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# Assessing the role of small farms in regional food systems in Europe: Evidence from a comparative study

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ABSTRACT

The importance of small farms is well established and recognized in developing countries, but far less is known about their role in Europe, where agriculture is largely industrialized. In this paper we use a comparative analysis of evidence from 15 European countries to assess the contribution of small farms to regional food production and availability, across geographies and products. We collected information about regional (NUTS-3) level production, trade and consumption of 91 products across 25 European regions using official statistics, expert interviews, and farm-level surveys. This information was used to develop product-specific systems maps which were coded and systematised. We then used a Random Forest algorithm to establish which system variables were more likely to explain variation along two dimensions: the contribution of small farms to regional production (i.e. proportion of regional production coming from small farms) and their contribution to regional food availability (i.e. proportion of their production that is consumed within the region). Our results suggest that the contribution of small farms to regional production is closely related to the relative abundance of small farms in the agricultural landscape, while their contribution to regional food availability is driven by structure of specific supply chains and the market linkages available to small farms, and in particular the degree of selfprovisioning and direct sales to consumers. These findings shed light on the relatively unknown word of European small farms, showing their importance in food production and availability, and providing new evidence to inform more effective policy for these often-neglected actors of the food system.

## 1. Introduction

The European food system is characterized by the dominant role of industrial farming and processing, the prevalence of global capital, and the integration of supply chains into corporate structures (McMichael, 2009; Lang and Heasman., 2015; Lowe et al., 1993; Therond et al., 2017). A key feature of this agro-industrial model is the dominance of large-scale farming, which has been able to harness enormous gains from increased productivity, efficiency and economies of scale (IPES--Food, 2016; Knickel et al., 2018; Rivera et al., 2018). Large-scale farming is closely linked with corporate food supply chains, including agro-industrial processors and global retailers, which provides farms

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with access to national, European and global markets (Clapp, 2018; O'Kane, 2012; Therond et al., 2017). The dominance of industrial agriculture in Europe has increasingly marginalized small-scale and alternative types of farms from competitive global markets, threatening their medium- and long-term prospects for survival (Nagayets, 2005; IRIS, 2019; Eurostat, 2018). In addition, the focus on large-scale farming has neglected the particular needs of small farms within European agricultural policy.

Despite their relative neglect in policy, small farms significantly contribute to food and nutrition security in many parts of the world (Wiggins et al., 2010; Hazell et al., 2010; Lowder et al., 2016), including Europe (Eurostat, 2018). Small-scale farms (i.e. those smaller than 5 ha) have been estimated to produce between 50 and 75% of the food calories consumed globally (Ricciardi et al., 2018; Samberg et al., 2016). Small farms also provide jobs and livelihoods in rural communities (Davidova and Bailey, 2014; Davidova et al., 2012; Rosset, 2000), and play an important role in sustaining agricultural biodiversity, contributing to environmental sustainability (D'souza, & Ikerd.,1996; Boyce, 2006; Altieri, 2009; Conway, 2011)and maintaining agricultural heritage (Daugstad et al., 2006).

Small-scale farming and its contribution to food security in developing countries have been the subject of a great deal of research, but relatively little is known about the specific role and importance of small farms in European food provisioning. In Europe, as in many other parts of the world, small farms are typically embedded in agricultural supply chains which are highly concentrated and dominated by a few large supermarket firms (Vettas, 2007; McCullough et al., 2008). This means that procurement systems tend to be centralized, and most food passes through large aggregation and distribution centres. Supermarket competition has led to an ever-increasing pressure on suppliers to improve efficiency, drive down their costs, and comply with stringent quality and safety standards (Vettas, 2007). These characteristics pose unique challenges for small farms to access markets, as they are only able to produce in small quantities, have relatively high transaction costs and cannot benefit from economies of scale. Due to their limited assets and capital, small farms are potentially less able to comply with standards demanded by supermarkets, and their size reduces their bargaining power with their buyers (van der Meer and Ignacio, 2007).

