



Innovation for Sustainable Sheep and Goat Production in Europe

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Report on new farm typologies for sheep and goat systems within the EU

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Table 1 – Key information

Country	Greece
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ABSTRACT

Deliverable 1.1 describes the steps followed in Task 1.1 within the iSAGE project for the formulation of a common typology of sheep and goat farming production systems across the European Union and Turkey and provides all the information collected and processed for this purpose. The development of the typology was of crucial importance for the efficient implementation of the project and therefore it was based on a meta-analysis of a literature review of the typological surveys in Europe and on data collected through an online survey of the iSAGE industry partners. From these processes, a tentative list of 18 farm types was produced. This initial list was deliberated and thoroughly discussed with the industry partners in a specific workshop held for that purpose in Zaragoza, in June 2016. As a result of this consultation, ten mutually exclusive farm types (five for sheep and five for goats) were identified for the final typology to be used in iSAGE. The identified typology is representative of the existing sheep and goat farms in EU and Turkey, is associated with supply chains and will inform selection criteria for case study farms.

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1. INTRODUCTION

A. Work Package 1 – Holistic sustainability assessment

The objective of the Task 1.1 was to develop a new common typology for sheep and goat farming production systems in Europe to be used in the subsequent tasks of the iSAGE project. Therefore, the completion of Task 1.1 was of crucial importance for the smooth running of the project. In order to determine the final typology, it was important to define farm types that represent the diversity of sheep and goat farming systems across the European Union (EU) and Turkey. These farm types were defined based on a meta-analysis that included an extended review of the relevant literature on typologies, data collected through an industry survey and industry benchmarking data. The final typology will be used to inform the selection criteria for case study farms in each country, in order to carry out farm sustainability assessments (WP1), socio-economic studies (WP2) and to test innovative practices under WP4.

The methodological framework followed in this Task was equally inclusive of all partners and all the relevant information available. The final typology incorporated the diversity of geographic and climatic regions, of breeds and genotypes of sheep and goats, of production systems (e.g. intensive, semi-intensive, extensive, semi-extensive), as well as of the various marketing methods and strategies and different market scales (global/national/regional/local). Task 1.1 maintained close collaboration with WP6, which coordinates the relationship between research partners and industry and the data collection and storage efforts with regards to the case studies.

B. The use of typologies in livestock farm management

A farm typology describes a classification of farms that is homogeneous according to specific criteria, usually related to economic performance and applied farm management practices (Andersen et al., 2007). In particular, a typology is a methodology that groups farms with similar or identical features and leads to the formation of clusters (farm types) that are comprised of relatively homogeneous production units. An efficient implementation of a farm typology will produce the maximum heterogeneity among clusters while simultaneously

ensuring the maximum homogeneity within each cluster (Mađry et al., 2013). Identification, stratification and grouping of diverse – in terms of natural, social and economic resources, and structural, production and operational characteristics – farm production systems that face different decision-making problems, allows consistent farm assessment, comprehensive policy recommendation and precise technological interventions and solutions to be introduced. Uniform policies, interventions and strategies are not appropriate for farmers and production systems, which are characterised by a high level of heterogeneity (Mađry et al., 2013). Instead, the detection of homogeneous fractions within these systems – through the use of a typology – can serve as a useful tool to propose better targeted policy measures and strategies (Gibon, 1994; Lesschen et al., 2005; Barrantes et al., 2009) , achieve improved management practices and higher economic performance (Ruiz et al., 2011; Gelasakis et al., 2012) and to comprehend the complex nature and interrelations among factors that govern their operation (Milán et al., 2011; Riveiro et al., 2013).

In livestock production systems, organisational and technical characteristics, farm structure, management and flock size, intensification level, feed supply, socio-economic and environmental attributes, productivity and workforce constitute important elements of the typification task (Gibon et al., 1999; Girard et al., 2001). Both expert consultation (qualitative) and statistical (quantitative) methods are used to classify diverse farming systems. Quantitative methods comprise multivariate statistical approaches, which include mainly the application of Principal Component Analysis (PCA) and Cluster Analysis (CA) and require large quantities of farm-level data. On the contrary, qualitative methods draw on experts, who are required to be knowledgeable, experienced, interested in the topic and representative a wide range of stakeholder perspectives (Clavel et al., 2011). Expert-based methods are less time-consuming compared to the analytical ones. The selection of the appropriate method for the classification of farms into farm types depends mainly on the objective and the goals of the study. A comprehensive overview of farming system typology methodologies can be found in Mađry et al. (2013).

3. METHODOLOGICAL APPROACH

A. Determination of the current status in sheep-goat farming

In an initial/preparatory step, the profile of the sheep and goat sector in each country was presented in a highly concise and schematic manner. Each country assigned the task to a person or a team who was in charge of communication and provision of feedback. The concise reports provided by each country were of about one page in length and provided basic information regarding:

- The current situation in sheep and goat production in each country (structure of farms and geographical dispersion, economic contribution, the main products and marketing practices, social importance, biodiversity issues etc).
- Basic strategic country priorities for development and future prospects of sheep and goat farming, including current programs (local, regional and/or national actions).

The purpose of these reports was to provide a general background of the sheep and goat sectors in the seven participating countries and to outline basic strategic priorities in each country. This would, implicitly, reveal specific production systems of particular national/regional/local importance. The final reports were delivered by all countries by 22nd May, 2016.

B. Meta-analysis of typological surveys

B.1. Literature review

The second stage involved a literature review¹ of existing typological surveys of the sheep and goat production sector in each participating country. This exercise gathered information from all the available papers, studies, reports and official typologies (of Ministries, Institutions, payment organisations, etc.) relating to sheep and goat typological analyses. Partners could also include typologies at a European level (intra-national typification of sheep and goat farming systems). Special care was taken to ensure the inclusion

¹ The responsible institutions for the literature review in each country were: LUKE (Finland), IDELE (France), AUTH (Greece), ICEA (Italy), INIA (Spain), RRAP& NIGDE (Turkey) and ORC (UK).

of country-specific farm types of particular national/regional/local importance; in these cases, partners were urged to provide more details concerning the functionality of the type (in a concise manner) in order to enable the potential final inclusion of this type within a broader, European-scale, type. This was to help gather more information on the importance of existing farm types with relevance to European regional particularities, but also to facilitate the future activities/tasks of iSAGE by avoiding the need to gather similar information at a later stage.

In order to achieve the best possible presentation of results, partners used a template, a model of which is presented in Table 1, in which to record the main findings of each typological survey in a consistent manner (e.g. variables used in the elaboration of the typologies, number of farms, methodology applied for the typification, basic farm types detected, conclusions, time and place framework, etc.). This would enable the detection of similar types across countries and, consequently, the formulation of common typologies. Surveys for sheep and goats were categorised accordingly, so that the necessity to produce separate typologies for the two farm groups could be decided later. . A report along this structure, as illustrated in Table 1, was thus produced by the partner responsible in each country, which reflected their own farm types and production systems.

Table 1. Template of literature review of national/regional farming systems typologies

No	Reference	Type of animal and production system	Main classification criteria- Study objective	Profile of the geographical region	Main classification variables	Methodology (Expert or Statistical, number of farms)	Farm types detected (Clusters)	Sustainability composite indicators
e.g. 1	Gelasakis et al. (2012), Journal of Dairy Science	Chios sheep breed – intensive system	Farm characteristics and overall management practices	Lowland plain areas in Northern Greece	Feeding practices, flock size, animal production traits, topography, facilities, health program	Statistical (PCA & CA, 66 farms)	<ol style="list-style-type: none"> 1. Intensive, specialised farms 2. Semi-intensive, high investment 3. Semi-intensive, low investment 4. Semi-intensive, traditional 	Facilities, housing, management, labor, livestock, land use and ownership, nutrition
...

When final elaboration of the typology was carried out, care was taken to ensure that each partner could assign all the sheep and goat production systems in their country to a type. The ability to do so would demonstrate that the typology was realistic, functional and comprehensive. Predetermined criteria were also taken into consideration in the development of the farm types, such as location, environmental importance, management practices, socioeconomic functions etc. A concise description of locally important production systems was also provided.

B.2. Industry survey

A survey that involved all the industry partners of the project was conducted using an on-line platform, to gather additional information on farm typologies, sustainability indicators and best farming practices. The survey included questions on the farm types of sheep and goat systems prevalent within in the iSAGE industry partners; indicators of physical and financial performance, animal health and welfare and environmental impact; innovative solutions to the challenges facing sheep and goat farms; and supply chains that represent best practice, and ensures a bottom-up approach in the identification of the farm types. The industry partners were urged to liaise with their research contacts in order to provide the relevant information. The survey started on 16th May, 2016, ended on 8th June, 2016 and was organised and managed by IAMZ-CIHEAM, which, under WP6, co-ordinates the relationship between research partners and industry and supervises data collection. 17 out of the 18 iSAGE industry partners completed the survey.

B.3. Conclusions

The lead partner of Task 1.1 (AUTH), received feedback from all partners of the data collected from the national reports (through the templates – Section B.1. Literature review) and industry reports (through the online survey – Section B.2. Industry survey). This was used to produce a tentative list of types and then to group some of the similar types based on the description of their main features. The final product of this step was a table/report containing a relatively large number of farm types. This tentative list, along with the categorisation of the farm types (see section C) was in turn discussed and approved by participating partners

through on-line meetings. Three on-line meetings (held 19th April, 13th May and 7th June, 2016) and e-mail discussions were conducted before the “broad” typology (proposed farm types) was finalised.

C. Finalisation of the typology

The “broad” typology (proposed farm types), obtained through the meta-analysis described above (Section B. Meta-analysis of typological surveys) was presented to all industry partners at the Industry Meeting in Zaragoza, Spain (21st–22nd June 2016, Mediterranean Agronomic Institute of Zaragoza – CIHEAM Zaragoza) to be validated and a final typology established. During the workshop, AUTH presented the results of the initial analysis and resulting “broad” typology and distributed a tentative report to partners that contained a relatively large number of farm types. Industry partners were asked to identify their production systems in the proposed farm types, but also to ensure that *all* sheep and goat production systems found in their country fell into one of the presented types. Following group discussions, research and industry partners agreed on a final typology, where the number of the proposed farm types was further reduced and specific and mutually exclusive farm types were established.

4. RESULTS

A. Description of the sector and priorities: country reports on the sheep and goat sector

The reports profiling the sheep and goat sector in each country are presented in Appendix A. These reports provided an indicative picture of the structural and technical characteristics of the sheep and goat sector (number of farms, number of animals, breeds, main production systems, etc.) and of its social and economic contribution (e.g. location of the farms, employment, contribution to GDP and share of the total value of livestock production) in each country. Moreover, some generic information was provided regarding the main sheep and goat products and their consumption trends, the impact of agricultural policy on the development of the sector and applied management practices observed. The second part of the reports includes the country priorities for development of the sector. These priorities,

which cover a wide range of immediate and/or short- and long-term actions for the achievement of strategic goals, were categorised into seven broad development axes based on the main aspect of production targeted for improvement (Table 2).

All countries identify better market access (such as export opportunities, understanding of public preferences and how to increase consumer awareness, development of niche markets, localised production and local supply chains) and efficient breeding programmes focused on functional traits, genomic selection and autochthonous breeds as strategic priorities for the development of the sector. Meanwhile, innovative production practices and improved human capital in rural areas were reported as priorities by six countries. Mentioned only twice were the priorities concerning environmental sustainability and improvement of the structural characteristics of the sector.

Table 2. Strategic priorities

Development axes	Finland	France	Greece	Italy	Spain	Turkey	UK	TOTAL
Innovation in farming practices-Productivity		X	X	X	X	X	X	6
Improvement of human and social capital		X	X	X	X	X	X	6
Environmental sustainability					X		X	2
Market access and economic performance	X	X	X	X	X	X	X	7
Product quality, hygiene and food safety		X	X	X	X	X		5
Genetic improvement	X	X	X	X	X	X	X	7
System structure and exogenous factors			X	X				2
TOTAL	2	5	6	6	6	5	5	35

B. Meta-analysis results

B.1. Literature review

In total, 45 typological studies on the sheep and goat sector were reviewed and 124 farm types (99 for sheep and 25 for goats) identified. The main criteria used for the classification of farms in these studies included flock size (small, medium, large); farm location (mountainous, lowlands, Less Favoured Areas – LFAs); feed dependency (on-farm production versus purchased feedstuff); grazing management practices and intensification of the production

system; number of lambings; breeds used; existing infrastructure, facilities and applied management technologies; type of product (milk, meat, wool, cheese, organic, PDO) and level of productivity. A detailed description of the main classification criteria, the type of animal and production system and the farm types identified can be found in Appendix B, where all country reports are presented.

B.2. Industry survey

The analytical results of the on-line industry survey focused on the identification of farm types are presented in Appendix C. This survey complemented the literature review and provided extensive additional knowledge on farm types acquired through a bottom-up approach. Although the description of the clusters given in the survey responses is not always clear, more than 50 farm types were identified by the industry partners: approximately 43 types for sheep and 13 for goats. These farm types, along with those obtained from the literature review, were then used for the formation of a new tentative list of farm types in Europe.

C. Tentative list of farm types - “Broad Typology”

As discussed previously, the detection and grouping of similar (or identical) farm types was based on the results of both the literature review and the results of the industry online survey. The initial product of this procedure was a tentative list of farm types that included 13 sheep and five goat farm types. The identification of the farm types in this extended typology was mainly based on the indicators frequently used in literature or identified from the online survey. These indicators included:

- Intensification of the production system
- Geographical characteristics
- Farm size
- Grazing management practices
- Feed dependency
- Milk or meat production and processing

Indicators of particular national/regional importance, such as product characteristics (PDO and PGI products; organic production), an important environmental role or the pluriactivity

of farms, were also taken into consideration. It has to be mentioned that the farm types of this “broad” typology did not form discrete, mutually exclusive clusters, but overlap, mostly because the grouping of the farms was not based on quantitative data at a farm-level.

