TECH CARE
Integrating innovative TECHnologies along the value Chain to improve small ruminant welfARE management

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State-of-the-art in **precision livestock farming technologies** for monitoring **small ruminant welfare**

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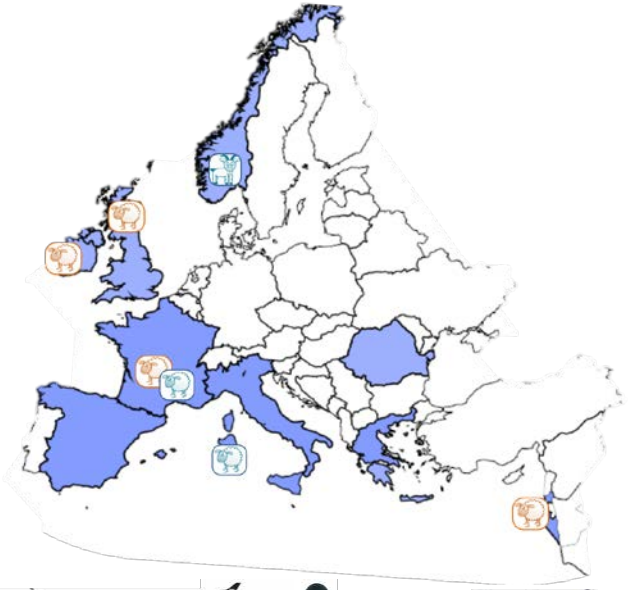
Objectives

- To **collate knowledge** on the use of PLF technologies and digital tools (**Tech**) on small ruminant (**SR**) farming systems, at different points of the value chains
- To **get insights** in their uses for addressing animal welfare issues (**Care**) in a large spectrum of situations

Methodology

- An **extensive literature review** (**SciRev**) was carried out with previously identified relevant **keywords**, shared among partners
- All **TechCare partners** contributed to the **SciRev** using several search **engines**. They also provided a **list of commercially available technologies** with potential for animal welfare monitoring (sheep, goat and cattle) **in their respective countries**



Methodology

- **Abstracts** were **downloaded** using the **Web of Science**, for screening and interpretation
- **Records** entailing both aspects (**TC** papers) were **retained** and **classified** according to <u>type of technology</u>, targeted <u>welfare indicators</u>, <u>animal species</u>, <u>production type</u> and <u>farming system</u>

