Small Ruminant Research 226 (2023) 107022

Contents lists available at ScienceDirect

Small Ruminant Research

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

Typology of German sheep farms - Differences in structure, characteristics, challenges and the provision of goods and services

Johan Schütte

Thünen Institute of Farm Economics, Germany

ARTICLE INFO

Keywords:
Farm typology
German sheep farms
Production systems
PAM cluster analysis
Situation of sheep farming

ABSTRACT

Sheep farming in Germany is continuously declining and the reasons for this development are manifold. This article aims to contribute to the research on the current situation of sheep farming by providing a typologisation of German sheep farms. Based on a comprehensive survey (N = 359), a cluster analysis with the Partitioning Around Medoids (PAM) algorithm was carried out. A total of nine farm types could be identified: five types of full-time farms, two types of part-time farms, two types of small-scale and hobby farms. The farms differ in terms of their size, production focus, farming systems and livestock management. The full-time farms focus partly on landscape management and partly on the production of meat, keeping their sheep in a variety of different farming systems. The farms vary significantly in flock size and the area farmed. The part-time and small-scale farms keep their sheep almost exclusively in paddocks. For part-time and small-scale farms, the focus is less on landscape management and more on production. The proportion of part-time and small-scale farms practicing purebred breeding and keeping endangered breeds is higher than among the full-time farms. While the number of lambs reared per ewe is higher on part-time and small-scale farms, lambs reach slaughter maturity faster on full-time farms. Across all identified farm types, the economic situation as well as the future prospects are not rated very positively and lack of profitability and flock protection are identified as major problems.

1. Introduction

Compared to other European countries such as the United Kingdom, Spain or France, Germany has only a very small sheep population. Just like in other European countries, a continuous decline in sheep numbers can be observed in Germany. While in Europe the sheep population has decreased from almost 300 million sheep in 1989 to less than 130 million sheep in 2019, the sheep population in Germany has decreased from 4.1 million sheep to 1.6 million sheep in the same period (FAO, 2021). A particularly sharp decline in sheep numbers was recorded after 2005, when the ewe premium was abolished due to the decoupling of CAP subsidies. EU subsidies were then only granted in the form of decoupled acreage premiums, from which the often land-scarce sheep farms hardly ever benefited. The remaining sheep are currently kept on 19,870 farms in Germany, of which 9503 farms keep less than 20 sheep. Over time, the number of farms with 500 or more ewes has fallen below 1000 (Statistisches Bundesamt, 2021a). A detailed table of farms keeping sheep by flock size classes can be found in appendix 1. The increasing prevalence of wolves since the early 2000 s is an additional challenge for sheep farmers, which discourages many of them from continuing in business (Böckermann, 2020; Deter, 2020). This trend is concerning because of the services that sheep farming provides in addition to the production of food and wool: the maintenance of dykes for flood protection, the maintenance of landscapes in marginal / low-yield areas such as heaths and low-nutrient grasslands, the maintenance of landscapes in terrain that is challenging to manage due to steep slopes and difficult-to-access locations with the associated protection against fires and avalanches (Schroers and Pikart-Müller, 2014). The influence of sheep grazing on biodiversity is controversially discussed (Boggia and Schneider, 2012). But with site-adapted grazing management, a positive influence on biodiversity is confirmed for different sites by various authors (Degabriel et al., 2011; Dostálek and Frantík, 2008).

The precondition to efficiently counteract the decline in sheep farming through targeted advice and support for the farms, is the most up-to-date and comprehensive knowledge about the structure and management of the farms, as well as about the situation of the farm managers. In Germany there is clearly a lack of data and information as sheep farming receives little attention in research. In recent years, only a few scientific articles have been published that explicitly deal with sheep farming in Germany. A common characteristic of these publications is

E-mail address: johan.schuette@gmx.de.

https://doi.org/10.1016/j.smallrumres.2023.107022
Received 15 November 2022; Received in revised form 17 June 2023; Accepted 19 June 2023
Available online 24 June 2023

that they each focus on a specific group of sheep farms or describe a particular aspect of farm management, like profitability or performance. Schroers and Pikart-Müller (2014) provide a detailed collection of data on landscape management with sheep. However, only full-time farms with a production focus on landscape management are included in the analysis. Klumpp et al. (2003) investigated the development potentials of organic sheep farming on the basis of an extensive survey; describing four standardised production methods of organic meat and dairy sheep farming. In addition, there are some regional evaluations of the economic viability of sheep farms, which are mostly limited to full-time farms and are compiled by advisory initiatives. These include, for example, the Baden-Württemberg sheep report, published by the State Institute for the Development of Agriculture and Rural Areas (LEL) in cooperation with an advisory office (LEL, 2015), and the annual report of the Saxony-Anhalt regional control association (Siersleben, 2020).

In contrast, in the international context, there are some comprehensive typologies of sheep farms which provide a systematic overview about the prevalent farm types and their characteristics. Many of these also refer only to a particular region e.g. Aragón (Spain) (Pardos et al., 2008) or north-west Spain (Riveiro et al., 2013) or a breed of sheep (Milán et al., 2003) or a group of sheep farms, such as dairy sheep farms (Gelasakis et al., 2012; Riveiro et al., 2013), or cereal-sheep farms (Caballero, 2001). There are also studies that attempt to provide a nationwide overview of the diversity of farm types (Ibidhi et al., 2018) or worldwide overview about sheep production systems (Morris, 2017). As far as the author is aware, there is currently no comprehensive typology of sheep farms in Germany. To close this research gap, the aim of this study is to typologise sheep farms in Germany on the basis of a Partitioning Around Medoids (PAM) cluster analysis to provide more knowledge about sheep farms, their diversity, and, at the same time, to assess the situation and issues in sheep farming perceived by the farmers for the farm types found. This will form the base for further studies: a) a national and international comparison of the performance and economics of sheep farming in Germany and b) an analysis of market and policy instruments to address the present decline in the sheep population.

2. Data and methodology

The following describes the collection of the dataset. This is followed by a brief introduction to the methodology used for typologisation. The methodology consists of a PAM clustering, which was performed from a distance matrix calculated with the Gower coefficient to account for the mixed scaling of the variables of the analysed dataset.

2.1. Data collection

To find out prevalent types of sheep farms and their production systems, a producer survey was conducted using a standardised questionnaire which consisted of 32 questions (see appendix 2). Using the same questionnaire provides a homogeneous dataset (in terms of variables) collected from very heterogeneous sheep farmers (in terms of conditions and locations). The survey of sheep farms was conducted from June 2019 to September 2019 with the participation of 457 sheep farmers. Out of the total questionnaires received, 88 were incomplete and 10 were not suitable for further analysis due to contradictory or implausible information. Therefore, the sample comprises evaluable datasets from 359 farms. A total of 86,776 ewes were represented, which corresponds to 8% of the 1.06 million ewes recorded in the official agricultural structure survey (Statistisches Bundesamt, 2021b). According to the Association for the Promotion of German Sheep Farming, there are currently about 950 full-time sheep farms in Germany (Deter, 2020). With 115 full-time farms surveyed, this represents more than 10% of the full-time farms. Official statistics show that about 52% of the total sheep population in Germany is kept on farms with a total flock size of at least 500 sheep (Statistisches Bundesamt, 2021b). These farms are often described as full-time farms. The remaining 48% of sheep, are kept by the almost 19,000 other sheep farmers. This shows the importance of part-time farming as well as small-scale and hobby farming in the sheep sector. The survey was conducted in all federal states of Germany, except for the city states. The questionnaire was sent in paper form to 154 farms that are training shepherds. In addition, an online version of the questionnaire was sent to the association members via e-mail distribution lists and newsletters of the regional sheep breeding associations. In addition, the survey was advertised in the magazine “Schafzucht” with a link to the online questionnaire so that sheep farmers who were not members of the breeding associations also had the opportunity to participate in the survey. Thus, in addition to the full-time farms, it was also possible to reach part-time farms as well as hobby and small-scale farms. “Schafzucht” is a leading national magazine for sheep farmers with a circulation of over 5400 copies (Schafzucht, 2021).

2.2. Method of typologisation

A typology is always the result of a grouping process in which one or more attributes are used to divide the elements of a population into different groups. By typologising observations, a reduction of complexity is achieved. A large number of individual cases can be reduced to smaller groups of types. Due to the reduced complexity, it is possible to compare farm types quickly and easily with one another and to find commonalities and differences between them (Bailey, 1994). Furthermore, farm typologies can help to identify priorities and target groups for specific policies and help as a tool for supporting advisors in their work with individual farmers, allowing them to assess different situations with reference to known functional types (Gibon et al., 1999).

An important method for typologisation is cluster analysis. The aim is to divide the observations of a dataset into different groups, where the members within a group should be as similar as possible while the members between different groups should differ as much as possible (Kaufman and Rousseeuw, 1990; Lesmeister, 2015). The methodology of cluster analysis is therefore a suitable and often used method to create typologies. Graskemper et al. (2021) have recently provided a review of existing literature on typologies of farmers. It can be seen that a large number of the typologies considered were created by applying cluster approaches. There are a variety of cluster algorithms. An appropriate fusion algorithm and an adequate measure of similarity between observations need to be chosen from this variety (Weltin et al., 2017). Most commonly used ones are the k-means method or hierarchical clustering methods. However, these methods are only suitable to a limited extent for the analysis of datasets with mixed scaled variables. The problem of mixed scaled variables can be approached by various means, such as conducting a factor analysis beforehand (Lesmeister, 2015), a separate calculation of similarity coefficients or distances for metric and non-metric variables or a transformation from a higher to a lower scaling level (Backhaus et al., 2011). The application of the Partitioning Around Medoids (PAM) algorithm described by Kaufman and Rousseeow (1990) appears to be a more advantageous approach. The cluster analysis is therefore conducted with the PAM algorithm and the Gower coefficient is used to calculate the distance matrix. All analyses are performed with the statistical software R.

2.2.1. Partitioning Around Medoids (PAM) algorithm

This clustering programme is characterised by the flexible selection of the distance measure and the acceptance of distance matrices as input. The distance matrix can be calculated with the Gower coefficient, which has a high suitability with mixed scaled variables. The objective of the PAM algorithm is to minimise the sum of the mean dissimilarities of all observations to their nearest medoids. Since this method is based on average dissimilarities to its nearest representative object instead of sums of squares of dissimilarities, this method is more robust to outliers. The representative objects of the clusters are called medoids. A medoid is defined as that object of the cluster for which the average dissimilarity

to all the objects of the cluster is minimal (Kaufman and Rousseeuw, 1990).

2.2.2. Best number of clusters

To determine the best number of clusters to be calculated the silhouette width s(i) is used. The higher the average silhouette width, the stronger the structure of the cluster solution. Therefore, the cluster number is selected for which the average silhouette width is the highest. The maximum value of the silhouette coefficient is 1. From a value of 0.25, a cluster structure is present (Kaufman and Rousseeuw, 1990).

2.2.3. Gower coefficient

The Gower coefficient compares cases pairwise and calculates the distance between them. The dissimilarity between two observations is the weighted mean of the contributions of each variable. More specifically, the distance is between two rows i and j is calculated as follows:

$$S_{ij} = \sum_{k=1}^{v} S_{ijk} \quad \delta_{ijk} \Big/ \sum_{k=1}^{v} \delta_{ijk}$$

S_{ij} is a weighted mean of S_{ijk} with weights δ_{ijk}, where δ_{ijk} is 0 or 1, and S_{ijk}. The k-th variable contribution to the total distance, is a distance between x_{ik} and x_{jk}. The 0–1 wt δ_{ijk} becomes zero when the variable x_k is missing in either or both rows (i and j), or when the variable is asymmetric binary and both values are zero. In all other situations it is 1. The contribution δ_{ijk} of a nominal or binary variable to the total dissimilarity is 0 if both values are equal, 1 otherwise. The contribution of other variables is the absolute difference of both values, divided by the total range of that variable (Gower, 1971).

3. Results

First, descriptive statistics of the survey results are presented. This is followed by a description of the farm types that emerge from the cluster analysis.

