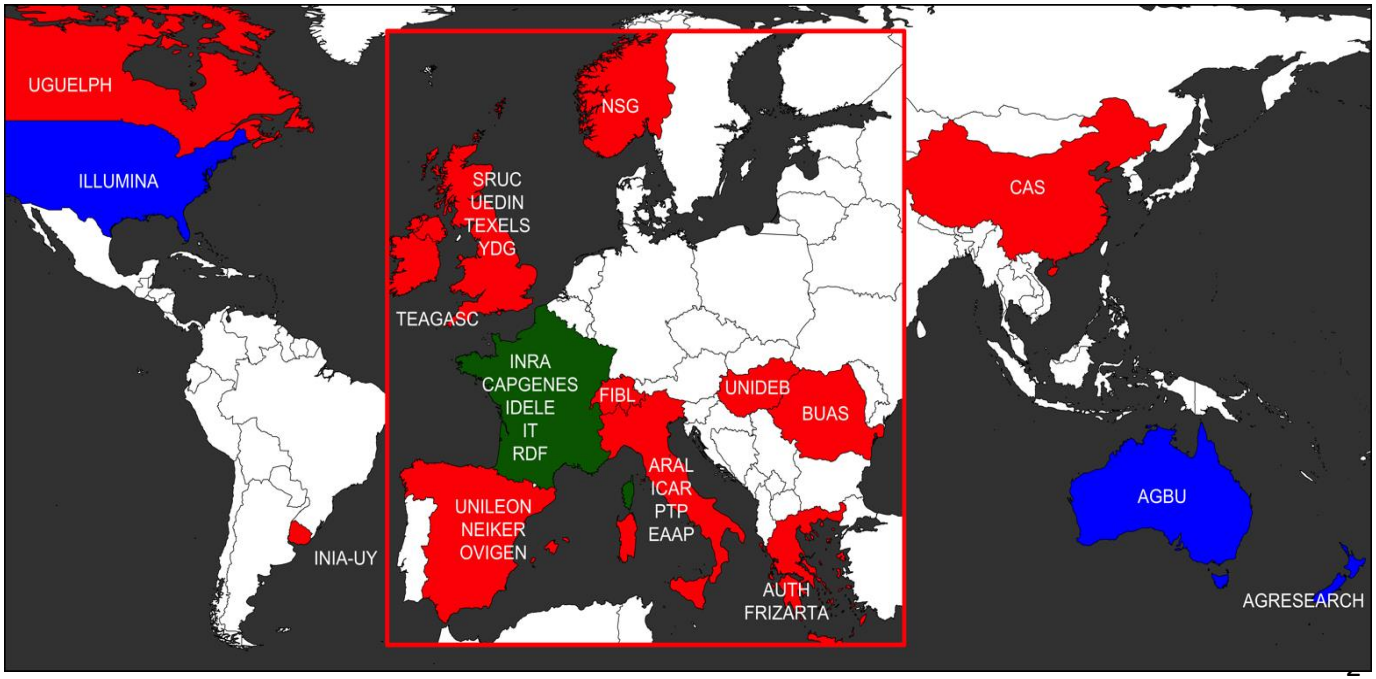
H2020-SFS-2016-2017 Multi-Actor Project
Research and Innovation Action
SMAll RuminanTs breeding for Efficiency and Resilience

Project period: Nov 2018 to Oct 2022

Coordination: INRA Toulouse (Carole Moreno-Romieux)

26 partners, 13 countries (10 EU + Uruguay + Canada + China), 50% of non–academic partners

Coordinator, partners, stakeholders (to implement)



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SMARTER is structured around 2 definitions of RESILIENCE and EFFICIENCY

RESILIENCE

The ability of an animal/system to maintain or revert quickly to high production and health status when exposed to a diversity of challenges, with a focus on nutritional and/or health challenges.

EFFICIENCY

Considered as the efficiency of feed resource use by animals: feed efficiency, the dynamics of body tissue mobilization and its impact on the environment. Focus on agro-ecological issue: competition with human nutrition (grains), water consumption, greenhouse gas emission.

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What are resilience and efficiency traits studied in SMARTER?

