Horizon 2020 Programme

INFRAIA-02-2017
Integrating Activities for Starting Communities

SmartCow: an integrated infrastructure for increased research capability and innovation in the European cattle sector

an integrated infrastructure for increased research capability and innovation in the European cattle sector

Project ID: 730924

Deliverable number: D3.4

Deliverable title: Precised/new Animal traits for ATOL/EOL: improvement of ATOL and EOL ontologies by developing and adding new traits. Improvement of website.

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1. Author(s)

Organisation name lead contractor	INRAE

Author	Organisation	e-mail
Hurtaud Catherine	INRAE	Catherine.hurtaud@inrae.fr

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SmartCow
an integrated infrastructure for increased research capability and innovation in the European cattle sector

EXECUTIVE SUMMARY

Background	An ontology is a "formal way of representing knowledge in which concepts are described both by their meaning and their relationships to each other". In ATOL, the phenotypic traits cover animal welfare traits, growth, meat, and milk production traits, nutrition traits and reproduction traits. In EOL, the traits cover feed characteristics, livestock farming environment (describing the environment, which surrounds the animal), farming structure, and farming system.
Objectives	The objective of Task 3.3 is to foster the use and to improve ontologies for bovine phenotypic traits (ATOL: Animal Trait Ontology for Livestock), and environment conditions parameters (EOL: Environment Ontology for Livestock).
Methods	These two ontologies have been implemented by SmartCow partners thanks to surveys or specific meetings.
Results & implications	We improved the website. We extracted « Bovine specificity » from ATOL and EOL and sent it to all partners of the European project to improve the terms already present, to develop and add new terms, and to promote this ontology beyond the consortium. Thanks to surveys (made by WP1 and WP6) and different specific meetings (The VOCAMP in February 2020, the training course on ontologies in December 2020), we added 138 new traits in ATOL and more than 40 in EOL. We have also developed links between measurement methods inventory and ATOL/EOL by implementing ATOL/EOL numbers for the animal traits in the chapters of the book of methods (Task 3.1). Some id from ATOL and EOL have been used by Agrimetrics to codify the data (Task 3.2).

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Table of contents

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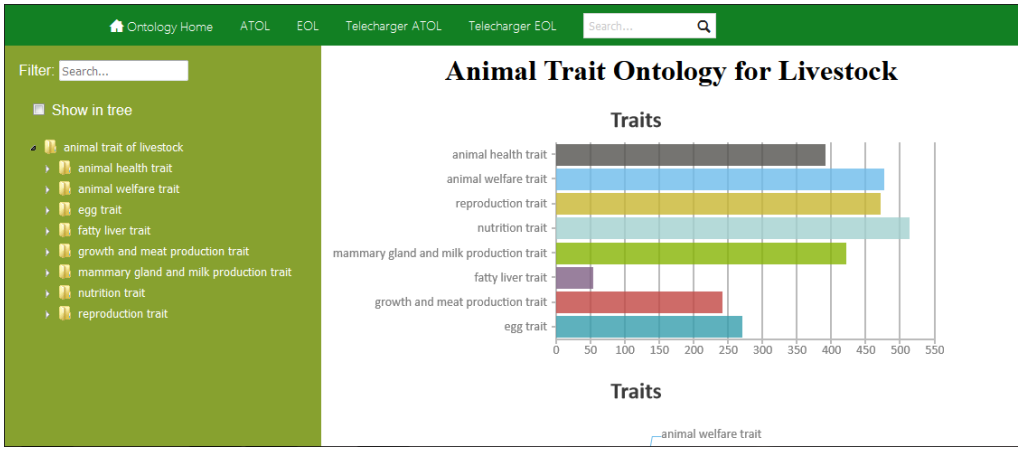
1 Web interface

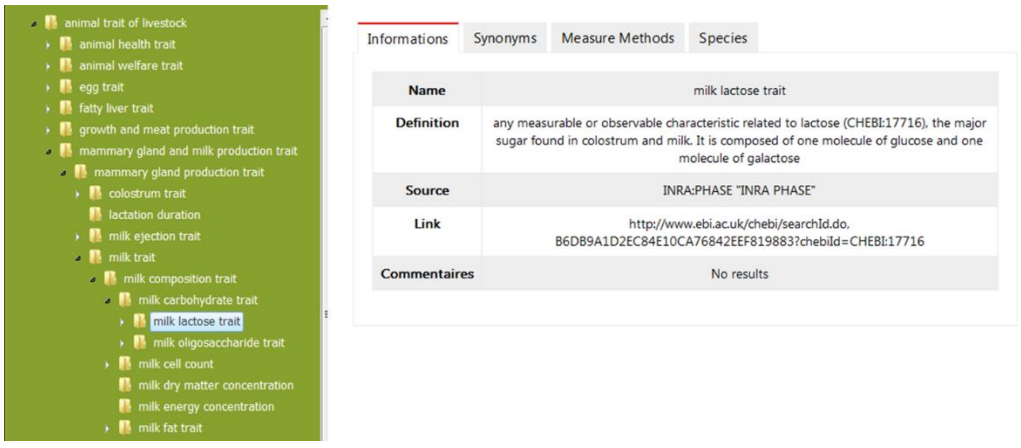
ATOL/EOL/AHOL website has been changed to have more readability.

