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small farms
small food businesses and
sustainable food security

28.09.2017
Deliverable 2.1

Report: Estimated spatial distribution and key characteristics of small farms in Europe

WP2 Estimation of the distribution and production capacity of small farms

Prepared under contract from the European Commission
Project number: 677363
Collaborative project
Horizon2020

Project acronym	**SALSA**
Project full title	Small Farms, Small Food Businesses and Sustainable Food Security
Duration	April 2016 – March 2020
Coordinating organisation	Universidade de Évora (UEvora)
Project coordinator	Teresa Pinto-Correia
Project website:	*www.salsa.uevora.pt*
Deliverable title	Estimation of the distribution and production capacity of small farms
Deliverable number	2.1
Work package	WP2
Authors	Nuno Guiomar; Teresa Pinto Correia; Karlheinz Knickel; Sérgio Godinho; Theodore Tsiligiridis; Fabio Bartolini; Marta Czekaj; Dionisio Ortiz Miranda; Sandra Šūmane; Hilde Bjørkhaug; Lee-Ann Sutherland; Mark Redman

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1. Introduction

At European level, typologies focused on farming systems (D'Amico *et al.*, 2013; van der Zanden *et al.*, 2016; Andersen, 2017) or on rural types (van Eupen *et al.*, 2012; Pinto-Correia *et al.*, 2016b) were developed, but none was focussed on small farms. The growing recognition of the small farms in policy has led to increased efforts in developing methodologies for assessing and mapping the distribution of small farms (e.g. Kuemmerle *et al.*, 2009; Samberg *et al.*, 2016; García-Pedrero *et al.*, 2017).

Generally, very little is known on the spatial distribution, context specificity and typology of small farms (Graueb *et al.*, 2016; Lowder *et al.*, 2016). This may be due to the lack of sufficiently detailed data, as well as the need for adequate and tailored analytical approaches to grasp the diversity of small farms (Samberg *et al.*, 2016). In Europe, the related assessments are extremely complex since small farms encompass a wide range of organizational and structural patterns (Brookfield and Parson, 2007; Davidova *et al.*, 2013). These are due to a range of farm and enabling environmental factors, as well as the multiple changes that have occurred in the last century (e.g. Jepsen *et al.*, 2015). Forest transitions and farmland abandonment that occurred in several parts of Europe (Kauppi et al., 2006; Kozak et al., 2007; Marey-Pérez and Rodríguez-Vicente, 2009; Mather, 2004; Mather et al., 1998, 1999; Terres et al., 2015), as well as agrarian land use intensification (Stoate et al., 2001; Weissteiner et al., 2011) has resulted not only in changes in the landscape but also in the farm structure (Hostert et al., 2011; Špulerová et al., 2011; Lieskovský et al., 2015). Probably related with the latter, new processes emerge, such as land concentration and land grabbing, leading also with changes in the spatial pattern of small farms (Franco and Borras, 2013; Petrescu-Mag et al., 2017; van der Ploeg et al., 2015).

It is clear that any definition of a small farm needs to be based on national and regional realities. Definitions involving only the criterion of farm size have universal appeal as they are relatively easy to apply and allow simple comparisons across countries and world regions. However, they don't capture all the complexities of farming. Definitions involving additional criteria to farm size are more meaningful, particularly those including indicators of the farm economic output, but data availability is often a limitation (Ruane, 2016). At the same time there is an increasing need to better understand the relative importance and role of small farms in different regional contexts in order to support the design of public interventions. This is crucial for many regions in Europe, where changes in the farm sector are occurring at exceptionally strong pace.

The main objective of this deliverable is to describe the analytical process which enabled the development of a European map of the distribution of small farms at the NUTS-3 level. This process considered different dimensions of farm size through the combination of different datasets with information obtained from key experts. These experts were identified based on the territorial, social and economic expertise needed. A cluster analysis has been performed at NUTS-3 level using the available statistical data on farm size. The distribution of the number of holdings and of the utilized agricultural area (UAA) by farm size classes is presented, as well as a map with the distribution of different clusters that represent different structural patterns of the distribution of small farms.

2. Material and methods

2.1. Overall approach

The first stage of this Work Package involved the elaboration of a European map showing the distribution of small farms at the NUTS-3 level. This was developed through a stepwise approach that combined diverse datasets and information gathered from key experts. The criteria used drew on the thresholds defined in the project's Conceptual Framework (Deliverable 1.1) of classifying small farms in two ways: by physical size (farms with less than 5 ha of UAA) and by economic size (farms with less than 8 Economic Size Units, ESU[1]) of Standard Gross Margin (SGM).

The first assessment was obtained following four main stages:

- SALSA partners were asked to provide information regarding spatial and statistical data availability and spatial distribution of small farms (ANNEX I);
- Consultation with experts: European experts (ANNEX II) were contacted in order to provide information concerning (see the ANNEX III for the main questions addressed to national experts):
    a) the available spatial and statistical data in their respective countries;
    b) the limitations of the available data to obtain the best estimate (in area) of the small farms at the NUTS-3 level;
    c) the spatial distribution of small farms in their countries (e.g. spatial aggregation of small farms, land fragmentation, heterogeneity of land cover);
    d) typologies of small-scale farming in their countries;
- Exploratory data analysis: a spatial and statistical analysis of the distribution of all the collected variables;
- Statistical analysis: the spatial distribution of small farms at NUTS-3 level was first assessed through cluster analysis (k-means using 10-fold cross validation), following correlation analysis in order to reduce the number of variables employed throughout.

The results of the cluster analysis were then combined with EDORA (European Development Opportunities for Rural Areas) structural types[2] (Copus, 2011). The aim was to ensure that the selected reference regions covered the diversity of situations identified within the data analysis.

During this process both SALSA partners and some of the national experts were asked to select 3-5 regions in their countries considering the different clusters and their distribution. The final selection was made by maximizing differences between regions accomplished by the combination between the results of cluster analysis and EDORA structural types.

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[1] Currently, 1 ESU equals 1,200€, but this value has changed over time to reflect inflation.
[2] The EDORA structural typology classifies regions according to their economic settings as predominantly urban, agrarian, consumption countryside, diversified with strong secondary sector and diversified with strong market services.

2.2. Data sources and indicators

Data at NUTS-3 level for all countries except for Germany (NUTS-2 level due to data availability) on the UAA and the Number of Holdings (NH) distributed by UAA farm size classes and by economic size classes were extracted from EUROSTAT[3] and from national-level official statistical databases on agriculture. While UAA farm size allows to assess the distribution of the physical size of the farms, the SGM provides a measure of a holding's business size and is representative of the level of profit that could be expected on the average farm under 'standard' conditions (e.g. with the average level of rainfall expected in a region). The NUTS-3 level was selected as it is the most detailed administrative level for which the data that were required can be found for all European countries. Most of the data comes from the latest agricultural censuses and Farm Structure Survey (2007-2010), although there are few exceptions for which the data are less up-to-date (Croatia and Austria).

Data were used to calculate a set of indicators (ANNEX IV), such as the percentage of all holdings, and of UAA below the before-mentioned size thresholds (5 ha for the physical size; 8 ESU for the economic size) (ANNEX V). Farms and small farms density were computed based on the ratio between the total number of holdings and the UAA in each region, and based on the ratio between the number of small farms with less than 5 ha and the UAA covered by these small farms (the higher the density of the farms, the higher the prevalence of small farms). The mean size of total farms and the mean size of small farms were also determined.

The analysis of the above mentioned structural and economic indicators was then conducted for the whole of Europe considering two different spatial contexts: country level and European level. The aim was to assess the relative distribution small farms in each region through Standard Scores (also known as *z*-values, *z*-scores or normal scores) of each indicator, using the following formula:

$$z_i = \frac{X_{ij} - \bar{X}_i}{\sigma_i}$$

where z_i is the Standard Score of the variable *i*, a dimensionless quantity corresponding to the number of standard deviations by which the values of the variables associated to each NUTS-3 are above or below the mean; X_{ij} the value of the indicator *i* in the NUTS-3 *j*; $\bar{X}_i$ is the mean value of the variable *i*, and σ_i is the standard deviation of the variable *i*. SSc is a dimensionless quantity, in which positive score indicates NUTS-3 above the mean, while the negative ones indicates NUTS-3 below the mean. The mean and the standard deviation were determined using the two above mentioned scales (ANNEX VI). Cyprus, Malta and Luxembourg were analyzed together with other countries given the limitations associated with their spatial dimension.

Labour Force and Family Labour Force were also analysed as they can be used as proxy for the importance of small farms in a region. Labour Force is expressed in persons and in Annual Work Units (AWU) where one AWU corresponds to the work performed by one person occupied on a full-time basis. The Family Labour Force (ANNEX VII) of the agricultural holding refers to persons who carry out farm work on the holding and are classified either as a holder or the members of the holder's family. In our analysis we used both indicators. In the same way, and due to the evidence already known that

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[3] Structure of agricultural holdings by NUTS-3 regions - main indicators [ef_r_nuts] –
http://ec.europa.eu/eurostat/en/web/products-datasets/-/EF_R_NUTS

farms in mountain areas tend to be small (e.g. López-i-Gelats et al., 2011; Pinter and Kirner, 2014), NH and UAA in mountain areas were also used in the analysis (ANNEX VII).

We also include the total UAA existing in each region in our analysis in order to consider the particular context of each region, since we are aiming not only to identify different regional types of small farms but also to assess their distribution.

2.3. Data analysis

Data analysis was divided into two fundamental steps:

a) analysis of the distribution of UAA and NH by farm size classes; and
b) cluster analysis using the data listed in Table 1 to assess the distribution of small farms in Europe at the NUTS-3 scale.

The distribution of the UAA and the NH by UAA farm size and by economic farm size was analyzed through box plots. The ratio between UAA in holdings with less than 5 ha of UAA and UAA in holdings with less than 8 ESU was computed to identify regions with larger farms with low economic size (ratio > 1), as well as regions with small farms representing substantial business operations (ratio < 1), resulting not only from farm specialization, but also from the integration of multiple economic activities into the small-farm production structure.

The first clustering approach, using k-means, considered different combinations between non-correlated variables (r < |0.7|; Tabachnick and Fidell, 2007), from the ones listed in ANNEX IV. In this first assessment the number of clusters in the data was automatically determined through v-fold cross-validation applied to the cluster analysis (10-fold cross-validation partitioning). Usually used in tree classification and regression methods, v-fold cross-validation randomly partitions the original samples into v subsets of similar size and uses 1-fold for validating (Burman, 1989; Fielding and Bell, 1997; Bergmeir and Benítez, 2012) and provides an estimate of the cross validation cost with the increase in the number of clusters.

