USE OF ELECTRONIC IDENTIFICATION AND NEW TECHNOLOGIES ON EUROPEAN SHEEP FARMS

Gautier Jean-Marc[1], Morgan Davies Claire [1,2], Keady Tim W. J.[1,3], Bohan Alan [1,3], Lagriffoul Gilles[1], Ocak Sezen[4], Beltrán De Heredia Ignacia[5], Carta Antonello[6], Gavojdian Dinu[7], Rivallant Pauline[8], Francois Dominique[8]

[1]Institut de l'Elevage, Toulouse, France

[2]Scotland's Rural College (SRUC), Hill & Mountain Research Centre, Kirkton, Scotland, UK

[3]TEAGASC, Animal and Grassland Research and Innovation Centre, Athenry, Ireland

[4]TOGEN, Gaziantep, Turkey

[5]Neiker Tecnalia, Vitoria-Gasteiz, Spain

[6]AGRIS-Sardegna - Research Unit: Genetics and Biotechnology, Olmedo, Italy

[7]Banat's University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania", Timisoara, Romania

[8]INRA Occitanie-UMR GenPhySE, Toulouse, France

jean-marc.gautier@idele.fr, claire.morgan-davies@sruc.ac.uk, Tim.Keady@teagasc.ie, alan.bohan@teagasc.ie, gilles.lagriffoul@inra.fr, sezenocak1@gmail.com, ibeltran@neiker.eus, acarta@agrisricerca.it, gavojdian_dinu@animalsci-tm.ro, pauline.rivallant@etudiants.purpan.fr, dominique.francois@inra.fr

ABSTRACT

Electronic identification of small ruminants is mandatory since 2010 in Europe. Associated with a context of widespread use of "connected" tools, the availability of solutions using new technologies to manage livestock and decrease workload, should become relevant for farmers. A survey was undertaken in the seven main EU sheep countries (France, Ireland, UK, Spain, Italy, Romania and Hungary) and Turkey (under two European projects: SheepNet and iSAGE) to determine the use of electronic identification (EID) associated technologies and barriers to the uptake of precision livestock farming (PLF) technologies. A total of 1,148 responses were collected and analysed. Sixty four percent of the respondents believe that EID and PLF are an opportunity for better flock/animal management but only 34% of them use it. This survey also highlighted the type of technologies used and the main motivations and barriers for PLF uptake. To date, in the sheep sector, new technologies are mainly related to drafting, animal location, concentrate feed management and performance testing. This is the first study undertaken at EU level targeting the sheep sector. It identifies the main gaps to tackle and proposes some pathways in order to foster the use of new PLF technologies.

Keywords*:* Sheep, precision livestock farming, Electronic Identification, technologies, Europe*.*

1. INTRODUCTION

Precision Livestock Farming (PLF) can be defined as "the 'sensor-based' individual animal approach" (Halachmi et al., 2019), using the principles and technology of process engineering. Precision Livestock Farming has been widely adopted in the management of high-value animals e.g. dairy cattle (Carpentier et al., 2018). Many commercial companies have already developed, or are in the

process of developing, PLF applications for intensive farming such as pig (Banhazi et al. 2007), and poultry (Fernandez et al., 2018) production. However, PLF has not yet been applied to animal species considered to have a lower economic value or interest, as is the case in small ruminants such sheep and goats, or in extensive management systems. This is despite the production efficiencies and welfare advantages that may be achieved by applying PLF in these systems.

Sheep systems are vital for the rural economy and society, especially where the climatic and topographical conditions are challenging. However, despite their crucial role for the economy, rural fabric, biodiversity and cultural heritage, the increasing lack of farm labour in these systems is a major issue (Morgan-Davies et al., 2017). Farmers are confronted with increasing pressures to care for a larger number of animals per labour unit to have an economically viable business. This will become more acute in future years. Precision Livestock Farming technologies could alleviate some of the issues e.g. enable remote tracking or behaviour monitoring. Since 2010, all sheep in EU members states are now equipped with EID tags or bolus. The legislation should further pave the way for use of PLF technologies in livestock management. There has been recent research undertaken in sheep systems to enable PLF be included in sheep systems e.g. weight crate for feeding management (Morgan-Davies et al., 2018). However, despite these developments, PLF technology uptake is a major issue (Pierpaoli et al., 2013). In sheep systems, barriers for adoption have been reported (Ruiz-Garcia & Lunedai, 2011), but it is still unclear as to how wide the issue is, and what are the motivations behind farmers' use (or lack of use) of PLF technologies. This paper presents the results of a survey undertaken in the main EU sheep producing countries on sheep farmers' use of PLF technologies and their motivations and barriers for using such technologies.

