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AGRICULTURE UNDER HUMAN INFLUENCE: A SPATIAL ANALYSIS OF FARMING SYSTEMS AND LAND USE IN EUROPEAN RURAL-URBAN-REGIONS

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Abstract: Peri-urban agriculture in metropolitan regions is exposed to severe urbanisation pressures related to land and labour availability, thus limiting farming activities. Nevertheless, peri-urban agriculture reveals specific characteristics that contribute to the local food supply and the management of a multifunctional countryside near towns. This paper seeks to investigate agricultural land-use and farming-system characteristics in peri-urban areas within Rural-Urban Regions (RUR) across the EU27. The RUR model, which includes an allocation of urban, peri-urban and rural areas, is developed and applied in spatial and statistical analyses to identify relationships between urbanisation and agriculture. The results indicate that metropolitan agriculture compensates shrinking land bases by increasing the intensity of the labour and turnover generated, and is furthermore specialised at developing horticultural produce that is oriented towards urban consumer markets.

Keywords: Peri-urban, horticulture, competiveness, specialisation, urban-rural relationships, metropolitan regions, land consumption

Zusammenfassung: Stadtnahe Landwirtschaft in Metropolräumen ist im Hinblick auf zunehmend begrenzter Anbauflächen- und Arbeitskraftverfügbarkeit sowie Nachbarschaftskonflikten und rechtlicher Beschränkungen schwierigen Rahmenbedingungen ausgesetzt. Dennoch wird deren Wert für die lokale Nahrungsmittelversorgung und die Bewirtschaftung multifunktionaler Landschaften zunehmend anerkannt. Hier werden Ergebnisse räumlicher und statistischer Analysen regionalisierter Agrardaten vorgestellt, die basierend auf der Abgrenzung von Stadt-Umland-Regionen und deren urbanen, peri-urbanen und ländlichen Teilräumen, Qualitäten stadtnaher Landwirtschaft identifiziert. Dabei zeigt sich, dass die begrenzten Flächenpotenziale durch höhere Erlöse bedingt durch Intensivierung und Spezialisierung auf Gartenbau kompensiert werden, die vor allem auch eine besondere Rolle städtischer Märkte nahelegt.

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1. Introduction

1.1 Agriculture in peri-urban areas

Historically, cities and urban agglomerations depend on the food supply from the agriculture produced in their hinterlands, while cities provide important markets for agricultural goods due to their concentration of people. According to Thünensian logic of land-use distribution, the adjacency to the urban market is particularly important for the cultivation of fresh and easily perishable products with high transportation cost, which is expressed by the society's high willingness-to-pay within these areas (Hall, 1966). Due to wide-reaching innovations in rail, road and shipping transportation modes, as well as advances in storage technologies, these traditional urban-rural relationships have been eroded and replaced by inter-regional or even global flows and exchange. With increasing environmental concerns, changing recreational and lifestyle interests, as well as a burgeoning consumer awareness for regional and quality food production (Wande & Bugge, 1997), agriculture today represents an important land-use actor in the hinterlands of urban agglomerations, since it provides multiple goods and services demanded by the urban society (Zasada, 2011).

However, the framework conditions for agriculture in densely populated and urbanised regions differ substantially from that of the remote rural countryside. There is a comprehensive understanding that farming in urbanised regions takes place in an environment characterised by specific pressures and opportunities tied to the urban area (Bryant and Johnston, 1992; Piorr et al., 2011). First and foremost, the physical conversion of non-sealed surfaces into built-up areas, such as into settlements and modes of infrastructure, occurs almost exclusively at the expense of farmland, and therefore culminates in the further erosion of the productive capacity of metropolitan agriculture, whereby productive land and fertile soils are lost as the number of farms decrease (EEA, 2006). Peri-urban farms have to compete with urban land-use interests on land markets where rents are increasing, along with shortages of arable land and fragmented ownership rights (Robinson, 2004; Munton, 2009).

In response, it has been argued that farms in the urban fringe and beyond have demonstrated a particular adaptive and innovative capacity to cope with the given framework conditions (Beauchesne & Bryant, 1999; Andersson et al., 2009). Regional and national case studies in metropolitan areas have shown a more frequent participation in pluriactivity and lifestyle farming in these areas including part-time, hobby or retirement farmers, along with agri-environmental schemes and landscape management (Tobias et al., 2005; Busck et al., 2008). Particularly in the case of horticulture, comparative location advantages, higher adaptability and urban market orientation have all been observed in various metropolitan areas (Péron & Geoffriau, 2007; Cantliffe & Vansickle, 2008; Zasada et al., 2011). Broad cross-regional comparative analysis of urbanisation's influence on farming is lacking. This is despite the comprehensive empirical evidence already available at a regional level concerning the diversity of the agricultural sector at the urban-rural fringe, specifically measured in terms of farm sizes, ownership rates, levels of turnover and revenue, occupation type and the specialisation of horticulture as defined by classical land use models. Beyond regional case studies, no large-scale assessments are currently available that would permit comprehensive evidence of peri-urban agriculture's characteristics.

1.2 Main objective, research design and methodology

The main objective of this paper is to investigate the specifics of farming in urbanised geographical settings compared to rural equivalents spread across European regions. It shall be argued that the existence of a specific peri-urban agricultural land-use pattern comes about as a result of specific individual farm structures. This argument is based on previous research findings (Zasada, 2011;Piorr et al., 2011).Small-scale farm structures, widespread land tenures as well as part-time and retirement farming shall be examined in connection with a higher revenue generation, in some cases, a concentration and specialisation on horticulture, and a cultivation of high-value produce. This paper aims to contribute to the empirical evidence of the relationship between farming and urbanisation by applying statistical analysis of European data on agricultural performance and farm structures at a regional level.