AHOL stand for Animal Health Ontology for Livestock.

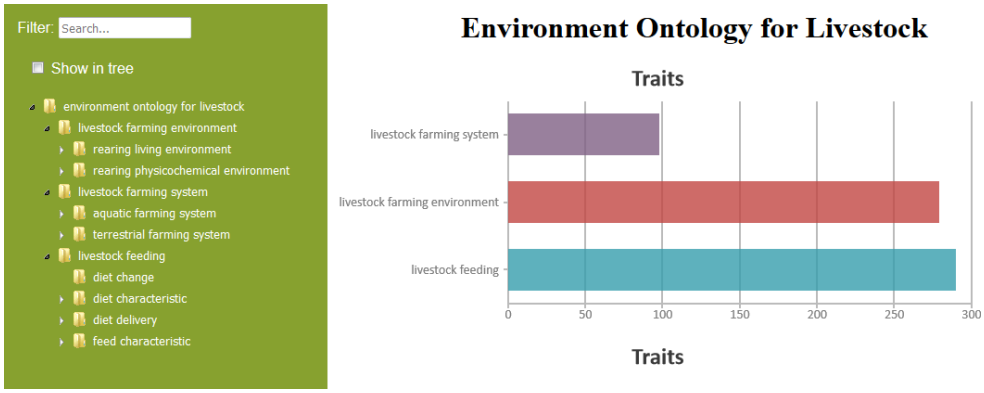
1.1 Former website

ATOL





EOL



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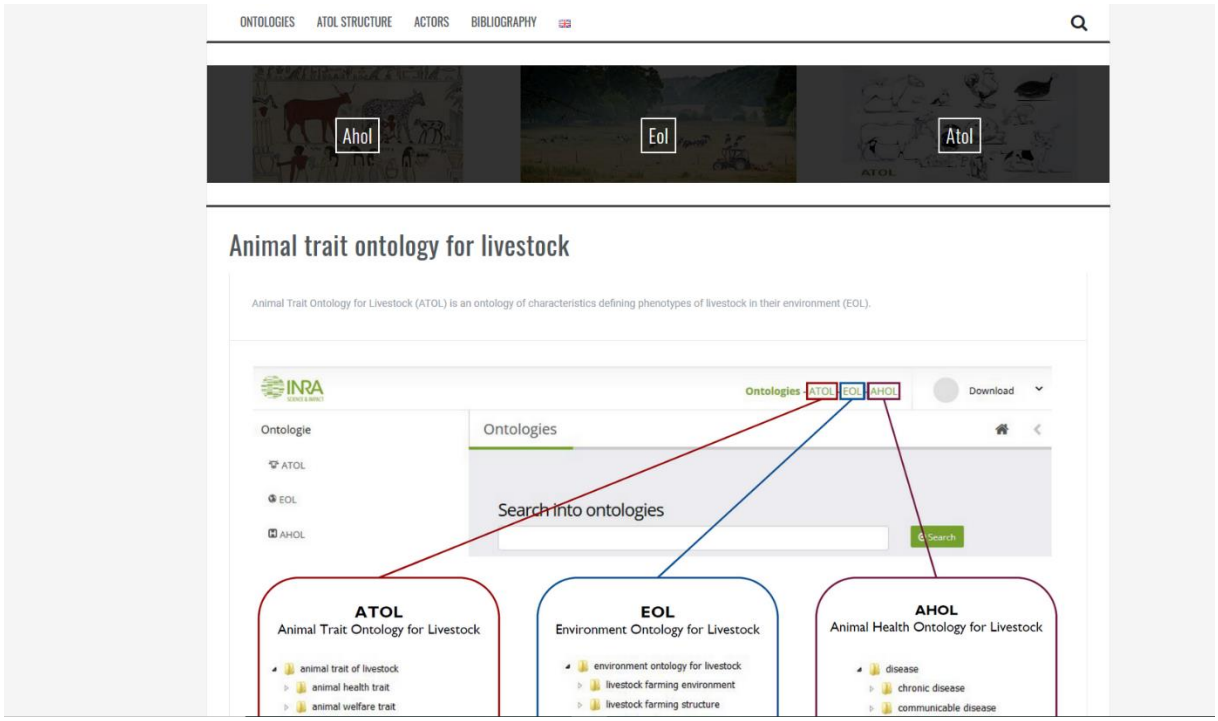
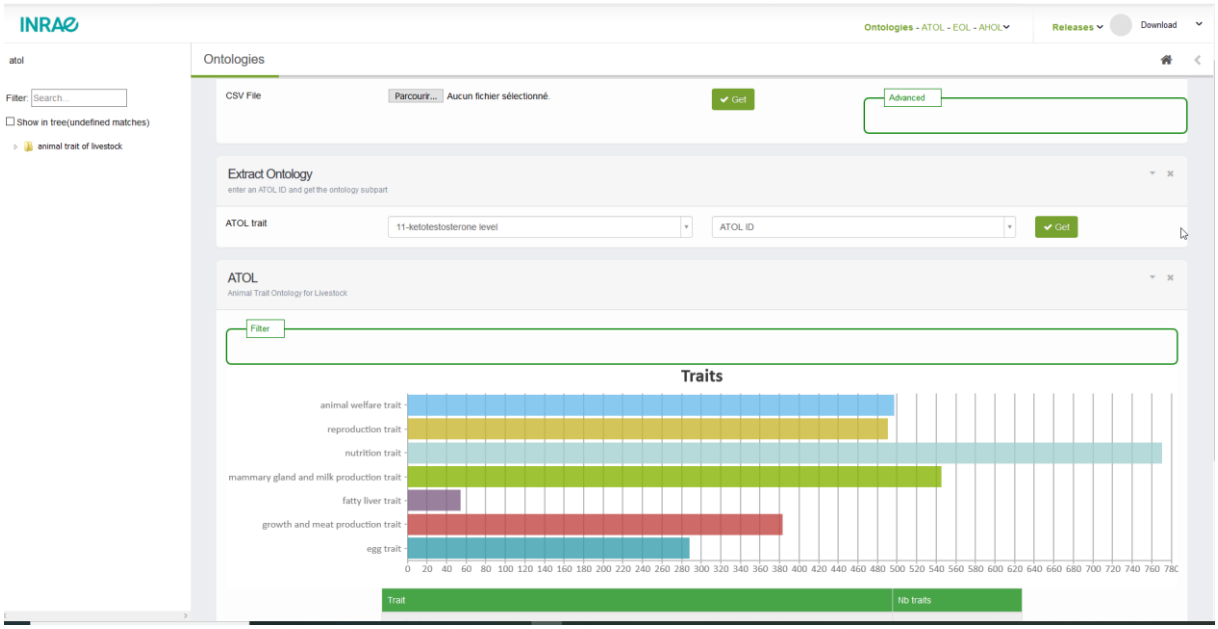
1.2 **New website:** https://www.atol-ontology.com/en/erter-2/