2. METHODOLOGY

Three surveys, based on a pool of common questions, were undertaken to determine the use of the different technologic devices on sheep farms. The first survey was undertaken in the UK by SRUC (Scotland's RUral College) in 2015 and 2016. The second survey was undertaken in early 2018 in France by IDELE through the EU H2020 iSAGE project (https://www.isage.eu). The third survey was undertaken across the seven main EU sheep countries (France, Ireland, UK, Spain, Italy, Romania and Hungary) and Turkey in 2018 through the EU H2020 SheepNet project (www.sheepnet.network).

The SRUC survey was conducted via farmers' interviews during British livestock events. There were 11 questions relating to their farming activities and to their use of PLF tools. Fifty-four answers were collected, of which 26 from the sheep sector.

The iSAGE survey was realised with an online internet questionnaire, on a voluntary basis. Sheep and goat sectors were targeted. There were 29 questions dealing with the general description of the farm, the use of electronic identification (EID reader type, reader trademark, EID connected tool, flock management software, valorisation), opinion on EID (opportunity, constraints and limitations), information about the farmer (age, sex, education level, member to a breeding society). The internet link to the questionnaire was sent to the farmers through different networks: farmer's trade union, levy board organization, technical organization and newsletters, breeding organizations etc. A total of 1,035 surveys were collected for sheep and goats. Only 578 complete answers were retained, of which 471 came from sheep farmers (62 % in dairy and 38 % in meat).

SheepNet used the same survey as used by iSAGE, in the countries involved in SheepNet (France, Ireland, UK, Spain, Italy, Romania, Hungary and Turkey). The iSAGE questionnaire was translated in the different languages of the SheepNet countries and sent to farmers of the different countries through different means of communication. The SheepNet survey was completed on a voluntary basis. A total of 1,315 surveys were collected and 651 were retained. Eliminated answers were mostly from very small flocks or were incomplete.

A total of 1,148 responses across 8 countries were retained and analysed. The data analysis was done with Excel and was mostly a descriptive analysis.

3. RESULTS

Almost 75% of the 1,148 completed surveys came from France (489) and Ireland (350). The remaining surveys originated from United-Kingdom (95), Turkey (92), Spain (60), Italy (40), Romania (18) and Hungary (4). Type of production and flock size were used to describe farm profile.

Three types of production were identified: meat ewes, dairy ewes and multi-purpose ewes, accounting for 61%, 26% and 13% of the sample, respectively. Flock size was classified into six categories: two extremes (less than 49 ewes and more than 1000 ewes) and four centrals (50 to 999 ewes) (Figure 1 a.). Overall, 31% of farms had a flock size between 50 and 199 ewes, 22% between 200 and 349 ewes and 17% between 350 and 499 and 17% had 500 and 999 ewes. The two extreme categories both encompassed 6% of the farms. When looking at flock size and type of production, it showed that meat and multi-purpose ewe farms were generally smaller than dairy ewes (Figure 1 b.), respectively between 50 and 199 ewes vs. between 350 and 999 ewes.