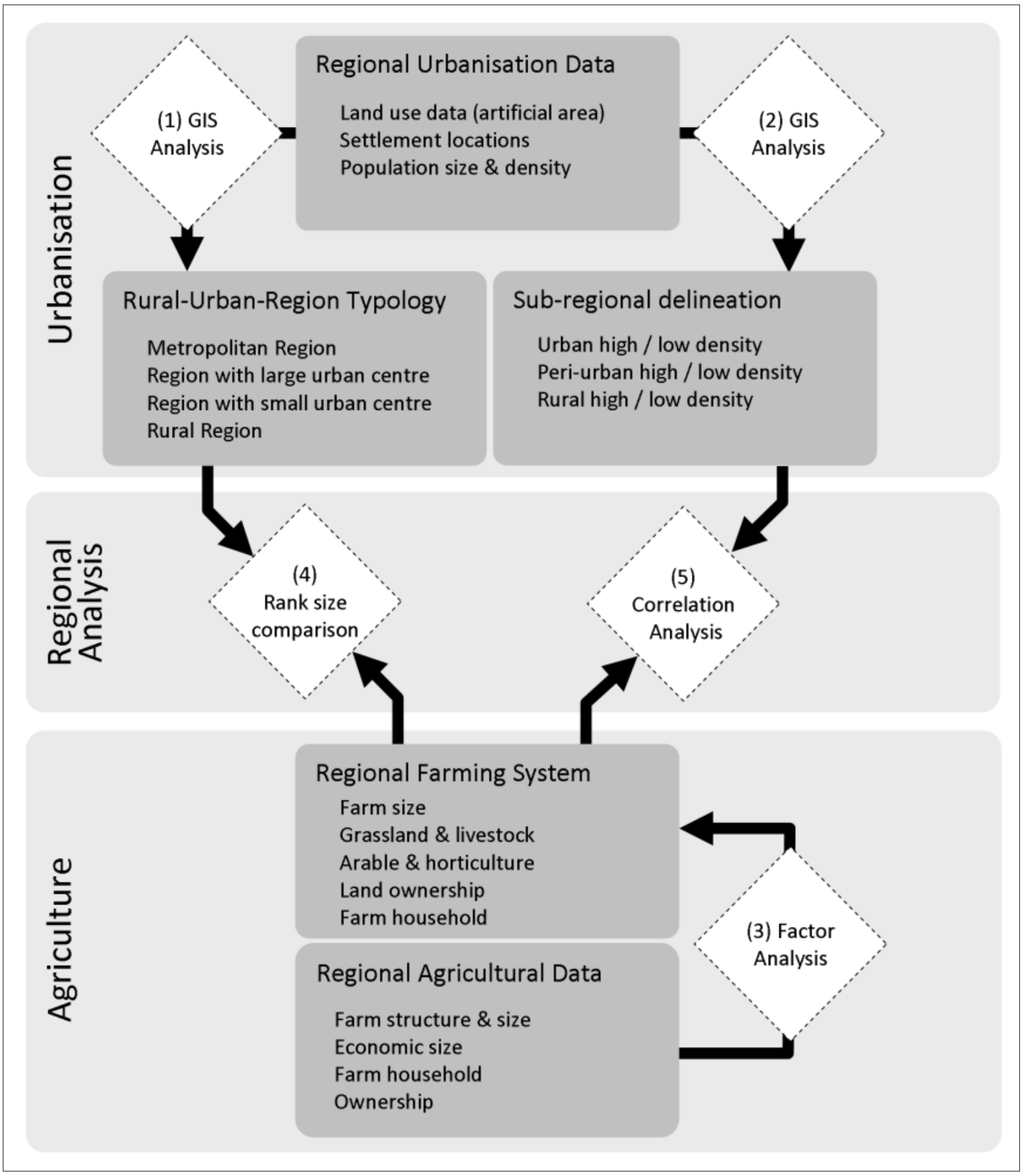

Fig 1. Analytical framework

2. Spatial determination of urbanisation

Within this paper, urban influence on agriculture and horticulture is perceived in a twofold manner; firstly by establishing whether the region in question belongs to a functional urban area of a city; and, secondly, by examining the topological perspective of urbanisation in terms of actual land use. As a common market for intra-regional land, labour, housing and trade, functional urban areas (FUA) also shape the hinterland catchment areas of urban agglomerations, which in turn also represent an important consumer market for regional agriculture (Hall & Hay, 1980; OECD, 2002). Urbanisation of rural areas also therefore refers to the intensity of the spatial interaction between urban settlements and the nearby farmland, as well as the conflicts and opportunities it brings about for peri-urban agriculture (Bryant & Johnston, 1992; Robinson, 2004; Gant et al., 2011).

For the implementation of both notions of urbanisation within a spatial modelling process, two different approaches are applied. As a first step, a European typology of RUR regions spatially combines NUTS3 units to common regions, which, in a second step, are further delineated into urban, peri-urban and rural areas as defined by urban land use, proximity to urban centres and population density. The typology shall encourage the exploration of the farming structure, intensity and farm produce in the peri-urban as an effect of urban and peri-urban region characteristics as well as population distribution pattern, demanding agricultural production in the centres' vicinity in different ways.

2.1 European typology of Rural-Urban Regions

Various European approaches exist to describe urban influence on neighbouring rural areas, as well as to spatially delineate regional functional urban areas (OECD, 2002; ESPON, 2005; EUROSTAT, 2010). These approaches are based on the classification of individual NUTS3 regions or even smaller entities. Within this paper, a more comprehensive analysis of farming systems was carried out using Rural-Urban Regions (RUR) based on a typology which was originally developed between 2007 and 2010 within the European research project PLUREL dealing with peri-urban land use relationships and sustainable urban development (Loibl et al., 2008 Piorr et al., 2011, Pauleit et al., 2013). The RUR classification was also based on NUTS3 aggregates as these represent the smallest spatial unit, where broad-range European-wide statistical data can be obtained. A RUR region was defined by its morphological characteristics and its intraregional relations, reflecting the influence spheres within the region. The regional classification originally does not only consider the extent of functional relationships of urban centres with their surroundings – the commuter catchment areas – but also distinguishes between mono-centric, poly-centric RURs and RURs with no reasonable centre und further divides the RURs into urban, peri-urban and rural sub-regions. For the current investigation, however, particularly the city size ranges and the urban population numbers to be supplied by peri-urban agriculture as well as the RUR‘s, peri-urban sub-regions are of interest.

The development of the RUR typology and the division into sub-regions were thus depending on data sets with a European-wide scope, namely the CORINE land-cover data set (CLC2000) of the European Environment Agency (EEA) and population numbers of urban centres (GISCO STEU points) and of the NUTS3 regions for the year 2000 by EUROSTAT which correspond with the land cover data from 2000. CLC2000 represents a 100x100m raster data set with 44 land cover classes, which allows quite accurate delineation results for the European wide scale. The European-wide delimitation of RURs finally required a number of working steps. At first, continuous city and settlement area were identified by uniting adjacent or closely neighbouring densely built up areas to "settlement morphological zones" (SMZ), using land cover data CLC2000, class 11 (settlement area). Adjacent or closely neighbouring settlement area patches representing parts of one settlement were merged into a continuous SMZ (Loibl et al., 2008; Zasada et al., 2013).

Second, applying the geographical positions of approximately 4,900 settlement points, derived from the GISCO STEU point database for cities larger than 10,000 inhabitants (in Germany and the Netherlands larger than 20,000) allowed to spatially link population numbers to urban areas building one SMZ. At the time the RUR classification was carried out (2008), no population figures for local administrative units (LAU) could be made available for entire Europe, so the STEU points in combination with population numbers obtained from the World Gazetteer database served as workaround for allocating inhabitants to core cities. As a third step, SMZs exceeding 50,000 inhabitants (if existing) have been defined as major urban centres of the particular NUTS3 region. These centres served here as the urban nuclei for identifying urban functional catchments as basis for RUR region delimitation.

In a third step, the functional catchment areas of these urban nuclei were estimated. Their extents should be identified by data describing regional interrelations like commuting-, food supply-, or recreation relations. As such European-wide data were not available to identify these relationships, assumptions were made and proxy data applied to estimate the functional outreach. As the urban population can be assumed as trigger for urban-rural relationships, it could be applied as proxy variable to describe the functional area coverage. This extent was also considered a decisive factor for determining the size of the urban market for agricultural goods and services. The influence radius of the city's population extent was thus geometrically expressed by drawing a circle around the core cities, where the radius was determined by a logarithmic expression of the population number. This approach was tested with available commuting data in Austria which allowed identifying the commuting catchments in detail and turned out as appropriate approach describing a proper functional relationship extent.