More than 30 maps indicating the distribution of small farms (considering both physical farm size as well as economic dimensions) within Europe were produced. Some of these indicators and the best results of several approaches to the cluster analysis were presented to the SALSA WP leaders and to the Panel of Experts in a project meeting (Rome, 27-28 October 2016). Pros and cons of the cluster analysis and maps were discussed, focussing on the variables that should be used for the clustering, and on the parallel issues of meaningfulness and communicability, as well as the risk to miss important variables. The complexity of some of the indicators, and the cluster analysis approach was discussed, and it was decided to use only a small set of non-correlated variables and reduce the number of clusters, in order to improve the comprehensibility of the results.

Following this, new analyses were performed and discussed, using just five indicators (Figure 1a-e):

- the share of UAA in each region;
- the share of UAA covered by small farms (defined as farms with less than 5 ha);
- the percentage of the region occupied by small farms, defined as farms with less than 8 ESU of SGM;
- the percentage of the number of holdings with less than 8 ESU of SGM, and;

- the density of small farms (number/ha) defined as farms with less than 5 ha.

These five variables were selected following an inspection of highly correlated pairs, and an analysis of the descriptive statistics (ANNEX IV).

We did not consider the Family Labour Force given the very low variability of the indicator (CV=~0.33). The spatial distribution of this indicator shows that the large majority of the NUTS-3 is covered by family farms. Thus, this indicator may be misleading, since many larger farms fall in the category of family farms.

Also the UAA in mountain areas was not used in the cluster analysis, since we found different types of relations between farm size classes in hilly and mountainous areas given the presence of livestock farms. Thus, UAA in mountain areas was found to have a too low robustness to be used as proxy variable for the prevalence of small farms at regional level.

The cluster analysis was then conducted again using k-means considering different combinations between the selected indicators and a reduced number of clusters (between 4 and 6). The two results were selected considered most informative and discussed by SALSA partners and by the Panel of Experts in order to

- identify gaps in the distribution of small farms in each country;
- reduce misleading interpretations; and
- select one of the maps to support the selection of 25 reference regions in Europe,

a)
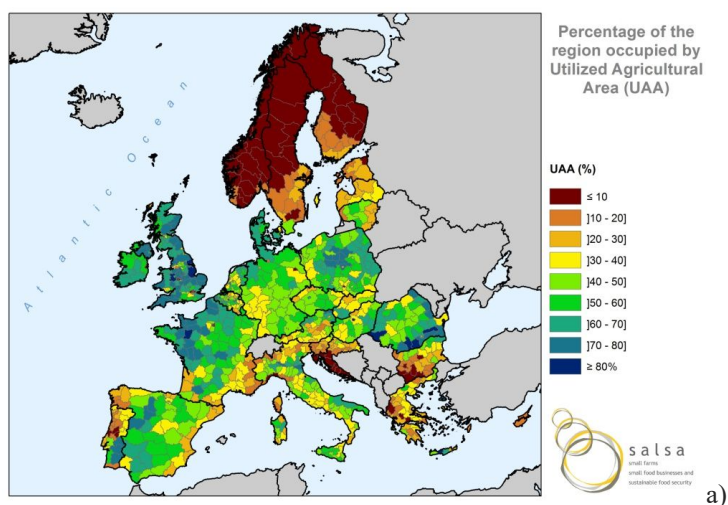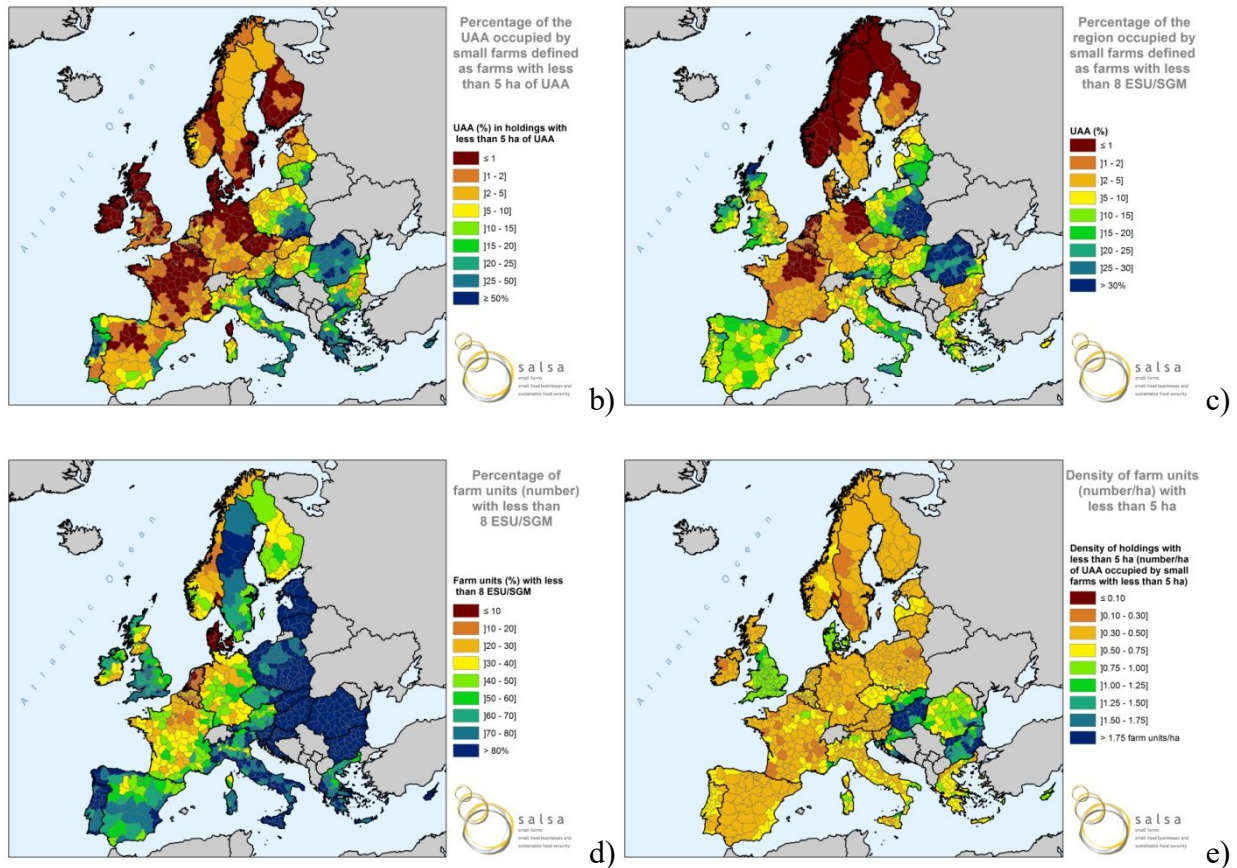
Figure 1. Maps with the distribution of the selected indicators in Europe at NUTS-3 level (except for Germany, at NUTS-2 level)
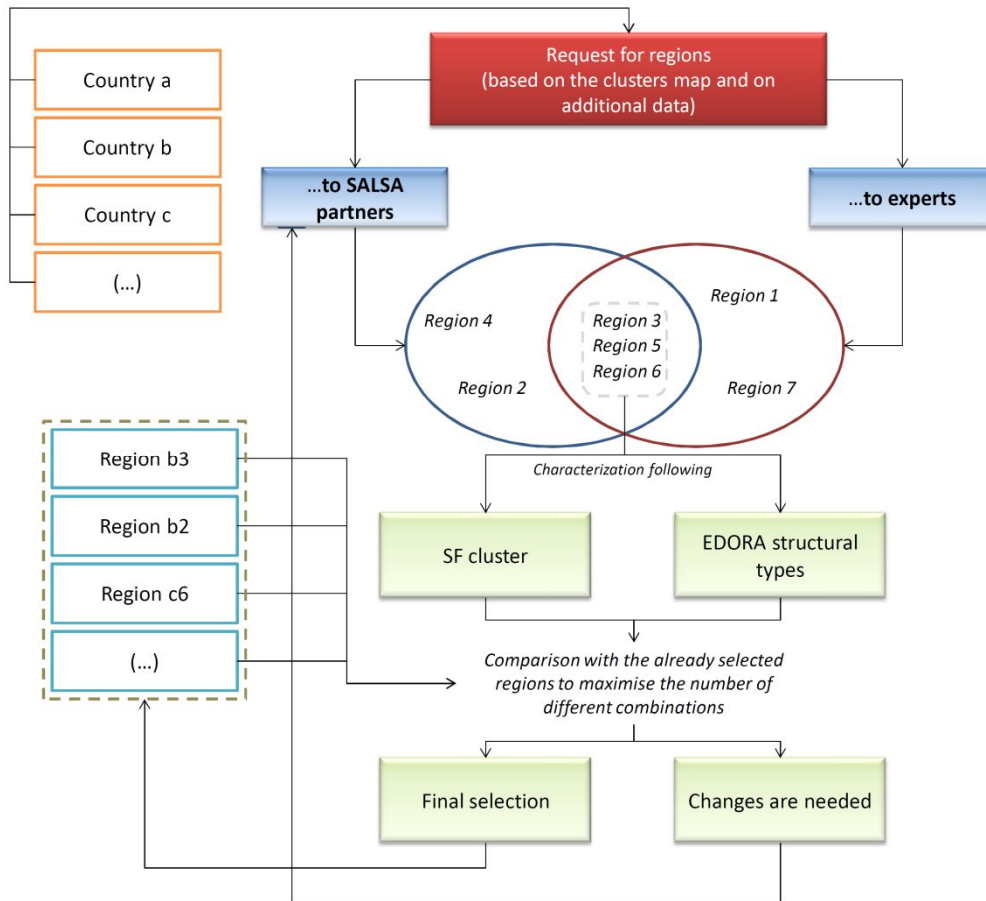
2.4. Selection of the reference regions

The results of the cluster analysis were then combined with the EDORA structural types (Copus, 2011) in order to select the 25 European reference regions.

The combination of both typologies allows to highlight different aspects of differentiation in Europe at regional level. In this way we ensure that the selected reference regions cover higher levels of diversity than if only one typology is used.

During this process both SALSA partners and some of the national experts were asked to indicate 3 to 5 relevant regions in terms of the distribution of small farms in their countries, as exemplified in Figure 2. The final selection was made in order to maximise the number of different combinations between small-farms' clusters and EDORA structural types.

Figure 2. The process of selecting the 25 reference regions in Europe

Some countries had a more homogeneous distribution of small farms and/or it was harder to agree on the selection of reference regions (e.g. Romania, Scotland and France). In these cases, country-level maps with indicators of the distribution of small-farms and additional data (e.g. land cover as shown in Figure 3; slope; elevation) were used to support the choice of reference regions.