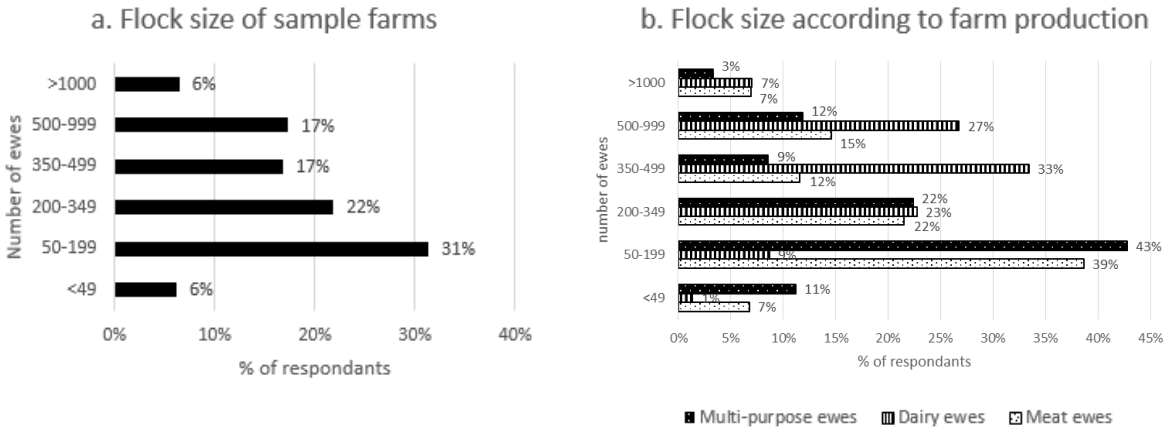

Figure 1. Sample flock size distribution: a. Overall sample, b. By type of production

An important point of the survey was that the majority of farmers (64%) agreed that sheep EID was an opportunity for sheep farming. This vision was shared by all farmers regardless of flock size. The lowest number of positive responses was from the smallest flocks (less than 199 ewes), which had a percentage of "Yes" around 50%. Conversely, 80% of the largest flocks (more than 500 ewes) thought that EID was an opportunity.

Thirty eight percent of European farmers were equipped with tools that utilised the benefits of EID (Figure 2). Four equipped farming profiles were defined: farmers equipped with an EID reader combined with farm management software (17% of farmers); farmers equipped with both an EID reader and equipment using EID (e.g. EID weigh crate, EID automatic feeder…; 14% of farmers); farmers with only an EID reader (4% of farmers); farmers with only digital equipment (3% of farmers). Equipment level changed with the type of production. Dairy flocks were the most equipped (62%), multi-purpose ewes flocks were the least equipped (16%) and meat flocks were intermediate (33%). Level of PLF farm equipment differed by country. Turkey, Ireland and Spain had more than 75% of non-equipped sheep farmers. France and United Kingdom had respectively 55% and 37% of non-equipped farmers. Romania, Spain and Italy had the best equipped farmers with less than 17% of non-equipped farmers.

There was a positive relationship between flock size and level of PLF equipment (Figure 3). The greater the number of ewes the more PLF equipment was available on farm. Less than 10% of farms with less than 199 ewes had equipment that used EID. Conversely, more than 75% of the farms with more than 500 ewes were equipped with EID PLF equipment. Farmers' age did not influence the level of equipment on farm.