As final step, those NUTS3 regions which share a common functional area were merged to common RUR regions. The urban nuclei with the largest population size have been considered as centre of the common RUR, the remaining nuclei within such a RUR were identified as subcentres. The plausibility of this approach has been checked on the basis of further examinations of functional relationships of large cities in a sample of countries. Finally about 1,300 NUTS3 regions within Europe were clustered into 898 RUR regions, with metropolitan, mono-centric and poly-centric and rural characteristics. For the current work the poly-centricity issue is not important as only the urban population numbers to be supplied by peri-urban agriculture are of interest and not the distribution into one or a several urban centres. Thus the RURs are here classified as *Metropolitan regions*, *Regions with large urban centres*, *Regions with medium-sized urban centres, Regions with small urban centres* and *Rural regions* (cf. Figure 2).

The analytical approach combines two main elements – (i) the classification of Rural-Urban Regions (RUR) and the delineation of urban, peri-urban and rural areas, as well as the (ii) statistical analysis of the farming systems used in response to the prevalent urbanisation carried out at the spatial level of administrative NUTS units. The analytical framework presented in figure 1 outlines the procedure and the main methodological steps – (1) urban-rural classification of regions, (2) spatial delineation of urban, peri-urban and rural areas within the regions, (3) identification of the main factors characterising farm systems, as well as uni- and bivariate statistics including (4) rank size comparisons and (5) correlation analysis to determine the characteristics and distinctiveness of metropolitan and peri-urban agriculture. Section three presents both the applied methodology and the results related to the spatial classification of urbanisation characteristics. In section four, the influence of urbanisation on farming systems in Europe is explored. A discussion of the results is carried out in section five, while section six contains the final conclusions.

(i) Metropolitan RURs (n=67) encompass one or more metropolitan cites of a minimum 500,000 inhabitants and more than one million inhabitants in the entire RUR. The average total population size is 2.7 million with a population density of 502 inhabitants per km². The share of urban area (artificial surface) amounts to 9.5%. Included in this regional class are several European capital regions such as London, Paris, Madrid or Berlin, but also poly-centric urban agglomerations such as the Dutch Randstad, Manchester-Liverpool or the Silesian and the Rhine-Ruhr region. (ii) *RURs with large urban centres* (n=112) contain one large core city of at least 200,000 inhabitants, without sub-centres or several medium-size core cities with 200,000 inhabitants or more. The average population size here is 857,000 with a 6.8% artificial surface share. Typical examples are the Swedish Skåne, the Czech South Moravian or the Spanish Alicante region. (iii) *RURs with medium-sized centres* (n=230) contain one or more urban centres of less than 200,000 inhabitants. The average population size of the region reaches 410,000 with a population density across the whole region of 142 inhabitants per km². This type of region encompasses the Polish Opole or Slupski regions, the Belgian Hasselt and the Hungarian Veszprem. *RURs with small urban centres* (n=120) represent regions with smaller urban centres with at least 50,000 inhabitants. On average, 409,000 inhabitants live in this region where urban area covers 4.7% of the total area. East Anglia, Almeria and Cagliari are among those regions. (iv) *Rural Regions* (n=370) lack medium-size urban centres, but contain dispersed small settlements within a rural area. These regions are populated by an average of 157,000 inhabitants with an average density of 84.5 inhabitants per km². It is by far the most frequent region type covering many small rural regions all over EU27 with exceptions of the new member states, like Poland, Czech Republic, Slovakia and Hungary, which lacks this type of region.

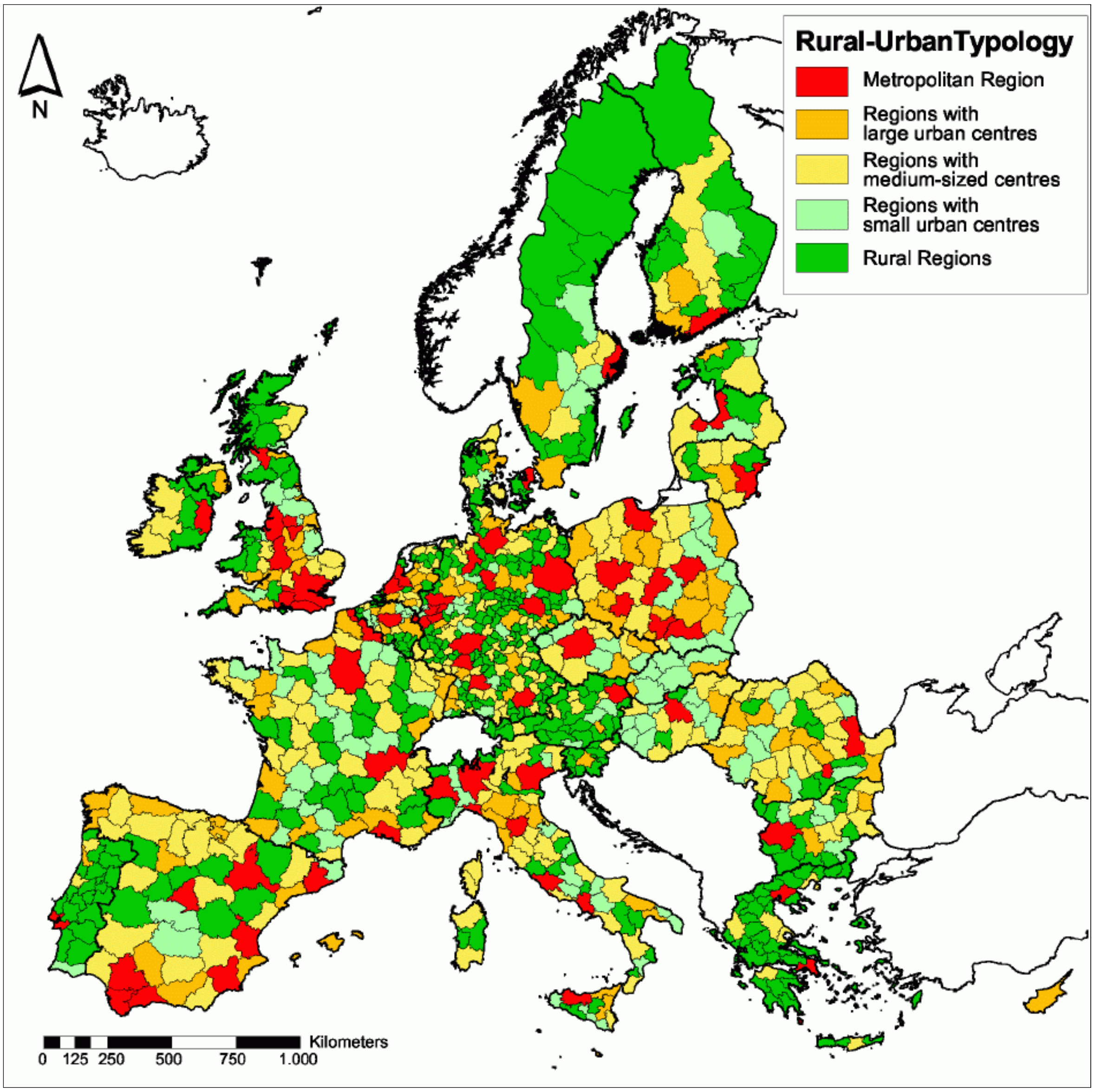

Fig 2. Clustering of NUTS3 entities to Rural Urban Regions.