Resilience

- **Disease resistance**: parasite, footrot, mastitis
- **Longevity / Survival**: lamb & embryo mortality, functional longevity
- **Trade-Off between** parasite resistance, longevity, production, feed efficiency and resource allocation when disease and/or nutritional challenge

Efficiency

- **Feed efficiency**: concentrate/hay/grass, new predictors
- **Resource allocation**
- **Microbiota**: to predict gas emission
- **Gas emission**: new tools

But also at the system level …

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Recorded population – DAIRY SHEEP

(ICAR Prague 2019)

Countries	Recorded population # ewes	% recorded pop.
Italy	**163,415**	3.2%
France [2]	**328,392**	23.5%
Spain	**275,196**	12.1%
Greece	**85,345**	1.2%
Portugal	**18,052**	5.3%
Slovak Rep	**6,151**	3.3%

Countries	Recorded population : # ewes	% recorded pop.
Croatia	**6,226**	5.0%
Slovenia	**2,455**	91.6%
Czech Rep	**1,410**	1.7%
Germany	**932**	-
Canada	**695**	-

[2] 542,616 in D recording

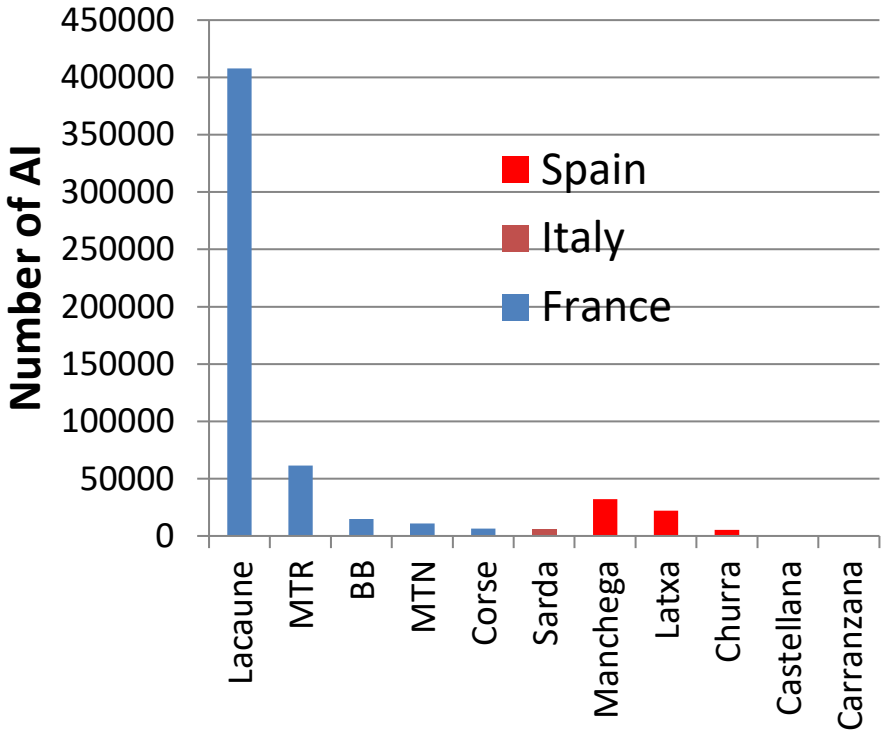
Recorded population – DAIRY GOATS

(ICAR Prague 2019)