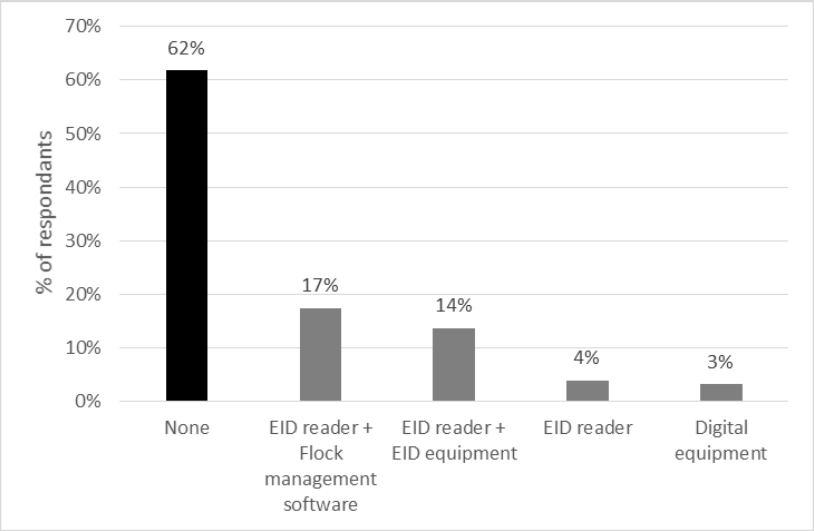

Figure 2. Repartition of equipment level of the farms surveyed

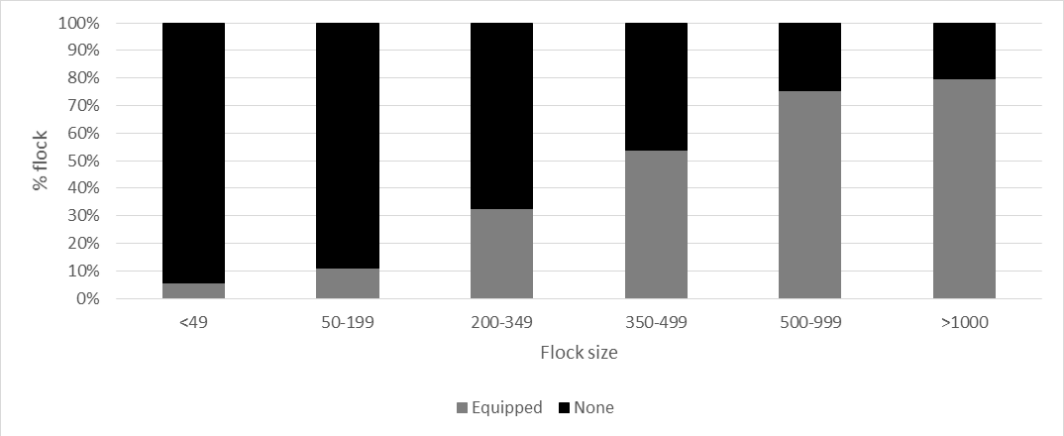

Figure 3. Equipment level according to flock size

Two major uses of EID were identified: recording animal movement (between 60% and 80% of farmers, depending on type of production) and sorting/drafting sheep into management groups (45% to 55% for meat ewes and dairy ewes). Electronic identification was used for automatic recording of animal weights in meat ewe production (40%) and for recording pedigree information for breeding in multi-purpose ewe production (almost 40%).

Precise flock management with the ease of recording flock data for management purposes, time saving and labour simplification were the three main motivations for PLF equipment. Modernisation, data sharing and welfare improvement did not appear to be triggers in the investment in PLF equipment. The main reasons for not using EID were rank by farmers per order of importance. The first one is the cost of equipment, second the flock size and third the accessibility to the equipment.

4. Discussion

This survey was undertaken in the seven main EU sheep producing countries and Turkey and thus is representative of the variation in flock size and the many different sheep production systems practiced in the EU. This survey shows global trends that can help to better understand motivations and constraints to the uptake of digital technologies.

Since 2010, EID for small ruminants has been mandatory in the EU. The aim of the EU regulation (n° 21/2004) was to ensure better traceability of all small ruminants during their lifetime. In practice, when a farmer sells animals, he has to complete a transportation document with all the official

animal numbers. In the early 2010s, most farmers saw EID only as an EU regulation constraint with an extra cost (Holtz, 2015 - unpublished). This survey shows that almost 10 years after the enforcement of this EU regulation, mentalities seem to have changed, as 60% of the respondents saw EID as an opportunity. Since 2010, the democratisation of the smartphone technologies and the increase of digital tools might have helped farmers to better grasp the potential of digitalisation on their farm. This, somewhat, more positive farmers' vision on EID could have an impact on the use of new management equipment and software and on development's orientations for sheep farming. But despite a favourable context, and a positive farmers' vision, equipment level is still low and only 38% of the European farmers surveyed were equipped with tools enabling the benefits of EID. The level of PLF equipment on farm increased with flock size. Seventy five percent of farms with more than 500 ewes had PLF equipment that utilised EID.

The equipment rate of European farmers surveyed differs between dairy and meat production systems as there was a higher level of PLF equipment on dairy farms (62% vs 33% on dairy and meat farms, respectively). This difference could be partially explained by a higher flock size on dairy farms (34% and 22% of dairy and meat farmers had more than 500 ewes, respectively) and a higher income form dairy relative to meat production. Furthermore sheep dairy farmers are probably more aware of technologies used in the (PLF strong) dairy cow industry. In terms of equipment, 87% of equipped farms have an EID reader either linked or not linked with EID PLF equipment. Forty percent of the readers used were a stick reader, probably due to its relatively low price (between 700 to 900€). Forty nine percent of farmers equipped with an EID reader combined it with flock management software. Only 17% of the respondents had EID PLF equipment. The equipment differed between dairy and meat production farms. For dairy production, auto-feeders in the milking parlour represented 58% of the equipment, followed by milk counters (30%). For meat production, weigh crates represented 74% of the equipment on farms. The main obstacle to the equipment of farms remained the high cost of EID readers/equipment. Flock size ranked second and could be related to the cost/benefit of the investment. The accessibility of the material, lack of support and communication were considered the third, fourth and fifth most important barriers, respectively, to the uptake of EID PLF equipment.