In the context of these challenges, small farms employ a range of strategies to be resilient, survive, adapt, innovate, and sometimes thrive. First, they can mobilize cheap or free family labour, know the local context well, and can enter and exit the market easily (Poulton et al., 2010). Second, many have improved their collective action by organizing in associations or cooperatives that help them to solve the problems of scale, market power, coordination, and transaction costs (Markelova et al., 2009). Third, there has been a shift from the production of undifferentiated commodities to a greater focus on differentiation and specialization as a means to add greater value (Vettas, 2007). Finally, small farms have sought to bypass modern procurement chains by selling directly to consumers, for example through farmer's markets and other forms of community supported agriculture (Brown and Miller, 2008). Food self-provisioning has also become an important adaptive strategy, by being a stable source of food in the face of global changes, supply chain disruptions, market fluctuations and economic crisis (Renting et al., 2012).

In this paper we draw on comparative evidence from across Europe to explore the role of small farms in regional food systems today. We use a food systems framework to understand how actors and activities interact to produce a series of outcomes (Ericksen, 2008; Ingram, 2011). This framework allows us to consider production, markets and consumption within a specific context of actors, institutions and governance (UNEP, 2016). The role of small farms in the food system is, to a great extent, shaped by the way in which farms are linked to supply chains, i.e. the linkages that connect production with processing, trade, retailing and consumption (Jackson et al., 2006). A supply chain approach looks at how the different parts of the chain are linked together – who buys from whom, how much, and at what price.

Our scale of analysis is regional, defined using the European Nomenclature of Territorial Units for Statistics (NUTS) level 3 (Eurostat, 2019). NUTS-3 regions vary in size from one country to the other, but generally involve a cluster of towns and rural areas with populations ranging from 150,000 to 800,000. Food systems differ regionally in terms of actors involved and characteristics of their relationships and activities (OECD, 2016). Situating small farm strategies within their regional context highlights the diversity of both challenges and development opportunities facing small farms (Rastoin, 2015; Cistulli et al., 2014). Regional food production can be strongly characterized by specific products that can be both quantitatively and qualitatively important in terms of economic profitability, consumption patterns and cultural preferences, as well as for social aspects (Brunori et al., 2016). Regionally-specific food products also shape the supply chain dynamics across regional food system, characterising the diversity of connections and forms of coordination between small farms and the other actors of the local food system. The regional scale also allows us to see "hidden" food flows, such as non-marketed production that is self-consumed, shared or gifted, which may not necessarily be captured by a national-level analysis (Pinto-Correia et al., this issue).

To bring together the insights of small farms in regional food systems, we use a comparative approach, which allows us to look at patterns across geographies and products. Our comparative analysis focused mainly on two dimensions of small-scale farming in Europe: the role of small farms in regional food production relative to other scales of farming, and their contribution to regional consumption, assessed through their supply chain linkages. We found that their role is closely related to the types of products and production systems, which are, in turn, linked to specific geographical areas, giving rise to important macro-regional differences. Our results suggest that, on the one hand, the contribution of small farms to regional food production is closely related to the relative abundance of small farms in the agricultural landscape. The importance of small farms for regional food availability, on the other hand, appears to be dependent on the structure of specific supply chains and the market linkages available to small farms.

## 2. Methodology

The analysis presented here is based on food system maps that were developed for 91 products in the 25 regions (NUTS3), belonging to 15 European countries (Table 1). The criteria for the selection of the countries and regions are explained in Guiomar et al. (2018). In each region we selected four products based on their importance for small farms (defined as having less than 5 ha or 8 Economic Size Units) in terms of revenue, production, consumption or cultural significance. The list of key products selected in each region is shown in Table 1. In most regions we studied four different products, but in four regions only two or three products were included in the analysis. The project's consortium was composed of full partners and subcontracted partners. Due to funding and time limitations, the latter were able to analyse fewer products per region. For each product, the food systems map visually represented the supply chain, showing the main actors involved in production, processing, trade and consumption, as well as an estimation of the different flows (in percentages) linking these actors. These maps were developed drawing from official statistics and expert knowledge obtained from key informant interviews. They were refined and validated using information from a household survey with farmers (see Guarin et al., this issue) and through focus group discussions with diverse stakeholders in each region. See Table 1 for details on numbers of interviews, surveys and participants in focus groups. Data was collected between 2016 and 2018. In all regions, identical protocols and reporting templates were used in order to ensure the comparability of the data.