3.1. Descriptive statistics of the surveyed farms

3.1.1. Farm type

30% of the surveyed farmers classified their farms as full-time farms, 42% as part-time farms and 28% as small-scale or hobby farms. The management of the farm as a full-time or part-time farm requires an intention to make a profit to be declared to the fiscal authorities and entitles the farmer to apply for direct payments of the Common Agricultural Policy (CAP). More than 40% of the farms operate other farming activities besides sheep farming, for example suckler cow husbandry, arable farming or horse husbandry. According to their self-assessment, 38% of the producers classified their farms as organic.

3.1.2. Production systems

In Germany, sheep are essentially kept in four different forms. A distinction is made between paddock husbandry and herding, with a further distinction being made in herding between site-independent and site-bound herding. Site-independent herding, called "Wanderschäferei" in Germany, largely corresponds to the traditional nomadic sheep husbandry form of transhumance. It is characterised by movements between summer and winter pastures, often covering long distances between pasture sites. In the following, sheep farmers with this form of farming are referred to as " transhumant shepherds". In contrast, site-bound herding of flocks is characterised by grazing areas closer to the farm site and fixed herding routes. The fourth form of sheep keeping can be seen in the year-round housing of the flocks (von Korn, 2016).

The predominantly used form of keeping sheep is paddock husbandry. More than 80% of the shepherds keep the animals on fenced paddocks a large part of the year. Site-bound shepherding is used by 19% of the shepherds and site-independent herding by only 10% of the farms. Housing is used by 50% of the farms, but often only in winter or for lambing. Only one of the farms surveyed keeps sheep indoors all year round. Seasonal lambing takes place on 59% of the farms. 26% of the farms have two or three lambing periods. On 15% of the farms, lambs are born throughout the year. On average, lambing takes place over a period of 3.9 months. Concentrate feed is used to feed ewes by 58% and lambs by 40% of the sheep farms. Ewes are productive for an average of 7.3 years and rear an average of 1.5 lambs annually per ewe. The average age of lambs at slaughter is 28 weeks and the average live weight is 41.08 kg. On 34% of the farms lambs reach slaughter maturity on pasture and without supplementary feeding, on 26% on pasture with supplementary feeding, on 16% indoors and on 24% in a combined indoor-pasture system. 58% of the farms sell part or all of their production directly to the final customer. 55% of the farms take flock protection measures. Flock protection fences are used by 49% of the farms and guard dogs by 6%.

3.1.3. Situation of sheep farming

On a scale from 1 (very bad) to 10 (very good) the farm managers assessed the prospects of sheep farming on their farm with a mean value of 4.74. The prospects of the entire sheep farming sector, was rated even lower with a mean value of 3.94. The economic situation of their farms was assessed by the farm managers with a mean value of 5.03. The worst perception was of the remuneration for their work in landscape management, with a mean value of 3.48. The main problems currently facing sheep farmers were ranked as low profitability by 55%, flock protection by 44%, and workload by 38% of respondents. Marketing (20%) and the scarcity of available land (29%) were also frequently perceived as problematic. Problems with farm succession (13%), finding employees (8%) and animal health (7%) were less frequently perceived as major problems. Other issues, such as bureaucracy or climate change or behaviour of the public, were specified and described as main problems by only 45 participants in the survey.

3.2. Identified sheep farm types and their characteristics

3.2.1. Selected variables

To perform the cluster analysis, a total of 17 variables were used, describing the size of the farm, the type of farming, the type of livestock management, the focus of the production and the extent of special areas. An overview of the descriptive analysis of the variables can be found in Table 1.

3.2.2. Number of clusters

Fig. 1 shows the average silhouette width as a function of the number of clusters. When the PAM algorithm is performed with a number of $k = 9$ clusters, the average silhouette width is maximized and an average silhouette width of $s(i) = 0.38$ is achieved. A cluster structure could accordingly be found. The cluster solution can be interpreted properly despite the relatively weak cluster separation. Significant differences also exist in this cluster solution between the mean values of a large number of "external" variables (e.g. breeds used or use of concentrated feed) that were not used in the original cluster construction, as can be seen in appendix 3. Aldendorfer and Blashfield (1984) describe a significance test on external variables as a good option to validate a cluster solution.

3.2.3. Allocation of farms to the clusters

Fig. 2 shows the allocation of the farms to the determined clusters according to the number of ewes and the combination of the husbandry systems used. The nine identified clusters are coloured differently in the diagram and the shape of the observation points indicates the type of operation.

The figure reveals a certain separation of the clusters on the basis of the variables "management systems" and "number of ewes" and "type of operation", even if further variables such as the production focus and the

Table 1
Description of clustering variables.

Variable	Description and scales	N	Mean	SD	Min	Max
newes	Number of ewes	359	239.90	521.89	3	5500
landsheep	Area for sheepfarming (ha)	359	83.94	205.24	0.3	2465
spec	Areas not specified as grass- or cropland (ha)	359	15.64	60.45	0	500
fullt	Full-time farm yes= 1, no= 0	359	0.31	0.46	0	1
sparet	Small-scale/Hobby farm yes= 1, no= 0	359	0.27	0.45	0	1
partt	Part-time farm yes= 1, no= 0	359	0.42	0.50	0	1
tpaddock	Time in fenced paddocks (months)	359	7.81	3.80	0	12
therding	Time in site-bound herding (months)	359	1.31	3.05	0	12
tpastor	Time in transhumance (months)	359	0.66	2.33	0	12
tstable	Time in stable husbandry (months)	359	2.83	2.58	0	12
landsc	Focus on landscape management yes= 1, no= 0	359	0.56	0.50	0	1
meat	Focus on meat production yes= 1, no= 0	359	0.88	0.33	0	1
wool	Focus on wool production yes= 1, no= 0	359	0.13	0.33	0	1
milk	Focus on milk production yes= 1, no= 0	359	0.03	0.17	0	1
pastoralism	Transhumance yes= 1, no= 0	359	0.10	0.30	0	1
herding	Site-bound herding yes= 1, no= 0	359	0.19	0.39	0	1
paddock	Paddock husbandry yes= 1, no= 0	359	0.89	0.32	0	1

Source: Author's own compilation based on own farm survey

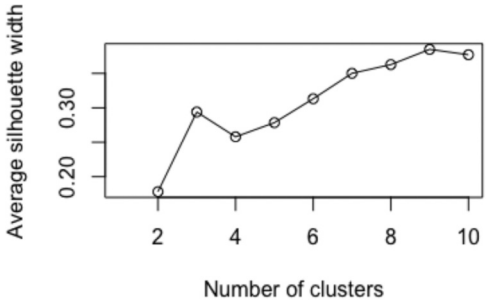

Fig. 1. Average silhouette width as a function of the number of clusters, Source: Author's own calculation based on own farm survey.

available land were used for the clustering. It can be seen that part-time and small-scale farms are clearly dominated by paddock husbandry (p_0_0_0), partly in combination with winter stabling (p_0_0_st), and that these farms have significantly smaller numbers of ewes. The full-time farms, on the other hand, are characterised by a large variety of combinations of husbandry systems and have significantly larger numbers of ewes.

3.2.4. Characteristics of the identified farm types

The nine identified farm types can be distinguished into five types of full-time farms, including three types with larger average herds kept predominantly in herding systems (types 1–3) and two types with smaller average herds kept predominantly in paddocks (types 4,5), two types of part-time farms (types 6,7) also with predominant paddock keeping and two types of small-scale and hobby farms (types 8,9) with almost exclusive paddock keeping. In Table 2 an overview of the main characteristics of the farm types is given. A more extended comparison of the identified farm types based on a mean value comparison of the cluster variables and other descriptive variables included in the analysis can be found in appendix 3.

This type of farm is characterised by site-independent herding. The average farming area is 400 ha and is entirely used for sheep farming. With an average of 24%, farms in this group use the highest share of other land compared to the other groups. Other land areas are mainly specified as heath, alpine pasture, nature conservation and dyke areas. With an average of 9% the share of owned land is the lowest of all groups. The focus of the farms is rather on landscape management than on primary production. With 3.05 ewes /ha the stocking rates are low. The share of farms using concentrate feed is lowest in this group with 39%. With an average of 1.2 lambs raised per ewe, rearing performance is the lowest of all groups. The lambs are slaughtered at an average age of 25.1 weeks with a live weight of 45.7 kg. 33% of the farms engage in direct marketing. Merino breeds are used by 72% of the farms, meat breeds by 56%. With 17%, this group has the lowest share of farms practicing purebred breeding. The majority of the farms have multiple lambing periods or even continuous lambing. 78% of the farm managers have completed an education as shepherds. Most frequently named as the main problems are workload (39%), profitability (33%) and flock protection (28%). Farmers in this cluster rate the economic situation of their farm with on average 5.7 points, the prospects of their sheep farming activities with 5.7 points and the remuneration of their services for landscape management with 4.5 points more positively and the prospects of the sheep farming sector with 3.6 points more negatively compared to the average across all farms.

2. Full-time site-bound herding farms (average flock size 626 ewes)

   All farms in this cluster practice site-bound herding as the main form of sheep farming. There are primarily full-time farms in this group. 81% of the farms are operated conventionally. They use an area of 188 ha for sheep farming. With 12%, the share of own land is below average of the sample. Farms in this group use on average 10% of other land mainly specified as heath or dyke areas. A production focus on meat production was stated for 88% and a focus on landscape management for 73% of the farms. With 15% more farmers state a focus on wool production than for the other full-time farm types. Land breeds and meat breeds are used equally by 42% of the farms and lambing is mainly seasonal. In this group on average of 1.37 lambs per ewe are reared and 58% of the farms use concentrate feed. The lambs are slaughtered at an average age of 23.8 weeks with a live weight of 41.5 kg. 58% of the farms sell part of their production directly. 85% of the farmers have an agricultural education (shepherd or farmer). They assess the economic situation for their own farms (4.9 points) and the prospects of the sheep farming sector (3.4 points) most negatively among the full-time farmers. 65% state the workload and 62% the profitability as the main problems. The scarcity of land is also perceived as a major issue by 42%.
3. Full-time combined herding and paddock farms (average flock size 607 ewes)

   Size-wise this type is comparable to type 2 but the area for sheep husbandry is larger with an average of 211 ha and the share of own land is higher at 22%. With an average of 13%, farms in this group have a high share of other land. Other land areas are mainly specified as marsh, heathland and nature conservation areas. The sheep are kept in fenced paddocks for part of the year and herded on surrounding land for a slightly larger part. The focus of the farms is both on meat production and on landscape management. Among the full-time farm types, the share of organic farms is highest in this group at 43%. With 57% predominantly meat breeds are used. The proportion of endangered breeds (according to the "Society for the Conservation of Old and Endangered Livestock Breeds" (GEH e.V., 2021)) is 20%

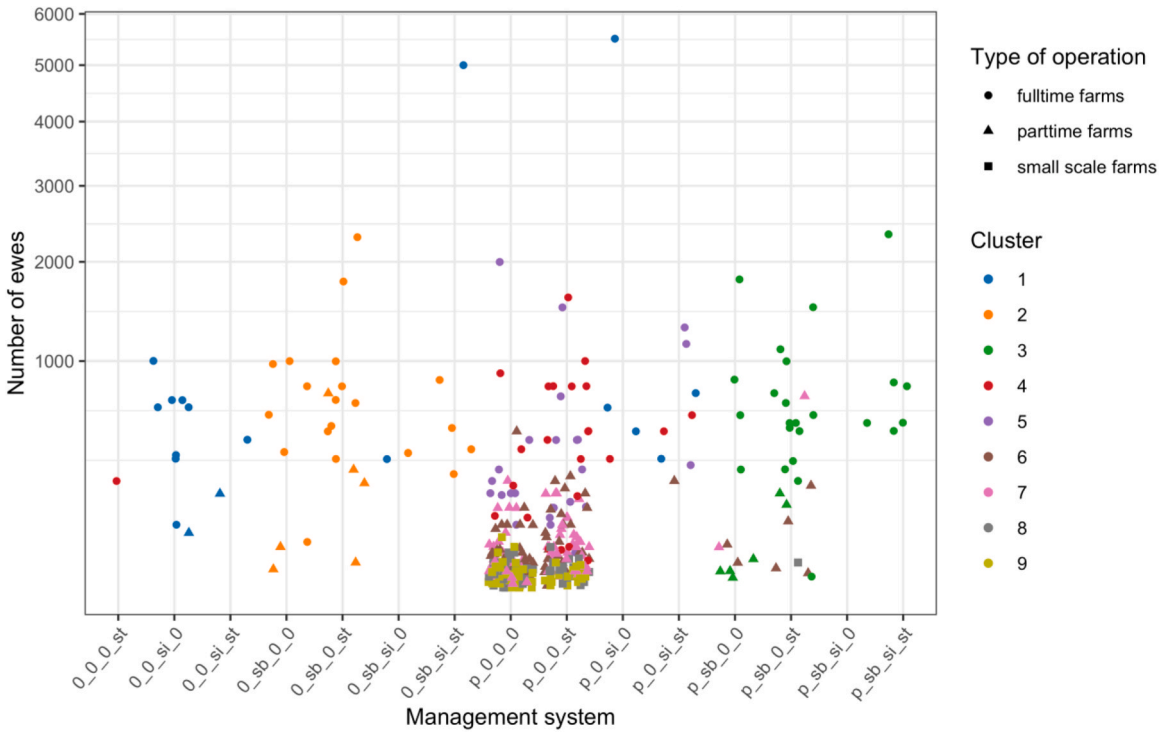

Fig. 2. Distribution of the farms in the identified clusters according to the number of ewes and the management systems used. For the management systems, the "p" stands for paddock management, the "sb" for site-bound and the "si" for site-independent herding and the "st" for stable management,
Source: Author's own calculation based on own farm survey.