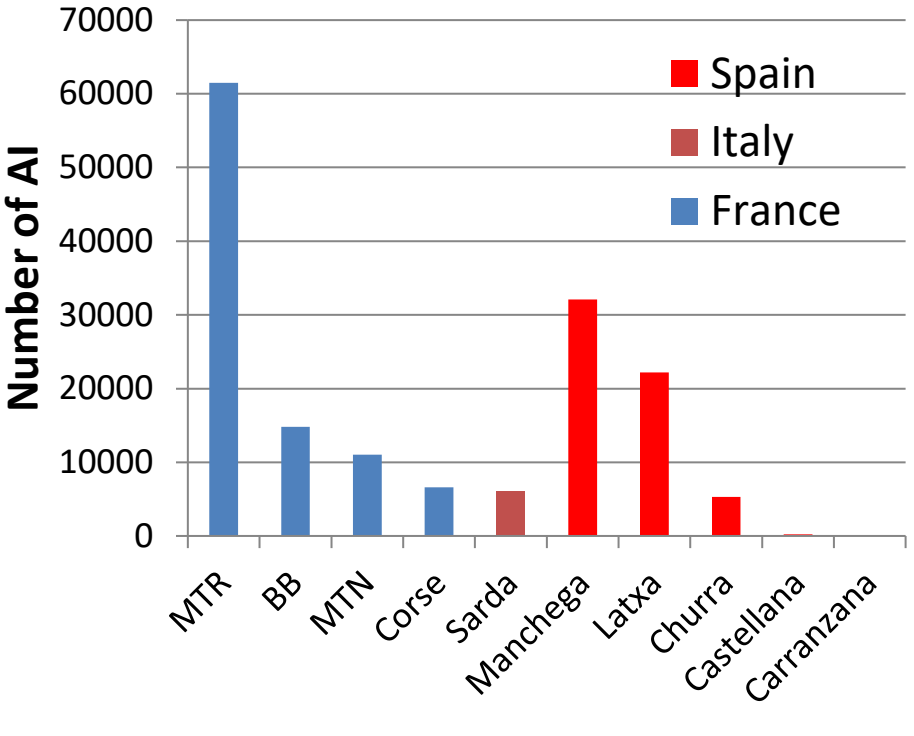
Countries	Recorded pop. # does	% recorded pop.
France	**248,395**	29.4%
Italy	**42,127**	7.2%
Spain	**55,645**	4.4%
Switzerland	**21,887**	42.9%
Portugal	**7,771**	25.2%
Germany	**6,996**	17.9%
Canada	**6,098**	-

Countries	Recorded pop. # does	% recorded pop.
Czech Rep	**6,093**	36.3%
Croatia	**3,968**	14.3%
Serbia	**4,304**	4.2%
Latvia	**1,251**	13.9%
Slovenia	**1,148**	33.8%
Slovak Rep	**240**	0.9%

Number of AI – DAIRY SHEEP (ICAR Auckland 2018)



With French Lacaune



Without French Lacaune

567,800 AI on the whole

Figures 2016

Main features of breeding schemes background

- Low impact of performance recording (at the exception of France)
- Low use of AI (at the exception of France)
- Few genetic programs (dairy sheep and goat in France, meat sheep in UK and Ireland)

Weakness of potential reference population
Cost of genotyping high with regards to animal economic value

⇒ Cost-effectiveness of genetic selection within country may be questioned
⇒ But : some international breeds (Lacaune, Alpine and Saanen, Charollais, Texel, Vendéens, Suffolk) with growing exchanges
⇒ **Interest of international initiatives**

Main features of small ruminants production

- Small ruminants in Europe mostly reared in difficult environments (mountains/hills, arid, humid or low forage resources areas), where rearing cattle is difficult to impossible

- Additionally, small ruminants use rangelands and contribute to maintaining an open environment, improving biodiversity and preventing fire damage in dry areas

- To maintain these benefits in environments vulnerable to environmental and economic challenges, small ruminants need to be resilient and efficient

Some figures to appreciate the impact of SMARTER

- 5 000 farmers, 1 500 000 ewes/goats will be directly targeted by SMARTER
- HD data set (existing or newly generating) : 500 000 phenotyped + 70 000 genotyped animals
- 46 breeds in SMARTER =20% of the sheep and goat populations in EU but via our non academic partners 70% of the EU populations will be impacted

19 meat sheep breeds

13 dairy sheep breeds

14 dairy goat breeds

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The 48 EU breeds in SMARTER










48 breeds (conventional, hardy, local…):

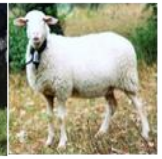
- 14 dairy goat breeds (Alpine, Saanen, Yorkshire composite,Bionda, Verzasca, Carpatina, Fossé, Frisa, Orobica, Provencale, Damascus, greek Eghoria, Skopelos, Guisandaesa),
- 14 dairy sheep breeds (Assaf, Basco-Béarnaise, Boutsiko, Chios, Churra, Frizarta, Lacaune, Latxa, Manech tête noire, Manech tête rousse, Corse, Sarda, Tsigai, Turcana)
- 20 meat sheep breeds (Charollais, Merino, Norwegian White sheep, Suffolk, Texel, BMC, Causse du lot, Rouge de l'Ouest, Ojalada, Romane, Lacaune, Scottish Blackface, Lleyn, Dorset, Solognote, Bizet, Charmoise, Vendeen, Castellana blanca & negra).