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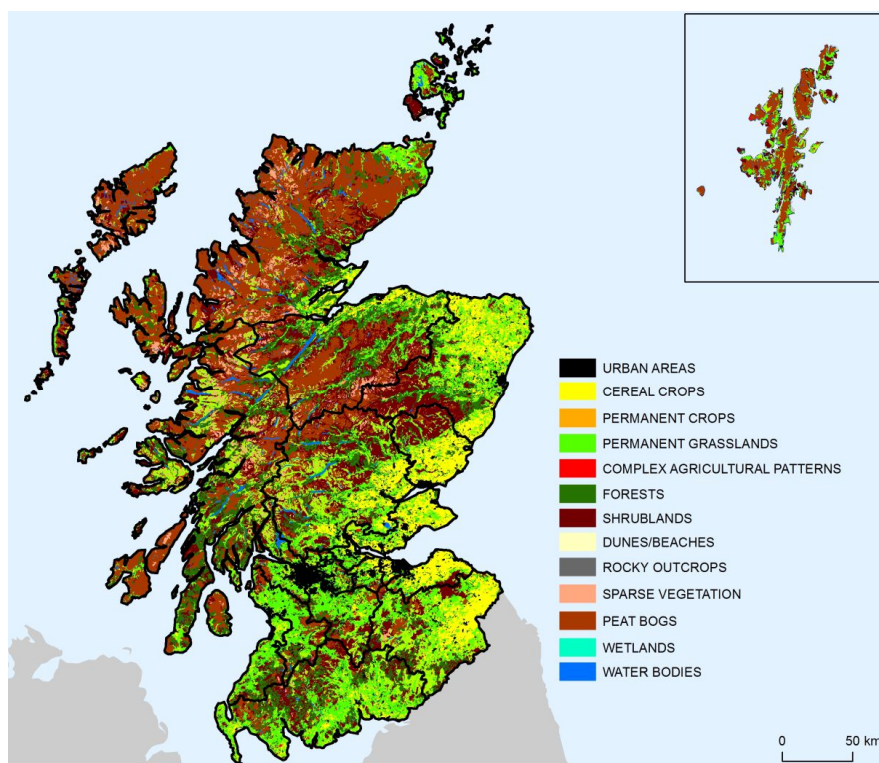
**Figure 3.** Land cover map of Scotland (Source: CORINE Land Cover 2012)

3. Results

3.1. Farm size distribution

Although small farms are numerous, they tend to cover only a smaller share of agricultural land (Figure 4). In Romania, 93% of farms have less than 5 ha of UAA (according to the agricultural census 73% have less than 2 ha). However the UAA covered by these farms is only 30% of the total UAA in the country (which is very significant in this particular case). The larger proportion of UAA at NUTS-3 level tends to be related with large farms, while the percentage of the number of holdings is higher in the low size class (both for structural and economic size). This skewed distribution was also observed in other studies (Rizov and Mathijs, 2003; Davidova *et al.*, 2012; Bakucs *et al.*, 2013).

Davidova *et al.* (2012) have concluded that in Europe farms below 8 ESU represent 80% of the agricultural holdings, but cover only 25% of the total UAA.

When we distribute UAA by economic size we can observe a bi-modal distribution. This result is similar to the ones obtained by other authors in studies developed in more detailed scales (Weiss, 1993, 1998; Bakucs *et al.*, 2013; Bojnec and Latruffe, 2013), who observed a decrease in the proportion of middle size classes.
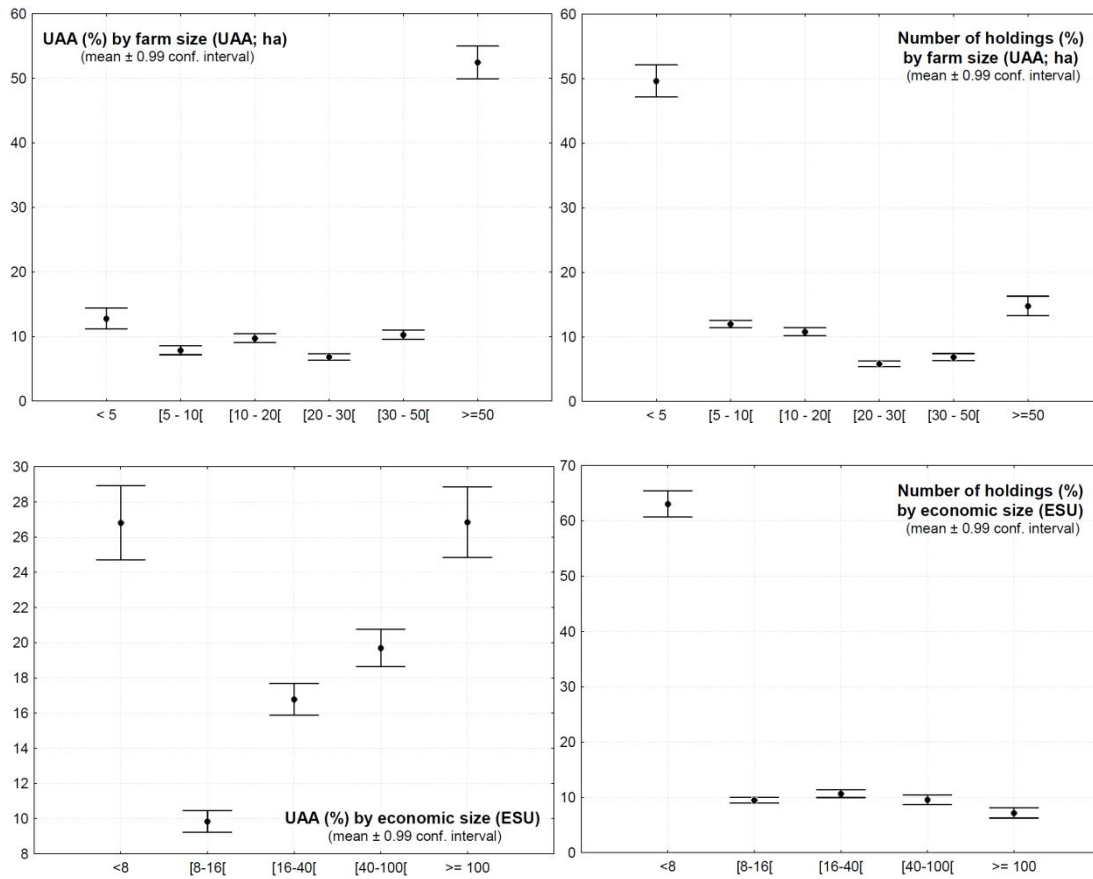
Figure 4. Distribution of the UAA and the number of holdings by farm size classes

Large differences can also be observed in the spatial distribution of both indicators using a ratio between the values of the holdings below 8 ESU and below 5 ha (Figure 5a and b). Values close to 1 indicate a balanced distribution between the two dimensions of farm size, whereas higher values represent areas with large areas covered by low-income farms. Values close to 0 may represent high intensity small-scale farms (e.g. in Netherlands). This is partially in accordance with Tocco *et al.* (2013), which highlighted the high prevalence of small farms in some European regions with farms classified as small but with higher values of the standard gross margin expressed in ESU. In any case, this distribution should not be analyzed without the representation of the distribution of the total UAA in each NUTS-3 (Figure 1a).
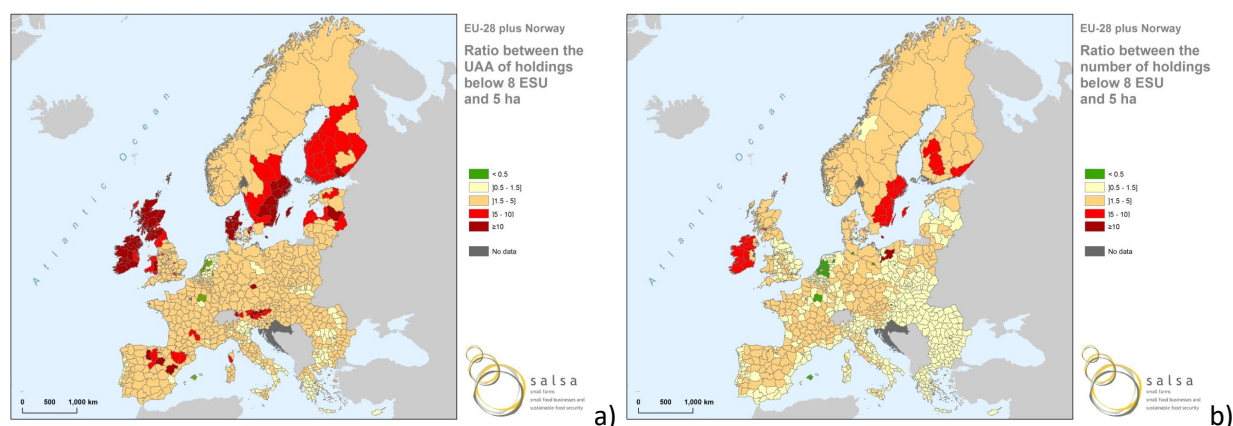
**Figure 5.** Ratio between the UAA in farms with less than 8 ESU and farms between 5 ha *a)* and between the number of holdings in farms with less than 8 ESU and farms between 5 ha *b)*. In both maps higher values represent regions with high representativity of farms with less than 5 ha with high incomes.

3.2. Distribution of small farms across Europe

The global value of the number of holdings is very similar both using the physical and the economic farm size (10,175,018 and 11,701,770 respectively), whereas the area covered by small farming systems is highly sensitive to the farm size dimension used. The final values vary between 14,989,048 ha and 41,262,900 ha, using the physical and the economic farm size, respectively. However, the spatial patterns of its distribution are to some extent similar.

Figures 1a and 1b are presenting the percentage of Utilized Agricultural Area (UAA) occipied by small farms considering the two dimensions of farm size (structural size and economic size). The figures show that small farms are predominant in the Eastern member states, in the Mediterranean belt, in some regions of the Iberian Peninsula with Atlantic influence, as well as in the North of Scotland (here closely related with the economic size). This distribution is even more strongly expressed when we analyze the distribution of the number of holdings with less than 5 ha of UAA and with less of 8 ESU of SGM (Figure 1d and Figures Ve-h in ANNEX V). However in this latter case other regions emerge, such as the Southern regions of the United Kingdom and most of Sweden.