Methodology

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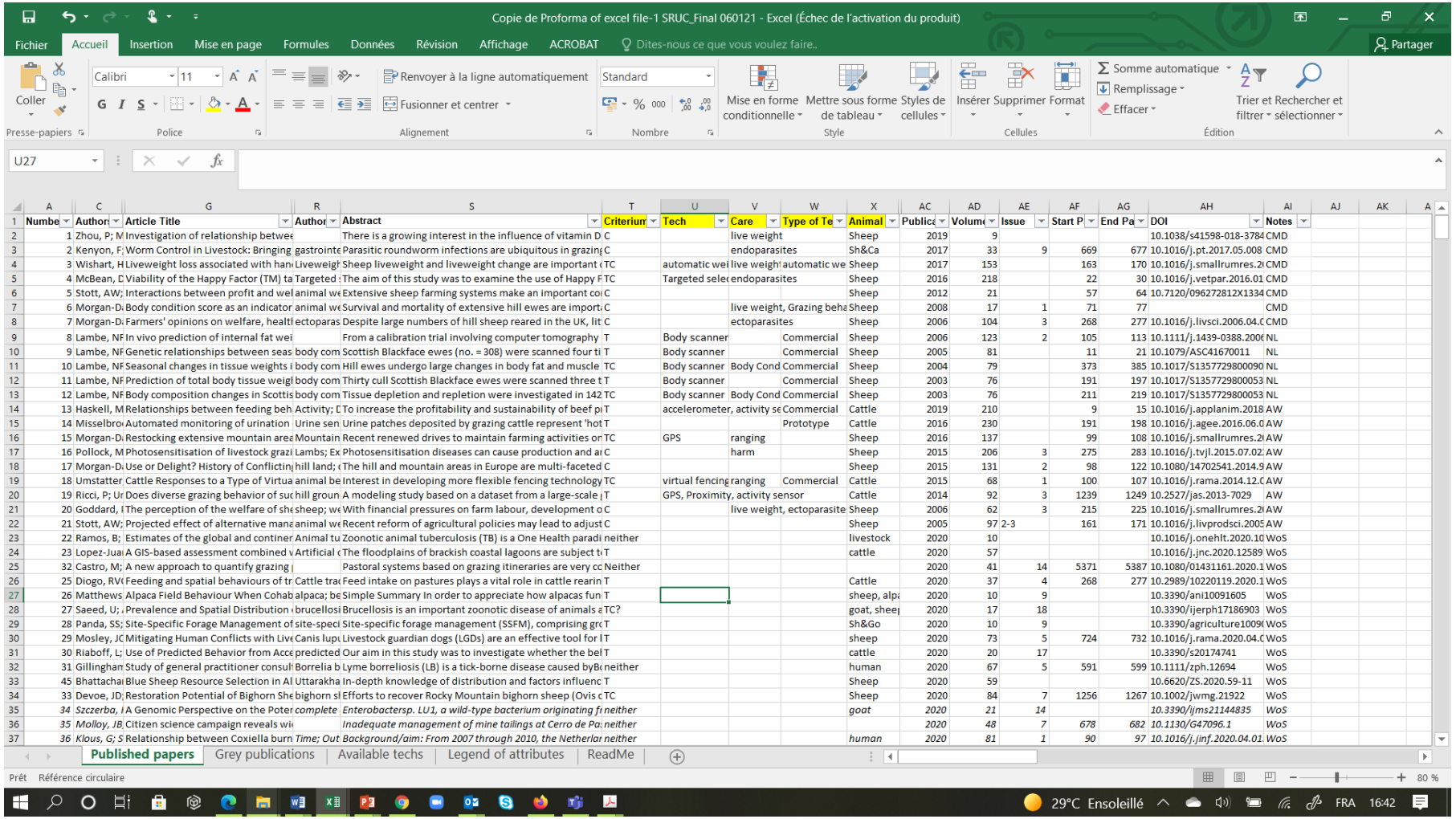
- **Outcome** =>

1) > **1000 abstracts** were collected

2) A **first reference** Excel **database** was built (compiling 660 relevant records)

3) A final **Core Excel database** was retained (**368 TC papers**)