Description of sheep production systems

1. **Confined sheep, purchased feed:** *Intensive dairy sheep farms that feed exclusively on purchased concentrates and forage (no arable land) and in which animals have very limited access to pasture. Relatively large farms with modern infrastructure and high investments, often applying technologically advanced production practices.*

These farms are market-oriented and pursue (and achieve) high yields and high productivity. They are less resilient to volatile international market conditions and abrupt or unforeseen changes in the market. They breed characteristic breeds (e.g. Assaf in Spain, Frizarta and Chios in Greece etc).

2. **Confined sheep, produced feed.** *Intensive dairy sheep farms that depend mostly on concentrates and forage produced on-farm, but in which animals have very limited access to pasture. Farms usually cultivate relatively large areas and are large in size, with modern infrastructure and high investments. They often use technologically advanced production practices.*

These farms are similar to Type 1, except from the fact that they produce their own feed on-farm. This vertical organisation provides more flexibility relative to Type 1 farms by rendering them less vulnerable to changes in the price of feedstuff – the main determinant of their economic performance. Such farms are more common in the Mediterranean EU (Greece, Spain and Italy).

3. **Semi-extensive dairy sheep.** *Semi-extensive dairy sheep farms obtain most of their nutrition through grazing, supplemented with forage and concentrates produced on-farm.*

These farms vary in their level of adoption of innovative practices, ranging from medium farms and late adopters (e.g. Chios sheep in Greece) to small, emerging Assaf farms in Spain. Ewes are not managed to lamb in any particular season.

4. **Dual purpose sheep.** *Dual-purpose refers to intensive or semi-intensive sheep farms, where milk is slightly more important economically than meat (e.g. 65:35 in some Greek farms) or another product,*

such as wool in the UK. They use relatively new technology but with low levels of innovation. Grazing is common on these farms, covering almost 50% of their nutritional needs.

Meat production is mostly suckling lambs or older up to 60 days of age. On-farm production of forage and some concentrates (mainly winter cereal) is not uncommon. Farms range from medium-sized to very large. Most commonly found in Greece and Spain.

5. Traditional sheep: Traditional both in terms of management and organisation, with sheep mostly grazing on natural grasslands. Although they can be found in many areas, they are more typical of mountainous areas and LFAs.

Traditional sheep farms are less embedded in competitive market conditions and, despite the fact that they maintain links with markets (milk and meat sales to wholesalers and/or retailers), they keep a non-trivial level of household self-consumption and/or direct sale of products to consumers (e.g. lamb carcasses). In some cases (e.g. in Spain), farms also undertake some sort of crop production activity for feedstuff or apply a “stratified” system (i.e. divided into three tiers: hill, upland and lowland e.g. in the UK).

6. Low input meat sheep: Semi-extensive meat producing sheep farms with low stocking rates. Found in mountainous areas and LFAs, or lowlands with low quality of rangelands. One of their basic characteristics is the low level of organisation in reproduction practices. Lambings can be scattered throughout the year or be concentrated in one season – usually spring – and farms mostly have just a single lambing per year.

Typical for France, Turkey, Finland, Italy and Spain. In the UK, these are lowland sheep farms part of a stratified system (see Type 5), which buy in upland-bred crossbred females for breeding.

7. Medium input meat sheep: Semi-intensive specialised meat producing sheep farms. Management focuses on intensifying lamb meat or on heavy carcass sales.

More intensive than Type 6, with more frequent lambings that may vary from one lambing per year (semi-extensive) to five lambings in three years (intensified production). All farms depend on grazing, but for varying lengths of time, ranging from long periods (e.g. the Archipelago area of Finland, where the winter is relatively mild) to short periods of grazing interspersed with long periods of confinement, fed concentrates and conserved forage (e.g. fat-tailed indigenous breed in Turkey and hardy breeds in France).

8. High input meat sheep: *Intensive meat producing sheep farms with high stocking rates and large flocks. They are managed by innovative farmers seeking to intensify and have three lambings in each two year cycle.*

Mostly located in lowland areas (most commonly in France and Finland) with low grazing and high reliance on fed forage and concentrates. Feedstuff is usually produced on-farm, revealing an important vertical organisation of meat production. These farms use heavy breeds bred for meat traits, focusing on heavy carcasses rather than more lambs.

9. Cheese producing sheep: *Semi-intensive farms manufacturing cheese on-farm. They graze good quality feed, covering their nutritional needs by more than 50%. Mostly situated in highland areas or LFAs.*

Cheese production can be a supplementary activity for many farms but most farms rely on it. More common in France (local breeds utilising mountain pastures). Sometimes they also have cultural roles (e.g. traditional methods of cheese-making).

10. Pluriactive sheep: *Sheep farms engaging in at least one economic activity other than sheep production. Their other key characteristic is their family character, with labour being predominantly supplied by family members, including for other off-farm incomes and on-farm activities. They are found all over Europe.*

Farms range from small to relatively large, extensive (e.g. Turkey) to semi-intensive (e.g. Assaf in Spain) and vary in terms of their supplementary activities (e.g. cash crops in France). They generally use good-quality grazing resources and have medium/high stocking rates.

11. PDO specialist sheep: *Small farms with low competitiveness in “industrial” markets but with important environmental, social, economic and cultural roles. These farms usually produce location-specific products (e.g. PDO cheese, or, less frequently, a PDO meat product) that they rely on for survival. They are found in particular territories where a local product plays an important commercial role (e.g. France, Spain, Italy and Greece).*

These farms are managed according to the standards of their PDO products (e.g. grazing period, types of feedstuff, etc). They are mostly low-yield dairy farms selling their milk to local cheese-makers. It is not uncommon either that these farms are transhumant (e.g. in Greece), spending their summers in the highlands and winters in lowlands, moving up to 300-400km between the two. They therefore provide

ecosystem services in the uplands as well as the lowlands. These farms sometimes specialise in meat or wool production of high quality, e.g. in the UK, sometimes not under a formal certification scheme. Both transhumant and sedentary farms achieve acceptable incomes and contribute to the viability and culture of their respective communities.

12. Organic/eco sheep: Environment-friendly and/or organic small/medium sheep farms. Commonly, these farms rear local breeds (e.g. in Turkey).

These farms follow certification restrictions and place low pressure on rangeland ecosystems. They are predominantly family-run and have varying levels of economic performance, labour productivity and overall sustainability.

13. Intensive organic/eco sheep: Large organic sheep farms with an entrepreneurial orientation. Farms specialise mostly in milk production, or are dual-purpose. They have tight links with markets and dairy industries.

Description of goat production systems

1. Traditional goat meat production: Extensive and semi-extensive systems, situated predominantly in LFAs and featuring rustic and local breeds (some are nowadays declared as endangered). Typically achieve low milk yields. Farms are characterised by low investment in facilities and machinery and use family labour. They sell suckling kids, in most cases, these farms survive because of their important environmental role in specific regions. They are mostly under organic production and maintain rangelands in good condition with low costs for the farmer.

2. Pastoral goat dual purpose systems: Low-input farms where animals mainly graze natural grass, but also forage crops, throughout the year. Feed supplementation with agricultural by-products in the stable depends on the season and the physiological state of the animals. These low-input farms generally have poor facilities, although most of them have adopted mechanical milking and supplemental feeding. Milk production is seasonal and sales of suckling kids contribute significantly to income. These farms can be transhumant.

3. Pastoral goat dairy systems: *Semi-extensive, with medium to large herds of local breeds and specialising in dairy production. Grazing and supplementary feeding is used, depending on the area. In general, supplementary feeding is contributes more than grazing, representing in most cases more than 50% of the total annual intake of animals. In mountain areas, goats graze throughout the year, but for farms in arable areas, goats graze when natural pastures or crop residues are available. Milk yields of these systems are higher than in dual purpose systems, with less seasonality in their production. Kids are often raised with their mothers; however, many farms use also artificial suckling. Suckling kids have little effect on farm profitability. The farm systems are characterised by higher investments in infrastructure, facilities and equipment (acceptable mechanical milking equipment and use of milk cooling tanks) than goat types 1 and 2.*

In addition to goat farming, some farmers produce and sell crops for supplementary income (pluriactive farms).

4. Confined goat milk: *Large intensive farms applying advanced technology, with automatic feeding and artificial suckling. Milking rooms are modern with cooling tanks. These large sized farms are characterised by high milk yields and require high inputs. Mostly depend on concentrates and forage and less on grazing (feeding management does not differ significantly from semi-intensive dairy systems). Kid sales are only a small part of income. Most farmers sell milk throughout the year to dairy industries. Seasonality is significantly reduced compared to previous systems.*

5. Cheese making production systems: *These are intensive and semi-intensive production systems located both in mountainous and plain areas of France. These specialised farms are small or medium sized and depend heavily on grazing.*

D. Final Typology

The initial list of farm types presented above (the 'Broad' typology) was deliberated and thoroughly discussed at the workshop in Zaragoza. It was apparent that a consistent definition on the terms "intensive" and "extensive" was necessary to be used across all countries. Based both on farm practices and literature, the distinction between "extensive" and "intensive" farm types was based on the level of input of purchased feedstuffs, complemented with information about stocking rate and/or grazing duration if needed. The

final outcome of this process, which represents the final 'narrow' typology to be used within iSAGE, includes ten farm types that are mutually exclusive and of importance in analysing the European sheep and goat sector:

- i. Sheep: Intensive dairy farms (e.g. high input of purchased feedstuff)
- ii. Sheep: Semi-intensive or extensive dairy farms (e.g. normally pasture fed animals)
- iii. Sheep: Intensive meat farms (e.g. high input of purchased feedstuff)
- iv. Sheep: Semi-intensive or extensive meat farms (e.g. normally pasture fed animals)
- v. Sheep: Dual-purpose farms (farms where the farmer sees value in 2 or more different products e.g. meat and wool, meat and dairy)
- vi. Goat: Intensive dairy farms (e.g. high input of purchased feedstuff)
- vii. Goat: Semi-intensive or extensive dairy farms (e.g. normally pasture fed animals)
- viii. Goat: Intensive meat farms (e.g. high input of purchased feedstuff)
- ix. Goat: Semi-intensive or extensive meat farms (e.g. normally pasture fed animals)
- x. Goat: Dual-purpose farms (farms where the farmer sees value in 2 or more different products e.g. meat and wool, meat and dairy).

These final farm types will enable all types of analysis within the project because they include the whole range of farms in Europe and Turkey. Each one of the ten types includes a broad range of sub-types of farms, with differences in their size, economic and environmental role, production systems, farming practices and local/regional/national and intra-national importance. Thus, these farms types also incorporate organic, PDO, PGI, pluriactive farms, cheese making farms or breed specific farms, for example. In addition, these types vary as to their relevance in innovation adoption, but also as to their needs in specific types of innovation. Therefore, this typology is of high relevance to iSAGE, which focuses predominantly on innovation.

E. Selection of case studies

According to the Description of Work, an outcome of this Task is the definition of the criteria for the selection of the case study farms. Based on the final typology, case study farms will be chosen for farm sustainability assessments (Task 1.3), farmer surveys (Task 2.1 and 2.2) and for testing innovative farm practices (Task 4.2). The main criteria for selection of the case study

farms is that these farms are representative of the identified farm types and cover a range geographic and climatic regions in each participating country. The selected case study farms may include organic, PDO, PGI, pluriactive farms, cheese making farms or breed specific farms that are of particular importance in a region/country. Is it also foreseen that potential case study farms of an identical or similar type that exist in multiple regions or countries should not be selected, to avoid repetition and to promote diversity in the case studies. It is also agreed that each country will determine farms that are representative of farm types, which are more relevant to their prevailing farming systems, consumption patterns, development priorities and innovation needs.

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APPENDIX A

FINLAND

The profile and strategic priorities of the Finnish sheep and goat sector

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Current situation of the sheep and goat sector

Agricultural production. In Finland, the main production branch is lamb meat production. Currently, the number of sheep is 155 000, with 74 000 ewes on 1400 farms. Positive development is seen in the lamb sector, however, and the number of sheep farms is increasing. The goat sector is substantially smaller, having only 4000 goats. Organic lamb production is 0.2 million kg, 22% of the total lamb production (0.9 million kg). The indication is that, in the future, one third of the conventional sheep farms would be willing to switch to organic production. The main breeds are Finnsheep and other original Finnish breeds, as well as the Texel and Oxford Down. Finnsheep are prolific, having the potential to provide year-round lambing. The length of grazing season is the longest in south Finland and the Archipelago, spanning from May to October, whereas farms in Lapland have short grazing seasons and long winters.

Food processing. Currently, lamb meat is mainly processed by 200 small-sized companies, while half of farms offer meat through direct selling channels. The number of direct selling points for consumers is 160 for lamb meat, compared to five companies offering goat milk and meat. 30 firms have organic status. In the future, direct selling for 'food circle groups' and to restaurants will be major channels for lamb and goat products.

Positive demand in consumer markets and creation of new cheese products has opened new market opportunities for goat milk. In contrast, in Finland at the moment there is only one sheep milk producer. Currently, there are no Finnish sheep or goat products named under PDO, PGI and TSG quality schemes.

Economic status. In Finland, the total share of agriculture of national GDP is 0.8%; the food industry in general covers 1.2% of national GDP. The share of sheep and goat sector

specifically is therefore small and there are no statistics available regarding its exact share. Gross annual revenue from lamb and goat sector is €53 million; in comparison, livestock revenues in total are €2.075 billion. The profitability coefficient from FADN bookkeeping for the lamb and goat sector, meanwhile, indicates that economic profitability is low and the producer price is quite stable but also low – around €4.00 per kg. Production is supported by governmental and EU subsidies. The main challenge for the meat production sector is to maintain an even supply of lamb meat throughout the year. A further challenge is the low consumption of lamb meat: 0.7 kg per person.