Table 2
Comparison of main characteristics of the identified farm types based on the mean values of selected variables. For the mainly used management systems, the "p" stands for paddock management, the "sb" for site-bound and the "si" for site-independent herding and the "st" for stable management.

Cluster no.	1	2	3	4	5	6	7	8	9	p.overall
	N = 18	N = 26	N = 30	N = 24	N = 26	N = 66	N = 72	N = 49	N = 48	
Number of ewes	1019	626	607	476	440	69	62	16	13	< 0.001
Area for sheepfarming (ha)	400.0	188.0	211.0	131.0	196.0	26.6	18.1	3.7	5.3	< 0.001
Total area (ha)	400	436	341	164	288	33.8	23.7	5.6	6.3	< 0.001
Main management systems	si	sb	sb+p	p	p	p	p	p	p	
Share of own land (total area)	0.09	0.12	0.22	0.32	0.18	0.32	0.56	0.36	0.54	< 0.001
Organic	0.28	0.19	0.43	0.13	0.35	0.46	0.39	0.27	0.63	
Lambs raised per ewe	1.20	1.37	1.39	1.51	1.35	1.48	1.61	1.69	1.48	< 0.001
Focus landscape management	0.89	0.73	0.87	0.00	1.00	1.00	0.00	0.00	1.00	< 0.001
Focus meat production	0.78	0.88	0.87	0.92	0.85	0.94	0.97	0.92	0.65	< 0.001
Feeding concentrates	0.39	0.58	0.63	0.83	0.58	0.45	0.56	0.65	0.69	0.027
Purebred breeding	0.17	0.35	0.33	0.50	0.38	0.55	0.53	0.60	0.54	0.018
Flock protection measures	0.83	0.65	0.67	0.54	0.58	0.47	0.36	0.67	0.60	0.002

Source: Author's own calculation based on own farm survey
1. Full-time transhumant shepherds (average flock size 1019 ewes)

and most farms have one or two lambing periods. On average, 1.39 lambs are reared per ewe. 63% of the farms use concentrate feed and the lambs are slaughtered at the age of 23.3 weeks at a weight of 42.0 kg. 37% of the farms engage in direct marketing. 80% of the farmers have an agricultural education. They assess the economic situation of the farm and the remuneration for services in landscape management more positively, and the prospects of sheep farming for their farms and for the entire sector more negatively than the average across all types. The main problems expressed in this group were profitability (60%), workload (53%) and flock protection (50%). In addition, marketing is perceived as an important problem by 40% of the farms in this group.

4. Full-time sheep meat mixed farms (average flock size 476 ewes)

Farms in this group have a clear focus on conventional sheep meat production and the sheep are kept on paddocks and in sheds. On average the farms are using 131 ha for sheep husbandry and with 32%, the share of own land in this group is the highest among the full-time farms. Farms in this group have on average 9% of other land. 25% of the farmers specified those areas as dykes and 12% as photovoltaic areas. With an average of 4.48 ewes/ha this group has the highest stocking rate among the full-time farm types and 83% of these farms use concentrate feed. Almost entirely meat breeds are used and 50% of the farms are purebred breeders. With 1.51 lambs reared per ewe, the rearing performance is the highest in this group among the full-time farms. Also, the proportion of farms using meat breeds is the highest at 79%. The lambs are slaughtered at the age of 25.1 weeks with an average weight of 44.6 kg. 42% of the farms engage in direct marketing. In this group 79% of the farms also have other farming activities, especially crop farming and cattle farming. 38% of the farmers have an agricultural education and 41% have an education as shepherd. On average, they assess the economic situation of their sheep farming with 6.09 out of 10 points, the prospects

of their own sheep farming and the prospects of the sheep farming sector more positively than all other farm types. The most frequently mentioned main problems are workload (58%), profitability (54%) and flock protection (50%).

5. Full-time farms with focus on extensive meat production and landscape management (average flock size 440 ewes)

   The focus of farms in this cluster is on landscape management and the production of sheep meat and the sheep are predominantly managed on fenced paddocks. The average area for sheep farming is 196 ha, of which about 18% is own land. Farms in this group have on average 9% of other land. Farmers mainly specified those areas as dykes (12%), conservation (8%) and photovoltaic areas (8%). With an average of 2.64 ewes/ha this group has the lowest stocking rate among the full-time farm types and with 1.35 lambs reared per ewe, the productivity is relatively low. Despite this, mainly meat breeds are used. 58% of the farms use concentrate feed and the lambs are slaughtered at 24.7 weeks and 41.3 kg. 50% of the farms have other farming activities and 38% of the farms engage in direct marketing. 54% of the farmers have an agricultural education and 38% a shepherd education. They assess the propsects of their own sheep farming and the prospects of the sheep farming sector more negatively than the average of the types. Profitability (50%), workload (46%) and flock protection (42%) are perceived as the most frequent problems.

6. Part-time landscape managing farms (average flock size 69 ewes)

   The focus of production in this group is equally on landscape management and meat production. The sheep are mainly kept on fenced paddocks on an area of 27 ha. The share of own land is 32%. and the share of other land areas mainly specified as photovoltaic areas or orchards is 12%. The lambing is mostly seasonal. Land breeds are used by 53% and meat breeds by 38% of the farms. 55% of the farms are breeding registered purebreds and 27% keep endangered breeds. 46% of the farmers stated that they farm organically. With an average of 1.48 lambs reared per ewe, farms in this group are close to the average of all farms surveyed. 45% of the farms use concentrate feed. The lambs are slaughtered at an average age of 28.3 weeks and liveweight of 40.3 kg. 56% of the farms engage in direct marketing. 38% of the farmers have an agricultural background in education. The assessment of the on-farm (4.8 points) and sector (4 points) prospects for sheep farming in this cluster is similar to the average of all farms. Profitability (61%), flock protection (42%) and workload (39%) are emphasised as the main problems.

7. Part-time direct marketers (average flock size 62 ewes)

   Particularly characteristic for this group is that 75% of the farms sell their products directly to the final consumer. Compared to the part-time farms grouped in cluster 6, these farms focus on meat production. The sheep are kept on fenced paddocks and the area for sheep farming is 18.1 ha. Farms in this group have on average 7% of other land areas not specified in more detail. Farms use meat and land breeds to a similar extent with 38% respectively 39% and 53% of the farms use purebred breeding and 15% use endangered breeds. Lambing is seasonal on 68% of the farms. The rearing performance of 1.61 lambs reared per ewe is relatively high. 56% of the farms use concentrate feed and the lambs are slaughtered at the age of 28.1 weeks with a weight of 41.7 kg. 51% of the farmers have an agricultural education. The perception of the situation hardly differs from the average across all groups and the most frequently mentioned main problems are profitability (58%), flock protection (44%) and workload (32%).

8. Small-scale breeders and self-suppliers (average flock size 16 ewes)

   This type includes small and hobby farms with a focus on breeding. The sheep are kept in fenced paddocks on 3.7 ha. The share of owned land is 36% and farms in this group have on average 8% of other land areas not specified in more detail. Opposite to farms of type 9 none of the farms has a focus on landscape management. Rather, the focus is on the production of meat and wool. With 60%, the proportion of purebred breeders is the highest of all groups and 27% of the farms use endangered breeds. Lambing is mostly seasonal and the use of land breeds is predominant, while meat breeds are use by 24%. With an average of 1.68 lambs reared per ewe, the rearing performance is the highest among all types. With 69%, a large proportion of farms in this group also use concentrate feed. 49% of the farms keep land breeds and 24% keep meat breeds. The average slaughter age of 30.1 weeks is comparable to the other group of small-scale farms, but the slaughter weight of 41.5 kg is considerably higher. The share of direct marketers is also considerably higher, with 78% of the farms. 24% of the farmers have an agricultural education. The biggest problems mentioned are flock protection (56%), profitability (44%) and the scarcity of land (35%).

9. Small-scale lifestyle sheep farms (average flock size 13 ewes)

Compared to the "small-scale breeders and self-suppliers", these farms keep slightly less animals although the area for sheep farming is larger with an area of 5.3 ha used for sheep farming. The share of owned land is above average at 54%. Farms in this group have on average 7% of other land areas not specified in more detail. The sheep are also kept in fenced paddocks and a focus on landscape management was stated for all farms while meat and wool production play a secondary role. The share of purebred breeders is high at 54% and 21% of the farms use endangered breeds. With an average of 1.48 lambs reared per ewe, farms in this group are close to the average of all farms surveyed. With 69%, a large proportion of farms use concentrates. 15% of the farms keep meat and 60% keep land breeds. The age of lambs at slaughter is very high at 31.6 weeks, while the slaughter weight at an average of 35 kg is the lowest in comparison across all groups. Lambing is mostly seasonal. 48% of the farms engage in direct marketing. Some farms also keep other animals such as horses, game or poultry. Only 17% of the farmers have an agricultural education. The biggest problems mentioned are profitability (54%), flock protection (39%) and the scarcity of land (39%).

4. Discussion

In order to counteract the decline in sheep farming, it is necessary to find suitable means to position sheep farming for the future. This requires an accurate and comprehensive picture of the current situation of sheep farming in Germany, which is lacking in current research. This study provides a fundamental contribution to closing this research gap by typologising nine different farm types by means of a PAM cluster analysis on the basis of a comprehensive survey. Differences between the farm types in various characteristics are shown, which determine the type and extent of the provision of market and non-market goods and services and thus the role of farms for society. Additionally, the main problems perceived by the farm managers and their assessment of the situation and perspectives of the sheep farms are outlined. In the following, the implications of the results will be discussed and contextualised.