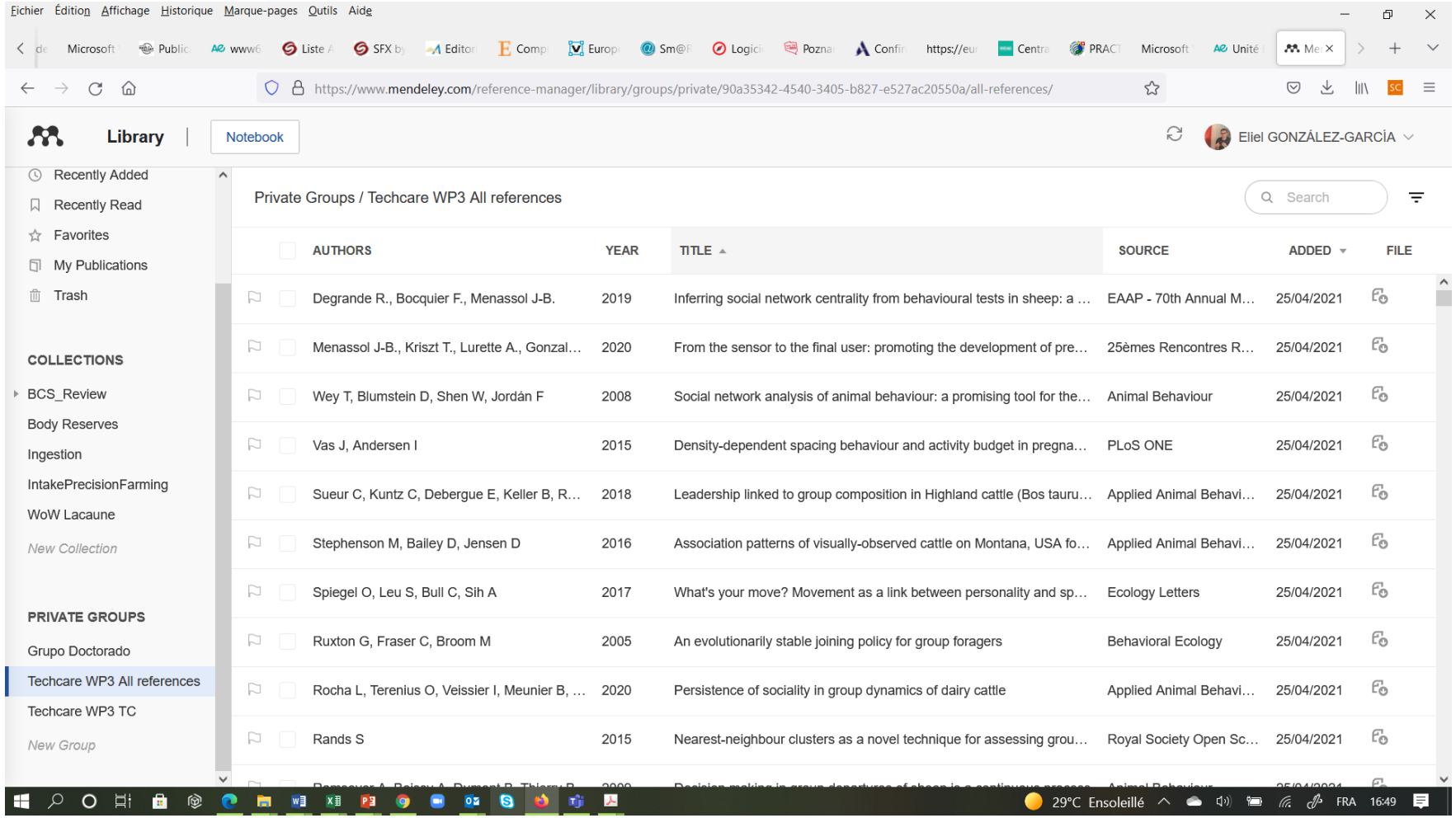
Numbe	Author	Article Title	Author	Abstract	Criterium	Tech	Care	Type of Te	Animal	Publica	Volume	Issue	Start P	End Pa	DOI	Notes
1	Zhou, P; M	Investigation of relationship betwee		There is a growing interest in the influence of vitamin D	C		live weight		Sheep	2019	9				10.1038/s41598-018-3784	CMD
2	Kenyon, F;	Worm Control in Livestock: Bringing	gastrointe	Parasitic roundworm infections are ubiquitous in grazing	C		endoparasites		Sh&Ca	2017	33	9	669	677	10.1016/j.pt.2017.05.008	CMD
3	Wishart, H	Liveweight loss associated with han	Liveweigh	Sheep liveweight and liveweight change are important	TC	automatic wei	live weigh	automatic we	Sheep	2017	153		163	170	10.1016/j.smallrumres.2	CMD
4	McBean, D	Viability of the Happy Factor (TM) ta	Targeted	The aim of this study was to examine the use of Happy F	TC	Targeted selec	endoparasites		Sheep	2016	218		22	30	10.1016/j.vetpar.2016.01	CMD
5	Stott, AW;	Interactions between profit and wel	animal we	Extensive sheep farming systems make an important coi	C				Sheep	2012	21		57	64	10.7120/09627812X1334	CMD
6	Morgan-D	Body condition score as an indicator	animal we	Survival and mortality of extensive hill ewes are importa	C		live weight, Grazing beha		Sheep	2008	17	1	71	77		CMD
7	Morgan-D	Farmers' opinions on welfare, healt	ectoparas	Despite large numbers of hill sheep reared in the UK, lit	C		ectoparasites		Sheep	2006	104	3	268	277	10.1016/j.livsci.2006.04.0	CMD
8	Lambe, NF	In vivo prediction of internal fat wei		From a calibration trial involving computer tomography	T	Body scanner		Commercial	Sheep	2006	123	2	105	113	10.1111/j.1439-0388.200	NL
9	Lambe, NF	Genetic relationships between seas	body com	Scottish Blackface ewes (no. = 308) were scanned four ti	T	Body scanner		Commercial	Sheep	2005	81		11	21	10.1079/ASC41670011	NL
10	Lambe, NF	Seasonal changes in tissue weights i	body com	Hill ewes undergo large changes in body fat and muscle	TC	Body scanner	Body Cond	Commercial	Sheep	2004	79		373	385	10.1017/S1357729800090	NL
11	Lambe, NF	Prediction of total body tissue weigl	body com	Thirty cull Scottish Blackface ewes were scanned three t	T	Body scanner		Commercial	Sheep	2003	76		191	197	10.1017/S1357729800053	NL