Priorities

- To improve the Finnish breeding programme for sheep. The programme is maintained by the industry partner ProAgria.
- The most urgent traits to be added to the breeding programme are related to maternal ability and lamb vitality: birth weight, weaning weight and number of lambs survived.
- To assess the genetic variation in tolerance against environmental variation. Sheep spend a lot of the time outside grazing and exposed to environmental factors.
- To expand the consumption of sheep products by assessing the needs of consumers and retail sector. Explore the bottlenecks and novel possibilities for increasing consumption (e.g. marketing of local products, direct on-farm selling)

FRANCE

The profile and strategic priorities of French sheep and goat sector

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Current situation of sheep and goat sector

According to the official data of the French Ministry of Agriculture, there are around 38 000 meat sheep, 4 800 dairy sheep and 11 000 goat farms in the country, rearing 4.3 million meat ewes, 1.6 million dairy ewes and 870 000 goats. In term of value, the sheep and goat sector represents approximately 6% of the total national livestock production.

With 80 500 tonnes carcass produced in 2015, meat sheep production has been stable for the past three years, following a preceding decrease since the beginning of the 1980s. Currently, more than a half of the meat consumed in France is produced abroad. In order to stand out from imported meat, the meat production sector has developed quality and origin identification labels: Protected Geographical Indication (PGI) and Protected Designation of Origin (PDO).

In 2015, 586 million litres of goat milk and 272 million litres of sheep milk were produced in France. Most of this production was collected by the dairy industry and processed into cheese. On-farm cheese production is also important, more so in the goat sector than in the sheep milk sector (about 22% of goat milk versus 6% of sheep milk). There are 14 PDO goat cheeses (e.g. Sainte Maure de Touraine, Rocamadour, Selles sur Cher, Chavignol), which together represent about 6% of pure goat cheese production. Meanwhile, more than 90% of dairy sheep farmers are involved in PDO production (Roquefort, Ossau-Iraty and Brocciu), representing around 40% of sheep milk production.

The sheep sector in France is mainly located in LFAs: 84% are in a disadvantaged area and 44% are in a mountain area (more than 85% for milk sheep sector). In these areas, flocks' pasture is important to maintain pastoral lands (rangelands, summer mountain grasslands).

The meat sheep sector is characterised by a lot of breeds and production systems. Hardy breeds are predominant in southern production areas, especially Mérinos d'Arles and Préalpes in the South East; Causses du Lot and Lacaune in the South West; and BMC, Rava, Bizet, Limousine, etc. in Massif Central. In these areas, lambs are raised indoors and terminal crosses are often used to improve carcasses conformation. In the mid-Western area, miscellaneous crosses are used, from Mouton Vendéen, Mouton Charollais, Texel, Rouge de

l'Ouest, etc. Ile-de-France, for autumn lambing, and Texel are the main breeds from the mid-East to North East. In regions from the mid-West to North East, lambs raised on grass are still produced, but indoor raising is increasing.

Dairy sheep farms are located in three traditional production areas: the Roquefort area, the western Pyrenees and Corsica Island. In these three areas, the ewes are local breeds, adapted to their environment and different livestock farming systems. Lacaune ewes, producing milk for the Roquefort industry, are raised indoors from autumn (for lambing) to spring; otherwise, they graze pastures or rangelands. There are three breeds in the French western Pyrenees: Basco-Béarnaise, Manech Black Face and Manech Red Face; and one breed, Corsica breed, on Corsica Island. In these latter two areas, ewes graze natural grassland all year long and often mountain pasture during summer.

For the goat sector, there are two main breeds: Alpine and Saanen. The breeds are adapted to a wide variety of production systems. In the southern part of the country, most of the goats graze grasslands or rangelands and more than half of the farmers carry out the cheese making and the selling of their products themselves. In the mid-West and South West, forage resources allow the intensification of livestock production and most of farmers deliver their milk to the dairy industry.

Sheep and goat sector priorities:

- To support consumption of sheep and goat meat and milk by promoting products
- To increase lamb production and adapt milk production to the market needs
- To improve the quality and value of products
- To increase farm income by improving sheep and goat productivity and decreasing production costs (especially through feed self-sufficiency)
- To develop breeding strategies that will improve profitability and sustainability
- To improve generational renewal and get better living conditions for breeders
- To help farmers to adapt to future developments: price volatility, climate change, etc. (through adaptation and to development of technical advice for farmers)

GREECE

The profile and strategic priorities of the Greek sheep and goat sector

Athanasios Ragkos and Alexandros Theodoridis (Aristotle University of Thessaloniki)

Current situation of sheep and goat sector

The economic and social importance of the Greek sheep and goat farming sector is substantial. Sheep and goat farming constitutes a suitable activity for most areas of the country; it develops pastures that are not suitable for alternative uses; it provides farm families with income and it makes use of excess farm family labour, particularly in mountainous and LessFavored areas, where the rural economy is poorly diversified. Sheep and goat farming constitutes the most important livestock production activity in the country, contributing by 0.4% to national GDP and by 45% to the total value of livestock production.

According to the official data of the Greek Milk and Meat Board, in 2015, there were 41 004 sheep and 14 973 goat farms in the country, rearing 9.4 million sheep and 4.3 million goats respectively in dual-purpose flocks producing milk and meat. Greece is ranked third among European Union (EU-28) countries in terms of the number of sheep reared, and first in the production of sheep milk, which is used in the production of 'feta', a Protected Designation of Origin (PDO) cheese and one of the most important exportable products of the Greek primary sector. Greece has certified more than 20 other sheep and goat cheeses with varying marketability and economic performance. These, however, provide latent dynamics to the sector. The total production of sheep and goat milk is 539 000 and 128 000 tonnes, respectively.

Sheep and goat meat production in 2013 was 85.7 thousand tonnes, accounting for 7.1% of total meat production in Greece and 12.5% of sheep meat production in EU-28. Nevertheless, the production of sheep and goat meat has followed a declining trend over the last few years.

The Greek sheep farming sector is characterised by a diversity of production systems that range from extensive, pastoral and semi-extensive to intensive patterns. The latter emerged over the past 20 years as a result of Common Agricultural Policy (CAP) incentives and changes in the standards of living in rural Greece. Extensive systems, which are characterised by limited requirements for purchased inputs and fixed capital, traditional

practices, use of grazing and low productivity, co-exist with intensive ones, which are capital intensive with high investments in buildings and machinery and use of purchased feed aiming at the maximisation of yields and profits. Semi-extensive systems adopt elements of both systems in order to increase their productivity. On the other hand, goat systems are more extensive in general, often using rangelands that are not appropriate for other uses in livestock production. The continuation of financial support to livestock farmers using these areas, however, is doubtful within the new CAP framework, which threatens the viability of the whole sector.

Priorities

- To support extensive grazing-based systems through the designation of appropriate land uses
- To expand the use of innovative practices in milking and reproduction
- To design and implement integrated breeding programs of local sheep and goat breeds
- To increase the quality of milk and dairy products by achieving higher levels of farmer knowledge and education concerning these issues
- To improve market access by introducing market-based promotion strategies for territorial and certified products
- To improve the economic resilience of intensive sheep farms against the adverse effects of economic crisis

ITALY

The profile and strategic priorities of Italian sheep and goat farming

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Current situation of sheep and goat sector

Within the Italian livestock sector, sheep and goat farming is a relatively minor activity. In terms of value, the sheep and goat sector represented approximately 10% of the total national livestock production, though the economic importance is much smaller: sheep & goat meat is 0.3% of total agricultural sector revenue, while milk represents 0.8% (ISMEA, 2013). According to ISTAT, in December 2015, the Italian sheep population reached seven million animals in 2015, while the goat population reached about one million animals.

For the sheep sector, the production is mainly concentrated in central southern regions and in the islands. The main focus of production is milk (dairy sheep account for over 60% of the total sheep population), whilst the meat sector is very small and the production is not enough to cover domestic consumption. Sardinia is one of the most important Italian regions for dairy sheep (more than three million animals). The breed is a typical Sardinian sheep for milk production, with which it is produced some PDO cheeses such as *Pecorino Romano*, *Pecorino Sardo*, and *Fiore Sardo*. Many other Italian cheeses are produced from sheep's milk and in many areas there is also the tradition of producing mixed milk cheese – mixing sheep's milk with cow's milk. In Italy, sheep meat is produced mainly from dairy lambs, slaughtered at weights of just over 10 kg. Northern Italy is instead characterised by sheep raised for meat, and in this case the lamb is slaughtered at a weight above 20 kg.

The sheep sector in Italy is almost exclusively based on a free range and semi-extensive grazing system, with grass and forage being the basis of nutrition for most of the year. However, for dairy sheep, extra feed can be provided (concentrates) during the late pregnancy and early lactation period. Sheep housing is mainly limited to the winter period. During these months, the animals are housed in more or less structured shelters where their diet is supplemented with fodder, and in some cases with concentrated feed.

As for the goat sector, the situation is different from the above. Although on the one hand the distribution throughout the country has a similar pattern, with most of the farmers concentrated in central, southern and insular regions, in recent years, there has been in

Northern Italy, especially in Lombardy and Veneto regions, the rise of numerous goat farms for milk production, often to replace existing cow dairy farms.

According to ISMEA (2013) the sheep farms can be classified in 3 types:

Characteristics	Sardinian semi-intensive	Central Appenine semi-intensive	Southern extensive
Locational			
Region	Sardinia	Tuscany, Latium	Calabria, Sicily
Structural			
Size	250 heads/farm	200 heads/farm	60–100 heads/farm
Feeding approach	Pastureland rotation & night shed	Pastureland rotation & night shed	Transhumance
Race	Sardinian	Sardinian, Comisana, Massese	Comisana, Sicilian, Cross-breeds
Production			
Productivity	High	Middle	Low
Main production	Milk	Milk	Milk
Milk use	Hard cheeses	Hard & semi-hard cheeses	Hard & semi-hard cheeses
Commercial			
Milk price	Low	Mid- to high	Mid- to high

In the northern part of Italy, the goat sector is mainly based on two different kinds of grazing system: semi-intensive and intensive systems. In the semi-intensive systems, the pasture is managed in a rational manner and the animals spend the night in a barn, where they are milked in the evening and in the morning and receive a concentrated feed supplement according to the production level. During the day, they are grazed in fenced areas or guided pastures. In these types of breeding systems, the average number of animals can range from 50 milking animals up to about 200, and often the milk is processed on farm for the production of sour cheese or for rennet coagulation. In Italy, there is only one PDO cheese

containing only goat milk: the *Luinese formaggella*, produced in the Varese foothills of the Alps. Other PDO cheeses containing goat milk always have a predominance of cow's milk. In the intensive system, goats live in a barn all year without ever having access to pasture. In these farms, specialisation is very high and the annual milk production exceeds one tonne of milk/head. The average number of animals in the barn always exceeds 200 milking goats. The goat milk marketed by these farmers is sold through local dairies, which turn it into cheese for the domestic or foreign market.

As for the rest of the country, goat farming is characterised by an extensive or semi-extensive grazing system, with grass and forage being the basis of nutrition. The marketing channels used by the goat farmers in these regions are mainly two: on farm processing of milk or conferring to local private milk processing plants organised for the distribution of cheese at the national level.

Strategic priorities for the IT sheep and goat sector (coming from industry partner direct experience)

1. Increase the level of knowledge of farmers in terms of company management –
2. Stimulate and improve milking practices
3. In dairy farms, valorise the meat of male lambs and kids
4. Carry out local projects for the exploitation of indigenous breeds
5. Improve the quality of milk and milk products
6. Encourage aggregation projects between farms within a territory for the creation of local supply chains
7. Promote farming practices that enable farms to make the most of the company's resources and territory.

In general, ISMEA considers the following weaknesses as relevant to be overcome:

1. Excessive dependence from US in terms of sheep cheese exports (Pecorino Romano)
2. Due strong seasonality demand (Easter), sheep and goat meat supply is low, and the meat sector is dependent on strong (seasonal) imports of lamb (and goat) live animals and meat.
3. Small farm size and aging farmers: low attractiveness of the sector.

SPAIN

Current state and strategic priorities of the Spanish sheep and goat sector

Daniel Martin-Collado

Current situation of sheep and goat sector (*Unless otherwise specified, all data come from official information published by the Ministry of Agriculture, Food and Environment of Spain)

The sheep and goat sector in Spain is mainly located in economically LFAs. Therefore, it is a key sector for the maintenance of rural livelihoods, territory cohesion and the utilisation and management of natural resources. Sheep and goat production has a long history in Spain, which is reflected in the large variety of native breeds, production systems and production goals (meat, milk and both) existing in Spain that stem from the ecological, cultural and diversity of policies across the Spanish territory. Out of the 52 sheep breed officially recognised, 43 are native breeds, of which 33 are endangered. The main sheep breeds according to population size are Churra, Rasa Aragonesa, Manchega, Assaf, Navarra, Lacaune, Segureña, and Latxa. Other native sheep breeds with lower population sizes but high regional economic and social importance are Castellana, Ojinegra de Teruel, Merina, and Carranzana. Goat breeds include 21 native breeds (which makes Spain the EU country with the third highest number of breeds), 15 of which are endangered. There is only one “foreign” breed. The main goat breeds according to census and geographical distribution are: Murciano-Granadina, Malagueña, and Florida. Other breeds of regional importance are Majorera, Palmera, and Tinerfeña.