2.2 Continuous delimitation of urban, peri-urban and rural areas

Taking the criticism of relatively coarse delineation methodologies at NUTS3 level for analytic purposes (Perlin, 2010) into consideration and gaining understanding of the specific role of urban and peri-urban areas in agriculture and rural development, a continuous delimitation approach was developed. EU27-wide the individual RUR regions are resolved into urban, peri-urban and rural areas of either high or low population density. Therefore the delimitation procedure made use of further geospatial data including a 100x100m raster map for population density (Gallego, 2010), municipality boundaries, LUCAS (Land use/cover area frame survey) data, the European settlement point database and CLC2000. The approach focuses on population concentration in certain land-cover classes by applying a logistic regression model. The delineation was conducted stepwise, in that map algebra functions were applied to establish Boolean decision rules within the GIS-routines to thereby extract the urban, peri-urban and rural areas with either high and low population density. Table 1 gives an overview of the urban, peri-urban and rural sub-regions and their delineation criteria.

Sub-regions	Delineation criteria
Urban, high density area (U_1)	CLC Class 111 (continuous settlement area) within U_2
Urban, low density area (U_2)	CLC 1 (artificial area) without CLC 13 (mining area) and population >20,000
Peri-urban, high density area (PU_1)	Population density >75 inhabitants per km² or population >10,000 and within PU_2
Peri-urban, low density area (PU_2)	Population density >40 inhabitants per km² and max. 300 m from urban area
Rural, high density area (R_1)	Population density >10 inhabitants per km²
Rural, low density area (R_2)	Population density >0 inhabitants per km²

Tab 1. Urban, peri-urban and rural areas and delineation criteria.

Urban high density areas are determined by CLC2000 class 111 ("continuous settlement area") which generally describes inner-city areas. Population numbers are not considered as criteria here since high-density urban cores are not necessarily populated by inhabitants, as they mainly host commercial and administrative functions. *Urban low density* areas require the presence of CLC land-cover class 1 ("artificial surfaces"), excluding mining areas, to include true urban land cover and population numbers above 20,000 inhabitants in the respective settlement areas.

Peri-urban low density areas require adjacent location (within a maximum distance of 300 meters) to the CLC class 1 (artificial surface, excluding mining area). The distance criteria ensures spatial connection to urban core regions and avoids exclusion of areas distinguished from urban areas as a result of rivers or small open space corridors. Additionally, the population density in peri-urban low density areas must exceed 40 inhabitants per km². *Peri-urban high density* areas are either defined by a minimum population density of 75 inhabitants per km², or by the land-cover class 11 (settlement area) and a settlement population of above 10,000 inhabitants inside the low density regions.

Rural areas are those without larger urban settlements and *low population density*. *Rural high density* areas require at least a population density of 10 inhabitants per km². *Rural low density* areas include all the remaining inhabited areas. The comparable low population density thresholds were used for classification to make them applicable for the entire municipal entities often consisting of uninhabited areas. Table 1 gives an overview of all classes and their criteria. Figure 3 shows a detailed extract of the sub-regional delineation for the area between London, Paris and the Rhine-Ruhr region, an area with particularly extensive peri-urban areas. (see Loibl et al., 2008, Zasada et al., 2013).

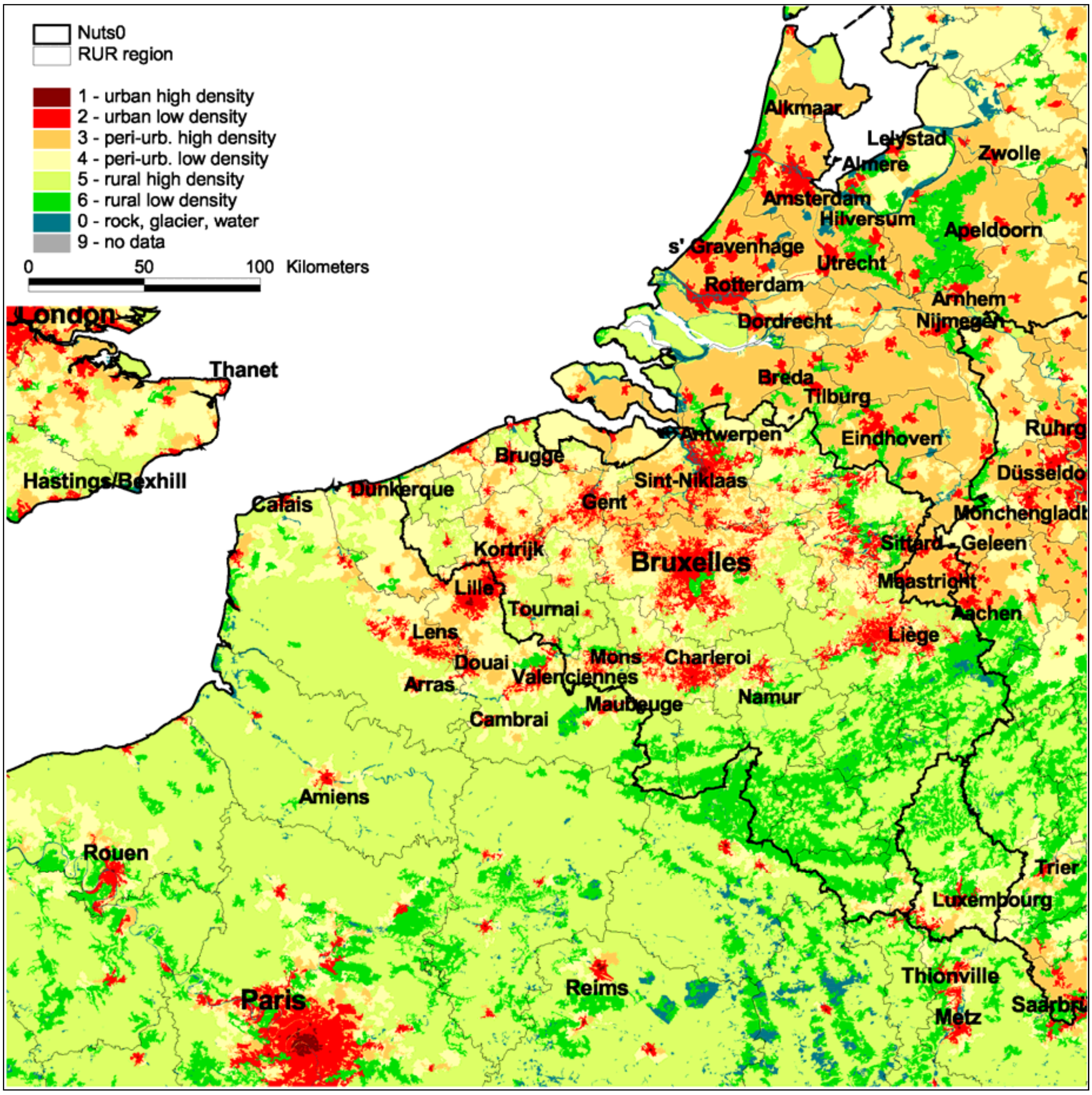

Fig 3. Delineation of the Rural-Urban Regions into urban, peri-urban, rural areas (detail from the EU27 map: Southern parts of the Netherlands, Belgium, Luxembourg, North-eastern France). Source: PLUREL project (Loibl et al, 2008, Zasada et al., 2013).