The use of EID by farmers is still very limited and is heavily dependent on farm system and type of equipment on the farm. To date, EID use remains mainly for the recording of animal movements as well as sorting sheep into management groups. This could be explained by the regulations and needs to document animal movements. Conversely, the recording of ultrasound results, health data and the monitoring of mating, animal performance and ancestry data are still undervalued. Finally, the use of EID is still strongly related to its first (mandatory) purpose, to ensure traceability.

5. CONCLUSIONS

This study helps to better understand motivations and constraints for digital technologies uptake by EU sheep producers Sheep production is in a favourable position to develop PLF (with widespread use of EID and expansion of new digital technologies such as smartphone), as 60% of the farm surveyed considered EID as an opportunity. Yet, only 38% of farms were equipped with tools that maximise the benefits of EID. Overall, dairy farms were better equipped than meat farms and some differences appear between countries. The level of equipment on farms depends on flock size, with nearly 75% of farms with more than 500 ewes having some EID equipment. However, cost of technology is still the largest barrier to it uptake on sheep farms. The benefits of EID remain mostly limited to the management of animal movements, which is mandatory. To promote a better use of EID equipment, research on the approach on cost/benefit of investments should be carried out as well as a better communication on the possible benefits.

ACKNOWLEDGEMENT

All farmers who have participated to the different surveys for this study.

REFERENCES

Banhazi, T., Dunn, M., Cook, P., Black, J., Durack, M. and Johnnson, I. (2007) 'Development of precision livestock farming (PLF) technologies for the Australian pig industry', In 3rd European Precision Livestock farming Conference, 1, pp 219-228.

Carpentier, L., Berckmans, D., Youssef, A., Berckmans, D., Van Waterschoot, T., Johnston, D., Ferguson, N., Earley, B., Fontana, I., Tullo, E., Guarino, M., Vranken, E., and Norton, T. (2018) 'Automatic cough detection for bovine respiratory disease in a calf house', Journal of Agricultural Engineering Research, 173, pp 45-56.

Fernandez, A. P., Norton, T., Tullo, E., Van Hertem, T., Youssef, A., Exadaktylos, V., Vranken, E., Guarina, M. and Berckmans, D. (2018) 'Real-time monitoring of broiler flock's welfare status using camera-based technology', Journal of Agricultural Engineering Research, 173, pp 103-114.

Halachmi, I., Guarina, M., Bewley, J., and Pastell, M. (2019) 'Smart animal agriculture: Application of real-time sensors to improve animal well-being and production', Annual Review of Animal Biosciences, 7; *In press*.

Holtz, J., Gautier, J.M., Lefrileux, Y. and Caramelle-Holtz, E. (2016). 'Use of electronic identification and new technologies in French goat farms'. IGC, Antalia, 26-28 septembre 2016.

Morgan-Davies, C., Wilson, R., and Waterhouse, A. (2017) 'Impacts of farmers' management styles on income and labour under alternative extensive land use scenarios', Agricultural Systems, 155, pp 168-178.

Morgan-Davies, C., Lambe, N., Wishart, H., Waterhouse, A., Kenyon, F., McBean, D., and McCracken, D. (2018) 'Impacts of using a precision livestock system targeted approach in mountain sheep flocks', Livestock Science, 208, pp 67-76.

Pierpaoli, E., Carli, G., Pignatti, E., and Canavari, M. (2013) 'Drivers of precision agriculture technologies adoption: A literature review', Procedia Technology, 8, pp 61–69.

Ruiz-Garcia, L. and Lunadei, L. (2011) 'The role of RFID in agriculture: applications, limitations and challenges', Computers and Electronics in Agriculture, 79, pp 42–50.