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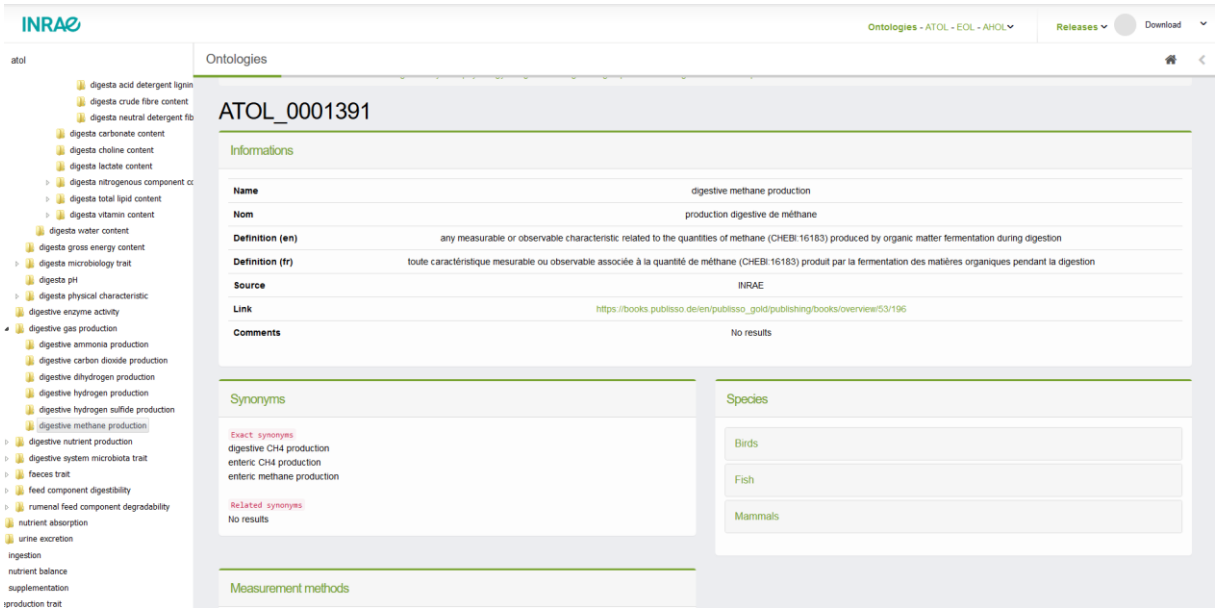
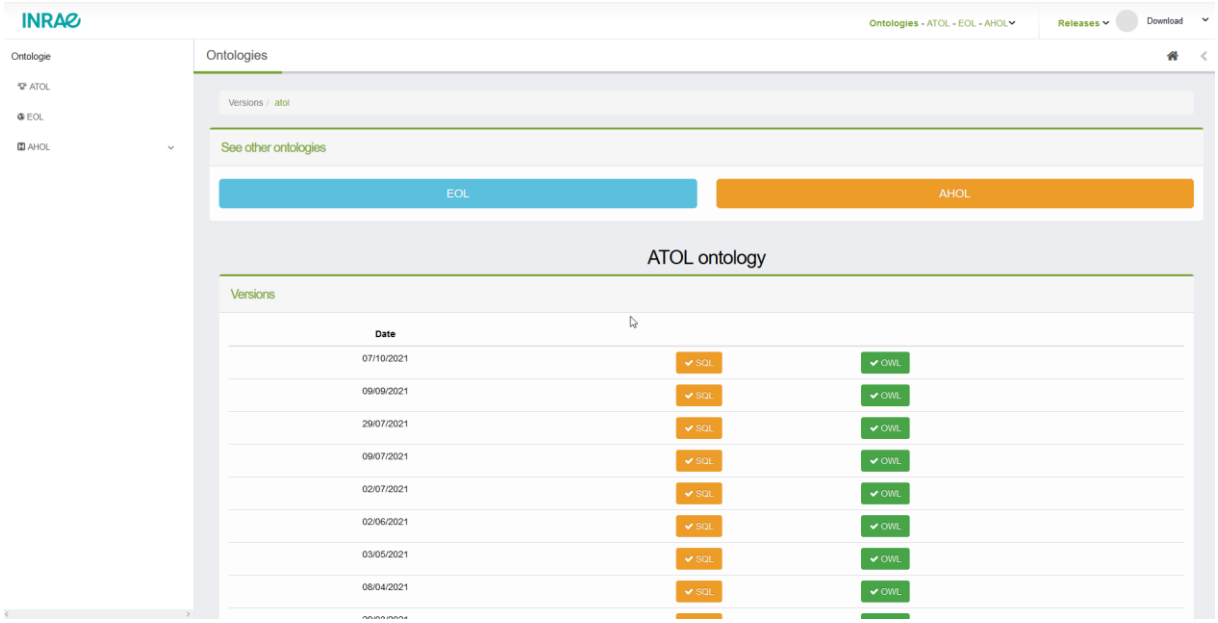