3. Analysis of agriculture in the context of urbanisation

European agricultural data from the EUROSTAT regional database was used for the analysis of the spatial distribution of agricultural land use and farm structure characteristics and performance indicators, related to those determinants which were identified most relevant in the peri-urban according to a profound literature review (see chapter 1.1 and Zasada 2011). Such are farm types and farming specialisation (e.g. specialised horticulture and the cultivation of high-value produce), as well as economic performance and farm size, land ownership, labour force and age structure. For those determinants different variables, and in case of classified databases distinct classes, were selected and the absolute values of selected variables were aggregated according to the NUTS3 clustering of RUR regions. To obtain spatial and temporal compliance with the RUR database, a spatial resolution of NUTS3 and the census year 2000 was chosen.

3.1 Factor analysis of European farming systems

In total 23 variables characterising agriculture under urban influence were selected for the statistical analysis. A particular prevalence of small farm sizes in urban proximity was the assumption leading to the selection of distinct area related farm sizes (absolute values in ha and relative share of farm size classes per NUTS3). Analogous, average gross margin in European Standard Unit (ESU) per ha utilised agricultural area (UAA) and share of highly productive farms (min. 100 ESU) were chosen as economic performance variables, assuming comparable advantages in the peri-urban. In order to analyse farm type and farm specialisation, the share of holdings with permanent grassland, with arable production and with different forms of horticultural specialisation were considered. In order to avoid bias due to different area sizes, only the ratio of holdings and not of UAA per NUTS3 was considered. Finally farm ownership, labour force, part-time farming and age structure were selected. Regarding farm ownership particularly the groups of younger and elderly farmers were examined, as proximity to cities could be a trigger to run a farm, full time or part-time. To prevent semantic redundancies through inter-correlations, to reduce the number of variables and to identify the main factors describing the regional farming system, Principal Component Analysis (PCA) was conducted, applying orthogonal Varimax rotation with Kaiser normalisation to maximise the factor differences.

Only 538 of the 898 regions have been included in the statistical analysis as a result of missing variable values for some German, Polish and Danish regions where either some of the variables show no data, or administrative regions have been regrouped which does not allow a comparison along a timeline. Finally seven factors have been extracted out of 23 variables (cf. Tab. 2).

The factor 1 “economic sizes” encompasses variables describing the physical and economic size of the farm holdings. It explains 31.67% of the total variance of all variables. The variables “share of holdings with min. 50 ha UAA” (0.79) and “share of holdings with max. 2 ESU” (-0.79) account for the highest factor loadings, followed by “share of holdings with max. 5 ha UAA” (-0.77), as well as “average size of holdings” (0.71) and “share of holdings with min 100 ESU” (0.54). Furthermore, the factor includes “share of holders with 100% working time in agriculture” (0.54). Consequently, the factor can be termed as “economic size”.

The factor 2 “grassland and livestock production” explains 12% of the total variance by combining positively correlated variables representing grazing livestock production (0.83) and the presence of permanent grassland (0.83). It is further characterised by the absence of permanent crops (-0.67) and farm holders, with less than 25% of working time spent in agriculture (-0.66), indicating full-time farming.

Factor 3 “horticulture” explains 10.7% of the total variance and is determined by the variables for high-value crop produce and specialised horticulture. The highest loading, however, has the variable “average standard gross margin” (0.87). Other variables included in this factor are “share of holdings with flowers and ornamental plants” (0.81) and “share of horticulture-specialist holdings” (0.84).

The following factors explain between 10 and 5% of the total variance and each is loaded by only 2 variables. The high numbers of factors with reasonable shares of explained variance depict the complex structure of the agricultural sector with little or no dependencies between the variables Factor 4 “land ownership situation” is loaded by the variables “share of area owned” (-0.92) and “share of area rented” (0.91). Factor 5 “arable production” is determined by the variables “share of holdings with arable production” (0.90) and “share of crop-specialist holdings” (0.77). Factor 6 “family labour force” and factor 7 “age structure” refer again more to farm household characteristics. Factor 6 is composed by “share of family labour force” (0.79), “labour force per holding” in average working units (AWU) (-0.75) as well as the share of female farm holders (0.53), while factor 7 is represented by the absence of young farmers (-0.91) and a higher “share of holders who are 65 years and older” (0.67).

Factors	1	2	3	4	5	6	7
N = 538	***Economic size***	***Grassland livestock production***	***Horti-culture***	***Land Ownership Situation***	***Arable production***	***Family labour force***	***Age structure***
Own value	*31.67*	*12.46*	*10.73*	*8.58*	*7.15*	*5.37*	*4.41*
Share of holdings with min. 50ha UAA in %	**0.79**						
Share of holdings max. 2 ESU in %	-0.79						
Share of holdings with max. 5ha UAA in %	-0.77						
Average size of holdings in ha	0.71						
Share of holdings min. 100 ESU in %	0.54						
Share of holders, with working time in agriculture 100% in %	0.54						
Share of holdings with vegetables, melons and strawberries in %	-0.46						
Share of grazing livestock specialist holdings in %		**0.83**					
Share of holdings with permanent grassland in %		0.83					
Share of permanent crops specialist holdings in %		-0.67					
Share of holders with working time in agriculture max. 25% in %		-0.66					
Average Standard Gross Margin in ESU per ha UAA			**0.87**				
Share of horticulture specialist holdings in %			0.84				
Share of holdings with flowers and ornamental plants in %			0.81				
Share of area owned in %				**-0.92**			
Share of area rented in %				0.91			
Share of holdings with arable production in %					**0.90**		
Share of field crops specialist holdings					0.77		
Share family labour force in %						**0.79**	
Labour force per holding in AWU						-0.75	
Share of female holders in %						0.53	
Share of holders who are max. 35 years in %							**-0.91**
Share of holders who are min. 65 years in %							0.67

Tab 2. Principal Component Analysis (PCA) of European regional farming system variables.

3.2 Cross-regional comparison of farming systems

Since census data have been used, the variable value distribution is characterised by large standard deviations, based on many cases with very small figures and strong variance between minimum and maximum values in relationship to the mean value. A considerable number of outliers among regions were found due to a large diversity of farming systems and regional concentrations in Europe, with the Dutch and Spanish vegetable production clusters as only one striking example. However, they were not excluded from the analysis, as they are meaningful for the representation of the spatial manifestation of regional specialisations and specific farm structures, which are assumed to be the result of urban influence.