12	Lambe, NF	Body composition changes in Scottis	body com	Tissue depletion and repletion were investigated in 142	TC	Body scanner	Body Cond	Commercial	Sheep	2003	76		211	219	10.1017/S1357729800053	NL
13	Haskell, M	Relationships between feeding beh	Activity; D	To increase the profitability and sustainability of beef pr	T	accelerometer, activity se		Commercial	Cattle	2019	210		9	15	10.1016/j.applanim.2018	AW
14	Misselbro	Automated monitoring of urination	Urine sen	Urine patches deposited by grazing cattle represent 'hot	T			Prototype	Cattle	2016	230		191	198	10.1016/j.agee.2016.06.0	AW
15	Morgan-D	Restocking extensive mountain area	Mountain	Recent renewed drives to maintain farming activities on	TC	GPS	ranging		Sheep	2016	137		99	108	10.1016/j.smallrumres.2	AW
16	Pollock, M	Photosensitisation of livestock grazi	Lambs; Ex	Photosensitisation diseases can cause production and ar	C		harm		Sheep	2015	206	3	275	283	10.1016/j.tvjl.2015.07.02	AW
17	Morgan-D	Use or Delight? History of Conflictin	hill land; (	The hill and mountain areas in Europe are multi-faceted	C				Sheep	2015	131	2	98	122	10.1080/14702541.2014.9	AW
18	Umstatter	Cattle Responses to a Type of Virtua	animal be	Interest in developing more flexible fencing technology	TC	virtual fencing	ranging	Commercial	Cattle	2015	68	1	100	107	10.1016/j.rama.2014.12.0	AW
19	Ricci, P; Ur	Does diverse grazing behavior of suc	hill groun	A modeling study based on a dataset from a large-scale	T	GPS, Proximity, activity sensor			Cattle	2014	92	3	1239	1249	10.2527/jas.2013-7029	AW
20	Goddard, I	The perception of the welfare of she	sheep; we	With financial pressures on farm labour, development o	C		live weight, ectoparasite		Sheep	2006	62	3	215	225	10.1016/j.smallrumres.2	AW
21	Stott, AW;	Projected effect of alternative mana	animal we	Recent reform of agricultural policies may lead to adjust	C				Sheep	2005	97	2-3	161	171	10.1016/j.livprodsci.2005	AW
22	Ramos, B;	Estimates of the global and continer	Animal tu	Zoonotic animal tuberculosis (TB) is a One Health paradi	neither				livestock	2020	10				10.1016/j.onehlt.2020.10	WoS
23	Lopez-Jua	A GIS-based assessment combined	Artificial (	The floodplains of brackish coastal lagoons are subject t	T				cattle	2020	57				10.1016/j.jnc.2020.12589	WoS