4.1. Different roles of farm types in the provision of non-market services

4.1.1. Landscape management

In particular, the larger full-time sheep farms (types 1,2 and 3) can be considered to play an important role in landscape management. On the one hand, this importance may be measured by the share of sheep kept by large full-time farms in total German sheep farming. According to official statistics, about 52% of the total sheep population in Germany is kept on larger farms with a total flock size of at least 500 sheep (Statistisches Bundesamt, 2021b). Thus, a large share of the total area farmed with sheep is also managed by farms of these types. On the other hand, the importance is determined by the type of land managed and the used farming system. The results show, that the share of other land areas is comparatively high for the larger full-time farm types. Those areas were mainly specified as nature conservation areas, heathland,

marshland, alpine areas and dykes. Many such landscapes provide a wide range of ecosystem services. High cultural value and biodiversity are attributed to the Lüneburg Heath (Müller et al., 2019) or the Swabian Alb (Walmsley et al., 2021), for example. In some of these Landscapes, such as heathland or steeper slopes sheep grazing cannot or can only partially be replaced by labour-intensive and cost-intensive manual or mechanical management (Schlauderer and Prochnow, 2003; VNP, 2021). For many of these landscapes herding sheep is a preferable way to achieve certain management objectives like nutrient removal and genetic exchange and dispersal of typical species on calcarious grasslands (Lehmair et al., 2020) or nutrient removal on heathland until the desired nutrient status is achieved (Jurkschat, 2017). But the results of this analysis show, that almost exclusively the farms of the larger full-time farm types use forms of site-independent and site-bound herding to keep their flocks. Moreover, forms of herding sheep enable the conservation of certain landscapes with the help of animals, where fencing is not possible due to the nature of the terrain or where the openness of the landscape should not be restricted by fences. Von Korn (2016) estimates that about half of the sheep in Germany are herded at present. In view of the high labour costs, many sheep farmers tend to replace herding completely or partially with paddock systems (von Korn, 2016). Given the apparent importance of herding sheep for the maintenance and conservation of certain landscapes, the trend away from herding towards keeping sheep in paddocks seems unfavourable and the preservation of the larger full-time farms with herding sheep seems to be important. Smaller full-time farms (types 4 and 5) and part-time farms (especially type 6) also play a role in landscape management or maintenance of landscape elements, in places where the objectives of landscape management can also be met with sheep farmed in paddocks. Compared to the larger full-time farms, where whole landscapes such as heaths or dry meadows are maintained, the smaller full-time farms in particular can be attributed an important role in dyke maintenance and the associated flood protection. This is reflected in the results by the high proportion of farms of these types that reported to manage dyke land. A study on dike maintenance in Saxony also describes that especially shepherds who keep their sheep in paddocks manage the majority of dikes (50%). Sheep are herded on only 15% of the dikes. On the remaining dike areas, a combination of both methods is used (Förster and Müller, 2015). The part-time farms seem to maintain more landscape elements such as orchards or photovoltaic areas, and the hobby and small-scale farms tend to maintain garden land and residual areas. The results show that in four of the five types of full-time farms, a large proportion of farmers indicated that their production focus is on landscape management and in the case of farm types 1, 3 and 5, a focus on landscape management was even more frequently indicated than a focus on meat production. The part-time farms of type 6 and the small-scale farms of type 9 also described landscape management as a production focus. This shows that a large proportion of the sheep farmers interviewed seem to be aware of their importance for landscape management and consider landscape management not only as a positive side effect, but as a service they provide.

4.1.2. Breeding and livestock biodiversity

The history of sheep breeding in Germany has been marked by major changes. In the middle of the 19th century, breeding was dominated by Merino breeds and sheep numbers in Germany reached a peak of 28 million sheep. Around the turn of the century, sheep farmers were confronted with an intensification of agriculture and competition from the import of foreign quality wool and the emergence of synthetic fibres, which led to falling prices for wool and a sharp decline in stocks. Breeding and production became almost exclusively oriented towards the production of lamb meat in West Germany from the 1960 s, from 1980 additionally supported by the EC market regulation and the associated ewe premiums, and in East Germany only later after the reunification around 1990 (von Korn, 2016). For today, based on the results of the study, can be assumed that small-scale and hobby farms in particular, but also part-time farms, play an important role in the breeding and conservation of rare and endangered breeds and are therefore essential for the preservation of livestock biodiversity. The proportion of purebred breeders (60%) and keepers of endangered breeds (27%) is highest among the farms of small-scale farms of type 8. The part-time farm types 6 and 7 and the small-scale farms of type 9 also stand out with above-average shares of purebred breeders and use of endangered breeds. The conservation of livestock breeds is important in cultural, ecological and animal welfare terms. Hoffman (2010) describes the conservation of livestock biodiversity as important for food security and rural development as it allows farmers to respond to changing conditions, such as climate change, new or re-emerging disease threats, changing market conditions or changing societal needs, by selecting or developing other breeds. Therefore, it is also a political objective to conserve indigenous livestock breeds and promote their use, which is defined in a national technical programme of the Federal Ministry (BMELV, 2008). The conservation of old livestock breeds, but also the promotion of innovative breeding approaches are mentioned as objectives in a current BMEL (2021) announcement on project funding. But also international programmes like the “Global plan of action for animal genetic resources” (FAO, 2007) show the importance for the conservation of livestock biodiversity. Farms that contribute to the conservation of livestock biodiversity through breeding should therefore be continued.

4.1.3. Transfer of professional knowledge and tradition

Due to its centuries-long tradition, sheep farming has a unique importance in German culture and the profession of shepherding has extensive professional knowledge. Cultural landscapes such as juniper heaths or nutrient-poor grasslands have been created through years of sheep grazing and are testimony to human activity in the natural environment. The custom of sheep husbandry in transhumance and herding still plays an essential role in the preservation of natural and cultural landscapes. For these reasons, southern German herding and transhumance was listed by the German Unesco Commission in 2020 as a national intangible cultural heritage. In addition, the shepherds’ songs, shepherds’ poems and shepherds’ dances that have been created over the centuries represent a special cultural asset (UNESCO, 2022). In the transmission of professional knowledge and the centuries-old shepherding traditions, a special role can be attributed to the full-time farm types. The results show that on these types of farms a proportion of 35%−78% of farmers have completed an education in shepherding, while the proportion on the remaining types of farms is only 2%−11%. Furthermore, the profession of shepherding is taught exclusively on the full-time farms. The preservation of the shepherding tradition and the passing on of professional knowledge to future generations is thus to a certain extent dependent on the preservation of full-time sheep farms.

4.2. Different roles of farm types in the provision of market goods

4.2.1. Meat

Sheep meat production plays only a secondary role in Germany. Annual per capita consumption in the past five years has regularly been only about one kilogram and the degree of self-sufficiency between 38% and 51% (AMI, 2022). Thus, the German market is dependent on imports and sheep farmers compete on quality with producers from abroad. Nevertheless, meat production is an important production objective of sheep farming. This is also evident in the results. Depending on the type of farm, the majority of sheep farmers (65–97%) see their production focus in meat production. The results show clear differences in meat production between the identified farm types. It is remarkable that the five identified full-time farm types show a narrower range in slaughter age and weight than the identified part-time and small-scale farm types where the produced lambs are older and lighter on average at slaughter. The low range of slaughter weight and age is probably due to the requirements of the slaughter and trading companies, as very

standardised lambs for slaughter are demanded. For slaughtering lambs with an age of more than 6 months or a weight of more than 50 kg or an increased degree of fatness or insufficient meatiness, there are significant reductions in the price received (Viehzentrale Südwest, 2021). If lambs are produced for own consumption or direct marketing, as is more often the case with part-time, small-scale and hobby farms, the lambs do not have to meet the strict requirements of slaughter and trading companies, as unique selling points, such as the use of rare breeds or regional specifity, can be emphasised (Feldmann, 2001).

4.2.2. Wool and milk

The production of milk and wool is at present only of minor importance in sheep farming in Germany. The focus of the farms is not often on wool production, but wool is produced in most farms at least as a by-product. This is also reflected in the results of this study: Depending on the type of farm, only 0–29% of the farms stated a focus on wool production. Wool has a low market price because it often does not reach the fineness as wool from New Zealand or China and there are only insufficient processing and collection structures in Germany. Research projects are currently being funded to find innovative processes and techniques for the collection, processing and marketing of wool in order to improve the market situation for sheep's wool (BMEL, 2021). In Europe, about 3 million tons of sheep's milk were produced in 2021, mainly for the production of cheese. Important producing countries are Greece, France and Spain (Eurostat, 2022). With 2.1 million kg, Germany has only a negligible share of the production volume and German sheep's milk production represents only a niche (Manek et al., 2017). Only 0–6% of the farms stated a focus on milk production. This result coincides with data from official statistics, according to which about only 1% of the ewes kept in Germany are classified as dairy sheep (Statistisches Bundesamt, 2021b). Market data on the production of sheep's milk are not systematically recorded for Germany. Manek et al. (2017) assessed the production of sheep's and goat's milk in Germany as an emerging niche that serves a market with surplus demand and is characterised by a high degree of individuality and scarcely developed processing structures.

4.3. Problems perceived by farmers

4.3.1. Profitability and workload

The profitability of sheep farms in Europe is comparatively low compared to farms in Australia, the Middle East or South America. However, sheep farms in Germany have a particularly low profitability compared to other European countries such as France, Spain or Ireland (Deblitz, 2021). Public payments currently account for about 60% of the returns from German sheep farms. They consist of decoupled acreage payments from the first pillar of the CAP and agri-environmental and landscape management programmes from the second pillar (BZL, 2022). Lack of profitability and the high workload were described by a large proportion of shepherds of all identified farm types as their main problem. This result fits with the findings of studies that have investigated the profitability of sheep farms. Siersleben (2020), Wagner (2019) and von Korn (2020) all report low profitability of sheep farming and insufficient remuneration for the shepherds' own work on the farms studied. The problem of a lack of profitability is also reflected in the assessment of the farm managers for the economic situation of their sheep farming. With a mean value of only 5.03 out of 10 points for all farm types, the economic situation was assessed as rather negative as shown in the results. Overall, the sheep farmers did not assess the economic situation of their farms significantly differently between the identified farm types. Thus, the lack of profitability seems to be a problem that affects all farm types equally. In order to define the causes of the problems of profitability and workload more precisely, a detailed analysis of the economic situation of the farm types is necessary. The reintroduction of the ewe premium within the framework of the CAP from 2023 in the amount of € 30 per ewe will be an economic relief for many sheep farmers who have little or no land of their own and therefore do not benefit from the acreage premiums (BZL, 2022).

4.3.2. Flock protection

Apart from profitability and workload, flock protection is also mentioned as one of the main problems of sheep farmers, whereby the assessment of the problem of flock protection does not differ significantly between the identified farm types. The results show, that a majority of the farms already take flock protection measures, while flock protection fences are more widespread than livestock protection dogs. Unexpected was the result that the proportion of farms that take flock protection measures is highest for the larger full-time farm types who are herding their sheep while the types of smaller sheep farms which keep their flocks in fenced paddocks take fewer flock protection measures on average. In addition, the farms that herd their sheep were less likely to rate flock protection as a major problem. One possible approach to explaining this difference is that herding sheep farms are characterised by closer supervision of the flock by the shepherd, which reduces the chances of predation compared to paddock farming. Herding in combination with other protection measures could thus be seen as a very effective way of protecting flocks, but it is not practicable for every type of farm. Overall, both the assessment of the problem and the extent of the measures already implemented show how serious the problem of flock protection is for sheep farmers.

4.3.3. Limitations of the study

The findings of this study have to be interpreted against the background of some limitations. One limitation can be seen in the distribution procedure of the survey and the associated sample. The data collection is based on a survey with voluntary participation, which was distributed through various channels. In principle, every sheep farmer was allowed to participate in the survey, as the invitation to participate was also publicly announced and advertised in a leading magazine for sheep farmers. In addition, the survey was sent out to sheep farmers with the assistance of the regional sheep breeding associations. This may have led to an increased proportion of breeders in the sample. In addition, producers that educate for the profession of shepherd, which are often larger full-time farms, were directly invited to the survey, as a contact list was available from these farms. Thus, the proportion of full-time farms and the average number of ewes are larger in the sample than in the total population in the official statistics. The allocation of the surveyed farms into the different determined clusters can therefore only be transferred to the population to a limited extent. Further limitations result from the questionnaire used: Firstly, the focus on breeding could not be explicitly selected as a possible production focus in the questionnaire. The fact that many farms put considerable emphasis on the production of breeding animals can thus only be indirectly determined from the high proportion of purebred breeders in the sample and the degree of organisation of the shepherds in the breeding associations. Secondly, a more refined specification of the grassland areas in the questionnaire (other than arable land, grassland, other areas) would have provided a better picture of the type and quality of the areas used for sheep husbandry and thus of the role of sheep husbandry in the maintenance and conservation of landscapes. In this study, an average of 13% of the land is specified as arable land, 77% as grassland and 10% as other land (heathland, moorland, dikes). Wagner (2019) describes for full-time sheep farms in Bavaria that only 21% of grassland is specified as meadows or pastures and 79% as sheep pastures, common pastures and extensive pastures. The more detailed specification of grassland areas indicates that much of the grassland used for sheep production is not suitable for a more intensive agricultural use. However, in creating the questionnaire, a balance between the effort required of the volunteers to respond and an even greater level of detail had to be created.