With the factors of regional farming systems at hand, differences and similarities between the region types were investigated with particular attention given to the characteristics of metropolitan regions. A comparison of mean values of each factor was carried out based on the identified regional classes, aiming at the identification of structural differences between the different region types regarding the agricultural characteristics. Normal value distribution and homogeneity of variances within the classes as requirements for an analysis of variance (ANOVA) could not be confirmed by conducting Kolmogorov-Smirnov and Levene testing. Therefore, testing of the medium rank sizes within the RUR types was applied by using the Kruskal-Wallis test procedure, as a non-parametric alternative to ANOVA (cf. Tab. 3).

		Rural-Urban Region Type				
	Chi² (Sig.)	Metro-politan Regions	Urbanised Region with large centre	Urbanised Region with medium-size centre	Rural Region with small centre	Rural Region without centre
Factor 1 (Economic Size)	2.70 (.609)	245.50	262.05	264.23	262.77	282.03
Factor 2 (Grazing Livestock)	11.24 (.024)	200.89	264.20	267.02	256.37	289.54
Factor 3 (Horticulture)	21.00 (.000)	358.58	304.68	269.17	232.61	257.91
Factor 4 (Land Ownership Situation)	7.73 (.102)	294.83	279.02	272.33	293.45	249.14
Factor 5 (Arable Production)	3.56 (.469)	254.61	242.89	283.77	266.12	272.06
Factor 6 (Family Labour Force)	10.10 (.039)	252.78	257.71	258.30	240.16	294.86
Factor 7 (Age structure)	3.87 (.424)	283.75	289.80	270.59	282.60	254.96

Tab 3. Medium rank size of factor score by Rural-Urban-Region type.

Among the seven factors, variances of factor scores of “grazing livestock” (factor 2), “horticulture” (factor 3) and “labour force” (factor 6) were found significantly explained by the RUR classification indicated by significance level and chi-square values (see Table 3).

Despite its missing significance, the analysis of the class differences of the rank size reveals, that particularly metropolitan regions are characterised by low factor scores (rank size 245.50) for economic size (factor 1), which indicates a majority of small farms with little turnover in the vicinity of the metropolitan areas. In contrast large farm sizes where land is the most important production resource are domain of the rural area regions. The factor scores for “ownership” show an uneven distribution across the different region types with low rank size values in rural regions (249.19) and high ones in metropolitan regions (294.83), indicating a pronounced land tenure in the latter regions. However, these findings need to be carefully interpreted.

The rank size comparison of the factor 2 “grassland and livestock production” shows an increasing tendency from metropolitan regions (200.89) to rural regions without centre (289.54). Whereas a 22.8% share of grazing livestock specialist holdings was observed in metropolitan regions, that value rises to 33.9% and 28.8% in rural regions with and without small centres. This is different for factor 3 (“horticulture”), where metropolitan regions are significantly characterised by a high medium rank size (358.58) and very low values for the rural regions, whether with (232.61) or without urban centres (257.91). This implies both concentrations of specialised horticultural farms as well as higher average standard gross margins per ha UAA in metropolitan and urbanised regions indicating most efficient and intensive agricultural land use within small plots. Compared to rural regions with small urban settlements – and less demand - (1.6%), the share of horticultural specialists is three time higher in metropolitan areas (6.4%). Also the standard gross margin per hectare in metropolitan (1.4) and urbanised areas (1.5) exceeds the other regions types (each with 1.0) by about 50%. The rank size comparisons for “arable farming” (factor 5) and “age structure” (factor 7) do not show any distinct pattern across the regional classes. In terms of labour force characteristics (factor six) especially rural regions reveals low rank sizes, indicating that family labour orientation is more pronounced there.

3.3 Influence of region type on horticultural production

As suggested in the literature and indicated through the previous variance analysis, horticulture and the cultivation of high-value produce such as vegetables and flowers represents an agricultural activity and specialisation that is most pronounced in metropolitan regions and peri-urban areas. The distribution of variable values representing horticulture is analysed using the RUR typology as well as the peri-urbanisation indicators. Descriptive statistics have been applied to address the role of the region types. The influence of peri-urbanisation is investigated using correlation analysis with regional shares of peri-urban areas.

A large variance of variable values exists across the European regions in general and among regions of the same type due to the skewness of the value distribution. Nevertheless, the results presented in table 4 reveal strong differences of mean values between the region types, particularly between metropolitan regions and the other region types. The average revenue generation per hectare UAA exceeds the other region types by nearly 50%, while horticultural specialisation and the cultivation area of flowers and ornamental plants is exceeded by about 100%. Although only minor variations exist between other region types, ascending values are observed from rural regions to regions with large urban centres. Unlike the other variables, the distribution of holdings with vegetables, melons and strawberries shows only marginal differences between the region types. Only low mean shares in rural regions are noticeable. However, concerning the maximum values, no distinct pattern of regional influence is found. High concentrations of horticultural production cannot be explained by examining the region type.

	Rural-Urban-Region Type					
	MetropolitanRegions	Urbanised Region with large centre(s)	Urbanised Region with medium-size centre(s)	Rural Region with small centre(s)	Rural Region without centre(s)	total
Average Standard Gross Margin in ESU per ha UAA						
Mean	1.39	1.46	1.04	1.06	1.01	1.11
Maximum	10.77	7.66	9.91	7.68	5.62	10.77
Std. Deviation	1.65	1.54	1.10	1.26	0.85	1.17
Share of specialist holdings with horticulture in %						
Mean	6.39	3.76	2.46	2.36	1.61	2.56
Maximum	47.12	44.27	52.93	49.62	40.55	52.93
Std. Deviation	8.52	6.37	4.97	5.73	3.28	5.23
Share of holdings with flowers and ornamental plants in %						
Mean	2.72	2.29	1.12	1.42	1.23	1.47
Maximum	35.42	26.34	11.35	50.49	37.81	50.49
Std. Deviation	5.40	4.63	1.66	5.32	3.82	3.94
Share of holdings with vegetables, melons and strawberries in %						
Mean	16.97	12.64	13.52	12.34	8.93	11.70
Maximum	88.60	88.85	82.09	60.86	86.81	92.09
Std. Deviation	16.54	13.75	17.11	12.86	12.54	14.57

Tab 4. Descriptive statistics for horticultural farming in Rural-Urban Regions.

Generally speaking, metropolitan regions are noticeably characterised by the frequent cultivation of high-value produce and by horticulture. Exemplary cases of those metropolitan regions that are characterised by a high share of horticultural holdings are Rotterdam (47.1%), Lisbon (22.3%), Barcelona (12.6%) and Genoa (7.9%). Regional concentrations are also noticed beyond the influence of the region type. Fruit and vegetable production is most common in the Baltic countries of Lithuania and Latvia, as well as in the Spanish “fruit bowl” located in the south-east of the country. Cultivation of flowers and ornamental plants is concentrated in large parts of the Netherlands, Slovenia and the French-Italian Mediterranean area. Substantial variations in terms of farm structure characteristics, such as the - farm labour characteristics or farm sizes, exist between those EU member states that joined before 2002 and those that joined after the 2002 accession round, as well as between northern and southern Europe. Many eastern and southern European regions, especially in Poland, Bulgaria, Romania and Greece, are characterised by small farm sizes and a high share of family labour. Furthermore, physical conditions and regional farming traditions affect regional farming systems.