The sheep and goat sector represented approximately 8% of the final livestock production and 3% of the final agrarian production in 2014, but its importance varies widely from region to region. Sheep and goat meat production represented 5.4% of total livestock production, while sheep and goat milk production accounted for 15% of total milk production in 2013. As is shown in more detail below, there has been a progressive drop in the sheep and goat meat share of total livestock production (9.9% in 2007), while the sheep and goat milk share has increased from 4% in 2007 to 5.5% of in 2014. As a response to this situation, the sector has moved towards greater organisation, leading to the creation and strengthening of farmers’ cooperatives and interbranch organisations. Also, in the last seven years, and

especially from 2012, there has been a remarkable increase of sheep and goat meat, cheese and live animals exports, maybe as a reaction to the drop of internal demand. In the period 2008–2014, exports increased 83.4%, with much of this driven by export to non-EU countries. Finally, it should be noted that current market uncertainties prevent stable profitability of farms and hampers private investment, providing a key role for governmental support for the maintenance of farm profitability.

Sheep sector

The Spanish sheep population reached 16.5 million animals in 2015, the second largest in EU-28 after the UK and accounting for 18% of the total census (Eurostat data, 2014). The sheep sector has, however, suffered 15 years of negative evolution of sheep numbers and sheep meat consumption. This negative trend started with the CAP reform in the year 2000, when the census reached 24.9 million sheep, but since 2010 has slightly lessened. Meanwhile sheep and goat meat consumption dropped from 2.7 kg per capita in 2006 to 1.7 kg per capita in 2014. Note that there is an important regional variability in per capita consumption. This consumption drop has been related to three main reasons: (I) animal protein consumption shift to cheaper options (eggs and pork and chicken meat); (II) population geographic changes from rural, with traditionally higher sheep and goat meat consumption, to urban areas; and (III) socio-cultural and consumption changes that focus on easy-to-make and pre-cooked food.

With regard to dairy sheep, in 2014, sheep cheese production reached 69 100 million tonnes. Cheese production has increased slowly but steadily during the last decade, with a sharper increase since 2012: production increased 15% from 2004 to 2011 and 60% from 2011 to 2014. Although cheese imports (cow, sheep and goats combined) are more important than exports, the sheep cheese sector, as well as the goat cheese sector, is closely dependent on exports to balance the profit.

The number of sheep farms in 2014 was 116 319. In contrast to sheep numbers, farm numbers increased 1.2% on 2013, as they did the previous year.

As is the case in goat products, sheep product labelling is well developed in Spain and is a common market channel for high quality sheep products. There are six sheep meat Protected Designations of Origin (PDOs) and seven pure sheep cheese PDOs, plus two cheese

PDOs that use a blend of milk including sheep milk. PDOs are the marketing strategy chosen by a remarkable proportion of native sheep breed farmers. PDO milk price at farm gate was in 2014 €9.6/hectograde dry mater, compared to the non-PDO milk price of €8.5/hectograde dry mater. The PDO meat price at farm gate, meanwhile, is an average of €0.4-0.5 /kg carcase weight higher than the non-PDO meat price.

Goat sector

In the last decade, the Spanish goat sector has undergone a series of changes that have evolved it towards greater development of farmers' skills and professionalisation of the sector. Despite this change, there is still great heterogeneity in terms of production systems, breeds used and farmers' training levels. Goat production systems range from traditional systems, with flocks of meat or dual-purpose (meat and milk) animals, to more specialised systems in dairy production, featuring advanced technology. Family businesses are the norm and hired labour is rare. The main production is milk, primarily for cheese making, with meat as a by-product.

The Spanish goat population represents the second largest in the EU-28 after Greece, with 22% of the census (2014 Eurostat data). Goat populations have undergone significant fluctuations, a result, amongst others things, of the price volatility of goat milk, but reached a total of 2.7 million animals in 2014. As with total goat numbers, the number of farms has fluctuated up and down in the last decade, peaking in 2015 at 78 239 farms (SITRAN data) after four years of consecutive increase (65 ,981 farms in 2012). This followed a previous three year period of farm number decline (71 723 farms in 2009).

According to female production type, 49.4% of the national census corresponds to lactating goats, of which 28.8% are used for kid production and 21.8%% are females that have not yet kidded. Regarding production figures, in 2013, total milk production reached 457.03 million L, of which 87.6% went for processing to industry and the remaining 12.4% was used for own consumption/commercialisation. As with sheep, labelled goat cheese products are well developed and represent an important market niche. There are four pure goat cheese PDOs and four cheese PDOs that blend goat cheese with sheep and/or cow's milk. In addition

to PDOs, two goat breeds are recognised under labels for high quality products made from 100% native breeds and one is in process of being recognised.

Sheep and goat sector priorities

1. Improve farm technology and boost innovation in farm practices, processes (cost-optimisation) and products.
2. Increase sector information transparency and data availability at farm and industry level
3. Increase sector professionalisation and farmer education on technical skills
4. Recognise environmental sustainability and conservation of natural resources as essential conditions of the sector's development
5. Continue increasing meat and milk production and quality through genetic selection. Include functional traits in breeding programmes, mainly focusing on highly productive breeds. Explore genomic information options to quicken selection response.
6. Reinforce and develop existing foreign markets and promote opening of new foreign markets
7. Further develop niche markets for unique products, using native breeds and traditional practices
8. Increase sheep and goat product promotion and product demand and raise awareness of the sector's current situation
9. Increase farmer negotiation power through increasing farm clustering and corporate concentration
10. Improve generational turnover and standards of living for farmers

TURKEY

Profile and strategic priorities of the Turkish sheep and goat sector

Sinan Ogun (Red Rock Agricultural Pastoral Tarim Limited Sirketi) and Sezen Ocak (Nigde University)

Current situation of sheep and goat sector

Turkey ranks first in Europe on number of goats, with 10.3 million animals, and second for sheep, with 31 million animals. Small ruminants constitute about 75% of the total number of livestock kept in Turkey. The sheep and goat breeds in Turkey are well adapted to the rangelands and marginal soils of Anatolia (the Asian portion of Turkey) and are of significant economic and cultural importance to the country, contributing to the vulnerable livelihood of the underprivileged farmers who live under extreme conditions in the central plateaus and the southern and eastern highlands of the country. The adapted endemic sheep and goat breeds convert what is otherwise poor vegetation in marginal soils into valuable animal products.

Nearly 90% of the country's sheep are fat tailed breeds (Akkaraman, Morkaraman, Awassi, Dağlıç, Sakız, mixed) and the other 10% are thin tailed (Kıvrırcık, Karayaka, Merino, Gökçeada-Imroz) raised as dual-purpose for dairy and meat. Akkaraman and Morkaraman sheep are the most abundant breeds, accounting for nearly 65% of the total number of sheep in the country. The indigenous thin tailed breeds of Turkey are Kıvrırcık and Karayaka. The Gökçeada (Imroz) and Sakız (Chios) are native to the Aegean region (including the islands) in the west of the country. Hair goats account for almost 90% of the 10.3 million goats in Turkey; the other 10% is made up of Damascus, Kilis, Angora, Saanen and various crossbreeds. Dairy goat production is mainly carried out in the Aegean and North West (Marmara) regions of the country and operates intensively with high technological input.

➤ Turkey's small ruminant system consists of small herds of indigenous animals that are managed using family labour. All breeds are multipurpose and suitable for use in low-input-low-output systems, generally grazing communal pasture land unsuitable for cropping and seasonal cereal stubble. As a consequence, production levels per head are low. In 2013, total production of sheep milk was 1,100 thousand tonnes and goat milk 415 thousand tonnes, whereas total production of sheep and goat meat were 295 and 57 tonnes, respectively.

The agricultural sector contributes 8% to Turkey's GDP. 52% of total agricultural production value is attributed to livestock production and small ruminants make up 26% of production value (Tuik 2013). In 2015, small ruminants made up 9% (sheep 6.3% goats 2.6%) of the total milk produced and 12% (sheep 8.7%, goats 3%) of the total red meat produced in the country.

There are about 3 million agricultural enterprises currently operating in Turkey, mainly small farm units with an average of five heads of livestock and 1.5 ha of land. Sole cropping constitutes 37.2%, mixed enterprise (crop-livestock) production for 62.3% and sole livestock production makes up a mere 0.5% of the total figure. Whilst small ruminant production in Turkey incorporates all systems from intensive and semi intensive to extensive, as well as some regional transhumance-nomadic pastoralism, the majority would be referred to as semi-intensive production, largely driven by climatic conditions and pastureland being relatively unimproved. Climatic conditions in the seven generally accepted geographical areas of Turkey (Marmara, Aegean, Black Sea, East Anatolia, South East Anatolia, Central Anatolia and Mediterranean) are distinctly different and this significantly impacts management decisions related to resource utilisation, breed selection and mating period. For instance, the growing season begins much earlier in the southern Mediterranean regions than in the rest of the country, impacting marketing strategies.

Priorities

- Turkey's regulation on protection of Animal Genetic Resources
- Improving the genetic pool of the National Herd Improvement Program
- National breeding programs for local breeds
- Increasing productivity
- Value adding market strategies for small ruminant products
- Supporting innovation and technology use at farm level, thereby increasing the quality of products
- Increase farmer education and capacity building
- Application of Precision Farming techniques to broad production systems

UK

The profile and strategic priorities of UK sheep farming

Phil Stocker (National Sheep Association) and Konstantinos Zaralis (The Organic Research Centre)

Current situation of sheep sector

The UK breeding flock stands at just below 16 million breeding ewes, with more than 90 different breeds and crosses used, all contributing to a richly diverse farming sector. There are some 75 000 registered sheep holdings in the UK with an estimate of 60 000 sheep keepers. Flock sizes range from single figures to 5 000 ewes. The average flock size in 2015 was 450 animals, up by 4% in number from 2005. The main focus of production is meat, with wool providing useful niche markets for some and currently fully covering the costs of shearing for the majority. Sheep dairy production in the UK is a very small sector, with only approximately 70 sheep dairy farms in production.

The sector is almost exclusively based on a free range to extensive grazing system, with grass and forage being the mainstay of nutrition. Housing is mainly limited to short periods of two to eight weeks approaching and around lambing, with a considerable number of flocks not being housed at all. The commercial sector primarily uses a stratified system, where the hills and uplands produce draft ewes and crossbred ewes for the lowlands and store lambs for finishing in the lowlands, with the lowlands focussing more on producing finished lambs for the market. While this stratified system is well established and successful, however, there are also many lowland farmers who run closed and semi-closed flocks, and others who concentrate on finishing store lambs on grass keep and arable catch crops. Sheep farming is the predominant enterprise in upland and lowland permanent grassland areas, alongside beef suckler herds, and also utilises rotational grass in mixed farming situations.

Around 50% of lambs marketed by farmers are sold through livestock markets with the remainder sold direct to abattoirs. The percentage of cull ewes sold via livestock markets and into the meat trade is closer to 80%. The UK is the third largest exporter of sheep meat globally, exporting an estimated 40% of production, and is also the third largest importer of sheep meat. Exports are predominantly into EU markets and volumes have consistently grown from 31 000 tonnes in 2001 to more than 100 000 tonnes in 2011. Although the UK does not have direct access to China for sheep meat, in 2014 UK exports represented a 13% share of

sheep meat imports to Hong Kong. Sheep meat imports to the UK are mainly from New Zealand, plus small quantities from Australia and Ireland. Since 2011, import volumes have largely been in line with export volumes. The UK domestic market accounts for some 60% of production and outlets are healthily diverse, including supermarkets; independent stores such as high street butchers, farm shops and direct farm sales; and wholesalers supplying the catering market. The domestic ethnic market is important for both lambs and cull ewes and is estimated to account for some 25% of total domestic consumption. Consumption of lamb in the UK has, however, fallen by 30% since 2000 and now accounts for just 6% of total meat consumption, with per capita consumption averaging less than 2kg. The age profile of those consuming most lamb reveals that consumption within higher age groups is higher and younger age groups lower.

Strategic priorities for the UK sheep sector

1. **Domestic and global market development.** The UK sheep industry should respond to changing consumer demand for sheep meat (and dairy products) and take advantage of any new opportunities that this presents. Future success depends on optimising and growing market opportunities for prime products and fifth quarter products, creating competition and demand. Encouraging wider and higher consumption of sheep meat is critical, particularly within younger age groups. Promotion will be a part of this, but we also need to see further product development and the offering of new and innovative cuts that offer a good eating experience and support, rather than limit, systems diversity. While a focus on developing the market for sheep meat has to be the primary aim, it is also important to achieve higher returns related to wool. There is also potential, on a small scale, to explore further development of sheep dairy farming.
2. **Ensure that the health status of the UK's sheep flock is protected.** That overseas trade routes remain open is essential and this requires both political and trade relationship development, and also the avoidance and close management of trade-affecting diseases. Sustainable approaches to maintain animal health and welfare at an optimal level should also be explored further.

3. **Safeguard the genetic diversity of the UK sheep flock and measure and exploit beneficial traits to improve the health and efficiency of the flock.** Although all UK sheep breeds have a role and bring beneficial genetic diversity, there is much efficiency improvement that could be achieved by genetic advancement through identification and selection of particular traits. Such traits could be meat yield based, but could also be maternal and/or health/robustness related.

4. **Increase the value and output from the UK flock, using new and innovative technology.** There is generally low investment in advice, health management and closer working with vets, and adoption of technology, and producers are slow in implementing best practice. Areas in need of technical improvement include genetics, health management and planning, nutrition, grassland management, the recording and use of information, handling and housing systems. All these areas need to reflect the nature of the sheep farming system: that it is diverse, land-based and includes high variability in land type, grassland and climate.

5. **Opportunities for new entrants and young people.** The relatively low capital costs involved in setting up a sheep enterprise mean that sheep farming still offers an achievable first step on the farming ladder for new entrants. However, there is a need for more novel approaches to access to land (such as share farming and partnership arrangements). Overall, the sheep industry needs to become more profitable and less volatile, so the industry not only attracts new blood but also retains it.