The lack of previous research studies on the topic is another issue. This is not a weakness of this study but the validation of the identified farm types by existing literature is only possible to a very limited extent.

At the time of the study no comprehensive publications on the structure and characteristics of sheep farms in Germany were available. Another limitation lies in the approach of a typology per se. In the case of this study, a typology is a good way to show the characteristics and situation of sheep farms, but deeper reasons for the perceived problems and the evaluation of the situation are not evident from the analysis and need to be investigated in further studies.

5. Conclusions

Sheep farming in Germany has shown a downward trend for many years. This trend is concerning, as sheep farming provides a multitude of societal services. In order to be able to counteract the decline with suitable measures, comprehensive and precise knowledge of the prevailing sheep farms and their situation is necessary. Therefore, the aim of this study was to typologise sheep farms in Germany to provide more knowledge about their diversity and to assess the situation and issues in sheep farming perceived by the farmers for the farm types found. In a comprehensive survey, 359 farms were recorded for this study, which overall exhibited a high degree of uniqueness. However, nine different farm types could be identified on the basis of a Partitioning Around Medoids (PAM) cluster analysis: five types of full-time farms, two types of part-time farms and two types of small-scale and hobby farms. Due to the differences in size in terms of number of ewes and farmed area, the production system used and the focus of production, the identified farm types provide market and non-market goods and services to a different extent.

The full-time farm types can be attributed an important role in landscape conservation, meat production and the transfer of professional knowledge and cultural values. Part-time farm types also play a role in meat production and in landscape management or maintenance of landscape elements, in places where the objectives of landscape management can also be met with sheep farmed in paddocks. Small-scale and hobby farm types can be seen as playing an important role in the breeding and preservation of endangered breeds. Accordingly, the farms of each identified type serve different important functions. The participants in the survey assess the situation for their farm and the sheep farming sector as a whole as not very positive across all identified types. The main problems are seen in the lack of profitability and flock protection, as well as the high workload, with only insignificant differences across the identified types. To maintain the diversity of sheep farming and the range of goods and services it provides, the problems expressed by sheep farmers need to be addressed.

5.1. Outlook and need for further research

The defined farm types are suitable to serve as a basis for further research. In order to accurately address the frequently mentioned main problem of low profitability, a comprehensive economic analysis is needed. Due to the feature of the PAM algorithm to form clusters around representative data points (medoids), it is possible to use these medoids as starting points for a detailed survey of profitability parameters for typical farms. For an in-depth profitability analysis and a comparison of the German farms and with farms abroad, using the typical farm approach described by Chibanda et al. (2020) appears to offer a suitable opportunity. Another basis for conducting in-depth economic analyses could be the German FADN network. With the help of a profitability analysis, the strengths and weaknesses of the farm types should be identified and best practice strategies and perspectives for the future should be derived. In further analyses, the effects of flock protection on the economic situation of farms should also be considered. As many sheep farms in Germany are also involved in other agricultural activities such as crop farming, an analysis of possible synergies that may be created by mixed farming would also be of great relevance.

Declaration of Competing Interest

The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The author wishes to thank Prof. Dr. Uwe Latacz-Lohmann and Dr. Claus Deblitz for critical review as well as Carol Davis for proof reading of the manuscript. The author is grateful to the Thünen Institute of Farm Economics for providing the resources and working environment for this research.

Appendix 1. Farms with sheep on 1 March 2020 by flock size classes

farms with. to. Sheep	farms	number of sheep
1–19	9 503	67 842
20–49	4 882	154 594
50–99	2 350	161 393
100–199	1 245	172 617
200–499	965	309 705
500–999	601	427 016
1 000 and more	324	516 097
total	19 870	1 809 264

Source: Author's own compilation based on Statistisches Bundesamt (2021a)

Appendix 2. Questionnaire

1. Allgemeine Angaben zum Betrieb:

1.1. Wo befindet sich Ihr Betrieb?
Bundesland: .....
Region (z.B: Landkreis, Naturraum): .....

1.2. In welcher Form betreiben Sie die Schafhaltung? *(1 Antwort)*
◯ Haupterwerb ◯ Nebenerwerb ◯ Hobby

1.3. Wie ist Ihre Wirtschaftsweise? *(1 Antwort)*
◯ konventionell ◯ ökologisch

1.4. Betreiben Sie weitere landwirtschaftliche Betriebszweige neben der Schafhaltung?
◯ ja ◯ nein Wenn ja, welche? .....

1.5. Angaben zur Betriebsleitung
Berufsausbildung des Betriebsleiters: .....
Alter des Betriebsleiters (Jahre): .....

1.6. Ist die Hofnachfolge gesichert?
◯ ja ◯ nein

1.7. Bilden Sie auf Ihrem Betrieb Schäfer/-innen aus?
◯ ja ◯ nein

1.8. Wie viele Personen sind in der Schafhaltung tätig? Wie viele Arbeitsstunden leisten diese?

	Anzahl der Personen	Ø Arbeitsstunden pro Person je Woche	Arbeitswochen pro Person pro Jahr
Familienarbeitskräfte inkl. Betriebsleiter			
Lohnarbeitskräfte inkl. Azubis			
Aushilfskräfte			

1.9. Wie viel Fläche steht Ihrem Betrieb zur Verfügung?

	Ackerland (ha)	Grünland (ha)	sonstiges (bitte spezifizieren z.B: Deiche, Heide, Photovoltaik) (ha)
Eigenland			
Pachtland			
kostenlos bereitgestelltes Land			z.B. Deichflächen 60

1.10. Welche Gesamtzahl an Schägen/Koppeln bewirtschaften Sie?
Gesamtzahl: .....

1.11. Nutzen Sie alle Betriebsflächen für die Schafhaltung?
◯ ja ◯ nein Wenn nein, wieviel ha nutzen Sie für die anderen Betriebszweige?.....

1.12. Haben Sie auf allen Flächen Zahlungsansprüche für Direktzahlungen?
◯ ja ◯ nein Wenn nein, für wieviel ha haben Sie keine Zahlungsansprüche?.....

1.13. Haben Sie eigene Maschinen für... *(Zutreffendes auswählen)*
☐ Grünlandpflege ☐ Futterbergung ☐ Futtertransport ☐ Tiertransport ☐ Stallarbeit

.

2. Angaben zur Schafhaltung

2.1. Wie ist die Hauptnutzungsrichtung Ihrer Schafhaltung? *(maximal 2 Antworten)*
☐ (Lamm-)Fleischerzeugung ☐ Milch/Milchprodukte ☐ Landschaftspflege ☐ Wollerzeugung

2.2. In welcher Form halten Sie Ihre Schafherde/n? *(Zutreffendes auswählen)*
☐ Koppelhaltung ☐ Standortgebundene Hütehaltung ☐ Wanderschäferei ☐ Stallhaltung

2.3. In welchen Zeiträumen halten Sie die Schafe jeweils in den verschiedenen Formen?

Haltungsform	von (TT.MM.)	bis (TT.MM.)
Koppelhaltung		
Standortgebundene Hütehaltung		
Wanderschäferei		
Stallhaltung		

2.4. Welche Schafrassen/Kreuzungen (Mutter x Vater) nutzen Sie? *(max. 4 nennen, die wichtigsten zuerst)*
Rassen: .....

2.5. Führen Sie eine Herdbuch-Zucht?
◯ ja ◯ nein

2.6. Haben Sie eigene Stallgebäude für die Schafe?
◯ ja ◯ nein Wenn ja, für wieviele Mutterschafe inklusive Nachzucht haben Sie Stallplätze?.....

2.7. Wie setzt sich Ihr Schafbestand im jährlichen Durchschnitt zusammen und welche Futtermittel setzen Sie ein?

Tiergruppe	Ø Anzahl Tiere	eingesetzte Futtermittel als Ergänzung zur Weide (z.B. Kraftfutter, Silage, Heu)
Mutterschafe		
Zutreter		
Lämmer		
Böcke		

2.8. Ablammung *(je Teilfrage 1 Antwort)*
Wie viele Ablammzeiträume haben Sie auf Ihrem Betrieb? ◯ 1 ◯ 2 ◯ 3 ◯ ganzjährig
Wo findet die Ablammung statt? ◯ auf der Weide ◯ im Stall

2.9. In welchen Zeiträumen finden die Ablammungen statt?

	von (TT.MM.)	bis (TT.MM.)
Zeitraum der 1. Ablammung		
Zeitraum der 2. Ablammung		
Zeitraum der 3. Ablammung		

2.10. Wie ist die Leistung Ihrer Mutterschafe und Lämmer?
Nutzungsdauer der Mutterschafe (in Jahren): .....
Anzahl aufgezogener Lämmer je zum Bock zugelassenen Mutterschaf pro Jahr: .....

Anzahl der vermarkteten Schlachtlämmer pro Jahr: .....
Durchschnittliches Alter bei der Schlachtung der Lämmer in Wochen: .....
Durchschnittliches Gewicht der Schlachtlämmer beim Verkauf (lebend): .....

2.11. Wie werden die Schlachlämmer schlachtreif? *(1 Antwort)*
◯ Weide ohne Zufutter ◯ Weide mit Zufutter ◯ kombinierte Stall-Weidehaltung ◯ im Stall

2.12. Welche besonderen Maßnahmen ergreifen Sie zum Herdenschutz? *(Zutreffendes ankreuzen)*
☐ keine ☐ Herdenschutzzäune ☐ Herdenschutzhunde ☐ sonstige: .....

2.13. Nimmt Ihr Betrieb an Förderprogrammen teil, die speziell auf die Schafhaltung abzielen?
◯ ja ◯ nein Wenn ja, an welchen?.....

2.14. Vermarkten Sie einen Teil Ihrer Produkte direkt? *(Zutreffendes ankreuzen und Anteil spezifizieren)*
◯ ja ◯ nein Wenn ja, welche Produkte und zu welchem prozentualen Anteil an der Produktion?
☐ Fleisch ..... % ☐ Milch ..... % ☐ Wolle ..... %
☐ Felle ..... % ☐ sonstige: ..... %

.

3. Einschätzung der Situation der Schafhaltung

3.1. Wie schätzen Sie die…ein?

	sehr schlecht 1	2	3	4	5	6	7	8	9	sehr gut 10
… wirtschaftliche Situation Ihres Betriebes	○	○	○	○	○	○	○	○	○	○
… Entwicklungsmöglichkeiten Ihrer Schafhaltung	○	○	○	○	○	○	○	○	○	○
… Entwicklungsmöglichkeiten des Sektors Schafhaltung	○	○	○	○	○	○	○	○	○	○
… Honorierung Ihres Beitrages für die Landschaftspflege	○	○	○	○	○	○	○	○	○	○

3.2. Mit welchen Hauptproblemen sehen Sie sich auf Ihrem landwirtschaftlichen Betrieb in Bezug auf die Schafhaltung aktuell konfrontiert? *(maximal 3 Antworten)*

☐ Arbeitsbelastung ☐ Flächenknappheit ☐ Herdenschutz ☐ Hofnachfolge
☐ Mitarbeitersuche ☐ Tierkrankheiten ☐ Wirtschaftlichkeit ☐ Vermarktung
☐ sonstige (bitte spezifizieren): ……

3.3. Welche Herausforderungen sehen Sie auf Ihren Betrieb im Zusammenhang mit der Schafhaltung zukommen?

3.4. Haben Sie Wünsche an die Politik?

○ ja ○ nein Wenn ja, welche?

3.5. Anmerkungen:

.