3.4 Peri-urban areas, horticulture and high-value crop production

The spatial model of delineated urban, peri-urban and rural areas within RUR regions was applied to investigate the influence of peri-urbanisation on the regional distribution of specialised horticulture and high-value production. The results of the correlation analysis between the peri-urbanisation and horticulture indicators are presented in table 5, suggesting a prevalence of horticulture in regions with higher shares of peri-urban areas. The extent of peri-urban areas with high population densities accounts for a strong influence on the revenue intensity per area of agriculture. The positive correlation can also be found between high-density peri-urban areas and the prevalence of horticultural specialists in areas where flower and ornamental plants are cultivated. In contrast, vegetable and fruit production shows no correlation or even a negative correlation to low density peri-urban areas.

	Peri-urbanisation Indicator	
	Share of peri-urban high density area in %	Share of peri-urban low density area in %
Average Standard Gross Margin in ESU per ha UAA	0.632**	0.324**
Share of horticulture specialist holding in %	0.285**	0.059
Share of holdings with flowers and ornamental plants in %	0.345**	0.139**
Share of holdings with vegetables, melons and strawberries in %	0.079	-0.105*

Tab 5. Pearson correlation between peri-urbanisation and horticulture & high-value farming.
**Correlation is significant at 0.05 level, **Correlation is significant at 0.01 level (2-tailed)*

A comparison of 10% percentiles (deciles) grouping of indicator values sheds a different light on the relationship between peri-urbanisation and horticulture/high-value production. The mean values for average standard gross margin per ha (aSGM) between regions with the lowest (decile 1) and highest share (decile 10) range from 0.74 to 3.1 (Fig. 4a). Seventeen Dutch and Belgian regions belong to the 20 regions of the 10thdecile led by Noord Limburg with an aSGM of 9.9. Regions with the lowest shares of peri-urban area, particularly regions in Eastern Germany, Scotland as well as in parts of Portugal and Spain, are all characterised by low aSGM. But differences even occur between regions with varying degrees of peri-urbanisation within countries such as in France and Italy. A similar picture occurs for the variables of horticultural specialisation (Fig. 4b) and the cultivation of flowers (Fig. 4c). The value distribution for the cultivation of vegetables (Fig. 4d) near urban agglomerations is very much influenced by additional factors beyond the location. Due to traditional small scale farming structures, many Lithuanian, Latvian, Bulgarian and Polish regions (also rural) are among the regions with the largest share of vegetable producers. Furthermore, the cultivation of vegetables is very much concentrated in certain specialised climate conditions and favoured regions in the Mediterranean such as south-eastern Spain, Malta or southern Italy. However, these concentrations do not represent a specific domain of agriculture near urban agglomerations.

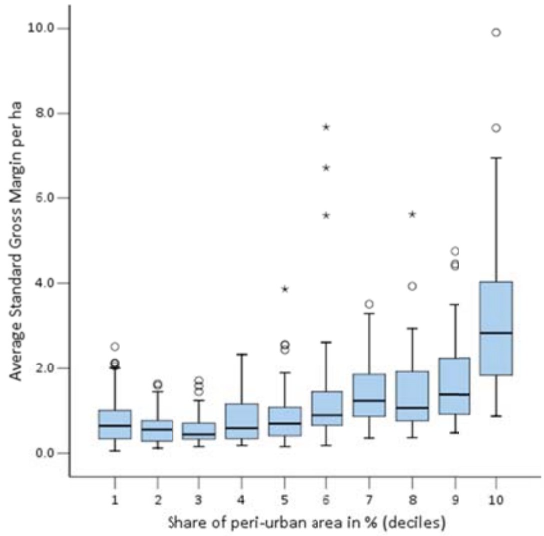

Fig 4a. Average Share of Standard Gross Margin in ESU per ha AA in regions with different shares of peri-urban area.

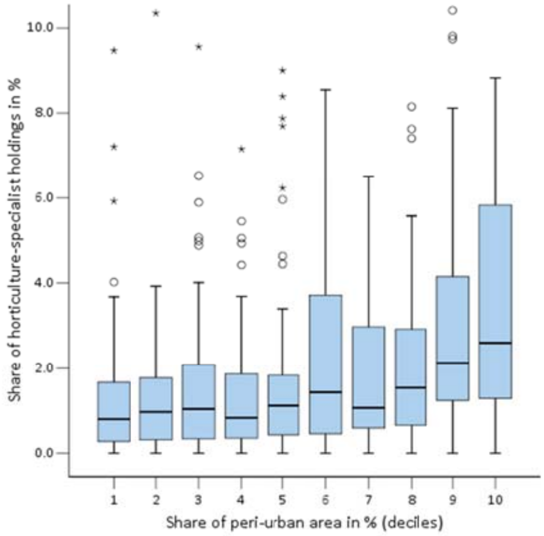

Fig 4b. Share of horticulture specialist holdings (in %) in regions with different shares of peri-urban area.

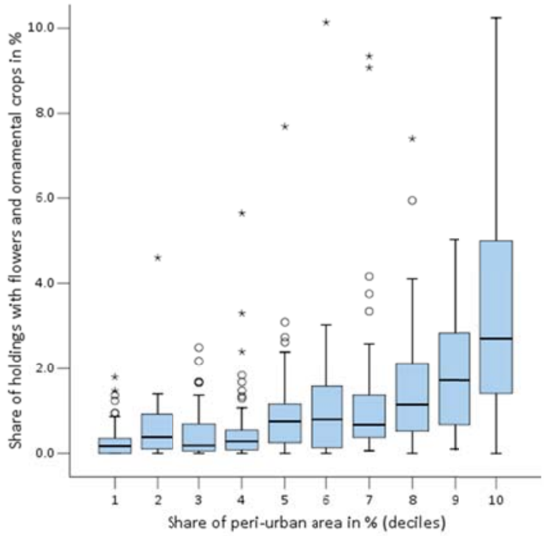

Fig 4c. Share of holdings with flowers and ornamental plants (in %) in regions with different shares of peri-urban area.

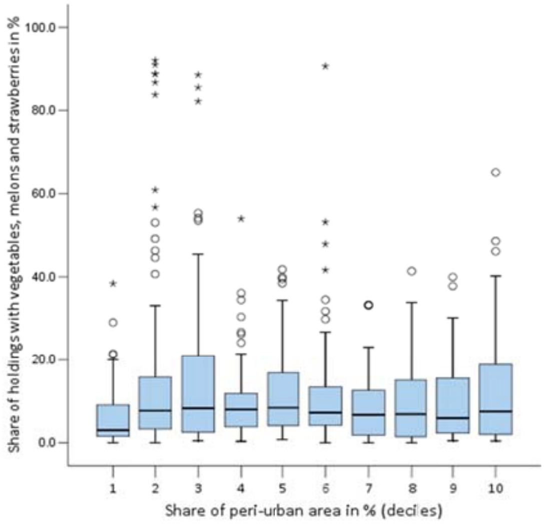

Fig 4d. Share of holdings with vegetables, melons and strawberries (in %) in regions with different shares of peri-urban area.