As mentioned before, the two more accurate results from the cluster analysis were selected and discussed by SALSA partners and also by some of the national experts (Figure 6).
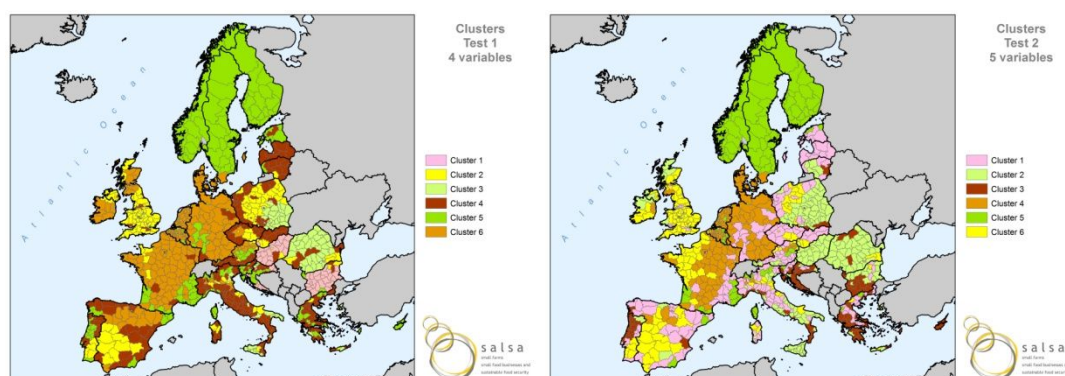
Figure 6. Maps selected based on the cluster analysis using different combinations between non-correlated variables

The map that was selected in being the most meaningful regarding the typology and distribution of small farms in Europe is shown in Figure 7. The same map was used to support the selection of the 25 reference regions.
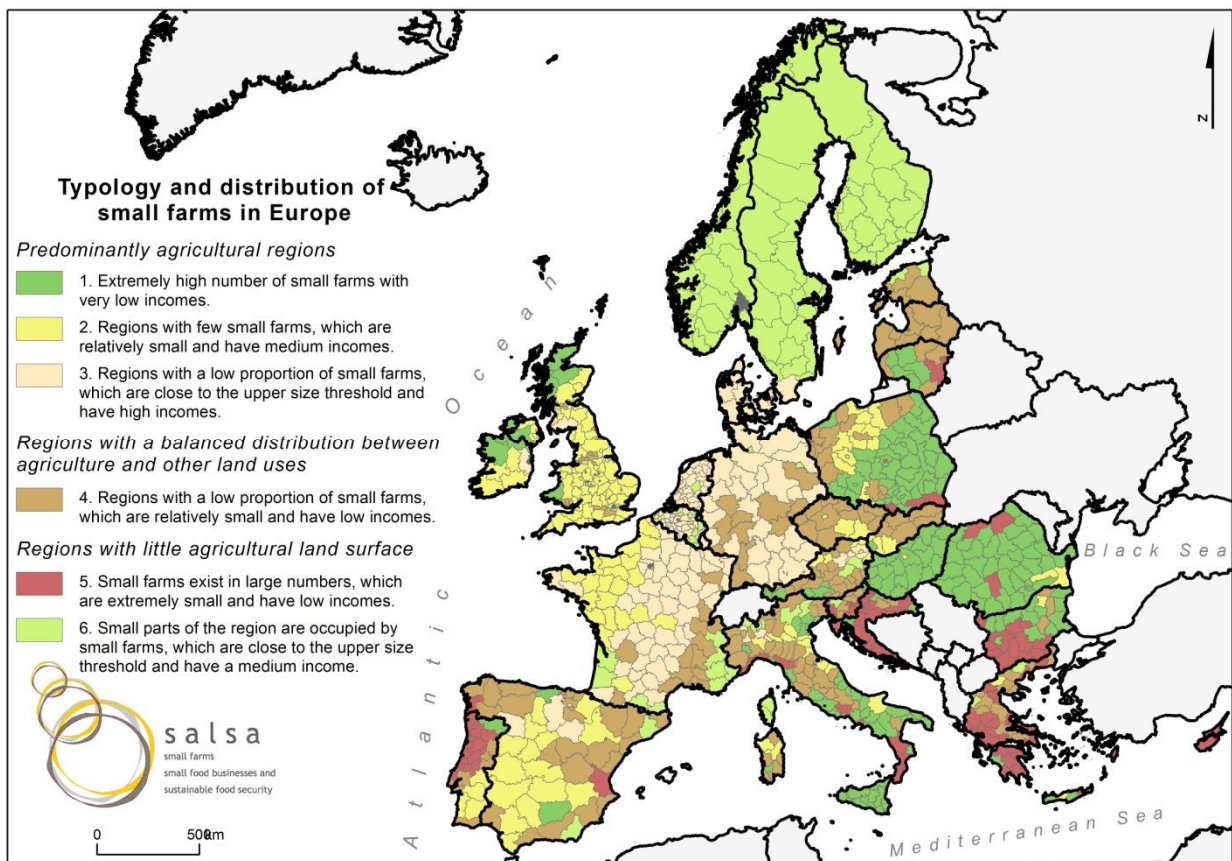
Figure 7. The typology and distribution of small farms in Europe in relation to dominant farm structure within regions

The clusters have the following characteristics which are briefly presented below.

a) Predominantly agricultural regions

- *Cluster 1. Extremely high number of small farms with very low incomes.* These are the core regions for small farms in Europe. These are predominantly farming regions (where the UAA = >50%), of which a very significant part of the farming area (20% or more) is occupied by small farms (defined by area) and almost all farm units (more than 90% of all farms) are small farms in terms of economic size. These farms are mostly extremely small, on average the smallest small farms in Europe, both in surface area and in economic size. These regions have few larger farms.

- *Cluster 2. Regions with few small farms, which are relatively small and have medium incomes.* These are predominantly large-scale farming regions, where small farms (both in terms of area and economic size) occupy just a small part of the farming area. The large farms occupy the majority of agricultural land and probably are responsible for the majority of production.
- *Cluster 3. Regions with a low proportion of small farms, which are close to the upper size threshold and have high incomes.* These are large-scale, specialized and market-oriented farming regions. The proportion of small farms is very low, and those that do exist are, on average, larger than in other regions of Europe, and have higher incomes.

b) Regions with a balanced distribution between agriculture and other land uses

Cluster 4. Regions with a low proportion of small farms, which are relatively small and have low incomes. These are regions where farming occupies only a small part of the territory (mean value is close to 35%), but where 70% of the farm units are small farms in economic terms, with very low incomes. Small farming is thus relatively important, although the farmers are mostly poor. These regions also have other types of farms.

c) Regions with little agricultural land surface

- *Cluster 5. Small farms exist in large numbers, which are extremely small and have low incomes.* These regions are either dominated by forestry or are primarily urban. The very large majority (80%) of farm units in these regions are extremely small in area (average < 2ha) and also in economic size.
- *Cluster 6. Small parts of the region are occupied by small farms, which are close to the upper size threshold and have a medium income.* These are mostly regions dominated by forests, which contain the lowest proportion of agricultural land in Europe. However almost half of the existing farm units are small in economic terms, so small farms are still relatively important in the farming landscape.

3.3. Selection of the reference regions

During the process of selecting the reference regions, SALSA partners and national experts were asked to indicate 3 to 5 relevant regions within their countries, considering the diversity of the distribution of small farms. Figure 8 shows illustrates this process on the basis of the three reference regions in Poland.
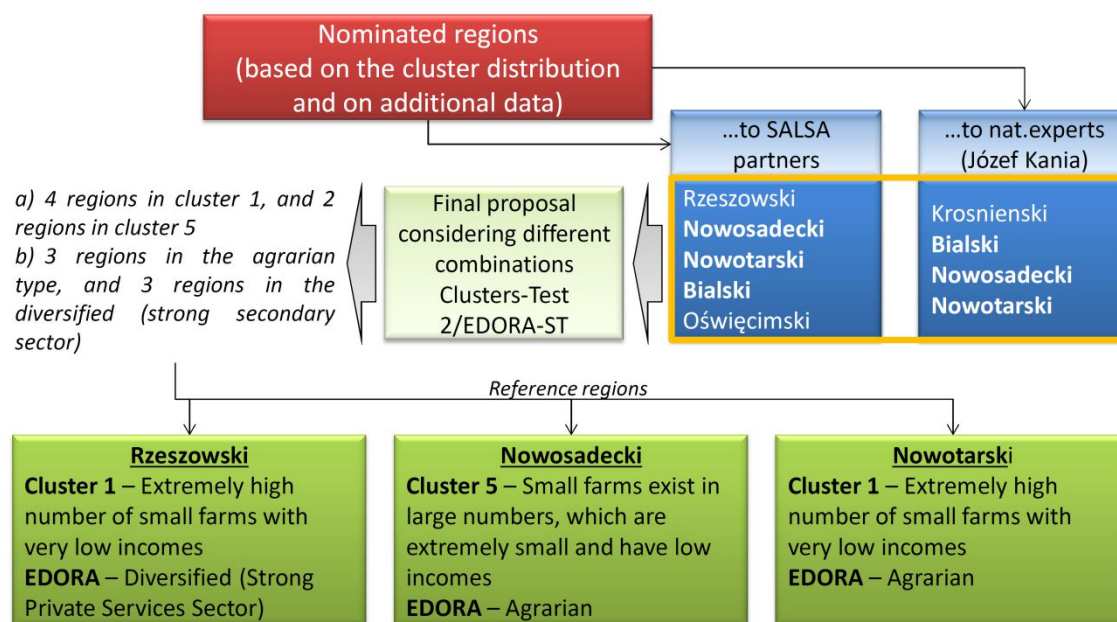
Figure 8. The process of selecting the three reference regions in Poland