1.3 New features

- Translation of all the traits and definitions of ATOL in French.
- Possibility to extract all or part of the ontology as a CSV file

- Possibility to download the ontology in OWL or SQL form



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- We have added the possibility of filtering the traits according to the species to answer the problem of SmartCow, for instance, sorting only on cattle.
- There was a problem with the too long definitions of some traits. We have solved this problem.
- At the ontology search level, we can now search by typing the synonyms or the ATOL identifier. Before that, we could only search by typing the exact label.

2 Addition of new traits

2.1 Survey of WP1

After studying the results of the survey made by WP1 on animal databases (task 1.2) and related measurement techniques (task 1.3), we added some new traits.

	Milk Composition Parameters - details collected																	Weighing - frequency recorded							
Country	Milk Fat % (Yes/No)	Milk protein % (Yes/No)	Milk Lactose % (Yes/No)	Somatic Cell Count (Yes/No)	Total bacterial count (TBC) (Yes/No)	Free Fatty Acids (Yes/No)	Trichloro methane (Yes/No)	Iodine (Yes/No)	Ketosis (Yes/No)	Casein B (Yes/No)	Urea (Yes/No)	Milk Progesteron e (Yes/No)	Milk Mid-infrared spectroscopy (MIR) (Yes/No)	Other (If other please list)	Milk Compositio n Parameters database format (e.g.Excel/ Oracle)	Milk Compositio n Parameters database central/indi vidual storage	Name of individual responsible for sample bank	Dairy Cows	Beef Cows	Bulls	Steers	In-calf heifers	Calves	Weighin g database format (e.g.Exce l/Oracle)	Weighing database central/individual storage
Ireland	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Lactose &	Oracle	Centralised d	Anne Geogh	weekly	N/A	2-3 times	n/a	4-5 times	bi-monthl	Oracle	Centralised databas
Denmark	Yes	Yes	Yes	yes		No	No	No		No	Yes		No	N/A	Excell etc.	Centralised d	Jens Bech A	Daily	N/A	N/A	N/A	Every two	bi-monthl	Excell etc.	Centralised databas
The Netherlands	Yes	Yes	Yes	Yes	Proportio	Proportio	No	No	No	No	yes	No	Yes	N/A	Excel	Both		Only in experiment							
Spain	Yes	Yes	Yes	Yes	No	No	No	No	No	No	Yes	No			Excel	Individual pe	Marta Terré	Twice dail	N/A	N/A	N/A	N/A	birth and	Excel	Individual personal
France	Yes	Yes	Yes								Yes	Proportion of	Yes	BHB, acet	Oracle	Both	Sarah Barbe	daily to w	monthly	monthly	N/A	bi-month	bi-month	Oracle	Both
Scotland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Twice a ye	Twice a ye	Weekly	Twice a ye	Monthly	Excel; Mic	Centralised databas
Scotland	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Proportion of	Yes	N/A	SQL/Excel	Centralised d	Ian Archibal	3*daily	N/A	N/A	N/A	monthy	monthly	SQL/Excel	Centralised databas
Germany	Yes	Yes	Yes	Yes	No	No	No	No	No	No	Yes	No	No	N/A	Herde	Centralised d	Klaus-Dieter	daily	N/A	N/A	N/A	Every 2 m	weekly	Herde	Centralised databas
Germany	Yes	Yes	Yes	Yes	No	No	No	No	No	No	Yes	No	No	N/A	Excel	Individual pe	N/A	daily	N/A	N/A	N/A	Every 2 m	weekly	Excel	Individual personal
Germany	Yes	Yes	Yes	Yes	No	No	No	No	No	No	Yes	No	No	N/A	Excel	Individual pe	N/A	daily	N/A	N/A	N/A	Every 2 m	weekly	Excel	Individual personal
Germany	Yes	Yes	Yes	Yes	No	No	No	No	No	No	Yes	No	No	N/A	Excel	Individual pe	N/A	daily	N/A	N/A	N/A	Every 2 m	weekly	Excel	Individual personal
Ireland	No	no	No	No	No	No	No	No	No	No	No	No	No	N/A	Oracle	Both	Anne Geogh	n/a	every 3 w	N/A	every 3 w	Every 2 m	every 3 w	Oracle	Centralised databas