4. Discussion

With the Rural-Urban-Region model, a typology of European regions has been developed to delineate urban agglomerations to their hinterlands – rural areas under urban influence. In contrast to the OECD (2002), EUROSTAT (2010) and ESPON (2005) approaches, the region typology goes beyond the objective to classify NUTS3 regions, but clusters them spatially into larger common entities (RUR). The application of the typology allows a comprehensive perspective on the behaviour of functionally inter-related areas. It has been argued that due to urban pressures and opportunities on farming, and due to the responding adjustments, substantial differences exist between modes of agriculture in metropolitan and remote rural areas (Gant et al., 2011; Robinson, 2004). The application of the RUR typology provides an analytical model to study the farming conditions in areas under urban influence. The additional spatial delineation of urban, peri-urban and rural areas gives further information about the (urban) land-use pattern and the population distribution within the RUR regions. Areas are identified that either belong to the urban cores, near-urban or more remote rural areas.

The RUR typology represents a straightforward approach to spatially delineate regional entities with functional urban-rural-relationships, as it makes use of a common model algorithm. As the RUR regions are composed of NUTS3 regions, the typology allows easy application for large-scale regional assessments in the form of European databases, such as EUROSTAT, which can be loss-free and used without additional downscaling procedures. However, the classification possesses two main limitations – sensitivity regarding the size of the NUTS3 regions and the variability of the spatial tailoring over time. In the case of large NUTS3 regions, the RUR algorithm is less capable of delineating influence spheres as RUR regions need to consist of entire NUTS3 regions. Further, in countries with rather small NUTS3 regions, like Germany, the Netherlands and Austria, RUR regions tend to be smaller in size and more rural in nature as the regional population size is correspondingly smaller. The second shortcoming occurs through the reconfiguration of administrative units in many countries, like Poland, the Czech Republic or Denmark. The delimitation and classification procedure provides the opportunity to update the RUR typology. As the for the analysis carried out for this paper the situation of the year 2000 was of interest, also the regional administrative borders of that year was considered.

In the context of this paper, the RUR typology as well as the model of sub-regional delineation has been applied to shape an analysis of urban influence on European agriculture. Despite the focus on urban and metropolitan framework conditions, it is well acknowledged that a multitude of influencing factors inside and outside agriculture exist that contribute to the formation and change of regional farming systems. These encompass the regional climate, natural and landscape conditions, socio-economic situations and development outside agriculture (Renetzeder et al., 2008), or the prevalence of specific farm businesses, farm households and attitudes of farm holders (van der Ploeg, 2003; Jongeneel et al., 2008). As urban-related effects are often less pronounced, further multivariate analyses are not feasible due to a lack of significance. Nevertheless, the European-wide cross-regional analysis enabled some observations of the characteristics of agriculture under urban influence.

In the existing literature empirical examinations of farming systems in the context of urbanisation is limited, individually focussing on certain farm activities or structural differences of farm households and businesses. To enable an exploratory approach to identify aspects, which possess urban-rural relevance a comprehensive approach, including a multitude of variables has been chosen. Within the rank size comparison between the different RUR types, at least three factors account for a significant explanatory value for the value distribution of the regional farming systems. It can be argued that, despite the influence of other regional parameter, the fact whether a region can be characterised as metropolitan, urbanised or rural has an important effect on the regional agriculture. Looking at the specific factors, which are particularly sensitive for urbanisation – Grassland production and grazing livestock, horticulture, labour force and land ownership to a minor extent, previous assumptions have been substantiated.

Among those, the clear urban-rural slope regarding the concentration of horticultural production might be the most powerful evidence to be drawn from this analysis. The high degree of horticultural specialisation and amount of revenues per ha in metropolitan and urbanised regions support these findings (table 4). Despite a high number of outliers, significant correlation between the share of peri-urban areas and the concentration of horticulture in the region was revealed, supporting previous empirical findings (Oliver, 2000; Péron & Geoffriau, 2007). However, peri-urban areas are first of all observed in countries and regions such as the Netherlands, Belgium or western Germany, which are characterised by a traditionally competitive and specialised farming sector (Cantliffe & Vansickle, 2008). Accompanied by indications for the absence of extensive grassland production and grazing animals as well as low degree of family labour force, it completes a picture of a rather intensified and economically competitive agricultural production in metropolitan and urbanised regions. So does the agricultural labour force in urbanised regions depend much less on the members of the farm household. The average labour force per holding is higher in metropolitan regions, which suggests higher labour intensity and the professionalisation of agriculture.

However, farmers in metropolitan regions tend to rent the land they cultivate more than their colleagues in rural regions. Peri-urban agriculture can be therefore considered as more vulnerable when viewed from the long-term perspective of land availability and competition especially under conditions where urban land use is experiencing continual growth, which is often accompanied by a complex pattern of ownership and property rights as well as land speculation, rising land prices or short-term rental contracts (Munton, 2009). Regarding further assumptions, there is little evidence of pronounced small-scale and part-time farming close to urban agglomerations when the focus is placed solely on pre-2002 member states. No indication of the frequent phenomenon of retirement farming in metropolitan regions was found in the data, since aging share did not significantly differ between the RUR types. Thus research findings from other regional cases (Busck et al., 2008; Tobias et al., 2005) could not be confirmed.

5. Conclusion

Despite the large differences of agricultural systems among European regions, the chosen approach to classify Rural-Urban-Regions and to delineate urban, peri-urban and rural land use has proven suitable to investigate how urbanisation influences farming. Agriculture in urbanised regions, and more specifically in peri-urban areas, differs from farming in (remote) rural areas. Characterised by specialised horticultural, and to some extent grassland and livestock production, regular arable farming is less frequent in metropolitan areas. In return, farms generate more revenue per ha area, but are also more labour intensive and dependent on rented land.

These specifics of the agricultural systems and framework conditions in urban and peri-urban areas, including the particular pressures, opportunities and respective development potentials, should be taken into consideration for municipal and regional planning and regulation systems as well as the European agricultural and rural development policy. Farming in urban environments is increasingly constrained and marginalised. Its role must not be underestimated, as it is highly specialised, adaptive and competitive. Peri-urban agriculture is in demand to generate regional and local food supply, as well as to provide goods and services beyond food production such as management of cultural landscapes, leisure and recreational opportunities and other ecosystem services. There are valid reasons to control urbanisation and preserve farming. Reflecting the differences of other remote rural conditions, peri-urban farming also requires a specific targeting for agricultural and rural development programming. Attention has to be paid to the specific characteristics and urban framework conditions under consideration. There is a large variance of farming systems and their framework conditions in metropolitan regions across Europe. The comprehensive study only gives indications for general tendencies. More regional in-depth investigations are necessary to learn about the mechanism and dynamics of farming in peri-urban areas, their individual constraints, and the opportunities for a sustainable rural development in peri-urban areas.

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