For the comparative analysis, the information from the 91 system maps was coded and converted into a database. We codified the

**Table 1**
Summary of regions and products included in this analysis, and number of interviews, surveys, and participants in focus groups discussions.

| Country | Region (code) | No. of key informant interviews | No. of small farm surveys | No. of people involved in focus groups | Products analysed |
|---|---|---|---|---|---|
| **Eastern Europe** | | | | | |
| Bulgaria | Montana (BG1) | 7 | 5 | – | Wheat, dairy |
| Croatia | Varazdinska (HR1) | 10 | 6 | 10 | Potatoes, Pork |
| Czech Rep. | Jihocecky Kraj (CZ1) | 5 | 5 | – | Eggs, Goat meat, cheese |
| Latvia | Latgale (LV1) | 10 | 36 | 16 | Potatoes, Wheat, Honey, Milk |
| | Pieriga (LV2) | 11 | 30 | 62 | Vegetables, Milk, Wheat, Apples |
| Poland | Rzeszowski (PL2) | 5 | 39 | 18 | Potatoes, Cereals, Poultry, Pork |
| | Nowosadecki (PL1) | 5 | 52 | 19 | Apples, Potatoes, Cereals, Milk |
| | Nowotarski (PL3) | 6 | 57 | 26 | Lamb, Potatoes, Milk, Cereals |
| Lithuania | Vilniaus Apskritis (LT1) | 14 | 10 | 19 | Cereals, Vegetables, Milk and derivatives, Fruit |
| Romania | Bistrita-Nasaud (RO2) | 17 | 60 | 33 | Apples, Potatoes, Milk and cheese, Pork |
| | Giurgiu (RO1) | 31 | 26 | 70 | Sunflower oil, Wheat, Eggs, Tomatoes |
| **Southern Europe** | | | | | |
| France | Vaucluse (FR2) | 50 | 10 | – | Wine, Cherry, Olive oil |
| Greece | Imathia (GR1) | 11 | 39 | 19 | Peaches, Cherries, Wine grapes, Beef |
| | Larisa (GR2) | 12 | 38 | 21 | Almond, Sheep and goat milk, Apples, Pulses |
| | Ileia (GR3) | 13 | 42 | 32 | Currants, Oranges, Olive oil, Pickled vegetables |
| Italy | Lucca (IT2) | 6 | 32 | 47 | Vegetables, Wine, Olive oil, Fruit |
| | Pisa (IT1) | 6 | 24 | 61 | Wine, Vegetables, Wheat, Bovine meet |
| Portugal | Alentejo Central (PT1) | 11 | 38 | 24 | Tomatoes, Lamb, Olive oil, Wine |
| | Oeste (PT2) | 5 | 36 | 20 | Wine, Pears, Eggs, Potatoes |
| Spain | Castellón (ES2) | 22 | 27 | 17 | Citrus, Almond, Pork, Olive oil |
| | Córdoba (ES1) | 20 | 40 | 18 | Olive oil, Wheat, Wine, Milk |
| **Northern Europe** | | | | | |
| Norway | Hedmark (NO1) | 27 | 31 | 8 | Lamb, Potatoes, Milk, Berries |
| France | Ille-et-Vilaine (FR1) | 12 | 10 | – | Pork, Apples |
| Scotland | East Scotland (UK2) | 7 | 15 | 12 | Beef, Lamb, Mixed horticulture, Potatoes |
| | West Scotland (UK1) | 7 | 31 | 10 | Salad leaves, Eggs, Lamb, Beef |

Note: The difference in sample size across regions is due to the difference in time and funding between full project partners and sub-contracted partners, as explained above.

information about the supply chain, including the different actors, the connections between them, and the relative magnitude of the flows within them. In addition to this information, we included data on the products' regional production and consumption, as well as general regional characteristics such as GDP or number of small farms.

To compare the importance of small farms across different products and regions, we developed a simple model. For each product, this importance was assessed along two axes: first, the share of regional production that comes from small farms. This indicates the contribution of small farms to the total regional output. And second, the share of what small farms produce that stays in the region. This is an indication of their relative importance with regard to regional consumption.

We carried out a further analysis to understand what factors are associated with the importance of small farms along the two axes described above. Why do small farms account for a higher share of production in some products and some regions than in others? And why do more small farms' products stay in some regions than in others? We used a Random Forest algorithm (Freeman et al., 2015) to organize, in order of importance, the characteristics/variables that explain the variability of the two main dependent variables described above. Random forest classification was implemented using the R package randomForest (Liaw and Wiener, 2002). A similar technique has been used to explain different relationships between farms and crop portfolios (Weigel et al., 2018). Finally, we used descriptive statistics to analyse the variables identified by random forest as those being more likely to predict the dependent variables.