France	No	No	No	No	No	No	No	No	No	No	No	No	No	N/A	Oracle/Acce	Both	Marc Barbet	N/A	Weekly to	Weekly to	Weekly to	Weekly to	Weekly to	Oracle/acc	Both
France	Yes	Yes	Yes	Yes	Yes	Proportio	No	No	No	Proportio	Proportio	Proportion of	Proportion of	N/A	Oracle/Acce	Both	Carole Ciriè	every mill	N/A	N/A	N/A	Weekly to	Weekly to	Oracle/acc	Both
France	Yes	Yes	Yes	Yes	Yes	Proportio	No	No	No	Proportio	Proportio	Proportion of	Proportion of	N/A	Oracle/Acce	Both	Sylvie Rude	every mill	N/A	N/A	N/A	Weekly to	Weekly to	Oracle/acc	Both
Belgium	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	No	Yes	No	Yes	N/A	Excel via Mil	Centralised d	Virginie Dec	dependin	N/A	N/A	N/A	girth perimeter	bi-m	excel	Centralised databas
England	Yes	Yes	Yes	No	No	Yes	No	No	No	Yes	Yes	Proportion of	Yes	N/A	Excel	Both	Barney Jone	As require	N/A	N/A	As require	As require	As require	Excel	Both
Netherlands	Yes	Yes	Yes	Yes	No	No	No	No	No	No	Yes	No	No	N/A	Access			Twice dail	N/A	N/A	N/A	Weekly la	On reque	Access	Centralised databas

For instance, we identified missing traits as:

- Milk bacterial count (ATOL_0005263)
- Milk trichloromethane content (ATOL_0005286)

2.2 Survey of WP6

After studying the results of the survey made by WP6 on traits related to feed efficiency and its determinants and on traits related to rumen fermentation, we also added some new traits.

U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI
rumen parameter (mol/100 mol except for pH)							Specifics for lactating cows							
pH	acetate	propionate	butyrate	valerate	isovalerate	NH3	parity	DIM (day)	milk production	Fat %	protein %	lactose %	MUN %	somatic cells (n)

For example, we identified missing traits as:

- Parity (ATOL_0005322)
- Rumen small entodiniomorphida count (ATOL_0005333)
- Rumen dasytricha count (ATOL_0005335)

2.3 VOCAMP

After the VOCAMP organized by Agrimetrics, we also added some new traits and we added id from ATOL in the excel files from Agrimetrics.

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	Term provided by	<variable>_<unit>	<sampling method>	sampling frequency < /time>
Methane data	CH_4 EMISSIONS (g/day)	enteric CH4 production_g/d	piration Chamber, Greenfeed, SF6, sniffer, other	
SRUC	measured value_lmd-ppm	enteric CH4 production_ppm/m	laser gun	
SRUC	session_number			3/week
		CO2 production_g/d		
		O2 consumption_g/d		
		enteric H2 production_g/d		
rumen	type of sampling		canulated, tubing, other	
rumen	Acetate concentration (run	rumen fluid acetate concentration_mmol/L	canulated, tubing, other	
INRA	C2	rumen fluid acetate concentration_mmol/L	canulated, tubing, other	
rumen	Butyrate concentration (ru	rumen fluid n-butyrate concentration_mmol/L	canulated, tubing, other	
INRA	C4	rumen fluid n-butyrate concentration_mmol/L	canulated, tubing, other	
rumen	Propionate concentration (	rumen fluid propionate concentration_mmol/L	canulated, tubing, other	
INRA	C3	rumen fluid propionate concentration_mmol/L	canulated, tubing, other	
Paris	total VFA	rumen fluid total VFA concentration_mmol/L	canulated, tubing, other	
		rumen fluid iso-butyrate concentration_mmol/L	canulated, tubing, other	
		rumen fluid iso-valerate concentration_mmol/L	canulated, tubing, other	
		rumen fluid n-valerate concentration_mmol/L	canulated, tubing, other	
		rumen fluid caproate concentration_mmol/L	canulated, tubing, other	
rumen	RUMEN NH3 CONCENTRATI	rumen fluid NH3 concentration_mmol/L	canulated, tubing, other	
rumen	RUMEN pH	rumen fluid pH	ex vivo, in vivo	
rumen	RUMEN pH type (juice/bolus)		ex vivo, in vivo	