6. **Establishing sheep farming in the uplands and lowlands as an attractive and desirable industry that provides positive public goods.** The need for this is particularly evident in the uplands, where sheep numbers have often been driven to unviable levels, resulting in habitat degradation. Sheep farming needs to be seen as a more attractive option than re-wilding. There is also a case to be made for sheep farming becoming a more common part of mixed rotational farming in predominantly arable areas. Work is needed to promote lamb in the UK as a quality product: one that is mainly grass fed, high-welfare and linked to environmental benefits (e.g. grazing in upland areas).

APPENDIX B

Template of literature review of national farming systems typologies [FINLAND]

NUMBER	REFERENCE	TYPE OF ANIMAL AND PRODUCTION SYSTEM	MAIN CLASSIFICATION CRITERIA-STUDY OBJECTIVE	PROFILE OF GEOGRAPHICAL REGION	MAIN CLASSIFICATION VARIABLES and INDICATORS	METHODOLOGY (Expert or Statistical, number of farms)	FARM TYPES DETECTED (CLUSTERS)	SUSTAINABILITY COMPOSITE INDICATORS
1	Statistics from sheep recording and monitoring system of ProAgria (2015).	Sheep meat production with Finnish breeds – Finnsheep and other original breeds – and with imported breeds – Texel, Oxford Down.	Farm practices	All regions	The way lambing and tugging is organised.	Total of 430 farms at the recording scheme.	1. Continuous lambing (30% of farms) 2. Spring lambing (70%).	Do not exist
2	National statistics by ELY centers (industry and environment center) (2015).	All production sheep types and breeds	Geographical location	-Archipelago at SW Finland: mild winter, long grazing season. -South and Mid Finland: more intensive production, large crop fields. -Lapland: Long winter, short grazing season.	Geographical location	-Archipelago (110 farms) -South and Mid Finland (1244 farms) -Lapland (100 farms) Total of 1454 farms.	1. Archipelago 2. South and Mid Finland 3. Lapland	Do not exist
3	Lammastalouden kehitysnäkymät, 11.7.2014 Eeva Heikkilä, Suomen Gallup Elintarviketieto Oy.	All sheep production types	Sheep market outlook: farm investment plans, production forecasts, views about profitability in near future,	All regions	-Subsidised area -Number of ewes -Age of farmer -Crop field area		1. Conventional vs. organic farms 2. Direct sales vs conventional marketing channels	Do not exist

	<p>Traditional sheep keeping. On Estonian and Finnish coast and islands. Knowsheep-project (2013).</p> <p>Hyvä lammas! Näkökulmia lammasketjun vastuulliseen toimintaan. Rautiainen J & Talola S (editors). 2012. Pro Agria.</p>		<p>choice of marketing channels, interest in organic production.</p>		<p>-Number of lambs sold per year</p> <p>- Number of lambs sold on average per farm per year</p>		<p>3. Specialisation: lamb meat/meat processing; conservation and management of traditional rural biotopes and landscape; wool and lambskin processing; animal breeding; support for rare Finnish breeds; etc..</p> <p>NOTE: There is only one farm producing milk.</p>	
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Template of literature review of national MEAT SHEEP farming systems typologies [FRANCE]

NUMBER	REFERENCE	TYPE OF ANIMAL AND PRODUCTION SYSTEM	MAIN CLASSIFICATION CRITERIA-STUDY OBJECTIVE	PROFILE OF THE GEOGRAPHICAL REGION	MAIN CLASSIFICATION VARIABLES/INDICATORS	METHODOLOGY (Expert or Statistical, number of farms)	FARM TYPES DETECTED (CLUSTERS)	SUSTAINABILITY COMPOSITE INDICATORS
1	<p>Perrot et al. (2013), L'élevage d'herbivores au Recensement agricole 2010. Cheptels, exploitations, productions. Institut de l'Élevage, dossier Economie de l'élevage, 440-441, 96 p.</p> <p>Dossier annuel ovins, année 2015 perspectives 2016. Institut de l'Élevage, dossier économie de l'élevage n°467, 40 p.</p>	<p>Heavy breeds, intensive system (high stocking rate)</p> <p>Heavy breeds, semi-intensive or extensive system (low stoking rate)</p> <p>Hardy breeds, semi-intensive or extensive system (no rangelands or little role)</p>	Farm structure and flock management	<p>Mid-West, south of Massif Central, etc.</p> <p>Mid-West, north border of Massif Central, mid-East, etc.</p> <p>South West, Massif Central</p>	<p>Presence of another production (beef cattle, cash crops)</p> <p>Localisation (agricultural district)</p> <p>Type of sheep breeds</p> <p>Stocking rate, feeding and flock management system</p>	By experts and valorisation of the French agricultural census data: about 8 500 farms with at least 150 meat ewes (>70% of the French sheep stocks)	<p>1. Specialised intensive farms: high consumption of conserved forage, speeding up of reproduction rhythm</p> <p>2. Specialised semi-intensive farms: low consumption of stored forage, one lambing per year (1 or 2 periods)</p> <p>3. Specialised semi-intensive farms: high consumption of conserved forage, one lambing per year (1 or 2 periods)</p>	Farm income, work conditions and life quality for farmers, generational renewal, technical results, feed self-sufficiency, disease control, environmental impacts

		Hardy breeds, pastoral extensive system		South East, South			4. Specialised pastoral farms: high dependence on individual and/or collective rangelands	
		Heavy breeds, intensive system		Mid-West, North East, North, etc.			5. Mixed farms with cash crops: autumn lambing, high consumption of conserve forage and concentrate	
		Heavy breeds, intensive or semi-intensive system		Middle-West, North border of Massif Central, Middle East, etc.			6. Mixed farms with beef cattle: low consumption of conserved forage and concentrate, spring lambing (or 2 periods)	

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Template of literature review of national DAIRY SHEEP farming systems typologies [FRANCE]

No	REFERENCE	TYPE OF ANIMAL AND PRODUCTION SYSTEM	MAIN CLASSIFICATION CRITERIA-STUDY OBJECTIVE	PROFILE OF THE GEOGRAPHICAL REGION	MAIN CLASSIFICATION VARIABLES/INDICATORS	METHODOLOGY (Expert or Statistical, number of farms)	FARM TYPES DETECTED (CLUSTERS)	SUSTAINABILITY COMPOSITE INDICATORS
1	<p>Perrot et al. (2013), L'élevage d'herbivores au Recensement agricole 2010. Cheptels, exploitations, productions. Institut de l'Elevage, dossier Economie de l'élevage, 440-441, 96 p.</p> <p>Dossier annuel ovins, année 2015 perspectives 2016. Institut de l'Elevage, dossier économie de l'élevage n°467, 40 p.</p>	<p>Lacaune breed flocks</p> <p>Semi-intensive and pastoral systems</p> <p>Roquefort PDO cheese production</p>	Farm structure and flock management	<p>Roquefort area : mountain areas located in the southern Massif Central</p>	<p>Localisation (agricultural district)</p> <p>Sheep breeds</p> <p>Feeding and flock management system</p> <p>Product process and marketing: milk provided to dairy enterprise or cheese making on farm</p>	<p>By experts and valorisation of the French agricultural census data: about 5 000 farms with at least 25 dairy ewes</p>	<p>1. Milk delivered to local dairy enterprise:</p> <p>1.1. Semi-intensive systems, located in the most favorable areas</p> <p>1.2. Pastoral systems, with sheep rangeland</p> <p><i>In Roquefort area, most of the farms are specialised farms (in milk sheep production)</i></p> <p>2. milk delivered to local dairy enterprise:</p> <p>2.1. Semi-intensive systems, located in Basque hills,</p> <p>2.2. Pastoral systems, with summer mountain pasture,</p> <p>3. On farm cheese making: pastoral systems with summer mountain pastures</p> <p><i>Most of the farms are mixed farms with beef cattle.</i></p>	<p>Farm income, work conditions and life quality for farmers, generational renewal, quality and value of products, feed-self-sufficiency, milk quality in particular for raw milk, disease control, environmental impacts, maintenance of mountain territories.</p>
		<p>Local breeds : Basco-Béarnaise, Manech Black Face and Manech Red Face</p> <p>Semi-intensive and pastoral systems</p> <p>Ossau-Iraty PDO cheese production</p>		<p>Western Pyrenees area : Bearn and Basque mountains, Basque hills</p>				

		<p>Corsica breed flocks</p> <p>Pastoral systems</p> <p>Brocciu PDO cheese production</p>		Corsica Island			<p>4. Milk delivered to local dairy enterprises: pastoral systems with sheep rangeland</p> <p>5. On farm cheese making: pastoral systems with sheep rangeland</p> <p><i>Most of the farms are specialised farms</i></p>	
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Template of literature review of national/regional GOAT farming systems typologies [FRANCE]

NUMBER	REFERENCE	TYPE OF ANIMAL AND PRODUCTION SYSTEM	MAIN CLASSIFICATION CRITERIA-STUDY OBJECTIVE	PROFILE OF THE GEOGRAPHICAL REGION	MAIN CLASSIFICATION VARIABLES/INDICATORS	METHODOLOGY (Expert or Statistical, number of farms)	FARM TYPES DETECTED (CLUSTERS)	SUSTAINABILITY COMPOSITE INDICATORS
1	Perrot et al. (2013), L'élevage d'herbivores au Recensement agricole 2010. Cheptels, exploitations, productions. Institut de l'Élevage, dossier Economie de l'élevage, 440-441, 96 p.	Saanen or Alpine breed Intensive and semi-intensive systems Dairy	Farm structure and flock management	West and , mid-west plains farming and south west plains and hillsides	Localisation (agricultural district) Flock size Feeding and flock management system Presence of another production (beef cattle, cash crops)	By experts and valorisation of the French agricultural census data: about 7 600 farms with at least ten goats	1. Large and middle - sized specialised farms, intensive and semi intensive livestock management, milk delivered to dairy enterprise	Indicators for all systems : Farm income, work conditions and life quality for farmers, generational renewal, quality and value of products, feed self-sufficiency, environmental impacts, health of goats.
	Dossier annuel caprins, année 2015 perspectives 2016. Institut de l'Élevage, dossier	Mainly Alpine or Saanen Semi-intensive system Dairy		South east hillsides and mountains	Product processing and marketing: milk provided to dairy enterprise or for cheese making on farm	2. Small-sized or middle sized, specialised farms, semi-intensive livestock , goat rangeland, management, milk delivered to dairy enterprise		
		Saanen or Alpine breed Intensive and semi-intensive systems Dairy		West and mid-west plains farming and south west plains and hillsides		4. Mixed farms with beef cattle, milk delivered to dairy enterprise		

<p>économie de l'élevage n°466, 27 p.</p>	<p>Saanen or Alpine breed</p> <p>Intensive and semi-intensive systems</p> <p>Dairy</p>		<p>West and mid-west and south west plains farming</p>			<p>5. Goats and cash crops, milk delivered to dairy enterprise</p>	<p>Specific indicators : Water resources management, phytosanitary treatment frequency index</p>
	<p>Saanen or Alpine breed</p> <p>Intensive and semi-intensive systems</p> <p>Dairy</p>		<p>Mid-west plains farming and south west plains and hillsides</p>			<p>6. On farm cheese making: small or middle sized, intensive and semi-intensive livestock management, milk delivered to dairy enterprise</p> <p><i>Most of the farms are specialised</i></p>	<p>Specific indicator : Raw milk quality</p>
	<p>Mainly Alpine or Saanen</p> <p>Semi-intensive system</p> <p>Dairy</p>		<p>South eastern hillsides and mountains</p>			<p>7. On farm cheese making: small-sized farms, pastoral systems with sheep rangeland</p> <p><i>Most of the farms are specialised</i></p>	<p>Specific indicators : Maintenance of mountain territories, raw milk quality</p>

Template of literature review of national/regional farming systems typologies [GREECE]

No	REFERENCE	TYPE OF ANIMAL AND PRODUCTION SYSTEM	MAIN CLASSIFICATION CRITERIA-STUDY OBJECTIVE	PROFILE OF THE GEOGRAPHICAL REGION	MAIN CLASSIFICATION VARIABLES/ INDICATORS	METHODOLOGY (Expert or Statistical, number of farms)	FARM TYPES DETECTED (CLUSTERS)	SUSTAINABILITY COMPOSITE INDICATORS
1	Gelasakis et al. (2012), Journal of Dairy Science	Chios sheep breed – intensive system	Farm characteristics and overall management practices	Lowland plain areas in Northern Greece	Feeding practices, flock size, animal production traits, topography, facilities, health program	Statistical (PCA & CA, 66 farms)	<ol style="list-style-type: none"> 1. Intensive, specialised farms 2. Semi-intensive, high investment 3. Semi-intensive, low investment 4. Semi-intensive, traditional 	Facilities, housing, management, labor, livestock, land use and ownership, nutrition
2	Ragkos et al. (2014), EAAP 2014 Conference, Copenhagen, Denmark	Transhumant sheep and goat farms	Farm structure and management	Mainland Greece and Crete	Farm size (number of farms), Distance of movement, Type of farm (sheep, goat or mixed), days of stay in summer rangelands	Statistical (Two-Step CA, 3040 farms)	<ol style="list-style-type: none"> 1. Mixed farms rearing sheep and goats and perform local movements 2. Farms performing remote movements 3. Farms performing small local movements 4. Goat farms 5. Small regional farms 	number of days spent grazing on mountainous rangelands, distance between summer and winter domicile (representing effects on the landscape if the movement of the flock is performed on foot)
3	Sintori & Tsimboukas (2011), IDF International Symposium on Sheep, Goat and other non-Cow Milk, 16-18 May, Athens	Dairy sheep farms	Farm structure & economic indices	Mainland Greece (Western Greece & Central Macedonia)	Feeding practices, Farm size, Gross Margin, Capital intensity, milk production yield, crop production	Statistical (FA, CA, 150 farms)	<ol style="list-style-type: none"> 1. Semi-intensive farms 2. Part-time farmers 3. Extensive farms 4. Crop-livestock farms 5. Intensive farms 6. Mixed livestock farms 	Production cost, gross margin and profit