The 25 European reference regions are presented in Figure 9. The distribution of these reference regions by cluster types and by EDORA structural types is presented in Table 1.
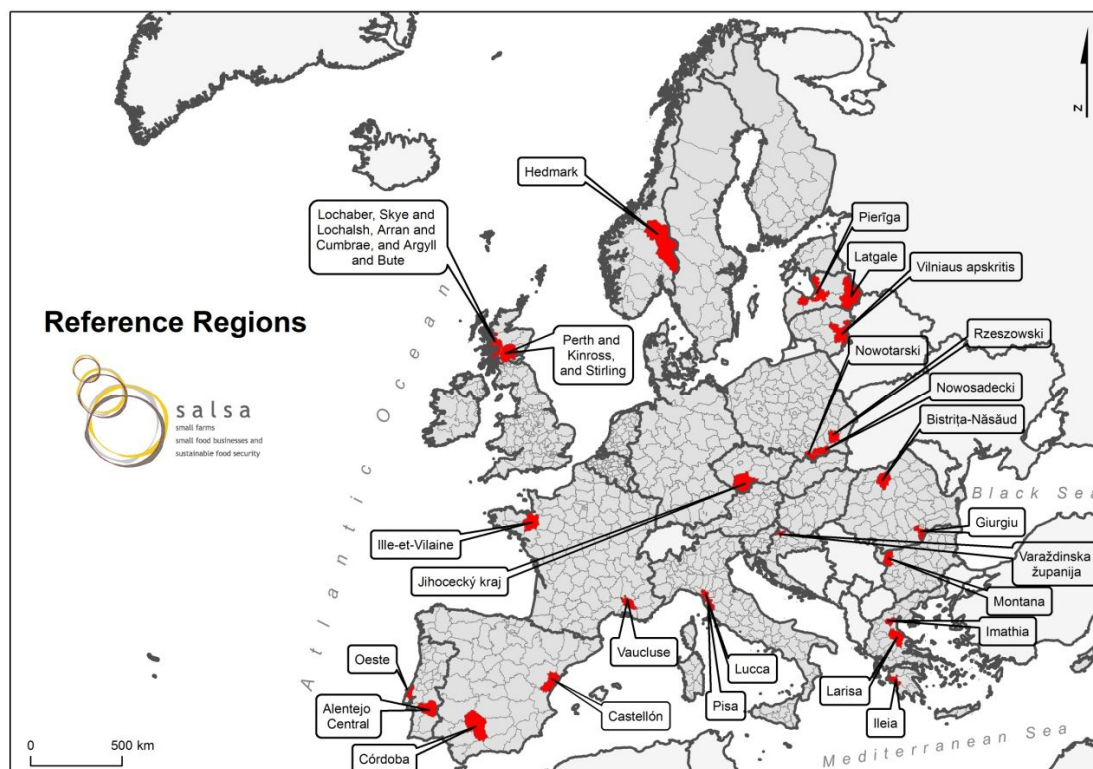

Figure 9. The geographic distribution of the reference regions

Table 1.

The characteristics of the 25 selected reference regions

NUT3_ID	NUT3	Country	Cluster types		EDORA structural types
BG312	Montana	Bulgaria	Predominantly agricultural region	Extremely high number of small farms with very low incomes	Agrarian
CZ031	Jihocecký kraj	Czech Republic	Region with a balanced distribution between agriculture and other land uses	Region with a low proportion of small farms, which are relatively small and have low incomes	Diversified (strong secondary sector)
EL121	Imathia	Greece	Region with little agricultural land surface	Small farms exist in large numbers, which are extremely small and have low incomes	Agrarian
EL142	Larisa	Greece	Region with a balanced distribution between agriculture and other land uses	Region with a low proportion of small farms, which are relatively small and have low incomes	Agrarian
EL233	Ileia	Greece	Predominantly agricultural region	Extremely high number of small farms with very low incomes	Agrarian
ES522	Castellón	Spain	Region with a balanced distribution between agriculture and other land uses	Region with a low proportion of small farms, which are relatively small and have low incomes	Consumption countryside
ES613	Córdoba	Spain	Predominantly agricultural region	Region with few small farms, which are relatively small and have medium incomes	Agrarian
FR523	Ille-et-Vilaine	France	Predominantly agricultural region	Region with few small farms, which are relatively small and have medium incomes	Diversified (strong private services sector)
FR826	Vaucluse	France	Region with a balanced distribution between agriculture and other land uses	Region with a low proportion of small farms, which are relatively small and have low incomes	Diversified (strong private services sector)
HR044	Varaždinska	Croatia	Region with little agricultural land surface	Small farms exist in large numbers, which are extremely small and have low incomes	No data
ITI12	Lucca	Italy	Region with little agricultural land surface	Small farms exist in large numbers, which are extremely small and have low incomes	Predominantly urban regions
ITI17	Pisa	Italy	Predominantly agricultural region	Extremely high number of small farms with very low incomes	Consumption countryside
LT00A	Vilniaus apskritis	Lithuania	Region with little agricultural land surface	Small farms exist in large numbers, which are extremely small and have low incomes	Predominantly urban regions
LV005	Latgale	Latvia	Region with a balanced distribution between agriculture and other land uses	Region with a low proportion of small farms, which are relatively small and have low incomes	Agrarian
LV007	Pierīga	Latvia	Region with a balanced distribution between agriculture and other land uses	Region with a low proportion of small farms, which are relatively small and have low incomes	Consumption countryside
NO021	Hedmark	Norway	Region with little agricultural land surface	Small parts of the region are occupied by small farms, which are close to the upper size threshold and have a medium income	Consumption countryside
PL218	Nowosadecki	Poland	Region with little agricultural land surface	Small farms exist in large numbers, which are extremely small and have low incomes	Agrarian
PL219	Nowotarski	Poland	Predominantly agricultural region	Extremely high number of small farms with very low incomes	Agrarian

PL325	Rzeszowski	Poland	Predominantly agricultural region	Extremely high number of small farms with very low incomes	Diversified (strong private services sector)
PT16B	Oeste	Portugal	Region with little agricultural land surface	Small farms exist in large numbers, which are extremely small and have low incomes	Diversified (strong private services sector)
PT183	Alentejo Central	Portugal	Predominantly agricultural region	Region with few small farms, which are relatively small and have medium incomes	Agrarian
RO112	Bistrița-Năsăud	Romania	Predominantly agricultural region	Extremely high number of small farms with very low incomes	Agrarian
RO314	Giurgiu	Romania	Predominantly agricultural region	Extremely high number of small farms with very low incomes	Agrarian
UKM27	Perth and Kinross, and Stirling	UK	Predominantly agricultural region	Region with few small farms, which are relatively small and have medium incomes	Diversified (strong private services sector)
UKM63	Lochaber, Skye and Lochalsh, Arran and Cumbrae, Argyll and Bute	UK	Predominantly agricultural region	Extremely high number of small farms with very low incomes	Consumption countryside

4. Final remarks

It is very difficult to capture the diversity, heterogeneity and/or variability in each country in a European-wide analysis with the same (and limited) dataset. The analysis is particularly complex in regions where the most extreme situations occur. For example, Romania can be considered as an hotspot of small farms, both in terms of structural and economic size. However, at European scale and with a simplistic and small set of variables, it is imposible to capture the Romanian asymmetries in terms of the small farms distribution, since they show, in this context, lower spatial variability. If we increase the number of variables or the number of clusters we lose readability, whereas with low number of clusters or a reduced number of variables we are not able to capture this variability.

One of the major constraints to the development of an analysis on this scale and with this particular complexity is related to the quality of the data and with particular elements that are considered relevant drivers of farm size in each country (e.g. biophysical constraints). The use of different size thresholds for including farms in national agricultural censuses, is also a major limitation, constraining an European-level analysis. Davidova *et al.* (2013) highlight the lack of adequate data concerns in particular subsistence farming. Subsistence farms tend to be excluded from official statistical surveys as they fall below size thresholds for data collection (ANNEX VIII). Finally, continuous changes in administrative boundaries (e.g. Poland) constrain the spatial integration of statistical data.

Still, our approach allows to:

- Differentiate the Scottish uplands (croft regions) from the lowlands or the sheep farming systems of the northwestern Ireland, which follow a pluriactivity tradition;
- Identify the three main farm structures characterized by Kostrowicki (1970) in Poland;
- Separate the plots subjected to intense afforestation in Portugal, but where the small agricultural plots remain.
- Differentiate the mountain or Apennine areas in Italy;
- Distinguish the Southern and Alpine areas from the rest of the regions in France.

Moreover, the cluster map only represent the farm structure in terms of its structural and economic sizes. It is not possible to infer similarities or dissimilarities between regions concerning farm types or land use intensity.

In view of the above mentioned limitations, and consideration of the tremendous importance of small farms in many European regions we recommend that more efforts should be made to:

- improve official statistical data on small farms (e.g. harmonise minimum farm size thresholds);
- further elaborate the typologies of small farms presented in this report; and
- further develop methods and technologies based on remote sensing for the assessment of the spatial distribution of small farms.

The high variability in the spatial distribution and types of small farms means that better information is needed in support of policy development.

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ANNEX I

WP2 preliminary questionnaire to SALSA teams

This questionnaire is a preliminary step to the work on WP2. With this questionnaire we would like to have a precise picture of the differences in data sets across the partner countries, and also to identify possible indicators to classify small farms.

CENSUS	1. Do you have national census on agriculture?
	2. What is the periodicity and which was the last one?
	3. How are small-farms registered? (please provide the minimum thresholds)
	4. What are the relevant variables included in the census that may help us tailor the definition of small farms?
	5. Is the data available on-line? Please provide the link.
	6. Which data are available? What is the level of spatial aggregation of the available data? (e.g. LAU; NUTS; 'raw data' – by 'raw data' we mean the original-detailed data for every farm of the census)
LAND COVER	7. Do you have national land cover maps? (for each land cover dataset please provide: scale; dates; number of land cover classes; minimum map unit; data type/format (e.g. shapefile); link for download, if available)
CADASTRE	8. Is the cadastre data available for research use? (please provide: type of sources, on-line link (if available))
	9. Is the Integrated Administrative and Control System (IACS) available for research use? (please provide: type of sources, on-line link (if available))
OTHER	Please provide any other relevant information concerning your country (data, reports, research studies, papers)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 677363

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ANNEX II

List of key experts

Country	Name	Institution
Austria	Julia Niedermayr	Federal Institute of Agricultural Economics
	Klaus Wagner	Federal Institute of Agricultural Economics
Bulgaria	Emilia Tcherkezova	National Institute of Geophysics, Geodesy and Geography, Bulgarian Academy of Sciences
Czech Republic	Diana Surová	ICAAM, University of Évora
Denmark	Søren Bech Pilgaard Kristensen	Department of Geosciences and Natural Resource Management, University of Copenhagen
Estonia	Helen Sooväli-Sepping	Tallinn University, School of Humanities (Centre for Landscape and Culture), School of Natural Sciences and Health
Finland	Timo Sipiläinen	Department of Economics and Management, University of Helsinki
France	Elisa Marraccini	INTERACT, UniLaSalle
Germany	Ekaterina Zavyalova	Johann Heinrich von Thünen Institute
Hungary	Zsolt Molnár	MTA Centre for Ecological Research, Institute of Ecology and Botany
	Marianna Biró	
Ireland	Eileen O'Rourke	Department of Geography, University College Cork
Italy	Mirco Corazzin	University of Udine
Poland	Józef Kania	Institute of Economic and Social Sciences, Department of Social Policy and Agricultural Extension, University of Agriculture in Krakow
Romania	Monica Mihaela Tudor	Institute of Agricultural Economics, Romanian Academy
Slovak Republic	Peter Bezák	Institute of Landscape Ecology, Slovak Academy of Sciences
Slovenia	Štefan Bojnec	Faculty of Management, University of Primorska
Sweden	Anders Wästfelt	Department of Human Geography, Stockholm University
UK	Sophia Davidova	University of Kent

ANNEX III

Assessment of small-scale farms in Europe: searching for its relevance and diversity at NUT3 scale

1. Spatial distribution of small-scale farming and related typologies

1.1. Small-scale farms are spatially clustered or show a scattered distribution along the country, region or municipality?