For example, we identified missing traits as:

- Dioxygen consumption (ATOL_0005315)
- Rumen iso-butyrate content (ATOL_0005317)

We also added id to Agrimetrics files:

Term	ATOL id	Finalised term	Idmethod	Methods
Lactose content, Lac Lactose percentage Lactose Lactose Lactose Lac Con	ATOL_0000619 (milk lactose concentration)	milk lactose concentration_gper100g milk lactose concentration_gperkg milk lactose concentration_gperL	HPLC enzymatic DifpH MIR	HPLC ISO 22662 | IDF 198 Enzymatic ISO 5765 | IDF 79AOAC 984.15 Differential pH-method ISO 26462 | IDF 214 Mid infrared(MIR) spectrometry ISO 9622 | IDF 141 AOAC 972.16
TP	ATOL_0001521 (milk protein concentration)	milk protein concentration_gper100g milk protein concentration_gperkg milk protein concentration_gperL	AmidoBlack MIR	Dye-binding (Amido Black) AOAC 975.17 Mid infrared(MIR) spectrometry ISO 9622 | IDF 141 AOAC 972.16
Protein prediction Prot con EIW Protein percentage Protein %	ATOL_0000617 (milk nitrogen concentration)	milk nitrogen concentration_gper100g milk nitrogen concentration_gperkg milk nitrogen concentration_gperL	Kjeldahl MIR	Titrimetry (Kjeldahl) ISO 8968 | IDF 20, parts 1 and 3 AOAC 991.20 AOAC 991.21AOAC 991.22 AOAC 991.23 Mid infrared(MIR) spectrometry ISO 9622 | IDF 141 AOAC 972.16
TB Fat Fat Fat prediction Fat con Fat Vet Fat percentage	ATOL_0001520 (milk fat concentration)	milk fat concentration_gper100g milk fat concentration_gperkg milk fat concentration_gperL	MIR RoseGottlieb Mojonnier Gerber Babcock Turbi	MIR ISO 9622 | IDF 141 AOAC 972.16 gravimetry (Röse-Gottlieb) ISO 1211 gravimetry (modified Mojonnier) AOAC 989-05 butyrometric Gerber ISO 19662 | IDF 238 AOAC 2018 Babcock AOAC 989.04 Automated turbidimetry I AOAC 969 Automated turbidimetry II AOAC 973.22
Lait Milk today session X YieldRaw Milk yield Milk yield Yield milk quantity mass KgMilkX (A or O)	ATOL_0001518 (milk yield)	milk yield_kgperday_ milk yield_kgpermilking milk yield_Lperday_ milk yield_Lpermilking milk yield_kgpersuckling milk yield_Lpersuckling	milkmeter weighing	ICARpercertificationpermilkmeters https:perperwww.icar.orgperindex.phppercertificationspericar-certifications-for-milk-meters-for-cow-sheep-goatspercertified-m
fat yield	ATOL_0000549 (milk fat yield)			
protein yield	ATOL_0000550 (milk protein yield) ATOL_0001750 (milk nitrogen yield)			
lactose yield	ATOL_0000618 (milk lactose yield)			
cellules cells SCC SCC cell count SCC	ATOL_0000991 (milk somatic cell count)	milk somatic cell count_X1000permL	Micro Fluo	Direct microscopic somatic cell countISO 13366-1 | IDF 148-1 Fluoro-opto-electronic methods ISO 13366-2 | IDF 148-2AOAC 978.26

2.4 MARGAU database

We extracted phenotypic traits measured in cattle in France (MARGAU dictionary) and we identified traits absent from ontologies (ATOL and EOL). Many traits concern animal morphology, heat signs and have not yet been added to the ontology (for example, morphology parameters in ontology are measured on carcasses and not on live animals).