24	Castro, M;	A new approach to quantify grazing		Pastoral systems based on grazing itineraries are very co	Neither					2020	41	14	5371	5387	10.1080/01431161.2020.1	WoS
25	Diogo, RV	Feeding and spatial behaviours of tr	Cattle tra	Feed intake on pastures plays a vital role in cattle rearin	T				Cattle	2020	37	4	268	277	10.2989/10220119.2020.1	WoS
26	Matthews	Alpaca Field Behaviour When Cohab	alpaca; be	Simple Summary In order to appreciate how alpacas fun	T				sheep, alpa	2020	10	9			10.3390/ani10091605	WoS
27	Saeed, U;	Prevalence and Spatial Distribution	brucellosi	Brucellosis is an important zoonotic disease of animals a	TC?				goat, shee	2020	17	18			10.3390/ijerph17186903	WoS
28	Panda, SS;	Site-Specific Forage Management of	site-speci	Site-specific forage management (SSFM), comprising gro	T				Sh&Go	2020	10	9			10.3390/agriculture1009	WoS
29	Mosley, JC	Mitigating Human Conflicts with Live	Canis lupu	Livestock guardian dogs (LGDs) are an effective tool for l	T				sheep	2020	73	5	724	732	10.1016/j.rama.2020.04.0	WoS
30	Riaboff, L;	Use of Predicted Behavior from Acce	predicted	Our aim in this study was to investigate whether the bel	T				cattle	2020	20	17			10.3390/s20174741	WoS
31	Gillingham	Study of general practitioner consul	Borrelia b	Lyme borreliosis (LB) is a tick-borne disease caused by B	neither				human	2020	67	5	591	599	10.1111/zph.12694	WoS
32	Bhattacha	Blue Sheep Resource Selection in Al	Uttarakha	In-depth knowledge of distribution and factors influenc	T				Sheep	2020	59				10.6620/ZS.2020.59-11	WoS
33	Devoe, JD	Restoration Potential of Bighorn She	bighorn sl	Efforts to recover Rocky Mountain bighorn sheep (Ovis c	TC				Sheep	2020	84	7	1256	1267	10.1002/jwmg.21922	WoS
34	Szczerba, I	A Genomic Perspective on the Poter	complete	Enterobactersp. LU1, a wild-type bacterium originating fi	neither				goat	2020	21	14			10.3390/ijms21144835	WoS
35	Molloy, JB	Citizen science campaign reveals wi		Inadequate management of mine tailings at Cerro de Pa	neither					2020	48	7	678	682	10.1130/G47096.1	WoS
36	Klous, G; S	Relationship between Coxiella burn	Time; Out	Background/aim: From 2007 through 2010, the Netherlar	neither				human	2020	81	1	90	97	10.1016/j.jinf.2020.04.01	WoS