Non EU breeds: Some wool Uruguayan sheep breeds (Uruguayan Creole sheep, Merino and Corriedale) and around 80 Chinese and Tibetan native breeds.









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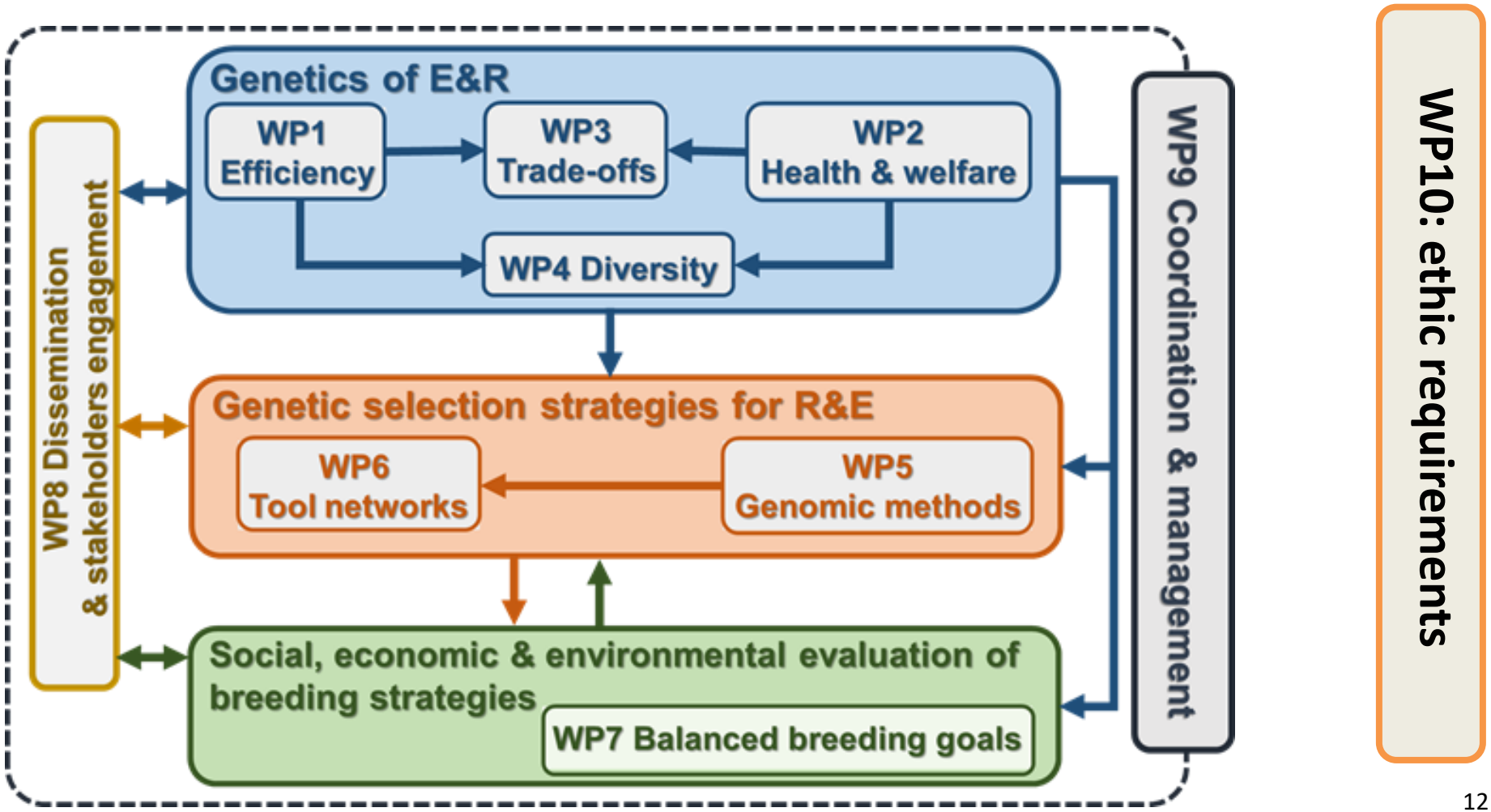
Organization of SMARTER project