2.5 List of traits added to ATOL

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ATOL_0005298	faeces pH	ATOL_0005332	digesta entodiniomorphida count	ATOL_0005388	feed apparent digestible chlorine
ATOL_0005299	rumenal feed organic matter degradability	ATOL_0005333	digesta small entodiniomorphida count	ATOL_0005389	feed apparent digestible cobalt
ATOL_0005300	faeces volatile fatty acid content	ATOL_0005334	digesta large entodiniomorphida count	ATOL_0005390	feed apparent digestible copper
ATOL_0005301	digesta volatile fatty acid content	ATOL_0005335	digesta dasytricha count	ATOL_0005391	feed apparent digestible magnesium
ATOL_0005302	digesta microbiology trait	ATOL_0005336	digesta holotricha count	ATOL_0005392	feed apparent digestible potassium
ATOL_0005303	digesta bacteria count	ATOL_0005337	body width	ATOL_0005393	feed apparent digestible sodium
ATOL_0005304	digesta protozoa count	ATOL_0005338	nitrogen balance	ATOL_0005394	feed apparent digestible sulfur
ATOL_0005305	digesta fungi count	ATOL_0005348	blood cortisol concentration	ATOL_0005395	dry matter intake
ATOL_0005306	digesta virus count	ATOL_0005349	saliva cortisol concentration	ATOL_0005396	nutrient requirement
ATOL_0005307	digesta archea count	ATOL_0005350	urine cortisol concentration	ATOL_0005397	digesta chromium content
ATOL_0005308	faeces microbiology trait	ATOL_0005351	faeces cortisol concentration	ATOL_0005398	digesta molybdenum content
ATOL_0005309	faeces bacteria count	ATOL_0005369	potassium requirement	ATOL_0005399	digesta sulfur content
ATOL_0005310	faeces protozoa count	ATOL_0005370	sodium requirement	ATOL_0005400	digesta sodium content
ATOL_0005311	faeces fungi count	ATOL_0005371	sulfur requirement	ATOL_0005401	chromium absorption
ATOL_0005312	faeces virus count	ATOL_0005372	chromium requirement	ATOL_0005402	molybdenum absorption
ATOL_0005313	faeces archea count	ATOL_0005373	molybdenum requirement	ATOL_0005403	sodium absorption
ATOL_0005314	digestive dihydrogen production	ATOL_0005374	faeces sulfur content	ATOL_0005404	sulfur absorption
ATOL_0005315	dioxygen consumption	ATOL_0005375	faeces chromium content	ATOL_0005405	urine chromium content
ATOL_0005316	digesta minor volatile fatty acid content	ATOL_0005376	faeces molybdenum content	ATOL_0005406	urine molybdenum content
ATOL_0005317	digesta iso-butyrate content	ATOL_0005377	faeces sodium content	ATOL_0005407	urine potassium content
ATOL_0005318	digesta iso-valerate content	ATOL_0005378	chlorine requirement	ATOL_0005408	urine sodium content
ATOL_0005319	digesta 2-methylbutyrate content	ATOL_0005379	digesta carbohydrate content	ATOL_0005409	urine sulfur content
ATOL_0005320	days of pregnancy	ATOL_0005380	faeces carbohydrate content	ATOL_0005410	mineral intake
ATOL_0005321	oestrus behaviour	ATOL_0005381	feed carbohydrate apparent digestibility	ATOL_0005411	calcium intake
ATOL_0005322	parity	ATOL_0005382	carbohydrate absorption	ATOL_0005412	chlorine intake
ATOL_0005323	daily milk yield	ATOL_0005383	milk chromium concentration	ATOL_0005413	chromium intake
ATOL_0005324	milking milk yield	ATOL_0005384	milk cobalt concentration	ATOL_0005414	cobalt intake
ATOL_0005329	digesta C4:0 fatty acid content	ATOL_0005385	milk molybdenum concentration	ATOL_0005415	copper intake
ATOL_0005330	digesta C5:0 fatty acid conten	ATOL_0005386	milk sulfur concentration	ATOL_0005416	iodine intake
ATOL_0005331	digesta ciliate count	ATOL_0005387	feed apparent digestible calcium	ATOL_0005417	iron intake
ATOL_0005418	magnesium intake			ATOL_0005490	digestive C2:0 fatty acid production
ATOL_0005419	manganese intake			ATOL_0005491	digestive C3:0 fatty acid production
ATOL_0005420	molybdenum intake			ATOL_0005492	digestive C4:0 fatty acid production
ATOL_0005421	phosphorus intake			ATOL_0005493	digestive C5:0 fatty acid production
ATOL_0005422	potassium intake			ATOL_0005494	digestive C6:0 fatty acid production
ATOL_0005423	selenium intake			ATOL_0005495	non structural carbohydrate requireme
ATOL_0005424	sodium intake			ATOL_0005496	structural carbohydrate requirement
ATOL_0005425	sulfur intake			ATOL_0005497	pectin requirement
ATOL_0005426	zinc intake			ATOL_0005498	starch requirement
ATOL_0005427	urine allantoin content			ATOL_0005499	sugar requirement
ATOL_0005428	protein intake			ATOL_0005500	acid detergent fibre requirement
ATOL_0005429	soluble nitrogen intake			ATOL_0005501	acid detergent lignin requirement
ATOL_0005430	free amino acid intake			ATOL_0005502	crude fibre requirement
ATOL_0005431	protein bound amino acid intake			ATOL_0005503	neutral detergent fibre requirement
ATOL_0005434	apparent metabolizable energy corrected for zero nitrogen correction			ATOL_0005508	average daily feed intake
ATOL_0005435	ileal digestible protein requirement			ATOL_0005509	average daily water intake
ATOL_0005436	urine urea content			ATOL_0005585	milk intake
ATOL_0005437	urine uric acid content			ATOL_0005586	suckling bouts
ATOL_0005438	gross energy intake				
ATOL_0005439	digestible energy intake				
ATOL_0005441	dry matter efficiency				
ATOL_0005442	carbohydrate requirement				
ATOL_0005443	faeces iso-butyrate content				
ATOL_0005444	faeces iso-valérate content				
ATOL_0005445	iso-butyrate absorption				
ATOL_0005446	iso-valerate absorption				
ATOL_0005447	digesta saturated fatty acid content				
ATOL_0005448	digesta unsaturated fatty acid content				
ATOL_0005488	digestive iso-butyrate production				
ATOL_0005489	digestive iso-valerate production				

2.6 List of traits added to EOL

- A branch concerning sensors (experts from INRAE did not agree with this addition, but we believe that this branch of ontology on sensors is essential in the context of SmartCow).