Appendix 3. Clustering solution and describing variables

		1	2	3	4	5	6	7	8	9	p. overall
		N = 18	N = 26	N = 30	N = 24	N = 26	N = 66	N = 72	N = 49	N = 48	
cluster variables	description										
newes	Number of ewes	1019 (1560)	626 (518)	607 (536)	476 (384)	440 (498)	69.0 (86.5)	62.0 (96.8)	16.1 (10.8)	13.1 (12.6)	< 0.001
landsheep	Area for sheepfarming (ha)	400 (655)	188 (156)	211 (208)	131 (93.3)	196 (246)	26.6 (37.6)	18.1 (26.0)	3.73 (2.70)	5.33 (8.16)	< 0.001
spec	Areas not specified as grass- or cropland (ha)	80.3 (136)	19.5 (46.2)	65.5 (142)	19.7 (52.8)	22.4 (51.3)	6.15 (20.3)	2.36 (11.8)	0.40 (1.33)	1.00 (3.40)	< 0.001
organisation form:											
fullt	Full-time farm	16 (88.9%)	20 (76.9%)	24 (80.0%)	24 (100%)	26 (100%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	
sparet	Part-time farm	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	49 (100%)	48 (100%)	
partt	Small- scale/ hobby farm	2 (11.1%)	6 (23.1%)	6 (20.0%)	0 (0.00%)	0 (0.00%)	66 (100%)	72 (100%)	0 (0.00%)	0 (0.00%)	
tpaddock	Time in fenced paddocks (months)	1.82 (3.95)	0.00 (0.00)	6.51 (3.83)	8.51 (2.49)	8.15 (3.37)	8.83 (2.12)	8.88 (1.93)	9.57 (2.88)	9.76 (2.57)	< 0.001
therding	Time in site-bound herding (months)	0.89 (2.93)	8.22 (2.06)	6.90 (3.29)	0.00 (0.00)	0.00 (0.00)	0.20 (0.81)	0.17 (1.00)	0.16 (1.11)	0.00 (0.00)	< 0.001
tpastor	Time in transhumance (months)	9.42 (2.98)	0.81 (1.78)	0.39 (1.23)	0.52 (1.42)	0.69 (2.32)	0.05 (0.37)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	< 0.001

(*continued on next page*)

(*continued*)

		1	2	3	4	5	6	7	8	9	p. overall
tstable	Time in stable husbandry (months)	1.96 (3.02)	2.71 (2.08)	2.68 (1.96)	4.08 (3.79)	2.60 (2.30)	2.89 (2.10)	3.34 (2.23)	2.62 (3.19)	2.20 (2.65)	0.076
landsc	Focus on landscape management yes= 1, no= 0	0.89 (0.32)	0.73 (0.45)	0.87 (0.35)	0.00 (0.00)	1.00 (0.00)	1.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.00 (0.00)	< 0.001
meat	Focus on meat production yes= 1, no= 0	0.78 (0.43)	0.88 (0.33)	0.87 (0.35)	0.92 (0.28)	0.85 (0.37)	0.94 (0.24)	0.97 (0.17)	0.92 (0.28)	0.65 (0.48)	< 0.001
wool	Focus on wool production yes= 1, no= 0	0.06 (0.24)	0.15 (0.37)	0.03 (0.18)	0.08 (0.28)	0.00 (0.00)	0.03 (0.17)	0.21 (0.41)	0.29 (0.46)	0.12 (0.33)	< 0.001
milk	Fokus on milk production yes= 1, no= 0	0.00 (0.00)	0.04 (0.20)	0.03 (0.18)	0.04 (0.20)	0.04 (0.20)	0.02 (0.12)	0.04 (0.20)	0.06 (0.24)	0.00 (0.00)	0.797
transhumance	Transhumance yes= 1, no= 0	1.00 (0.00)	0.19 (0.40)	0.20 (0.41)	0.12 (0.34)	0.12 (0.33)	0.02 (0.12)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	< 0.001
herding	Herding yes= 1, no= 0	0.11 (0.32)	1.00 (0.00)	1.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.09 (0.29)	0.03 (0.17)	0.02 (0.14)	0.00 (0.00)	< 0.001
paddock	Paddock husbandry yes= 1, no= 0	0.28 (0.46)	0.00 (0.00)	1.00 (0.00)	0.96 (0.20)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	< 0.001
describing variables											
dyke	Managing dikes yes= 1, no= 0	0.11 (0.32)	0.04 (0.20)	0.10 (0.31)	0.25 (0.44)	0.12 (0.33)	0.03 (0.17)	0.01 (0.12)	0.02 (0.14)	0.00 (0.00)	< 0.001
heath	Managing heaths yes= 1, no= 0	0.17 (0.38)	0.08 (0.27)	0.20 (0.41)	0.04 (0.20)	0.04 (0.20)	0.02 (0.12)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	< 0.001
conserv	Managing conservation areas yes= 1, no= 0	0.06 (0.24)	0.00 (0.00)	0.13 (0.35)	0.00 (0.00)	0.08 (0.27)	0.02 (0.12)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.001
marsh	Managing marshland yes= 1, no= 0	0.00 (0.00)	0.00 (0.00)	0.13 (0.35)	0.04 (0.20)	0.00 (0.00)	0.00 (0.00)	0.01 (0.12)	0.00 (0.00)	0.00 (0.00)	< 0.001
orcha	Managing orchards yes= 1, no= 0	0.00 (0.00)	0.00 (0.00)	0.03 (0.18)	0.00 (0.00)	0.00 (0.00)	0.05 (0.21)	0.01 (0.12)	0.02 (0.14)	0.00 (0.00)	0.618
alm	Managing alm pastures yes= 1, no= 0	0.06 (0.24)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.02 (0.12)	0.01 (0.12)	0.00 (0.00)	0.00 (0.00)	0.522
photo	Managing photovoltaic areas yes= 1, no= 0	0.06 (0.24)	0.00 (0.00)	0.03 (0.18)	0.12 (0.34)	0.08 (0.27)	0.12 (0.33)	0.01 (0.12)	0.00 (0.00)	0.00 (0.00)	0.007
dump	Managing dumps yes= 1, no= 0	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.03 (0.17)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.352
anteilgl	Share of grassland (%)	0.67 (0.38)	0.73 (0.32)	0.67 (0.33)	0.71 (0.30)	0.77 (0.25)	0.75 (0.33)	0.79 (0.30)	0.86 (0.31)	0.85 (0.26)	0.091
anteilel	Share of own land (%)	0.09 (0.13)	0.12 (0.16)	0.22 (0.32)	0.32 (0.33)	0.18 (0.22)	0.32 (0.36)	0.56 (0.38)	0.36 (0.41)	0.54 (0.41)	< 0.001
anteilpl	Share of rented land (%)	0.64 (0.32)	0.72 (0.31)	0.61 (0.36)	0.56 (0.36)	0.60 (0.30)	0.37 (0.35)	0.33 (0.33)	0.36 (0.38)	0.20 (0.31)	< 0.001
sharefree	Share of land free to use (%)	0.27 (0.30)	0.12 (0.24)	0.15 (0.21)	0.12 (0.26)	0.22 (0.31)	0.28 (0.37)	0.09 (0.19)	0.21 (0.37)	0.18 (0.34)	0.029
sharespec	Share of areas not specified as grassland or arable land (%)	0.24 (0.35)	0.10 (0.25)	0.13 (0.25)	0.09 (0.21)	0.09 (0.19)	0.12 (0.25)	0.05 (0.17)	0.08 (0.22)	0.07 (0.20)	0.109
landtot in ha	Total farm area (ha)	400 (655)	436 (705)	341 (429)	164 (89.5)	288 (540)	33.8 (41.9)	23.7 (34.6)	5.60 (11.2)	6.34 (9.24)	< 0.001
farming organisation:											
konventionell	Conventional farming	13 (72.2%)	21 (80.8%)	17 (56.7%)	21 (87.5%)	17 (65.4%)	36 (54.5%)	44 (61.1%)	36 (73.5%)	18 (37.5%)	
ökologisch	Organic farming	5 (27.8%)	5 (19.2%)	13 (43.3%)	3 (12.5%)	9 (34.6%)	30 (45.5%)	28 (38.9%)	13 (26.5%)	30 (62.5%)	
age	Age of the farmer (years)	47.4 (13.3)	53.6 (9.03)	50.9 (9.67)	51.5 (5.43)	56.0 (10.9)	52.9 (12.0)	52.3 (12.4)	53.4 (11.0)	54.6 (11.0)	0.325
agricedu	Agricult./ shepherd education yes= 1, no= 0	0.89 (0.32)	0.85 (0.37)	0.80 (0.41)	0.79 (0.41)	0.88 (0.33)	0.38 (0.49)	0.51 (0.50)	0.24 (0.43)	0.17 (0.38)	< 0.001

(*continued on next page*)

(*continued*)

		1	2	3	4	5	6	7	8	9	p. overall
eduagr	Agricultural education yes= 1, no= 0	0.11 (0.32)	0.38 (0.50)	0.33 (0.48)	0.38 (0.49)	0.54 (0.51)	0.27 (0.45)	0.42 (0.50)	0.20 (0.41)	0.15 (0.36)	0.002
edushep	Shepherd education yes= 1, no= 0	0.78 (0.43)	0.42 (0.50)	0.47 (0.51)	0.42 (0.50)	0.35 (0.49)	0.11 (0.31)	0.10 (0.30)	0.04 (0.20)	0.02 (0.14)	< 0.001
higheredu	University degree yes= 1, no= 0	0.11 (0.32)	0.35 (0.49)	0.23 (0.43)	0.25 (0.44)	0.42 (0.50)	0.41 (0.50)	0.28 (0.45)	0.37 (0.49)	0.38 (0.49)	0.237
succession	Succession already regulated yes= 1, no= 0	0.47 (0.51)	0.46 (0.51)	0.37 (0.49)	0.39 (0.50)	0.35 (0.49)	0.34 (0.48)	0.32 (0.47)	0.16 (0.37)	0.23 (0.42)	0.127
trainees	Training of trainees yes= 1, no= 0	0.28 (0.46)	0.32 (0.48)	0.30 (0.47)	0.38 (0.49)	0.19 (0.40)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	< 0.001
othent	Additional enterprises yes= 1, no= 0	0.11 (0.32)	0.38 (0.50)	0.43 (0.50)	0.79 (0.41)	0.50 (0.51)	0.45 (0.50)	0.43 (0.50)	0.27 (0.45)	0.35 (0.48)	< 0.001
crop	Crop productio yes= 1, no= 0 n	0.11 (0.32)	0.08 (0.27)	0.20 (0.41)	0.25 (0.44)	0.04 (0.20)	0.12 (0.33)	0.11 (0.32)	0.02 (0.14)	0.02 (0.14)	0.019
cattle	Cattle production yes= 1, no= 0	0.00 (0.00)	0.08 (0.27)	0.10 (0.31)	0.17 (0.38)	0.15 (0.37)	0.05 (0.21)	0.10 (0.30)	0.04 (0.20)	0.02 (0.14)	0.176
crop and animal	Crop and animal production yes= 1, no= 0	0.00 (0.00)	0.12 (0.33)	0.00 (0.00)	0.12 (0.34)	0.15 (0.37)	0.00 (0.00)	0.01 (0.12)	0.00 (0.00)	0.00 (0.00)	< 0.001
other	Other additional enterprises yes= 1, no= 0	0.00 (0.00)	0.04 (0.20)	0.07 (0.25)	0.21 (0.41)	0.12 (0.33)	0.20 (0.40)	0.03 (0.17)	0.06 (0.24)	0.08 (0.28)	0.010
poultry	Poultry production yes= 1, no= 0	0.00 (0.00)	0.04 (0.20)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.02 (0.12)	0.07 (0.26)	0.08 (0.28)	0.08 (0.28)	0.212
horses,game, other	Horses or game production yes= 1, no= 0	0.00 (0.00)	0.04 (0.20)	0.07 (0.25)	0.04 (0.20)	0.04 (0.20)	0.08 (0.27)	0.11 (0.32)	0.06 (0.24)	0.15 (0.36)	0.487
seaslamb	Seasonal lambing yes= 1, no= 0	0.17 (0.38)	0.50 (0.51)	0.47 (0.51)	0.21 (0.41)	0.42 (0.50)	0.64 (0.48)	0.68 (0.47)	0.71 (0.46)	0.77 (0.42)	< 0.001
2lamb	Two lambing periods yes= 1, no= 0	0.33 (0.49)	0.23 (0.43)	0.33 (0.48)	0.46 (0.51)	0.23 (0.43)	0.15 (0.36)	0.12 (0.33)	0.14 (0.35)	0.06 (0.24)	0.001
3lamb	Three lambing periods yes= 1, no= 0	0.22 (0.43)	0.23 (0.43)	0.17 (0.38)	0.12 (0.34)	0.08 (0.27)	0.03 (0.17)	0.03 (0.17)	0.06 (0.24)	0.00 (0.00)	< 0.001
contlamb	Continuous lambing yes= 1, no= 0	0.28 (0.46)	0.04 (0.20)	0.03 (0.18)	0.21 (0.41)	0.27 (0.45)	0.20 (0.40)	0.17 (0.38)	0.10 (0.31)	0.12 (0.33)	0.088
lambttotal	Total lambing period (months)	6.38 (4.28)	4.12 (2.73)	3.43 (2.27)	4.72 (3.82)	5.22 (4.09)	4.04 (3.67)	3.86 (3.66)	3.26 (2.77)	3.17 (3.24)	0.015
concl	Using concentrates for lamb yes= 1, no= 0	0.17 (0.38)	0.38 (0.50)	0.43 (0.50)	0.54 (0.51)	0.42 (0.50)	0.44 (0.50)	0.47 (0.50)	0.43 (0.50)	0.31 (0.47)	0.300
conc	Using concentrates at all yes= 1, no= 0	0.39 (0.50)	0.58 (0.50)	0.63 (0.49)	0.83 (0.38)	0.58 (0.50)	0.45 (0.50)	0.56 (0.50)	0.65 (0.48)	0.69 (0.47)	0.027
weidemit	Lambs get finished on grassland with additional feeding yes= 1, no= 0	0.19 (0.40)	0.12 (0.33)	0.00 (0.00)	0.17 (0.39)	0.23 (0.43)	0.31 (0.47)	0.28 (0.45)	0.42 (0.50)	0.31 (0.47)	0.006
weideohne	Lambs get finished on grassland without additional feeding yes= 1, no= 0	0.50 (0.52)	0.27 (0.45)	0.33 (0.48)	0.35 (0.49)	0.27 (0.45)	0.28 (0.45)	0.31 (0.46)	0.35 (0.48)	0.49 (0.51)	0.403
stallz	Lambs get finished in the stable with additional feeding yes= 1, no= 0	0.12 (0.34)	0.42 (0.50)	0.30 (0.47)	0.13 (0.34)	0.31 (0.47)	0.15 (0.36)	0.18 (0.39)	0.02 (0.14)	0.03 (0.16)	< 0.001
kombiniert	Lambs get finished in a combination of stable and	0.19 (0.40)	0.19 (0.40)	0.37 (0.49)	0.35 (0.49)	0.19 (0.40)	0.26 (0.44)	0.24 (0.43)	0.21 (0.41)	0.18 (0.39)	0.643