4	Arsenos et al. (2014), Proceedings of the 4 th ISOFAR Scientific Conference. 'Building Organic Bridges', at the Organic World Congress 2014, 13-15 Oct., Istanbul, Turkey	Goat farms	Structural and management characteristics	Mainland Greece (8 regions)	Replacement rate, Flock size, milk yield, Prolificacy, Facilities score, Farmer's experience, Grazing distance, Cultivated land, weaning age	Statistical (PCA & CA, 103 farms)	<ol style="list-style-type: none"> 1. Large, semi-intensive, high producing and investing farms 2. Semi-extensive, low-input, traditional farms 3. Medium-sized, semi-intensive, low replacement rate and less grazing farms 4. Semi-extensive, traditional farms on expansion, producing heavy weight kids' carcasses 	Facilities, housing, management, labor, livestock, grazing management and nutrition, production traits
5	Aggelopoulos et al. (2014), J of Envir Protection and Ecology, 15 (4)	Sheep and goat farms	Economic indices	Grevena (Northern Greece)	Total production cost, variable capital cost, farm income, farm family income, net profit	Statistics (CA, 81 farms)	<ol style="list-style-type: none"> 1. Small sized farms, animals kept indoors in mountainous areas 2. Transhumance farm system, mountainous, large sized farms 3. medium sized farms, semi-mountainous farm system 	Animal traits, economic results

6	NAGREF, Animal Institution (2004) WELFOOD project, Leonardo Da Vinci Community Vocational Training Action Project (n° 2004 - L-B-PP-170001), 2004-2006	Sheep and goat farms	Management practices & production parameters	The entire country	Feeding dependency, housing, milk and meat productivity	Expert	<p>1. Indoor ewes (ewes are kept indoors and are fed with concentrates. High productivity, domestic breeds)</p> <p>2. Flock ewes (open air milking and lambing. Moderate productivity, grazing)</p> <p>3. Nomadic flock ewes (grazing in the mountainous areas. Low milk and meat productivity)</p>	-
7	Kazakopoulos et al. (1998), Report of the FAIR3 - CT96 - 1893 programme titled "Diversification & reorganisation of activities related to animal production in LFAs	Sheep and goat farms	NA	The entire country	NA	NA	<p>1. Home fed (small sized flocks; kept indoors & bred intensively)</p> <p>2. Intensive (medium size, lowlands, high performance breeds, housed animals)</p> <p>3. Extensive with or without transhumance (applied in LFAs. Local breeds, grazing)</p>	-

Template of literature review of national/regional farming systems typologies [ITALY]

No	REFERENCE	TYPE OF ANIMAL AND PRODUCTION SYSTEM	MAIN CLASSIFICATION CRITERIA-STUDY OBJECTIVE	PROFILE OF THE GEOGRAPHICAL REGION	MAIN CLASSIFICATION VARIABLES/ INDICATORS	METHODOLOGY (Expert or Statistical, number of farms)	FARM TYPES DETECTED (CLUSTERS)	SUSTAINABILITY COMPOSITE INDICATORS
1	ISMEA (2013), Settore ovicapriino – Scchda di settore	It officially refers to both sheep and goats, but the reported typology only covers sheep. Main production is milk	Farm characteristics and structure, overall management practices	All Italy	Herd size, geographic area, breeds, nutrition management (pasture rotation, rangeland, transumance), milk yields, milk use, milk price	Unknown	1.Semi-intensive Sardinian 2. Semi-intensive, Central Appenine 3. Extensive, Southern	none

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Template of literature review of national/regional farming systems typologies [SPAIN]

No	REFERENCE	TYPE OF ANIMAL AND PRODUCTION SYSTEM	MAIN CLASSIFICATION CRITERIA-STUDY OBJECTIVE	PROFILE OF THE GEOGRAPHICAL REGION	MAIN CLASSIFICATION VARIABLES/ INDICATORS	METHODOLOGY (Expert or Statistical, number of farms)	FARM TYPES DETECTED (CLUSTERS)	SUSTAINABILITY COMPOSITE INDICATORS
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1	Riveiro et al. (2013). Agricultural Systems, 120: 27-37	<p>Assaf breed sheep farms; Mainly mixed crop-livestock system Intensive (high stocking density) with some grazing</p>	<p>Production structure variables grouped in the following groups:</p> <ul style="list-style-type: none"> -Size -Utilised agricultural area -Built-up area -Current value of investment subsidies per unit -Weighted average age of capital goods -Relative weight of areas of investment 	Highland plain of North West Spain	<ol style="list-style-type: none"> 1. Weighted value of the number of ewes 2. Stocking rate relative to ewes 3. Forage per unit-ha/100 ewes 4. Grain per unit -ha/100 ewes 5. Pens per unit-m²/ewe 6. Barn per unit-m²/ewe 7. Fraction of buildings 8. Gap between first and last building (years) 9. Value of investment in buildings & machinery 10. Current value of investment subsidies for buildings & machines. 11. Weighted average age of capital goods 12. Power per unit self-propelled machinery(€/ewe) 13. Outsourcing; hired services (no.) 	<p>Statistical; selection of the 13 variables listed in 'MAIN CLASSIFICATION VARIABLES/ INDICATORS', out of 190 original variables, by eliminating correlated and uninformative variables. Then PCA on selected variables and cluster analysis of PCs.</p> <p>44 farms</p>	<ol style="list-style-type: none"> 1. Large traditional farms (9%) 2. Small traditional farms (14%) 3. Farms with a complementary agricultural activity (16%) 4. Emerging small farms (19%) 5. Modernised medium-sized farms (28%) 6. Dairy sheep farms without cultivated land (14%) 	<p>Economic viability based on 27 quantitative and 14 qualitative production structure variables, as described in 'MAIN CLASSIFICATION CRITERIA-STUDY OBJECTIVE' (including farmer age)</p>
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2	Milán et al (2011). Journal of Dairy Science, 94: 771-784	<p>Spanish Assaf and Awassi sheep farms.</p> <p>Mainly mixed crop-livestock system Intensive (high stocking density) with some grazing</p>	<p>Farm typology based on structural, technical, and management variables.</p> <p>Specifically: farm location and land use; flock size; sheep breeds and species other than sheep; family and hired workers employed; animal feed management and organisation; feed typology and origin; reproduction; breeding management and replacement; productive performances; farm facilities and machinery; flock health care; and miscellaneous, including critical points and concerns.</p>	Highland plain of North West Spain	<p><i>(Variables in order of importance according to Correspondence analysis)</i></p> <p>1 – cereal surface 2 – stakeholder age 3 – lambing interval 4 – ewe-ram ratio 5 – age at first lambing 6 – artificial insemination 7 – ewe-lamb replacement criterion 8 – drying-off system 9 – electronic identification 10 – total surface 11 – forage dependency, 12 – concentrate dependency, 13 – -reproductive system 14 – -forage surface 15 – flock size 16 – milk yield 17 – lactation length 18 – ewes per milking stall 19 – milk SCC 20 – labor</p>	<p>Statistical: correspondence analysis and cluster analysis. 69 farms</p>	<p>1. Large area farms (12%). Predominantly Awassi sheep; devoted to cereal and forage production; high level of self-consumed commodities</p> <p>2. Large flocks (12%). Predominantly Assaf sheep; intermediate farm surfaces devoted to forage production.</p> <p>3. High yielding farms (42%). Predominantly Assaf sheep, with intermediate sized flocks and very intensive management.</p> <p>4. Landless farms (16%). Predominantly Assaf sheep</p>	<p>Flock size variation. External feed dependence. Housing facilities Pluriactivity Owned surface area Farmer age Farmer education</p>
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3	Assaf breed typologies according to Breeders Association (ASSAF.E)	Assaf dairy sheep breed (Milk is sold for cheese making. Lambs are sold as a secondary product at 22–23 days old with an average live weight of 11kg.)	Farm typology based mainly on: flock size, labour (family or hired), animal feed, reproduction and breeding management practices	Highland plain of North West Spain		Expert	<ol style="list-style-type: none"> Semi-intensive familiar systems (30% of farms). Intensive systems where sheep are kept indoors. <ul style="list-style-type: none"> (2.1) Medium size intensive farms (50% of farms). (2.2) Large business farms (20% of farms). 	-
4	Ruiz et al. (1997). EAAP Publ. 89: 42-47	Latxa sheep breed ; grassland based farming system	Reproduction strategy	Mountain areas; Atlantic side; North of Spain; Basque Country	Lambing distribution (first and last lambing; average lambing date); reproductive practices (yearlings) and management (artificial insemination dates).	Statistical (70 flocks x 4 seasons)	<ol style="list-style-type: none"> Very early and very long lambing season Early and long lambing season Late and concentrated lambing season Very late and very concentrated lambing season 	Grazing and feeding costs; access to pastures, productivity (milk yield per sheep); labour availability; profitability
5	Ruiz et al. (2011). Opt. Medit. 100: 231-239	Latxa sheep breed ; grassland based farming system	Marketing and Commercialisation	Mountain areas; Atlantic side; North of Spain; Basque Country	Milk commercialisation channels	Expert	<ol style="list-style-type: none"> Milk sellers Cheese makers 	Feeding costs; productivity (milk yield per sheep); labour availability; profitability (milk price)
6	Ripoll et al. (2012). Agric. Syst. 105: 46-56	Latxa, Rasa Aragonesa & Lacaune breeds ; Meat sheep Systems (mixed crop-livestock) and dairy sheep (grassland based)	Location and productive orientation.	Alpine (Spanish Pyrenees); semi-arid (Ebro valley ecosystems); Atlantic mountains	Reproduction system (1 lambing/year; 3 lambings in 2 years or 5 lambings in 5 years) and productive orientation (milk vs. meat)	Expert (4 case studies)	<ol style="list-style-type: none"> Meat, 1 Lambing/year Meat, 3 lambings/2 year Meat, 5 lambings/3 year Dairy, 1 lambing/year 	Productivity (8 indicators), stability & resilience (5), adaptability (7); equity (10); self-reliance (7)

7	Latxa breed typologies according to the data provided by Breeders Association and advisory services (CONFELAC, ARTZAI GAZTA)	Latxa sheep breed; dairy sheep system	1. Reproduction strategy 2. Commercialisation 3. Grazing management	Mountain areas; Atlantic side; North of Spain; Basque Country	Start of lambing dates, length of the lambing season, fertility of yearlings, main product, milk and cheese commercialisation channel, geographical location, reproduction schedule, grazing resources	Expert	1. Early lambing (December or earlier) and milk seller 2. Early lambing (December or earlier) and cheese maker 3. Late lambing (January or later) and milk seller 4. Late lambing (January or later) and cheese maker	-
8	Rivas et al. (2014). Revista Mexicana de Ciencias Pecuarias, 5: 291-306	Manchega sheep breed; Mixed crop-livestock system Mainly extensive, of pastoral type	Farm size Technology use	Highland plain of southern Central Spain; La Mancha region	Number of ewes. 37 technology innovations identified: 9 in management, 3 in feeding, 7 in reproduction and genetics, 8 in health and milk quality, 4 in natural resources and 6 in equipment and facilities	Expert; Separation of farms based on percentiles of farm size (n of ewes) and number technology innovation used. 157 farms	Two typologies were defined with two types each: (<i>Size based</i>) 1.1 Small (50%) 1.2 Large farms (50%) (<i>Technology use based</i>) 2.1 Medium use of technology innovations (50%) 2.2 High use of technology innovations (50%)	External feed dependency, owned area, labour, productivity, marketing channels