## 3. Results and discussion

### 3.1. Product-specific food system maps

The food system maps show the most important nodes and flows for specific products in each region, from production to processing, distribution and consumption – with a special focus on the role and linkages of small farms. An illustrative example of citrus in the Castellón region in

Spain is presented in Fig. 1. The diagram shows that for this crop in this region small farms are fundamentally part of an export-oriented system mediated by cooperatives and other traders. Very little of small farms' production is consumed directly in the region; local consumption is instead supplied by large retailers. The size of the arrows is related to the importance of the flow, as assessed by experts and found in official statistics.

To assess the importance of small farms in each product-specific system we constructed a matrix (Fig. 2). Product-specific systems in which small farms contribute more than 50% of the regional production are in the top quadrants, and if less than or equal to 50% in the lower quadrants. Similarly, product-specific systems in which half or less of the small farm's production stays within the region are on the left quadrants, and if more than half remains, they are in the right-hand side. Using this matrix, the product-specific systems can be grouped according to the relative importance of small farms. The top right of the matrix (quadrant D) includes those product-specific systems in which small farms account for a large share of regional production and where a high share of their production stays in the region. In these systems, small farms are likely to play an important role in both production and consumption. The bottom left (quadrant A) includes product-specific regions where small farms account for a small share of the production and where a low share of this production stays in the region. These are likely export-oriented systems dominated by large-scale agriculture. Systems in the top-left (quadrant B) and bottom-right (quadrant C) represent intermediate cases, where small farms are more relevant for either production (C) or consumption (B), but not both.

Fig. 3 shows the 91 product-specific systems as they spread across the matrix, revealing some region- and product-specific patterns. Within our sample of regions and products, small farms play a range of different roles, contributing to both local food availability and export markets. The top right quadrant (where a high share is produced by small farms and a high share of this production stays in the region) is populated almost exclusively by product-specific systems from Eastern Europe, while the bottom left quadrant contains many of the Southern European systems. This distribution may reflect the prevalent types of products and production systems in each macro-region. For example, the production of fruits and oil plants in the Mediterranean region is oriented for export. This sector is dominated by large-scale agriculture, but small farms do participate –albeit with most of their production not consumed locally. The product food systems for Northern Europe, which are a smaller proportion of our sample, tend to cluster towards the left-side quadrants (i.e. relatively small share of regional production), but they span the top and bottom quadrants: small farms produce dairy and meat mostly for export (thus in the bottom quadrant), while their vegetable and potato production tends to stay locally.

### 3.2. *Understanding the importance of small farms in regional food systems*

The second part of our analysis aims to identify the factors that explain why product-specific systems spread across the matrix as they do. The random forest analysis ranked the variables most likely to explain the two axes of variation used in our matrix (Fig. 4). The X axis (share of regional production coming from small farms) was found to be positively associated with the percentage of small farms in the region, population density and the percentage of regional area occupied by small farms, and negatively associated with average farm size in the region. The Y axis (share of small farms' production that stays in the region) was found to vary according to the identity of the main first market link (i.e. the market actor buying the biggest share from small farms); it was positively associated with the degree of self-provisioning (i.e. share of production that is kept by small farms) and direct selling (i.e. the share of production that is sold directly from small farms to consumers without intermediation, for example in farmers' markets), and negatively associated with the country's GDP per capita.

The random forest analysis suggests that our two axes are associated with different factors. In the case of the share small farms in regional production, the predictor variables are broad characteristics of the region beyond product-specific system. These results suggest that small farms account for a larger share of the region's production in regions where small farms represent a larger proportion of total farms (Fig. 5a), where small farms occupy a larger share of the utilized agricultural area (Fig. 5b), and where farm sizes are on average smaller (Fig. 5c). These results make intuitive sense, and are consistent with other studies, focused on the global level, which find that the importance of small-scale production is highly related to farm size (e.g. Ricciardi et al., 2018; Samberg et al., 2016). Population density, the fourth variable as ranked by the random forest analysis, is more intriguing (Fig. 5d). Our results suggest that small farms account for a higher share of regional