(e.g. in southern Portugal the small-scale farms are spatially clustered nearby the urban areas (Pinto-Correia et al., 2016), whereas in Warminsko-Mazurskie, an important dairy region in Poland, it can be observed a mixture of large-scale and small-scale farms (Dries and Swinnen, 2010, 2004))

1.2. If the small farms present a clustered pattern, it is possible to identify geomorphological-based elements or other spatially explicit features related with that spatial agglomeration?

(e.g. small-scale farms prevail in the mountain areas of the district of Murau (Austria) (Pinter and Kirner, 2014), and in southern Portugal most of the small farms can be found around the localities)

1.3. It is possible to establish distance or elevation range thresholds related with the distribution of small-scale farms?

(e.g. the small farms are distributed within a buffer around the town defined based on a specific distance)

1.4. What are the main types of small agriculture that can be observed in each region or municipality?

(e.g. vegetable gardens, dairy farms, small-scale forestry)

1.5. What's the degree of specialization of the small farms in each region or municipality? The land cover within each cluster of farms is heterogeneous or homogeneous? The overall landscape, even containing large-scale farms, it's heterogeneous or homogeneous (this information is relevant in order to minimize errors related with high heterogeneous landscapes)?

(e.g. although located in the same region (Central Alentejo NUT 3 – Portugal), and both showing a spatially clustered distribution, the small farming that can be observed in Reguengos-de-Monsaraz is mostly related with vineyards, while the spatial pattern of the land cover in the small holdings of Montemor-o-Novo is more complex, presenting a mixture of olive groves, vineyards, vegetable gardens and pastures)

1.6. It is common to find scattered small patches belonging to the same owner?

1.6. Based on CORINE Land Cover data, which land cover classes contain the small-scale farms in each region or municipality?

(e.g. in the municipality of Montemor-o-Novo (Central Alentejo NUT 3 – Portugal) most of the small-scale farms are included in three land cover classes:

241 - Annual crops associated with permanent crops

Permanent crops are either in juxtaposition with arable land/pastures or located along the border of the parcels. The occupation rate of non-permanent crops is more than 50 %.

242 - Complex cultivation patterns

This class includes juxtaposition of small parcels of annual crops, city garden pastures, fallow land and/or permanent crops eventually with scattered houses or gardens.

243 - Land principally occupied by agriculture, with significant areas of natural vegetation

This class includes land occupied by agriculture with areas of natural or semi-natural origin (including wetlands and water bodies, out crops).)

1.7. Is there any type of infrastructures that could be used to identify the prevalence of small farms in a particular location *(e.g. houses, agricultural facilities)*? It can be observed landscape-related features with ownership division *(e.g. fences, roads, walls, hedgerows)*?

1.8. Is there any kind of other indicators or proxies that can be used to identify the extent of small farming in each region or municipality?

2. Data availability

2.1. In addition to the CORINE Land Cover, available on the European scale, it is available any (digital) land cover dataset at the country (or NUT 3) level in a more detailed scale? If yes, it is possible relate land cover classes with the more or less likelihood of presence of small farms? What are the main characteristics of these data *(e.g. number of land cover classes, scale, minimum map unit, minimum distance between lines)*? The access to the data is public?

2.2. What are the main characteristics of the agricultural statistical data *(e.g. minimum area of the farm, type of indicators, frequency of the data collection)*? The access to the data is public? The alphanumeric

data is linked to any geographic database? Can you provide the main indicators (UAA, labour force, number of holdings, economic size, crop types) by farm size class at NUT3 level?

2.3. The cadastral data is available (even if only for some regions or municipalities)? If yes, how can we have access to these data?

OBSERVATION: The requested information should be, as far as possible, detailed enough in order to explore relations between the available spatial and statistical datasets (at least at the NUT 3 level).

ANNEX IV

Descriptive statistics of the variables used in the analysis

	Mean	IQR	CV
Utilized agricultural area (ha)	191720.39	46505.00 - 276246.50	1.03
Share of utilized agricultural area in each region (%)	42.55	28.07 - 57.84	0.48
Total number of holdings	15537.12	2700.00 - 16830.00	1.61
UAA in small holdings (<5 ha of UAA)	16444.09	1335.00 - 17165.89	1.86
Percentage of the UAAa covered by UAAa5	12.13	1.15 - 17.14	1.37
Percentage of the region covered by UAAa5	4.30	0.52 - 5.33	1.50
Normalized difference (UAA/hold. < 5 ha)	-0.72	-98 - -59	-0.54
Standard score for UAA/country level (hold. < 5 ha)	0.00	-0.70 - 0.53	1310.60
Standard score for UAA/european level (hold. < 5 ha)	0.00	-0.49 - 0.02	1764.25
Number of small holdings (<5 ha of UAA)	11189.73	630.00 - 11476.00	2.10
Percentage of small holdings (<5 ha of UAA)	49.50	22.55 - 75.93	0.58
Normalized difference (number of holdings/hold. < 5 ha)	0.10	-0.48 - 0.56	19.77
Standard score for the number of holdings/country level (hold. < 5 ha)	-0.01	-0.67 - 0.40	-166.50
Standard score for the number of holdings/european level (hold. < 5 ha)	0.00	-0.49 - 0.06	1816.14
UAA in small holdings (<8 ESU[1)])	44073.92	7305.00 - 45335.00	1.43
Percentage of the UAAa covered by UAAa8	25.77	7.41 - 39.45	0.85
Percentage of the region covered by UAAa8	9.75	2.50 - 13.61	1.00
Normalized difference (UAA/hold. < 8 ESU)	-0.37	-0.88 - -0.21	-3.69
Standard score for UAA/country level (hold. < 8 ESU)	0.00	-0.58 - 0.46	2165.75

Standard score for UAA/european level (hold. < 8 ESU)	0.00	-0.58 - 0.00	1380.31
Number of small holdings (<8 ESU[1])	13817.37	1165.00 - 14545.00	1.85
Percentage of small holdings (<8 ESU[1])	63.17	40.48 - 86.56	0.43
Normalized difference (number of holdings/hold. < 8 ESU)	0.29	-0.19 - 0.80	2.32
Standard score for the number of holdings/country level (hold. < 8 ESU)	0.00	-0.67 - 0.49	1318.54
Standard score for the number of holdings/european level (hold. < 8 ESU)	0.00	-0.51 - 0.04	1690.88
Farms density	0.12	0.03 - 0.15	1.46
Small farms density	0.09	0.01 - 0.11	1.83
Mean size of holdings	29.97	6.71 - 39.80	1.24
Mean size of small holdings (<5 ha)	1.92	1.32 - 2.47	0.40
Total labour force (AWU[2])	12714.41	2490.00 - 15380.00	1.27
Total Family Labour Force[3] (AWU[2])	10207.01	1750.00 - 11715.00	1.46
Proportion of the Family Labour Force	72.53	62.33 - 90.17	0.33
Number of holdings in less favoured areas	6315.58	0.00 - 8260.00	1.58
UAA in less favoured areas	96401.90	0.00 - 11994.00	1.59
Number of holdings in mountain areas	2766.32	0.00 - 2820.00	2.40
UAA in mountain areas	29403.18	0.00 - 32280.00	2.17

IQR: interquartile range; CV: coefficient of variation

[1] ESU: European size unit, which is a standard gross margin of 1,200€ that is used to express the economic size of an agricultural holding.