(*continued on next page*)

(*continued*)

		1	2	3	4	5	6	7	8	9	p. overall
	grassland yes= 1, no= 0										
ms/ha schafflächeges	Ewes per ha	3.05 (0.95)	3.64 (1.46)	3.58 (1.85)	4.48 (2.56)	2.64 (1.10)	3.13 (1.97)	4.33 (3.22)	5.72 (4.14)	4.81 (3.51)	< 0.001
cullage	Cullage ewes (years)	7.72 (1.88)	6.28 (1.65)	6.86 (1.66)	6.08 (1.57)	6.73 (1.49)	7.49 (1.66)	7.12 (2.20)	7.52 (2.04)	7.91 (2.04)	0.093
lambs per ewe	Lambs reared per ewe	1.20 (0.22)	1.37 (0.42)	1.39 (0.25)	1.51 (0.25)	1.35 (0.23)	1.48 (0.35)	1.61 (0.35)	1.69 (0.26)	1.48 (0.43)	< 0.001
ageslaughtering	Age at slaughtering (weeks)	25.1 (8.43)	23.8 (9.12)	23.3 (9.06)	25.1 (7.99)	24.7 (9.31)	28.4 (12.6)	28.1 (9.36)	30.1 (16.8)	31.6 (15.1)	0.051
weightslaughtering	Weight at slaughtering (kg live weight)	45.7 (3.85)	41.5 (5.62)	42.9 (6.41)	44.6 (8.86)	41.3 (7.75)	40.3 (8.85)	41.7 (7.87)	41.5 (10.9)	35.0 (12.9)	0.002
herdbook	Practising registered purebred breeding yes= 1, no= 0	0.17 (0.38)	0.35 (0.49)	0.33 (0.48)	0.50 (0.51)	0.38 (0.50)	0.55 (0.50)	0.53 (0.50)	0.60 (0.49)	0.54 (0.50)	0.018
gefährdet laut geh	Breeding of endangered breeds yes= 1, no= 0	0.06 (0.24)	0.04 (0.20)	0.20 (0.41)	0.12 (0.34)	0.19 (0.40)	0.27 (0.45)	0.15 (0.36)	0.27 (0.45)	0.21 (0.41)	0.143
meatbreed	Using meatbreeds yes= 1, no= 0	0.56 (0.51)	0.42 (0.50)	0.57 (0.50)	0.79 (0.41)	0.62 (0.50)	0.38 (0.49)	0.38 (0.49)	0.24 (0.43)	0.15 (0.36)	< 0.001
landbreed	Using landbreeds yes= 1, no= 0	0.61 (0.50)	0.42 (0.50)	0.43 (0.50)	0.12 (0.34)	0.46 (0.51)	0.53 (0.50)	0.39 (0.49)	0.49 (0.51)	0.60 (0.49)	0.011
mountainbreed	Using mountainbreeds yes= 1, no= 0	0.17 (0.38)	0.08 (0.27)	0.03 (0.18)	0.00 (0.00)	0.27 (0.45)	0.18 (0.39)	0.15 (0.36)	0.20 (0.41)	0.19 (0.39)	0.098
merino	Using merinobreeds yes= 1, no= 0	0.72 (0.46)	0.50 (0.51)	0.43 (0.50)	0.21 (0.41)	0.42 (0.50)	0.15 (0.36)	0.08 (0.28)	0.04 (0.20)	0.04 (0.20)	< 0.001
hairbreed	Using hairbreeds yes= 1, no= 0	0.00 (0.00)	0.00 (0.00)	0.03 (0.18)	0.04 (0.20)	0.08 (0.27)	0.06 (0.24)	0.11 (0.32)	0.16 (0.37)	0.10 (0.31)	0.182
otherbreed	Using other breeds yes= 1, no= 0	0.06 (0.24)	0.00 (0.00)	0.03 (0.18)	0.08 (0.28)	0.00 (0.00)	0.05 (0.21)	0.04 (0.20)	0.02 (0.14)	0.06 (0.24)	0.787
direct	Direct marketing activities yes= 1, no= 0	0.33 (0.49)	0.58 (0.50)	0.37 (0.49)	0.42 (0.50)	0.38 (0.50)	0.56 (0.50)	0.75 (0.44)	0.78 (0.42)	0.48 (0.50)	< 0.001
herdprotection	Apply flock protection measures yes= 1, no= 0	0.83 (0.38)	0.65 (0.49)	0.67 (0.48)	0.54 (0.51)	0.58 (0.50)	0.47 (0.50)	0.36 (0.48)	0.67 (0.47)	0.60 (0.49)	0.002
hpfence	Using flock protection fences yes= 1, no= 0	0.83 (0.38)	0.62 (0.50)	0.60 (0.50)	0.42 (0.50)	0.58 (0.50)	0.38 (0.49)	0.35 (0.48)	0.55 (0.50)	0.51 (0.51)	0.003
hpdog	Using Flock protection dogs yes= 1, no= 0	0.11 (0.32)	0.08 (0.27)	0.20 (0.41)	0.12 (0.34)	0.12 (0.33)	0.05 (0.21)	0.01 (0.12)	0.00 (0.00)	0.04 (0.20)	0.008
econfarm	Assessment of the economic situation of the farm scale 1–10 points	5.70 (1.99)	4.87 (2.56)	5.30 (2.45)	6.09 (2.16)	5.04 (2.47)	4.97 (2.12)	5.01 (2.32)	4.50 (2.48)	4.69 (2.45)	0.252
econsheep	Assessment of the prospects of sheepfarming for the own farm scale 1–10 points	5.65 (2.33)	3.87 (2.40)	4.43 (2.30)	5.94 (2.08)	4.34 (2.46)	4.78 (2.26)	4.75 (2.49)	4.47 (2.51)	4.84 (2.42)	0.082
econsector	Assessment of the prospects of sheepfarming for the sector scale 1–10 points	3.60 (1.61)	3.38 (2.37)	3.99 (2.51)	4.36 (2.23)	3.62 (1.98)	4.00 (1.76)	3.84 (2.20)	4.24 (2.36)	3.98 (1.89)	0.756
complandcons	Assessment of remuneration of landscape management services scale 1–10 points	4.50 (2.79)	3.31 (2.43)	3.93 (2.96)	3.51 (2.43)	4.62 (2.82)	3.34 (2.36)	2.79 (2.07)	3.61 (2.36)	3.00 (2.57)	0.033
probecon	Profitability is a problem yes= 1, no= 0	0.33 (0.49)	0.62 (0.50)	0.60 (0.50)	0.54 (0.51)	0.50 (0.51)	0.61 (0.49)	0.58 (0.50)	0.44 (0.50)	0.54 (0.50)	0.437

(*continued on next page*)

(*continued*)

		1	2	3	4	5	6	7	8	9	p. overall
probanimalealth	Animal health is a problem yes= 1, no= 0	0.06 (0.24)	0.00 (0.00)	0.03 (0.18)	0.08 (0.28)	0.00 (0.00)	0.09 (0.29)	0.08 (0.28)	0.06 (0.24)	0.11 (0.31)	0.588
probherdprot	Flock protection is a problem yes= 1, no= 0	0.28 (0.46)	0.31 (0.47)	0.50 (0.51)	0.50 (0.51)	0.42 (0.50)	0.42 (0.50)	0.44 (0.50)	0.56 (0.50)	0.39 (0.49)	0.435
probemploy	Finding employees is a problem yes= 1, no= 0	0.11 (0.32)	0.23 (0.43)	0.23 (0.43)	0.12 (0.34)	0.19 (0.40)	0.06 (0.24)	0.01 (0.12)	0.00 (0.00)	0.00 (0.00)	< 0.001
probmarketing	Marketing is a problem yes= 1, no= 0	0.22 (0.43)	0.08 (0.27)	0.40 (0.50)	0.17 (0.38)	0.08 (0.27)	0.26 (0.44)	0.25 (0.44)	0.19 (0.39)	0.13 (0.34)	0.041
probsuccessio	Succession is a problem yes= 1, no= 0	0.17 (0.38)	0.15 (0.37)	0.03 (0.18)	0.00 (0.00)	0.35 (0.49)	0.08 (0.27)	0.19 (0.40)	0.10 (0.31)	0.09 (0.28)	0.003
probscarcityofland	Scarcity of land is a problem yes= 1, no= 0	0.22 (0.43)	0.42 (0.50)	0.23 (0.43)	0.17 (0.38)	0.31 (0.47)	0.32 (0.47)	0.22 (0.42)	0.35 (0.48)	0.35 (0.48)	0.395
probworkload	Workload is a problem yes= 1, no= 0	0.39 (0.50)	0.65 (0.49)	0.53 (0.51)	0.58 (0.50)	0.46 (0.51)	0.39 (0.49)	0.32 (0.47)	0.21 (0.41)	0.22 (0.42)	< 0.001

References

Aldenderfer, M.S., Blashfield, R.K., 1984. Cluster Analysis (Quantitative Applications in the Social Sciences), 44. Sage University Papers Series, p. 66.

AMI. (2022). Markt Bilanz Vieh und Fleisch 2022. Agrarmarkt Informations-Gesellschaft mbH.

Backhaus, K., Erichson, B., Plinke, W., Weiber, R., 2011. Multivariate Analysemethoden. Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-16491-0.