Methodology

- **For which** =>

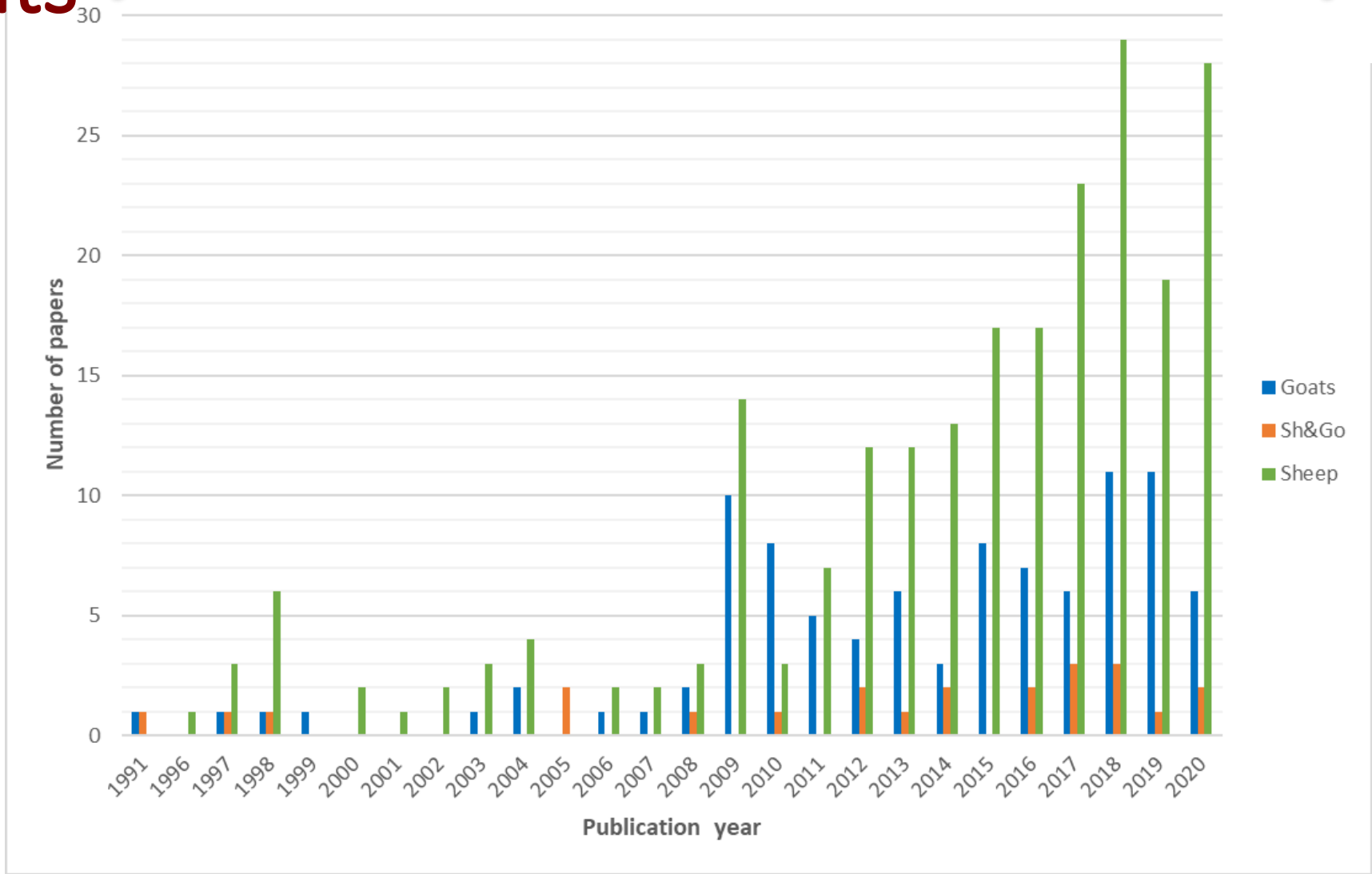
- Full papers were uploaded in a **Mendeley Platform built for it**

- **Analyses** and **interpretations** were made after **extensive readings**



Results

Progress in the number of articles



Results

- ✓ Image analysis (video camera) is the **most quoted technology**. GPS (used basically for animal geo-referencing), and accelerometry are second and third in the rank, followed by heart rate and ultrasonography
- ✓ **Most frequent welfare issues** are undernutrition and malnutrition (monitored by behavioural sensors); then, general or chronic fear, issues related to animal transport, and heat stress
- ✓ The **range** of available technologies is **narrower** for good housing, for which environmental sensors are often coupled with body thermal condition/emissions
- ✓ A **narrow portfolio of technologies** is available for detecting mastitis, lameness and endoparasites. However, this is counterbalanced by the **higher levels of sensitivity** of the devices used.