[2] AWU: Annual Work Units, corresponding to the work performed by one person occupied on a full-time basis.
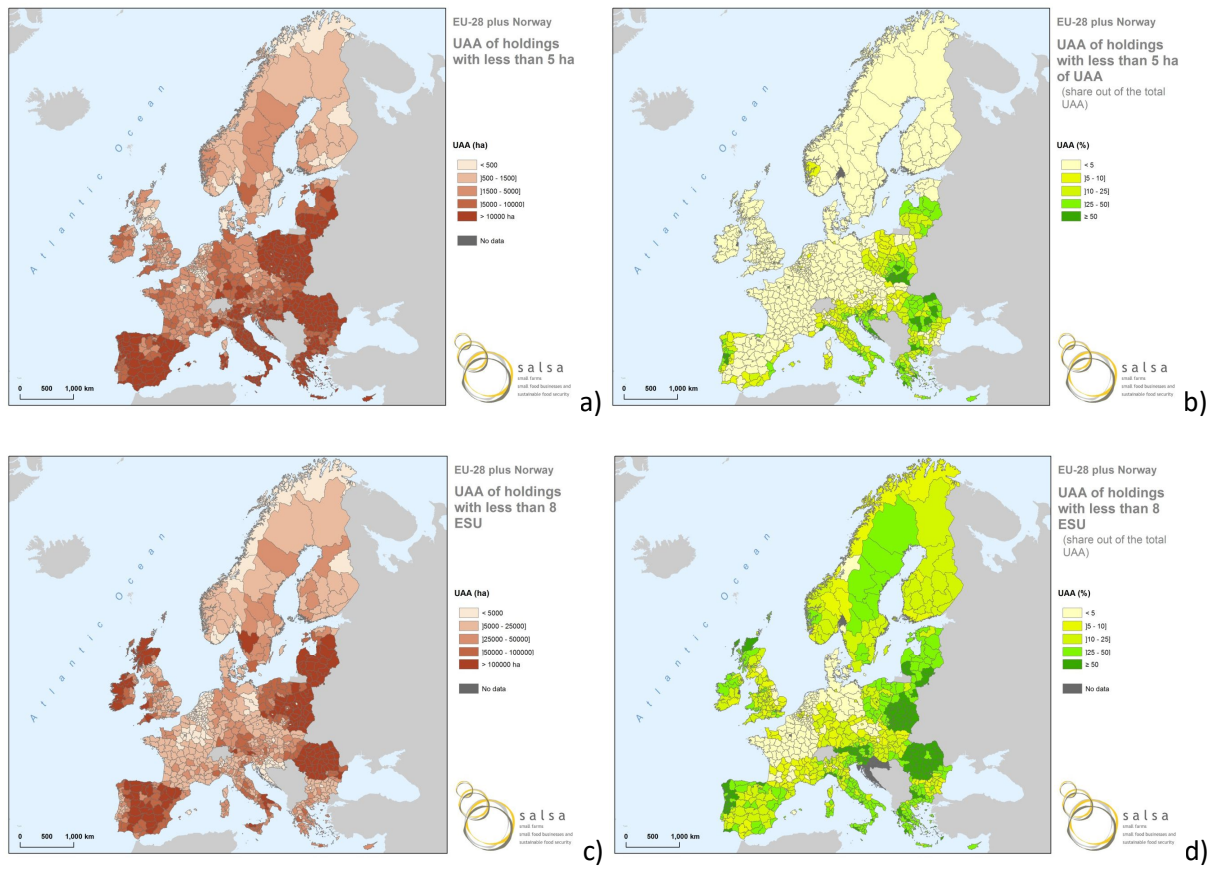
[3] Family labour force of the agricultural holding refers to persons who carry out farm work on the holding and are classified either as a holder or the members of the sole holder's family (spouse, relatives and brothers and sisters of the holder or his/her spouse).
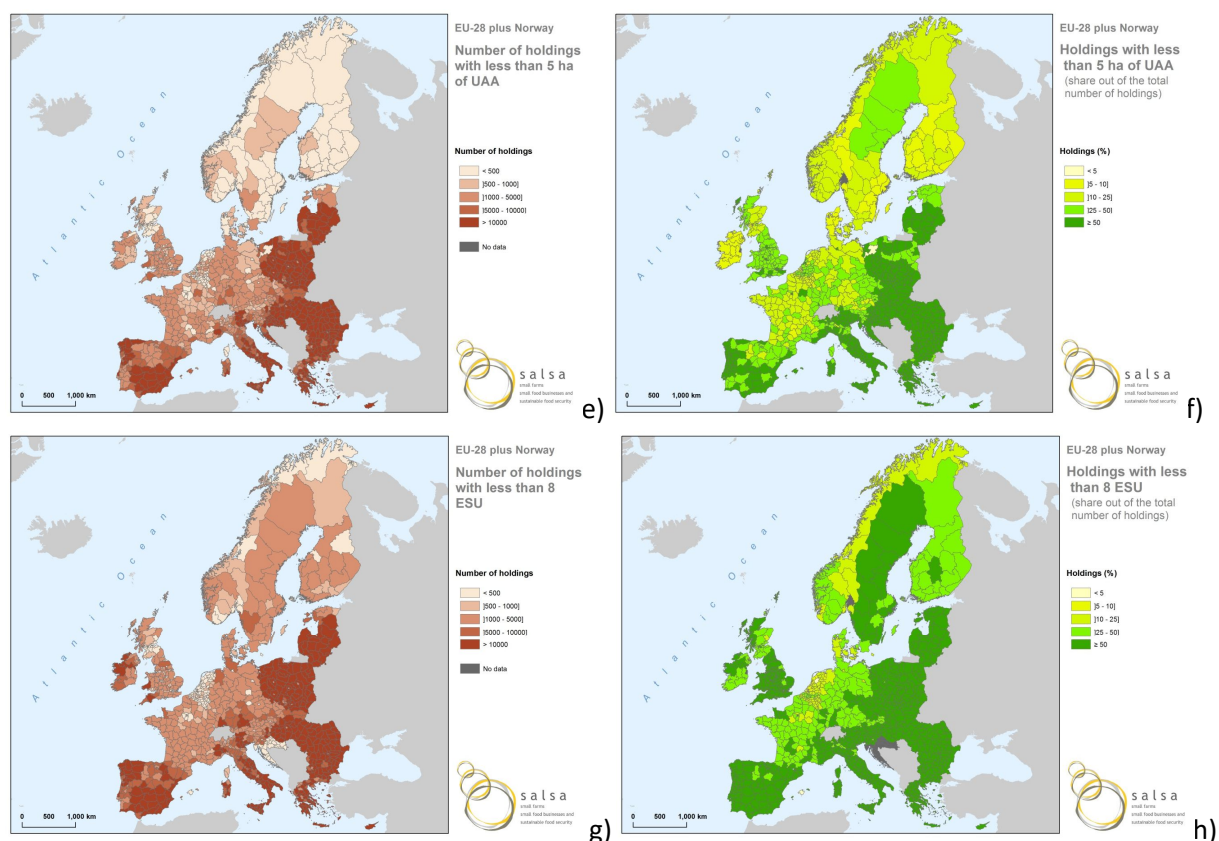
ANNEX V

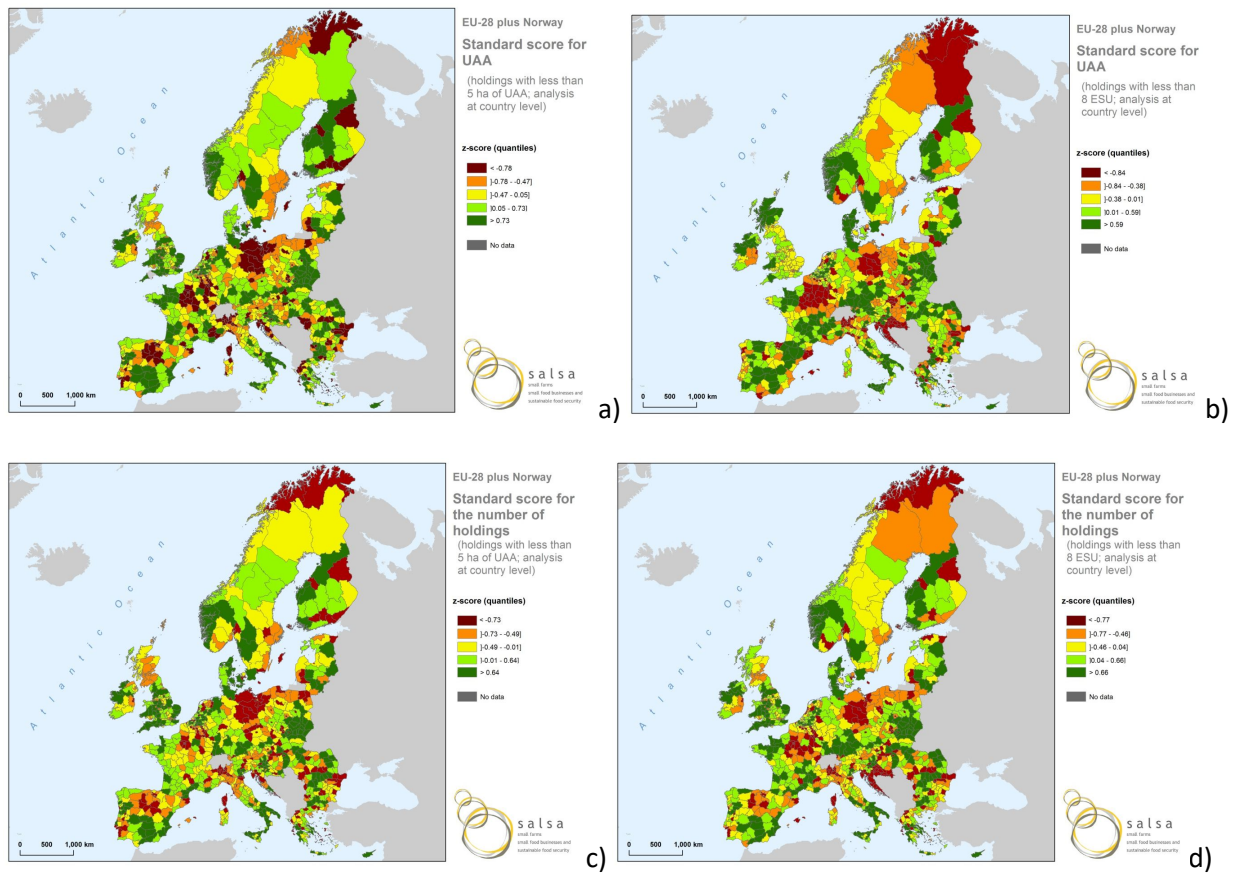*Spatial distribution of the variables used in the analysis*