9	Rivas et al. (2015). Italian Journal of Animal Science, 14: 179-186	Manchega sheep breed; Mixed crop-livestock system Mainly extensive, of pastoral type	General farm characteristics: production and economic structure, size, land use and possession, diversification of production, organisation and flock management, productivity, socio-economic factors and farm management	Highland plain of southern Central Spain; La Mancha region	<ul style="list-style-type: none"> - Family labour (%) - stocking rate (livestock unit/ha) - lamb productivity (lambs/ha) - milk productivity (kg/ha) - total surface area (ha) - cultivated area per ewe (ha/ewe) - total investment per ewe (€/ewe) - ownership surface per ewe (ha/ewe) - ewes (n) - grazing area (%) 	Statistical: factor analysis and cluster analysis. 157 farms	<ol style="list-style-type: none"> 1. Smallholders (39.5%). Small family farms 2. Large scale (40.1%). Large extensive farms 3. Mixed technified farms (20.4%) 	Economic viability based on farm economic return from 2011 to 2013. Other potential sustainability indicators: owned surface, external feed.
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10	Toro-Mujica (2012). Small Ruminant Research, 104: 28-36	<p>Manchega sheep breed; Organic farms.</p> <p>Mixed crop-livestock system</p> <p>Mainly extensive, of pastoral type</p>	<p>Livestock management, economic and social variables. Specifically, variables related to production and economic structure, size, land use, diversification of production, organisation and flock management, productivity, socio-economic aspects and farm management</p>	Highland plain of southern Central Spain; La Mancha region	<ul style="list-style-type: none"> - Farm surface area (ha) - Pasture area (ha/ewe) - Flock size (LU) - Stocking rate (LU/ha) - Work units (WU/100 ewes) - Work unit per area (WU/100 ha) - Total income (D) - Unit cost of fixed labour (D /ewe) - Total cost of fixed labour (D /year) - Sheep amortisation (% of total cost) - Machinery amortisation (% of total cost) - Unit gross margin (D /l) - Net margin (D /year) - Unit net margin (D /l) - Unit cost supplementary feed cost (D /l) - Land in ownership (%) - Supplementary feed (kg/ewe and year), - milk productivity (l/ewe and year), - experience in the activity (years) and - technical efficiency 	<p>Statistical: review and selection of variables, PCA and cluster analysis.</p> <p>30 farms</p>	<ol style="list-style-type: none"> 1. Family subsistence systems (29%). Smallest flocks, lowest stocking rate and lower productivity of labour per animal 2. Semi-intensive commercial system (29%). Larger flocks with higher levels of technology and less use of family labour. 3. Family commercial system (42%). Medium-sized flocks; best performance in terms of global sustainability 	<p>Land ownership</p> <p>Supplementary feed</p> <p>Technical efficiency</p> <p>Marketing channels</p> <p>Economic profitability aspects: net margin, net margin without subsidies</p>
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11	Manchega breed typologies according to Breeders Association (AGRAMA)	Manchega breed, milk and meat production	Type of product (milk or meat), farm size, intensification of production system, pure livestock production	Highland plain of southern Central Spain; La Mancha region		Expert	<p>1. Dairy sheep farms where main product is milk and who sell 8–14kg lambs with a maximum age of 35 days as a secondary product</p> <ul style="list-style-type: none"> - 1.1 Small family farms (450–500 ewes) - 1.2 Large semi-intensive farms (1000 ewes) <p>2. Meat sheep farms that do not milk at all and feed-fatten lambs.</p> <p>(mainly large semi-extensive farms that rear on average 750 ewes. There are smaller farms – 500 ewes – very similar in terms of technology, but they are disappearing. The main difference between farms is the commercialisation of lambs under the Cordero Manchega PDO or not.</p>	-
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12	Rasa Aragonesa breed typology by Oviaragon	Rasa Aragonesa sheep breed	Geographical location, intensification of the production system, reproduction management practices, product (suckling lamb, lamb of 24–25 kg), marketing system, entirely livestock/mixed production	North East of Spain (Aragon): Mountain areas and semi-arid regions (Ebro valley ecosystems);	<p>- Structural data: Number of ewes/males Human labour (% family labour)</p> <p>- Productivity indicators: births/deaths replacement (net & per ewe)</p> <p>- Economic data Total incomes: lamb sold, grants. Cost: feeding, labour, health, reproduction, commercialisation, general</p> <p>- INDEX/HUMAN LABOR - INDEX /EWE (EO) - GROSS MARGIN</p>	Expert: Constan sample (35 farms)	-RAINFED, ARID lands -MIXED RAINFED lands -MOUNTAIN lands (transhumance)	Economic viability based on farm economic index. Other factors to consider: generational replacement, stability...
13	Castel et al. (2010). Present situation and future perspectives for goat production systems in Spain. Small Ruminant Research 89, 207–210	Goat production systems in Spain	Farm size Technology use	Whole country	<p>-Number of goats -Grazing surface per goat (ha) -Labour per 100 goats (YWU) - Concentrate per goat (kg) -Forage supply per goat (kg) - Milk produced per goat, per year</p>	Expert: separation of farms based on typologies and breed (7 farms Murciano-Granadina, 8 farms Malagueña, 21 farms Canaria and 18 Payoya)	1. Confined systems 2. Grazing systems	External feed dependency, owned area, hand labour productivity, marketing channels

Template of literature review of national/regional farming systems typologies [TURKEY]

No	REFERENCE	TYPE OF ANIMAL AND PRODUCTION SYSTEM	MAIN CLASSIFICATION CRITERIA-STUDY OBJECTIVE	PROFILE OF THE GEOGRAPHICAL REGION	MAIN CLASSIFICATION VARIABLES/ INDICATORS	METHODOLOGY (Expert or Statistical, number of farms)	FARM TYPES DETECTED (CLUSTERS)	SUSTAINABILITY COMPOSITE INDICATORS
1	Gürsoy, O. 2006. Small Rumin Res, 62:181-191	Sheep and Goats farming systems	Economics and profitability	Turkey	Population, farms size, products, management practices, pasture and rangeland- genetic resources, supports	Statistical data	Sedentary/transhumant/nomadic	Productivity
2	Ocak et al., 2006 3 rd HAICTA Conference, Volos-Greece	Goat breeds: sedentary/transhumant/nomadic	Production – distribution of breeds-management practices	Turkey, particularly Mediterranean region	Regional breed distribution and production system in the Mediterranean region	Review; State Institute Statistical data	Extensive and semi intensive ; traditional and low investment	Land use, management
3	Keskin et al, 2008, J Anim Vet Advances 7:1583-1588	Sheep-goat farming system	Population, livestock production, farm size, gross margin	Southeastern Anatolia	Economic size	Statistical data; interviews	Extensive landless farm Semi-intensive mixed with crop	Standard gross margin, gross production value
4	Davran et al.,2009, Trop Anim Health Prod 41:1151-1155	Goat: highland	Environmental and economical sustainability assessment and gender	Mediterranean highland	Household number, education level, gender role, production system	Statistical data from 8 villages, 4 districts	Extensive; low input Semi intensive; medium investment	Productivity, financial indicators, socio-economic sustainability
5	Ocak et al., 2010, Trop Anim Health Prod 42:155-159.	Goat-lowland and upland	Farm structure and management practice	Lowland-upland areas in Turkey	Production system-geographical zones, population and production traits,	Statistical data (of TSI and FAO)	Semi intensive-traditional-low input Extensive-low	Productivity, management, suggestions for policy makers
6	Atsan et al., 2009. Journal of Animal and Veterinary Advances, 8: 80-84.	Turkish Fat-Tailed native sheep-Semi intensive system	Comparative economic returns from artificial insemination and natural service	North-eastern Turkey	Introducing prolific breeds via artificial insemination for crossbreeding, fertility and productivity	Experimental data	Semi intensive closed flock	Production, e.g., lamb growth and survival, early sexual maturity

7	Atsan et al., 2007. Italian Journal of Animal Science, v. 6, n. 4, p. 407-414	Three main native breeds of sheep: semi intensive	An economic assessment of differently managed sheep flock	Eastern Turkey	Evaluation of production and economic effects of feeding management and hormonal strategy on fat tailed sheep	Statistical data	Semi intensive closed flock	Economic return of different management systems prior to mating, for sheep flocks raised in eastern Turkey
8	Emsen, 2009. XVII Fe.Me.S.P.Rum. Italy.	Thin/Fat Tailed ewes and their crosses with Romanov: semi intensive	Commercial sheep production – performance of Romanov sheep and their crosses with various breeds.	Turkey	Reproductive traits, growing performance and lamb survivability	Statistical data; review	Semi intensive	Productivity, adaptation, carcass performance
9	Gunlu and Alasahan, 2010. Vet Hekim Der Derg 81(2): 15-20, 2010	Goat: native dairy goats; extensive and intensive	General situation of goat breeding in Turkey and suggestions for effective goat breeding	Turkey	Breeds, population, farm size, production system	Review	Extensive and intensive	Productivity, product chain, marketing, policy
10	Aksoy and Yavuz, 2012. Anadolu J Agr Sci, 2012, 27(2):76-79	Native sheep and goat breeds, traditional breeding system	Analysis on the reasons for quitting sheep and goat farming: A case of east Anatolia	East Anatolia	Reasons for quitting sheep and goat farming	Interviews	Extensive Semi intensive Family Labour	Labour, productivity, disease, subsidies

Template of literature review of national/regional farming systems typologies [UK]

NUMBER	REFERENCE	TYPE OF ANIMAL AND PRODUCTION SYSTEM	MAIN CLASSIFICATION CRITERIA-STUDY OBJECTIVE	PROFILE OF THE GEOGRAPHICAL REGION	MAIN CLASSIFICATION VARIABLES/ INDICATORS	METHODOLOGY (Expert or Statistical, number of farms surveyed)	FARM TYPES DETECTED (CLUSTERS)	SUSTAINABILITY COMPOSITE INDICATORS
1. (need to confirm data set)	<p>Department for Environment, Food and Rural Affairs (2015), Structure of the agricultural industry in England and the UK at June 2015, Crown Copyright 2015.</p> <p>https://www.gov.uk/government/statistical-data-sets/structure-of-the-agricultural-industry-in-</p>	<p>Entire UK sheep sector:</p> <p>(Total UK grazing livestock Total UK Female sheep breeding flock. Total UK sheep and lambs.)</p>	<p>Annual UK government publication, showing makeup of UK agricultural sector.</p>	<p>UK England.</p>	<p>Flock size Land use Farm size</p>	<p>Statistical (annual survey by UK government)</p>	<p>1.Less Favored Areas (upland) More than 50% of total holding area is within a designated LFA.</p> <p>2. Lowland Less than 50% of total holding area is within a designated LFA.</p>	<p>Flock size Land use</p>

NUMBER	REFERENCE	TYPE OF ANIMAL AND PRODUCTION SYSTEM	MAIN CLASSIFICATION CRITERIA-STUDY OBJECTIVE	PROFILE OF THE GEOGRAPHICAL REGION	MAIN CLASSIFICATION VARIABLES/ INDICATORS	METHODOLOGY (Expert or Statistical, number of farms surveyed)	FARM TYPES DETECTED (CLUSTERS)	SUSTAINABILITY COMPOSITE INDICATORS
	england-and-the-uk-at-june							
2.	<p>English Beef and Lamb Executive (EBLEX) (2014), The breeding structure of the British sheep industry 2012, AHDB.</p> <p>http://beefandlamb.ahdb.org.uk/wp/wp-content/uploads/2014/09/The-breeding-structure-of-the-British-sheep-</p>	Entire UK sheep sector	Overview of breeding makeup & structure of UK sheep sector.	Great Britain (England, Scotland and Wales).	<p>Total breeding flock and ewe numbers.</p> <p>Ewe breed numbers.</p> <p>Crossbred ewe populations.</p> <p>Number of farms keeping breeding ewes.</p> <p>Ram breed use.</p> <p>Number of purebred ewes.</p> <p>Number of crossbred ewes.</p> <p>Lamb crop.</p>	Statistical (results of survey)	<p>Types of breed:</p> <ol style="list-style-type: none"> 1.Farms using 'Hill Ewes'. 2.Farms using 'Longwool crosses'. 3.Farms using 'Shortwool ewes'. 4.Farms using 'Terminal sires'. 5.Farms using other types of breed. 	Flock size.

NUMBER	REFERENCE	TYPE OF ANIMAL AND PRODUCTION SYSTEM	MAIN CLASSIFICATION CRITERIA-STUDY OBJECTIVE	PROFILE OF THE GEOGRAPHICAL REGION	MAIN CLASSIFICATION VARIABLES/ INDICATORS	METHODOLOGY (Expert or Statistical, number of farms surveyed)	FARM TYPES DETECTED (CLUSTERS)	SUSTAINABILITY COMPOSITE INDICATORS
	industry-2012-180914.pdf							
3.	Anderson.E et al. (2006), A multidimensional farming system typology, SEAMLESS report no.12, SEAMLESS integrated project, (online),	All farm types	Characterise farm types to assist with assessment of agricultural systems.	Austria Belgium Denmark Finland France Germany Greece Ireland Italy Luxembourg Netherlands Portugal Spain	Farm specialisation Land-use Scale of production Intensity of production	Number of farms	Size – large, medium, small – plus intensity – high, medium, low – plus specialisation/land-use – sheep and goats/land independent,sheep and goats/others	Land-use Intensity Size

NUMBER	REFERENCE	TYPE OF ANIMAL AND PRODUCTION SYSTEM	MAIN CLASSIFICATION CRITERIA-STUDY OBJECTIVE	PROFILE OF THE GEOGRAPHICAL REGION	MAIN CLASSIFICATION VARIABLES/ INDICATORS	METHODOLOGY (Expert or Statistical, number of farms surveyed)	FARM TYPES DETECTED (CLUSTERS)	SUSTAINABILITY COMPOSITE INDICATORS
4.	Morgan-Davies.C et al. (2006), Farmers' opinions on welfare, health and production practices in extensive hill sheep flocks in Great Britain, Livestock Science, 104 (2006), pp. 268-277. https://www.researchgate.net/profile/Claire_Morgan-Davies/publication/222972730_Farmers'_opinions_on_welfare_health_and_production_practices_in_extensive_hill_sheep_flocks_in_Great_Britain	Hill sheep farms	Characterise variations in animal health and welfare concerns & issues depending on farm typologies.	Upland areas in northern England and Wales.	Hill flock size, upland flock size, land availability, level of inputs, stocking density.	Number of farms; statistics (chi-squared).	<ol style="list-style-type: none"> 1. Low stocking density + low inputs 2. Low stocking density + moderate inputs 3. Low stocking density + high inputs 4. Low stocking density + very high inputs 5. Moderate stocking density + low inputs 6. Moderate stocking density + moderate inputs 7. Moderate stocking density + high inputs 8. Moderate stocking density + very high inputs 9. High stocking density + low inputs 10. High stocking density + moderate 11. High stocking density + high inputs 12. High stocking density + very high inputs 13. Very high stocking density + low inputs 	Level of inputs stocking density