Results

Example 1

Welfare issue	Indicators	Technologies
Undernutrition (insufficient amount of feed supplied)	BCS	Computer tomography Dimension imaging ……
	Behaviour (work to access feed, water)	**Accelerometers**
	Metabolic disease	Radio-frequency Rumen sensor ……..
	Milk fatty acid composition	In-line milk composition
	Milk protein	FTIR …….
	Milk urea	Biochemical analyser …….
	Milk yield	Electronic milk-meters
	Queuing at feeders	GPS ……..
	Weight loss	Automatic scale WoW

Results

Example 2

Welfare issue	Indicators	Technologies
Heat stress	Body temperature	Infrared thermography Body thermometer ……
	Competition for shade	GPS + proximity sensor GNSS ……..
	Inactivity	Accelerometer GPS ……..
	Increased respiration rate	Infrared thermography Respiration rate monitor ……
	Infertility (various)	Ultrasonography Alpha-Detector …..
	Reduced feed or **water intake**	**Accelerometer** GPS ……
	Reduced milk yield	Electronic milk-meter …..

Results

Precision Livestock Farming 15, 256-265

A PLF approach for allocating supplementary feed to pregnant ewes in an extensive hill sheep system

H. Wishart, C. Morgan-Davies and A. Waterhouse
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Facilitated by an **automatic drafting weigh crate** with electronic identification (**EID**) **reader**, thereby **allowing** individual ewe EID ear tags to be read and **sheep sorted automatically**.

Results

Computers and Electronics in Agriculture 138 (2017) 137–147

Contents lists available at ScienceDirect

Computers and Electronics in Agriculture

journal homepage: www.elsevier.com/locate/compag

Original papers

Automatic detection of suckling events in lamb through accelerometer data classification

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Fig. 2. The sensor device ready for deployment.

Device easily attachable to the lamb that would **reliably detect suckling episodes** and **report them wirelessly to a data collection point**.
Suckling is characterized by a **rather simple and distinguished acceleration signature** which makes it possible to detect the. An algorithm is proposed.

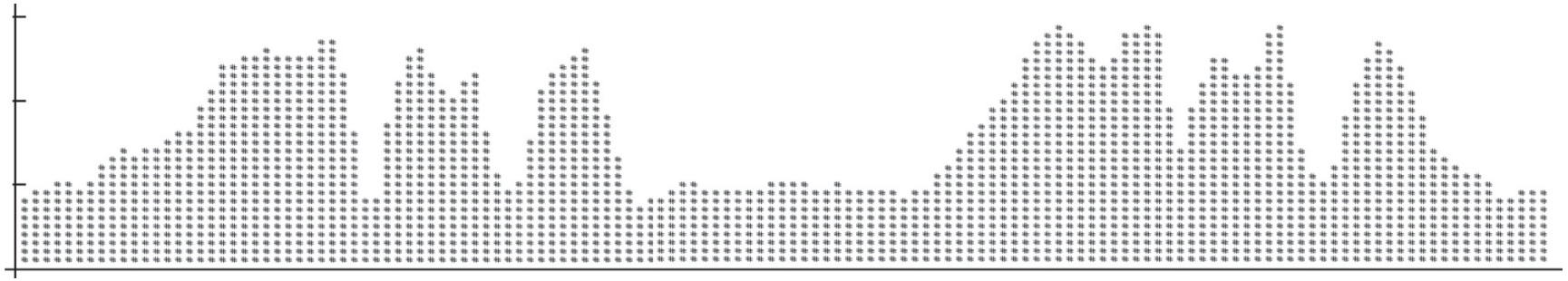

Fig. 3. A lamb with the sensor device attached.

Conclusions

- ✓ **Using PLF** technologies and **digital tools** for monitoring and/or improving **AWE issues in SR** still in its infancy
- ✓ **For a large proportion of works** available in the literature, the AWE is not the priority
- ✓ However, a **clear potential for developing promising solutions** are identified for a large spectrum of situations **(combining Tech and Care)** and conditions
- ✓ Developing good and affordable **Early Warning Systems** must be the highest priority i.e. based on <u>different interoperating sensors</u> to effectively monitor welfare issues with different sources of information
- ✓ **Further research is warranted** to effectively match and test **Tech** and prioritised **Care** issues (among main ambitions of **TechCare** project).

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Abstract ID: **36263**

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Thank you for your attention!

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