Bailey, K.D., 1994. Typologies and taxonomies an introduction to classification techniques. In: Virding, A. (Ed.), Sage University Paper series on Quantitative Applications in the Social Sciences, Vols. 07–102. Sage.

BMEL. (2021). Bekanntmachung über die Förderung von Innovationen zum Erhalt und zur Verbesserung der Schaf-und Ziegenhaltung. (Accessed 2022–10-27) https://www.bundesprogramm.de/fileadmin/2-Dokumente/Bekanntmachungen/bekanntmachung-schaf-ziege.pdf.

BMELV. (2008). Tiergenetische Ressourcen in Deutschland Nationales Fachprogramm zur Erhaltung und nachhaltigen Nutzung tiergenetischer Ressourcen in Deutschland.

Böckermann, T. (2020). Löninger Schäfer denkt ans Aufhören. (Accessed 2021–05-18) https://www.noz.de/lokales/herzlake/artikel/1995528/elf-wolfsangriffe-220-tote-schafe-da-bleibst-du-nicht-mensch.

Boggia, S., & Schneider, M. (2012). Schafsömmerung und Biodiversität, Bericht aus dem AlpFUTUR-Teilprojekt 24 "SchafAlp". (Accessed 2021–04-05) http://www.alpfutur.ch/berichte/schafalp_biodiversitaet.pdf.

BZL (Bundesinformationszentrum Landwirtschaft). (2022). Wirtschaftlichkeit der Schafhaltung. (Accessed 2023–02-20) ⟨https://www.nutztierhaltung.de/schaf/oekonomie/keine-schaeferei-ist-wie-die-andere/⟩.

Caballero, R., 2001. Typology of cereal-sheep farming systems in Castile-La Mancha (South-Central Spain). Agric. Syst. 68 (3), 215–232. https://doi.org/10.1016/S0308-521X(01)00009-9.

Chibanda, C., Agethen, K., Deblitz, C., Zimmer, Y., Almadani, M.I., Garming, H., Rohlmann, C., Schütte, J., Thobe, P., Verhaagh, M., Behrendt, L., Staub, D.T., Lasner, T., 2020. The typical farm approach and its application by the Agri benchmark network. Agric. (Switz.) 10 (12), 1–25. https://doi.org/10.3390/agriculture10120646.

Deblitz, C. (2021). agri benchmark Beef and Sheep Report 2021 - a summary of main findings. (Accessed 2023–02-21) ⟨http://catalog.agribenchmark.org/blaetterkatalog/BSR2021/⟩.

Degabriel, J.L., Albon, S.D., Fielding, D.A., Riach, D.J., Westaway, S., Irvine, R.J., 2011. The presence of sheep leads to increases in plant diversity and reductions in the impact of deer on heather. J. Appl. Ecol. 48 (5), 1269–1277. https://doi.org/10.1111/j.1365-2664.2011.02032.x.

Deter, A. (2020). *Schäfer: Traditionsberuf am Ende ?* Top Agrar. (Accessed 2021–04-10) https://www.topagrar.com/panorama/news/schaefer-traditionsberuf-am-ende-11955721.html.

Dostálek, J., Frantík, T., 2008. Dry grassland plant diversity conservation using low-intensity sheep and goat grazing management: Case study in Prague (Czech Republic). Biodivers. Conserv. 17 (6), 1439–1454. https://doi.org/10.1007/s10531-008-9352-1.

Eurostat. (2022). Milk and milk product statistics. (Accessed 2023–02-24) https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Milk_and_milk_product_statistics.

FAO. (2007). Global plan of action for animal genetic resources and the Interlaken declaration. (Accessed 2021–04-08) https://www.fao.org/3/a1404e/a1404e.pdf.

FAO. (2021). FAOSTAT Online Database: Live Animals. http://www.fao.org/faostat/en/#data/QA.

Feldmann, A. (2001). Alte und gefährdete Haustierrassen bieten Chancen in der Vermarktung. Schriften zu Genetischen Ressourcen Schriftenreihe der Zentralstelle für Agrardokumentation und -information (ZADI) und Informationszentrum Biologische Vielfalt (IBV), 17, 129–137. https://www.genres.de/fileadmin/SITE_MASTER/content/Schriftenreihe/Band17_Gesamt.pdf.

Förster, C., & Müller, U. (2015). Deichpflege mit Schafen. Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie (LfULG). (Accessed 2021–04-11) https://slub.qucosa.de/api/qucosa%3A71700/attachment/ATT-0/.

GEH e.V. (2021). *Rote Liste*. (Accessed 2021–03-21) https://www.g-e-h.de/index.php/rote-liste-menu/rote-liste.

Gelasakis, A.I., Valergakis, G.E., Arsenos, G., Banos, G., 2012. Description and typology of intensive Chios dairy sheep farms in Greece. J. Dairy Sci. 95 (6), 3070–3079. https://doi.org/10.3168/jds.2011-4975.

Gibon, A., Sibbald, A.R., Flamant, J.C., Lhoste, P., Revilla, R., Rubino, R., Sørensen, J.T., 1999. Livestock farming systems research in Europe and its potential contribution for managing towards sustainability in livestock farming. Livest. Prod. Sci. 61 (2–3), 121–137. https://doi.org/10.1016/S0301-6226(99)00062-7.

Gower, J.C., 1971. A general coefficient of similarity and some of its properties. Biometrics 27 (4), 857. https://doi.org/10.2307/2528823.

Graskemper, V., Yu, X., Feil, J.-H., 2021. Farmer typology and implications for policy design – an unsupervised machine learning approach. Land Use Policy 103 (January), 105328. https://doi.org/10.1016/j.landusepol.2021.105328.

Hoffmann, I., 2010. Livestock biodiversity. OIE Rev. Sci. Et. Tech. 29 (1), 73–86. https://doi.org/10.20506/rst.29.1.1966.

Ibidhi, R., Frija, A., Jaouad, M., Ben Salem, H., 2018. Typology analysis of sheep production, feeding systems and farmers strategies for livestock watering in Tunisia. Small Rumin. Res. 160 (5), 44–53. https://doi.org/10.1016/j.smallrumres.2018.01.010.

Jurkschat, M. (2017). Heidepflege mit Schafen. In Broschüre; Landesamt für Ländliche Entwicklung, *Landwirtschaft und Fluererneuerung*. ⟨https://lelf.brandenburg.de/sixcms/media.php/9/Heidepflege_mit_Schafen.pdf⟩.

Kaufman, L., Rousseeuw, P.J., 1990. Finding Groups in Data: An Introduction to Cluster Analysis (Wiley Series in Probability and Statistics). Wiley.

Klumpp, C., Häring, A.M., & Boos, S. (2003). *Die Entwicklungspotenziale der Ökologischen Schafhaltung in Deutschland (Abschlussbericht Projekt 02OE590)*. http://www.orgprints.org/5275.

Lehmair, T.A., Pagel, E., Poschlod, P., Reisch, C., 2020. Surrounding landscape structures, rather than habitat age, drive genetic variation of typical calcareous grassland plant species. Landsc. Ecol. 35 (12), 2881–2893. https://doi.org/10.1007/s10980-020-01120-7.

LEL (Landesanstalt für Entwicklung der Landwirtschaft und der ländlichen Räume). (2015). Schafreport Baden-Württemberg 2015. (Accessed 2021–03-11) https://docplayer.org/67808527-Schafreport-baden-wuerttemberg-2015.html.

Lesmeister, C., 2015. Mastering Machine Learning with R. Packt Publishing Ltd.

Manek, Gwendolyn; Simantke, Christel; Sporkmann,Katrin; Georg, Heiko; Kern, A. (2017). Abschlussbericht: Systemanalyse der Schaf- und Ziegenmilchproduktion in Deutschland.

Milán, M.J., Arnalte, E., Caja, G., 2003. Economic profitability and typology of Ripollesa breed sheep farms in Spain. Small Rumin. Res. 49 (1) https://doi.org/10.1016/S0921-4488(03)00058-0.

Morris, S.T., 2017. Overview of sheep production systems. Adv. Sheep Welf. https://doi.org/10.1016/B978-0-08-100718-1.00002-9.

Müller, S.M., Peisker, J., Bieling, C., Linnemann, K., Reidl, K., Schmieder, K., 2019. The importance of cultural ecosystem services and biodiversity for landscape visitors in the Biosphere Reserve Swabian Alb (Germany). Sustainability. https://doi.org/10.3390/su11092650.

Pardos, L., Maza, M.T., Fantova, E., Sepúlveda, W., 2008. The diversity of sheep production systems in Aragón (Spain): Characterisation and typification of meat sheep farms. Span. J. Agric. Res. 6 (4), 497–507. https://doi.org/10.5424/sjar/2008064-344.

Riveiro, J.A., Mantecón, A.R., Álvarez, C.J., Lavín, P., 2013. A typological characterization of dairy Assaf breed sheep farms at NW of Spain based on structural factor. Agric. Syst. 120, 27–37. https://doi.org/10.1016/j.agsy.2013.05.004.

Schafzucht. (2021). *Cross-Mediadaten 2021*. (Accessed 2021–04-15) http://www.ulmer-verlag.de/server_mediacenter/Schafzucht_Mediadaten_2021.pdf.

Schlauderer, R., & Prochnow, A. (2003). Ökonomische Aspekte des Offenlandmanagments. In Culterra (31) Offenland und Naturschutz.

Schroers, J.O., & Pikart-Müller, M. (2014). Landschaftspflege mit Schafen. Kuratorium für Technik und Bauwesen in der Landwirtschaft e.V. (KTBL).

Siersleben, K. (2020). Jahresbericht 2020 LKV ST e.V. (Landeskontrollverband Sachsen-Anhalt e.V.). (Accessed 2021–04-12) https://www.lkv-st.de/?name=content&csid=7.

Statistisches Bundesamt. (2021a). Land- und Forstwirtschaft, Fischerei Viehhaltung der Betriebe Landwirtschaftszählung 2020 - Fachserie 3 Reihe 2.1.3.

Statistisches Bundesamt. (2021b). Land und Forstwirtschaft, Fischerei Viehbestand 3. November 2020 - Fachserie 3 Reihe 4.1.

UNESCO. (2022). Bundesweites Verzeichnis Immaterielles Kulturerbe Süddeutsche Wander- und Hüteschäferei. (Accessed 2023-02-24) https://www.unesco.de/kultur-und-natur/immaterielles kulturerbe/immaterielles kulturerbe deutschland/schaeferei.

Viehzentrale Südwest. (2021). Preise für Schlachtlämmer und Schlachtschafe. https://www.vz-gmbh.de/schaf-lamm-preise.

VNP (Verein Naturschutzpark Lüneburger Heide). (2021). Methoden der Heidepflege. https://www.verein-naturschutzpark.de/heidepflege-methoden/.

von Korn, S. (2016). *Schafe in Koppel- und Hütehaltung*. Verlag Eugen Ulmer.

von Korn, S. (2020). Abschlussbericht: Wirtschaftlichkeit der Schafhaltung in Deutschland. (Accessed 2022–04-11) https://www.nutztierhaltung.de/fileadmin/Redaktion/Dokumente/5-Schafe/3-Stallbau/Abschlussbericht_Wirtschaftlichkeit_Schafhaltung.pdf.

Wagner, F. (2019). Schafreport Bayern 2019: Auswertung der Wirtschaftsjahre 2017/18. (Accessed 2022–04-10) https://www.stmelf.bayern.de/mam/cms01/landwirtschaft/dateien/2019_schafreport_by_kurz.pdf.

Walmsley, D.C., Delory, B.M., Alonso, I., Temperton, V.M., Härdtle, W., 2021. Ensuring the long-term provision of heathland ecosystem services—the importance of a functional perspective in management decision frameworks. Front. Ecol. Evol. *9*. https://doi.org/10.3389/fevo.2021.791364.

Weltin, M., Zasada, I., Franke, C., Piorr, A., Raggi, M., Viaggi, D., 2017. Analysing behavioural differences of farm households: an example of income diversification strategies based on European farm survey data. Land Use Policy 62, 172–184. https://doi.org/10.1016/j.landusepol.2016.11.041.