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WP1: novel traits to improve resource use efficiency

J.J.Arranz – University of León

Identification of new phenotypes

Experimental populations (GRE,FRA,ESP,URU)

Residual feed intake (concentrate + forage), metabolic profiles, rumen microbiota, methane emissions, NIRS from faeces, novel biomarkers => proxies for farms

Analysis of the genetic determinism of feed efficiency

Commercial farms populations: through proxies prop osed by task 1

Genetic relationships btw efficiency and production

GxE interaction for the resource use efficiency related phenotypes

Dairy sheep Lacaune FRA x GRE

Meat sheep Romane extensive x intensive

Alpine/Saanen goats intensive vs extensive & season vs out of season breeding

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WP2: novel traits to improve health and welfare

J.Conington – SRUC

Health & resistance to disease

Resistance to internal parasites, footrot, mastitis in meat sheep

Foetus and young survival / lamb vigour – Welfare indicators

Behaviour *(artificial rearing, extensive grazing, shelter-seeking activities, milking learning)*

Longevity, culling causes

Expe (seeking novel traits/indicators) on-farm populations (genetic parameters)

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WP3: genetics of trade-offs and synergies between resilience and efficiency related traits

R.Rupp – INRA

Identify trade-offs & synergies among traits under genetic control

Review of genetic correlations between efficiency and resilience traits
Meta-analysis

Experiments

Nutritional and infectious challenges (parasites, protein restriction, inflammartory challenge
Epigenetics: methylation data on goat experiment

Modelling

Prediction models to manage trade-offs & optimise R&E in challenging conditions

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WP4: genomic characterization of hardy or underutilised breed's environmental adaptation using existing and newly generated data

B.Servin – INRA

Data Management and Production

Sampling, genotyping, phenotyping
more than 20 breeds (ex. breed reportedly resistant to parasites, breeds adapted to mountain pastures …), around 50 animals per breed

Genetic Diversity and Demography

Merge data from above task with publicly available data

Signatures of Selection and Adaptation

Identify genomic regions involved in the adaptation

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WP5: genomic/genetic modelling and methods of selection for resilience and efficiency traits

R.Pong-Wong – Roslin
A.Legarra - INRA

Novel methods for efficiency and resilience

Random regression / reaction-norm models

Data mining of longitudinal data and characterise events of environmental challenges

From longitudinal data (milk): can the environmental challenge be identifiable? heritable? selected for resilience against? Climate data?

Genomic prediction methodology

Metafounders
Quantify the bias in genomic prediction (method LR)
Create an indicator of the quality of prediction from one population to the other

Improve management of genetic diversity with genomic data

Region related with inbreeding depression … Tools for disassortative mating to maximize heterozygosity … Optimum contributions method to maximize genetic gain and manages genetic diversity at specific critical regions of the genome

WP6: practical selection tools to benefit from international cooperation

J.M.Astruc – IDELE
D.Berry - TEAGASC

See slides thereafter

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WP7: balanced breeding goals for agro-ecological resilience

T.Byrne - Abacusbio
V.Thénard - INRA

Agro-ecological impacts of breeding at farm level

Include new R&E traits identified in WP1 & 2 … impact on sustainability … farm model

Breeders & farmers preferences for R&E breeding, acceptability of new techniques and willingness to share information

Interviews (farmers & breeding organisations) => farmers' breeding decisions, practices to improve flock's R&E, may use genomics, agree to share data across countries

Economic, environmental and social value of traits

Mathematical modelling of income & labour, Multi-criteria analyses, Choice modelling to estimate weights for R&E

Balancing breeding goals

Assess the economic and other impact of the different indexes according to the breed and the environment

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ICAR committed in WP6 "Practical Selection Tools to Benefit from International Cooperation"

Task 1: HARMONIZATION: phenotypes, genotypes, pedigree

Task 2: INTERNATIONAL EVALUATION: genetic, genomic

Task 3: PRACTICALITIES of international evaluations

Task 4: ASSESS BENEFIT: modelled benefit of harmonization of phenotyping & int'l evaluation on long-term genetic gain

ICAR-connected

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ICAR committed in WP6 "Practical Selection Tools to Benefit from International Cooperation"

Guidelines

- Recommendations to measure efficiency and resilience traits in a similar way in each country => facilitate possible future common evaluation
- Suggest/define recording of new environmental effects