Figure V. Utilized agricultural area (UAA) in holdings with less than 5 ha of UAA *a)* and *b)* and in holdings with less than 8 ESU *c)* and *d)*; number of holdings with less than 5 ha of UAA *e)* and *f)* and of holdings with less than 8 ESU *g)* and *h)*
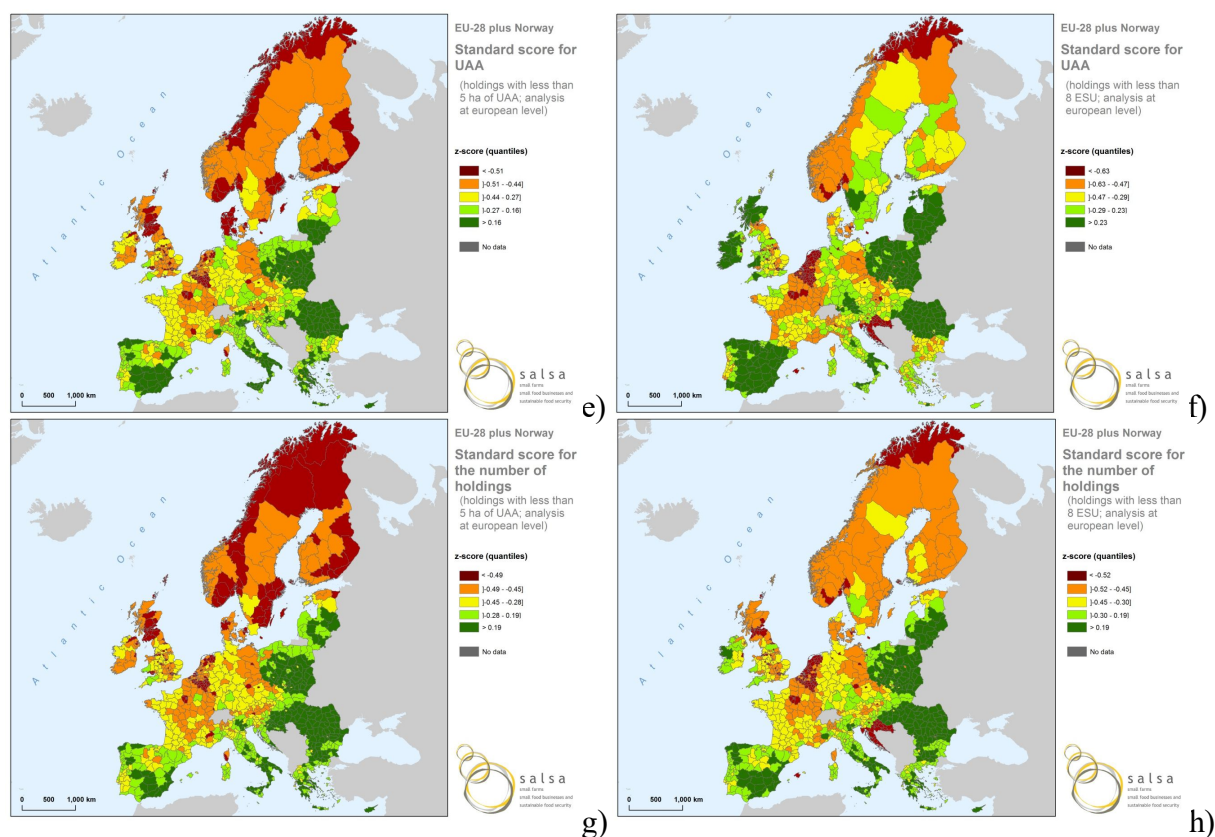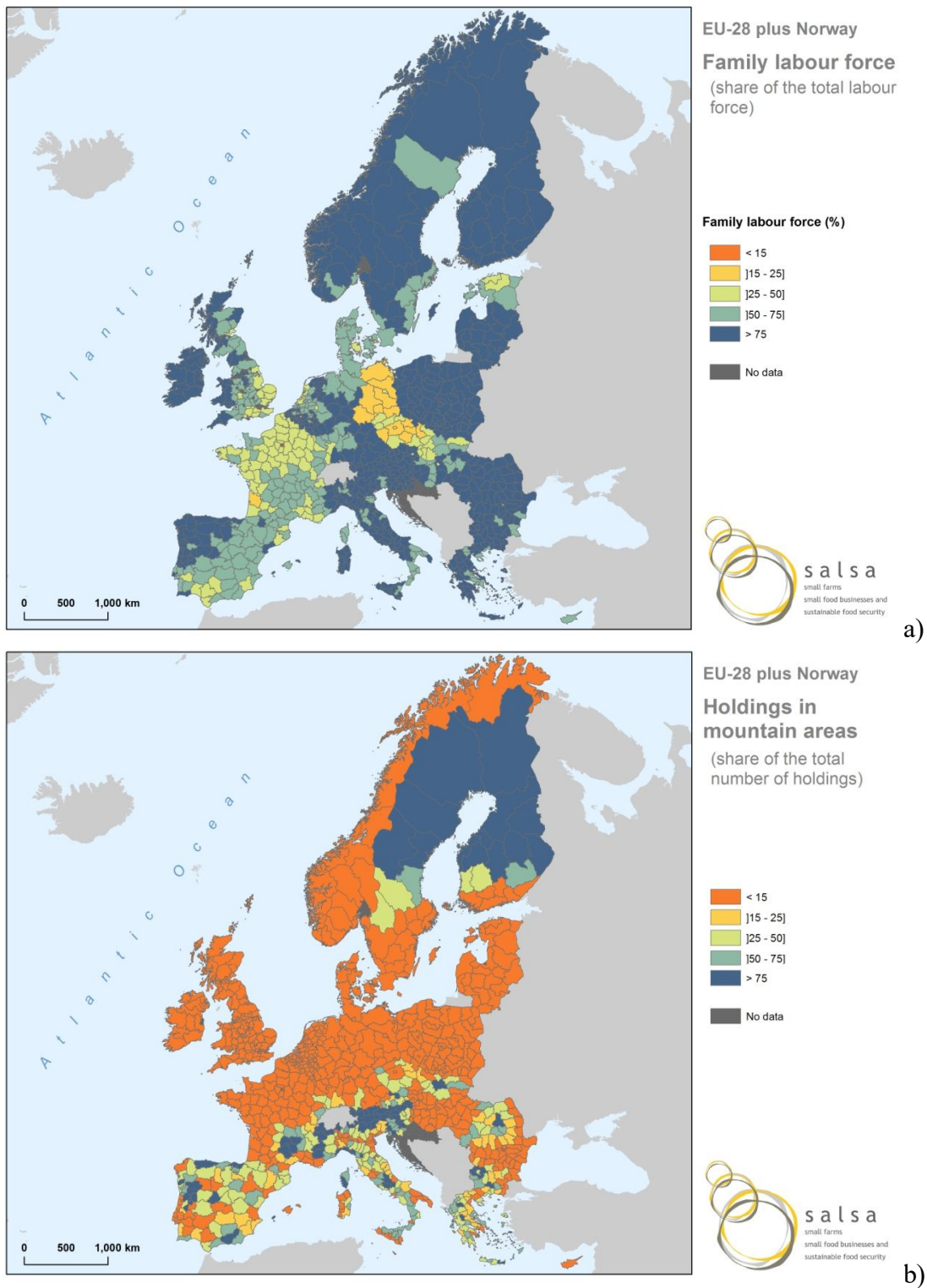
ANNEX VI

Spatial distribution of the standard scores

Figure VI. Standard scores, computed at country level, for UAA *a)* and *b)*, and for the number of holding *c)* and *d)* considering the structural and economic size of the farms, respectively; and computed at European level, for UAA *e)* and *f)*, and for the number of holding *g)* and *h)*.

ANNEX VII

Family labour force and number of holdings in mountain areas

Figure VII. Percentage of the Family Labour Force *a)* and distribution of holdings in mountain areas *b)*

ANNEX VIII

Eligibility criteria for inclusion data in agricultural census

Box VIII. Eligibility criteria for inclusion data in agricultural census

GERMANY

The thresholds of coverage of the Agricultural Structure Survey 2007 and the Census of Agriculture 2010

In the Agricultural Structure Survey 2007 all holdings are questioned, which reach at least one of the following thresholds of coverage:

- The holding has a utilized agricultural area of at least 2 ha or at least:
  o 8 cattle or pigs or
  o 20 sheep or
  o 200 laying hens or pullets or broilers and other cocks or geese, ducks and turkeys or
  o 30 are of stocked areas under vines or areas under fruit trees, for profit making purposes, also if it is a non-yielding area, or hops or tabacco or tree nurseries or outdoor vegetable cultivation or outdoor flower or ornamental plant cultivation or medicinal or culinary plant cultivation or horticultural seeds for profit making purposes or
  o with 3 are for of fresh vegetables or flower or ornamental plant cultivation under glass, for profit making purposes.

In the Census of Agriculture 2010 all holdings are questioned, which reach at least one of the following thresholds of coverage

- The holding has a utilised agricultural area of at least 5 ha or at least
  o 10 cattle or
  o 50 pigs or
  o 10 breeding sows or
  o 20 sheep or goats or
  o or 1000 poultry or
  o 0,5 ha each of area under fruit trees, vines or tree nurseries or of tobacco or hops or
  o 0,5 ha of outdoor vegetable or strawberry cultivation or
  o 1,0 ha of permanent outdoor crops or
  o 0,3 ha of outdoor flower or ornamental plant cultivation or 0,1 ha each of area of mushrooms or of crops under glass or other assessible protective cover.

GREECE

The 2010 census targeted all agricultural holdings with at least: 0.1 hectares of agricultural land or 0.05 hectares of glasshouse crops, or owned animals and, in particular, one cow, or two other 'large animals' (e.g. oxen, buffalo, donkeys), or five 'small animals' (sheep, goats, pigs), or fifty poultry or twenty beehives.

NORWAY

In the Agricultural Census 2010 data was collected from all agricultural properties, without a threshold.

POLAND

A natural person's agricultural holding is understood as an agricultural holding from 0.1 ha of

agricultural land, either owned or used by a natural person, as well as an agricultural holding of a person having no agricultural land, or with agricultural land less than 0.1 ha, who have at least: 1 head of cattle, or/and 5 head of pigs, or 1 sow, or/and 3 head of sheep or/and 3 head of goats, or/and 1 horse, or/and 30 head of poultry, or/and 1 ostrich, or/and 5 head of female rabbits, or/and 5 head of other fur-bearing female animals, or/and 3 head of other animals kept for slaughter, or/and 1 beehive.

SPAIN

The "general" minimum threshold is 1 ha, but a lower threshold is set for intensive orientations. More specifically, the farms are eligible for the Agricultural Census 2009 when falling in one of the following independent criteria:

- Agricultural holdings with at least 1 ha of utilised agricultural area (UAA);
- Agricultural holdings with at least 0.2 ha of UAA used for fresh vegetables, melons and strawberries, flowers and ornamental plants (outdoors or under low protective cover) or irrigated fruit and berry plantations and citrus plantations, or nurseries, or woody crops under greenhouse;
- Agricultural holdings with at least 0.1 ha of UAA used for under-glass fresh, vegetables, melons and strawberries;
- Agricultural holdings with at least 0.1 ha of UAA used for under-glass flowers and ornamental plants;
- Agricultural holdings with at least 0.5 ha of UAA used for tobacco;
- Agricultural holdings with at least 0.5 ha of UAA used for hops;
- Agricultural holdings with at least 0.5 ha of UAA used for cotton;
- Agricultural holdings with one or more livestock units and a total standard output equal to or above 0.75 of the economic size of holdings.

UNITED KINGDOM

Registration is voluntary (i.e. you have to register to receive subsidies but at that scale, many do not). Farms have to be at least 1 ha to receive the Single Farm Payment.

Holdings of less than 1 hectare are defined as "minor holdings" – they only receive a census form every third year. This definition excludes intensive poultry and horticulture, holdings with a full-time farmer, and those with more than £2000 standard gross margin. Just over half of Scotland's total holdings fall into this category. Further information in the attached ppt.

There is no official definition of 'small farms', but there is a designation for 'crofts': "A croft is a small agricultural unit, most of which are situated in the crofting counties in the north of Scotland being the former counties of Argyll, Caithness, Inverness, Ross & Cromarty, Sutherland, Orkney and Shetland, and held subject to the provisions of the Crofting Acts. Many crofts are on estates. A landlord may have many crofts on his estate. The rent paid by the tenant crofter, except in fairly rare circumstances, is only for the bare land of the croft, for the house and agricultural buildings, roads and fences are provided by the crofter himself. Since 1976 it has become more common for a crofter to acquire title to his croft, thus becoming an owner-occupier. Should he fail to reside on or near the croft, he can himself be required to take a tenant" (http://www.crofting.org/faqs/67). Note that crofts are 'small' but are difficult to accurately assess in terms of size – there is no official size limitation. In addition, a croft will often have an amount of 'in-bye' land which is in the sole possession of the crofter, but also a share in local communal grazing. The 'in-bye' land can be less than a hectare up to several hundred hectares; common grazing is typically over 10 hectares and could be also be several hundred ha. Crofts are located in areas where the agricultural land is poor, so most commonly they involve extensive grazing of beef and sheep.