NUMBER	REFERENCE	TYPE OF ANIMAL AND PRODUCTION SYSTEM	MAIN CLASSIFICATION CRITERIA-STUDY OBJECTIVE	PROFILE OF THE GEOGRAPHICAL REGION	MAIN CLASSIFICATION VARIABLES/ INDICATORS	METHODOLOGY (Expert or Statistical, number of farms surveyed)	FARM TYPES DETECTED (CLUSTERS)	SUSTAINABILITY COMPOSITE INDICATORS
	/links/02e7e52a5a0d3942aa000000.pdf						14. Very high stocking density + moderate inputs 15. Very high stocking density + high inputs 16. Very high stocking density + very high inputs	
5.	Poux.X et al. (2006), Study on environmental consequences of Sheep and Goat farming and of the Sheep and Goat premium system, European Forum on Nature Conservation and Protection. http://ec.europa.eu/agriculture/external-studies/2006/s	Sheep and goat farms.	Develop framework in order to comment on environmental consequences of different sheep management systems in different areas.	France Greece Ireland Italy Spain UK	Overall fodder availability Need for off-farm feed resources Stocking density, other possible use(s) of on-farm forage production. Rationale behind production Located in LFA or not	Number of farms	<ul style="list-style-type: none"> ● Atlantic: <i>Sedentary, intensively stocked, managed grassland.</i> <i>Sedentary sheep and arable.</i> <i>Sedentary semi natural forage.</i> ----- Continental: <i>Sedentary managed grassland.</i> <i>Sedentary crops & grassland.</i> <i>Sedentary forage crops and fodder.</i> ----- Mediterranean: 	Effect on landscape Water Biodiversity and soil

NUMBER	REFERENCE	TYPE OF ANIMAL AND PRODUCTION SYSTEM	MAIN CLASSIFICATION CRITERIA-STUDY OBJECTIVE	PROFILE OF THE GEOGRAPHICAL REGION	MAIN CLASSIFICATION VARIABLES/ INDICATORS	METHODOLOGY (Expert or Statistical, number of farms surveyed)	FARM TYPES DETECTED (CLUSTERS)	SUSTAINABILITY COMPOSITE INDICATORS
	heap2007/full_text_en.pdf						<p><i>Sedentary managed forage area.</i></p> <p>Pastoral: <i>Sedentary semi-natural grassland.</i> <i>Pastoral on stubble and fallows (shepherded)</i> <i>Indoor.</i></p>	
6.	<p>Chadwick.R et al. (2007), The implications of farm-scale methane mitigation measures for long-term national methane emissions, Final Report to Defra on project CC0270, 2007.</p> <p>http://nora.nerc.ac.uk/646/1/000646%5B1%5D.pdf</p>	Ruminant livestock farms.	Characterising CH ₄ emissions of different farming systems and likely effectiveness of mitigation measures.	England Wales Scotland	<ul style="list-style-type: none"> - Grazing days - Fertiliser & feed inputs. - Number of animals. 	Number of farms.	<p>Lowland: <i>300 grazing days.</i> <i>125kg concentrates fed/sheep.</i> <i>30% white clover in grassland.</i> <i>120kgN/ha on grazed grass.</i> <i>600 sheep, 75 lambs.</i></p> <p>Upland: <i>300 grazing days.</i> <i>100kg concentrates fed/sheep.</i> <i>30% white clover in grassland.</i> <i>56kgN/ha on grazed grass.</i> <i>400 sheep, 70 lambs.</i></p>	CH ₄ , NH ₃ , N ₂ O, NO ₃ and NO _x emissions.

NUMBER	REFERENCE	TYPE OF ANIMAL AND PRODUCTION SYSTEM	MAIN CLASSIFICATION CRITERIA-STUDY OBJECTIVE	PROFILE OF THE GEOGRAPHICAL REGION	MAIN CLASSIFICATION VARIABLES/ INDICATORS	METHODOLOGY (Expert or Statistical, number of farms surveyed)	FARM TYPES DETECTED (CLUSTERS)	SUSTAINABILITY COMPOSITE INDICATORS
7.	<p>Beaufoy, G., Bignal, E., Hadjigeorgiou, I., Romain, B. and Susmel, P., 2006. Study on environmental consequences of Sheep and Goat farming and of the Sheep and Goat premium system, European Forum on Nature Conservation and Pastoralism.</p> <p>http://www.efncp.org/download/poux2006.pdf</p>	Sheep and goat farming	Study on behalf of DG Agri to examine environmental effects of sheep and goat farming, as well as of EU support systems.	France Greece Ireland Italy Spain UK	Predominant animal feeding system – forage and fodder resources & intensity of management	Expert knowledge	<p>Atlantic: Atlantic – Sedentary intensively stocked Atlantic – Sedentary sheep and arable Atlantic – Sedentary semi-natural forage</p> <p>Continental: Continental – Sedentary managed grassland. Continental – Sedentary crops & grassland. Continental – Sedentary forage crops and fodder.</p> <p>Mediterranean: Mediterranean – Sedentary managed forage area. Mediterranean – Pastoral Mediterranean – sedentary semi-natural grassland Mediterranean – pastoral on stubble and fallows (shepherded) Mediterranean - indoor</p>	Intensity of management Forage & fodder resources.

NUMBER	REFERENCE	TYPE OF ANIMAL AND PRODUCTION SYSTEM	MAIN CLASSIFICATION CRITERIA-STUDY OBJECTIVE	PROFILE OF THE GEOGRAPHICAL REGION	MAIN CLASSIFICATION VARIABLES/ INDICATORS	METHODOLOGY (Expert or Statistical, number of farms surveyed)	FARM TYPES DETECTED (CLUSTERS)	SUSTAINABILITY COMPOSITE INDICATORS
8.	<p>McLaren, A., Lambe, N.R., Morgan-Davies, C., Mrode, R., Brotherstone, S., Conington, J., Morgan-Davies, J. and Bungler, L., 2014.</p> <p>Characterisation of terminal sire sheep farm systems, based on a range of environmental factors: a case study in the context of genotype by environment interactions using Charollais lambs. <i>animal</i>, 8(06), pp.867-876.</p>	Terminal sire sheep farm systems	To define different terminal sire flock environments and investigate the presence of genotype by environment interactions.	UK	<p>Seasonal grazing</p> <p>Weather & vitamin/mineral supplementation</p> <p>Use of hay/silage field grazing</p> <p>Ram management and use of hill/rough type grazing</p>	Statistics analysis) (cluster	<ul style="list-style-type: none"> Cluster 1: Mainly in-bye/improved grazing, few vitamin/mineral supplements, mean farm size 128ha, mean flock size 249.4 ewes. Relatively low rainfall and higher hours of sunshine. Higher average temperatures. Rams with ewes average 48.1 days. Supplementary feed blocks used for 1.2 months. Lambs access to concentrate feed before weaning average 6.5 days. 44% flock treated for liver fluke. <p>-----</p> <ul style="list-style-type: none"> Cluster 2: Increased use of hay/silage field grazing. Less in-bye/improved land grazing. Average farm size 543.8ha, 587.7 ewes. Rams with ewes average 33.4. Lambs access to concentrate feed average 8.1 weeks before weaning. 	<p>Seasonal grazing</p> <p>Use of hill/rough type grazing</p>

NUMBER	REFERENCE	TYPE OF ANIMAL AND PRODUCTION SYSTEM	MAIN CLASSIFICATION CRITERIA-STUDY OBJECTIVE	PROFILE OF THE GEOGRAPHICAL REGION	MAIN CLASSIFICATION VARIABLES/ INDICATORS	METHODOLOGY (Expert or Statistical, number of farms surveyed)	FARM TYPES DETECTED (CLUSTERS)	SUSTAINABILITY COMPOSITE INDICATORS
	https://www.researchgate.net/profile/Justin_Morgan-Davies/publication/261406354_Characterisation_of_terminal_sire_sheep_farm_systems_based_on_a_range_of_environmental_factors_A_case_study_in_the_context_of_genotype_by_environment_interactions_using_Charollais_lambs/links/004635358f1bd86044000000.pdf						<p>-----</p> <ul style="list-style-type: none"> Cluster 3: Heavy reliance on in-bye/improved grazing, less use of hay/silage field grazing. Over 50% made up of improved grazing. Average farm size 173.6ha, 578.3 ewes. Higher rainfall, lower winter temperatures, fewer hours of sunshine, higher use of mineral supplements. Lambs access to concentrate feed average 5.4 weeks before weaning. 	

APPENDIX C

iSAGE on-line Industry Survey results on Farm Types

Industry Partner	Research Partner	Specie - Purpose	Farm types [Typology 1]	Farm types [Typology 2]	Farm types [Typology 3]	Farm types [Typology 4]	Farm types [Extra Notes]
ARDIEKIN (Spain)	NEIKER (Spain)	Sheep - Dairy	One lambing per year: early start of the lambing season	One lambing per year: late start of the lambing season	Cheese making at farm level	Selling of milk	Typologies should be differentiated taking into account at the same time the reproductive management and the processing & marketing strategy.
CAPGENES (France)	IDELE (France)	Goat - Dairy	Selling of milk versus cheese making at farm	Breed	Number of goat	Food system	
AGRAMA (Spain)	INIA (Spain)	Sheep - Dairy	Dairy sheep. Small family farms	Dairy sheep. Large semi-intensive farm with high use of technology	Meat sheep are mainly large semi-extensive farms, with no breeding programs		
PAN (Turkey)	ATAUNI (Turkey)	Goat - Dairy	Out of season breeding	Artificial insemination	Embryo transfer	Elite nuclei herd breeding	
OVARIAGON (Spain)	IAMZ-CIHEAM (Spain)	Sheep - Meat	Dryland arid vs dryland semi-arid vs mountain	Innovative vs traditional	Livestock vs mixed agriculture-livestock		

ICEA (Italy)	UNIVPM (Italy)	Sheep & Goat - Dairy & Meat	Organic goat: selling milk (2 sub-typologies: extensive or semi- intensive)	Organic goat: on-farm cheese making (2 sub- typologies: extensive or semi-intensive)	Organic sheep: extensive, transhumant lamb for meat (three lambings in two years)	Organic sheep: extensive pasture- based system selling milk, not necessarily on the organic market	Organic sheep: semi- intensive (2 sub typologies: either on- farm organic cheese making or selling milk, not necessarily on the organic market), light lamb sold on conventional market
ACOP (Greece)	AUTH (Greece)	Sheep & goat - Dairy	Intensive, lowland area, on-farm feed production, large sized flocks, milk production	Semi-extensive, mountainous and LFA, grazing, medium sized flocks, milk production			
FRIZARTA (Greece)	AUTH (Greece)	Sheep - Dairy	Semi-intensive, traditional farms in semi- mountainous areas with systematic grazing	Semi-intensive, low investment farms with on- farm feed production and seasonal grazing	Intensified, high investment farms in lowlands, following a genetic improvement scheme and specialised in milk production		
RRAP (Turkey)	RRAP (Turkey)	Sheep & goat - Dairy & meat	3 lambings in 2 years	Processing the meat regionally as niche product	Goat meat producer	Extensive/grazing- based production	
ASSAFE (Spain)	INIA (Spain)	Sheep - Dairy	(1) Semi-intensive familiar systems	(2) Intensive systems	(2.1) Medium size intensive farms	(2.2) Large business farms	

CNBL (France)	IDELE (France)	Sheep - Dairy	2 types for Roquefort area: 1. Semi-intensive systems with selling of milk, 2. Pastoral systems with selling of milk	3 types for western Pyrenees: 1. Semi-intensive system (Basque hills) with selling of milk ; 2. Pastoral system with summer mountain pasture with selling of milk; 3. Farm cheese making	2 types for Corsica island : 1. selling of milk, 2. on-farm cheese making		At the national level, the typologies proposed by IDELE are used
AHDB (UK)	SRUC (UK)	Sheep - Meat	Severely disadvantaged area (SDA) breeding flocks	Non-severely disadvantaged area (non-SDA) breeding flocks	Non-SDA February/March lambing flocks	Non-SDA April/May lambing flocks	Store lambing finishing
NSA (UK)	ORC (UK)	Sheep - Dairy & meat	Hill and upland sheep. These would be permanent and largely unimproved grass farms with climatic limitations. Typically they may not finish lambs but would sell onto other lower ground farms to finish. They would also be involved in the production of recognised cross bred females for selling onto lowland breeding farms -- a system known as stratification.	Lowland sheep farms as part of a stratified system. These farms may be lowland permanent pasture or/and rotational grassland and would be buying upland bred crossbred females for breeding. They would be crossing these ewes with recognised terminal sires for finished lamb production	Lowland closed/semi closed flocks. These are breeding flocks on lowland ground, similar to type 2, but they would not be part of the stratified system. They would either keep their own genetics in-house, breeding their own replacements and not buying in, or would buy a range of crossbred ewes from other lowland farms. Their output would be finished meat lambs	Pedigree breeders. These sheep farms would specialise in showing and selling male and female breeding stock of a range of pure breeds. In addition, this group would include breeders of new composite breeds with particular traits	Specialist/artisan sheep producers. These would be relatively small in number but producing specialist products for relatively niche or small markets, often at a high premium. They would include sheep dairy production, high value wool production and quality lamb/mutton

							production for more direct marketing initiatives. A further typology includes specialist finishers of store lambs - these farmers might only keep sheep for part of the year, buying store lambs from farms that don't finish them, often taking grazing and land from larger farms, and finishing those lambs
CABRA (Spain)	CSIC (Spain)	Goat - Dairy & meat	Level of intensification: extensive/mixture/intensive	Flock Size: >500 goats / >250/<500 goats/<250 goats	Type of product: milk/milk-cheese/meat	Technology: automatic milking (yes/no)/automatic feeding (yes/no)/management software (yes/no)	Membership of breeding programme: yes/no
PROAGRIA (Finland)	LUKE (Finland)	Sheep - Meat	Continuous lambing (30% of farms)	Spring lambing (70%).	Conventional farm	Organic farms	Direct sales
AESLA (Spain)	IAMZ-CIHEAM (Spain)	Sheep - Dairy	Family farms with a reduced dimension and following a traditional production system	"Industrial" farms, with a big dimension and under intensive exploitation systems	Farms with artisanal transformation of milk		

SEASG (Turkey)	NIGDE (Turkey)	Sheep & goat - Dairy & meat	Three lambings in two years	One lambing per year	Selling milk and offspring		
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