- Add a new brick to the section of the ***guidelines of the SGC WG***

Section 16: Dairy Sheep and Goats

Section 14: Alpaca & Goat ID & Fiber

Section XX: Meat and Reproduction in Small Ruminants

Section YY: Resili-ence & Efficiency in Small Ruminants

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ICAR committed in WP6 "Practical Selection Tools to Benefit from International Cooperation"

Across-Countries genetic & genomic evaluation

Is it worth carrying out multi-country evaluation in small ruminants?
Background = few exchanges, low connectedness, small reference population in most countries, genotyping costs

- 3 pilots studies to assess feasibility

Dairy sheep	Manech & Latxa	FR,SP	A Legarra
Dairy goats	Alpine & Saanen	FR, CN, IT, UK, CH	H Larroque, L Brito
Meat sheep	Charollais, Vendéens, Texel, Suffolk	IR, UK, FR, UY, HU	D Berry

=> Common int'l pedigree file, file formats for exchanging genot/phenot/pedigree
=> Practical and cheap community SNP panels in a common and agreed format

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ICAR committed in WP6 "Practical Selection Tools to Benefit from International Cooperation"

Across-Countries genetic & genomic evaluation

Towards a routine multi-country evaluation in small ruminants?

- Practicalities of international evaluation
  - → Propose specification for routine evaluation in an organized international framework (cf. Interbull?, Interbeef?, alternative model?)
    - Agreement, data sharing acceptability
    - Technical issues
    - Business model, profitability
    - Needs (or no) from the countries
  - → Business Plan & business model

This is why I am here today

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ICAR committed in WP6 "Practical Selection Tools to Benefit from International Cooperation"

Reference center

Define, propose, conceive what could be a zootechnical reference center in small ruminants

- In cattle, Interbull is now the European Union reference centre for performance testing/genetic evaluation in bovine. What about in sheep and goats ?
  - cf. EU Regulation on Animal Breeding 2016/1012 (article 29)
  - SMARTER could help to define the outline of Reference Centre for performance testing/genetic evaluation in sheep & goats

This is also why I am here today

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ICAR committed in WP8 "Dissemination, training and stakeholder's engagement"

Task 1: stakeholder's engagement through stakeholder platform and ICAR/EAAP network

Task 3: dissemination and training for stakeholders

ICAR-connected

Task 4: dissemination tools

Task 2: dissemination and training for scientific community

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ICAR committed in WP8 "Dissemination, training and stakeholder's engagement"

Network

Stakeholders' platform – ICAR in charge of this task

- **Provides the participatory framework through a stakeholder's platform**
  - Platform composed of researchers, representatives of industry, farmer's organisations, policy makers/regulators at national & EU level
- **Dialogue between SMARTER partners & stakeholders**
  - Platform plays a key role in dissemination & exploitation of results
  - Platform gives feedback to SMARTER with external points of view.
- **Interbull invited to be stakeholders**

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ICAR committed in WP8 "Dissemination, training and stakeholder's engagement"

Network

Dissemination & training for stakeholders – ICAR in charge of this task

- **Organisation of (national) stakeholders round table sessions in 10 local countries** (audience size 50-100 attendees)
- Presentation to stakeholders at conferences such as in **ICAR** 2020 (the Netherlands) and **ICAR** 2022 (Canada).
- **National seminars and conferences** (ASPA in ITA, Foro Nacional de Ovine in ESP, J3R in FRA, Teagasc sheep open days in IRE, …)
- **Stakeholders regionally trained** in local languages
  - Stakeholder platform will be useful to advise about topics of interest

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Participation of the WG to SMARTER

Among the partners / third parties of SMARTER: ICAR (ICAR Secretariat – Martin Burke and Cesare Mosconi), IDELE (Jean-Michel Astruc & Valérie Loywyck), SRUC (Joanne Conington), AGRIS Sardinia (Antonello Carta)

Involve as much as possible all member of the SGC WG:

- ✓ Information through ICAR meeting and newsletter.
- ✓ Specific session in ICAR meeting (the Netherlands / Canada)
- ✓ Participation to elaboration of guidelines (as for current sections).
- ✓ Feedback on reflection/thoughts on business plan for international evaluation
- ✓ Feedback on reflection/thoughts on reference center

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