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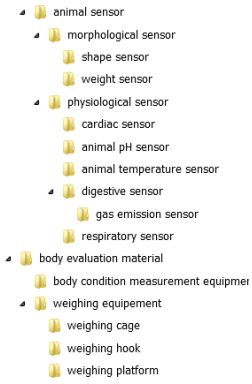
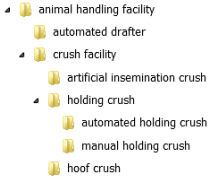
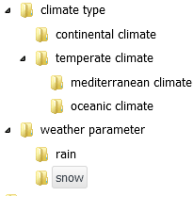


- A branch describing the « animal handling facility »



- A branch describing “milking parlour”

- A branch describing “climate and temperatures”



3 Links with the book of methods

We added links between ATOL and the book “Methods in cattle physiology and behaviour research” written by Kuhla et al (Task 3.1). An example:

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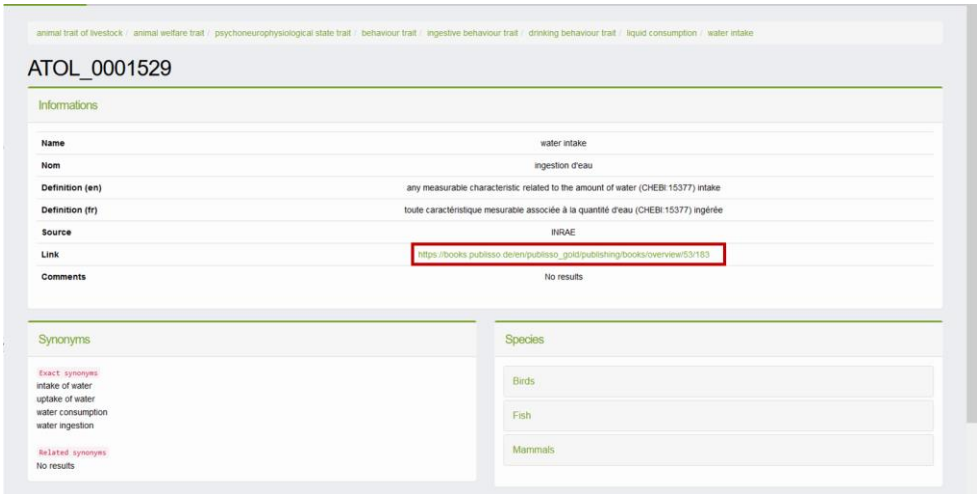

4 Organization of a training course "Ontologies in SmartCow" in December 15-16th 2020

The objectives of the training were to:

- Understand the usefulness of the ontologies to annotate experimental dataset
- Use these ontologies and reference them in publications
- Use the ontologies adapted to SmartCow

The target participants were scientists, technicians, bachelor, master or PhD students.
The program of the training course was as following:
On the first day:

- Introduction of the course
- What is an ontology?
    1. Definition
    2. History
    3. Examples of use of ontologies (application of ontologies)
    4. Exercises:
        How to build a small ontology?
        How to use ontologies to annotate data with the open-source editor Protégé?
        How to use ontologies to retrieve data with the open-source editor Protégé?
- The ontology engineering lifecycle and its best practices

On the second day:

- Presentation of French ontologies from INRAE
    a. ATOL ontology
    b. EOL ontology
    c. AHOL ontology
- Example of application/use of an ontology AHOL for professional use
- Text based annotation with ontologies

The speakers were O. Dameron from University of Rennes 1, M. Solanki from Agrimetrics (Task 3.2), J. Bugeon, M.C. Salaün, C. Nédellec and C. Hurtaud from INRAE. We have 40 registered people and between 17 and 24 participating in the three half-days. Because of CoViD 19, we have modified the training type: from face-to-face training to a webinar. At the end, it was a positive point: more participants from many European countries participated to the webinar with many interactions.

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5 Conclusion

Finally, we added 138 new traits in ATOL and more than 40 new traits in EOL. These results represent a significant improvement of ATOL and EOL ontologies, but could have been better if the SmartCow researchers had collaborated more with us and verified the presence of all the traits observed in their research during SmartCow project. An idea could be a translation in German, Dutch, Spanish… to have a better use by experimental farm technicians and then to have a transmission of annotated data to researchers.
The use of ontologies remains complicated in our research field even if everyone is aware of the importance of data interoperability linked to proper identification of data.
The training was an essential step for data management. We think that it would have been useful at the start of SmartCow for anyone likely to generate databases.

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