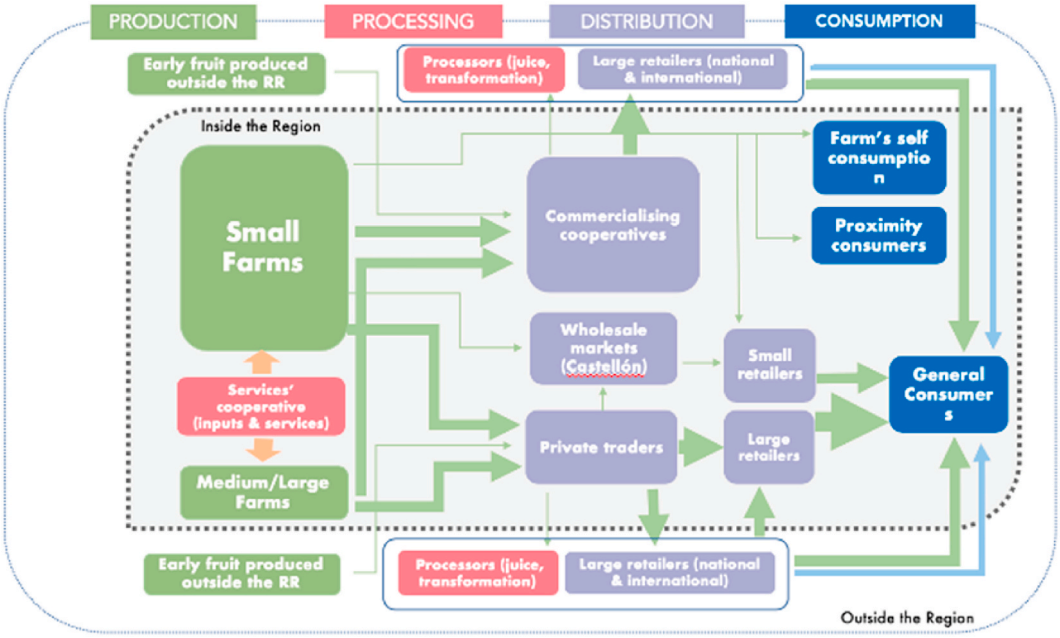


**Fig. 1.** Regional food system diagram for citrus in Castellón (Spain).

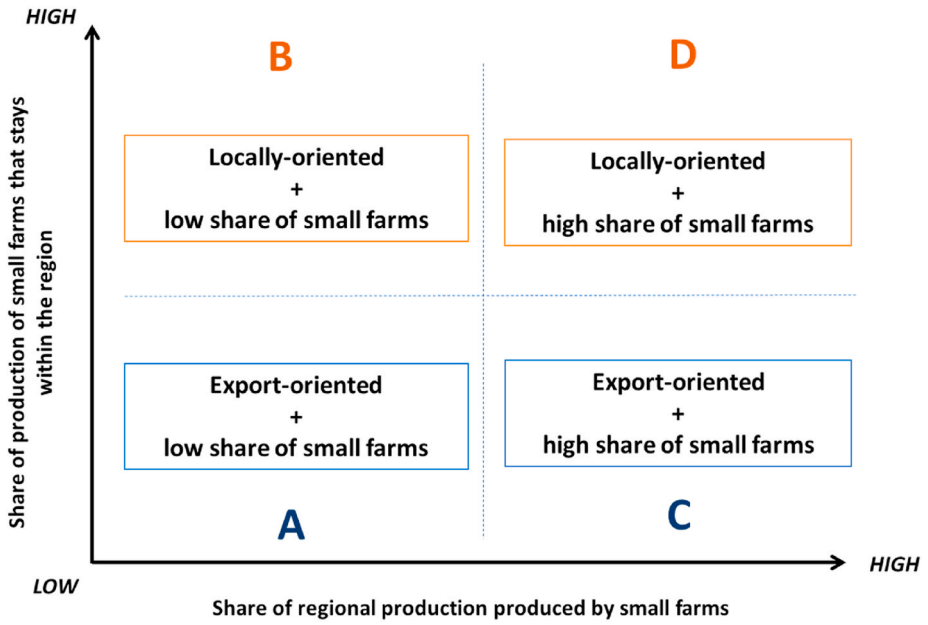


**Fig. 2.** A matrix to classify product-specific food systems involving small farms.

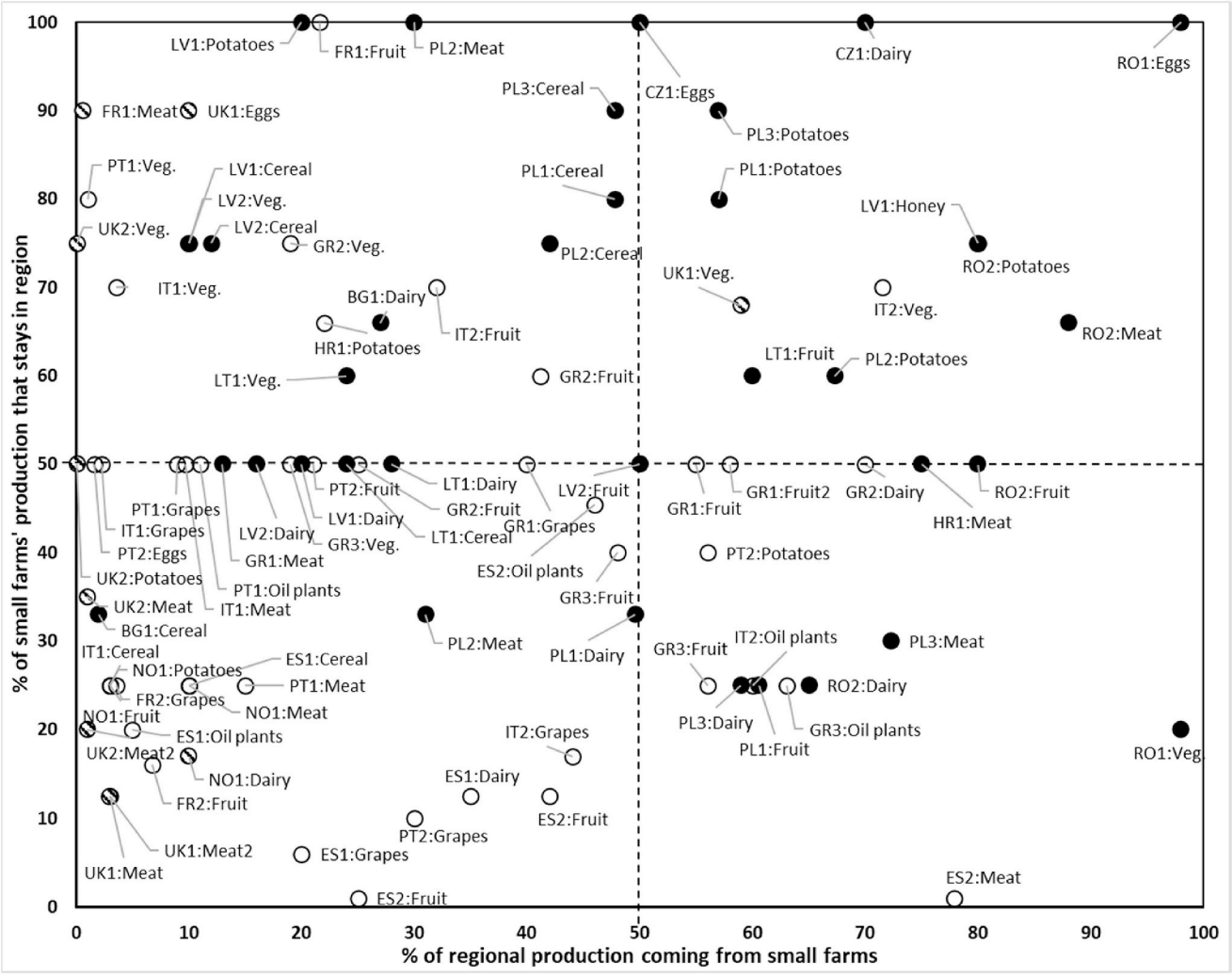


**Fig. 3.** Product food system distribution across the four food system types. Dots are colour-coded to represent region: white dots = Southern Europe; black dots = Eastern Europe; dots with diagonal stripes = Northern Europe. See Table 1 for region codes. (Source: Data codified from the 91 product specific system maps).

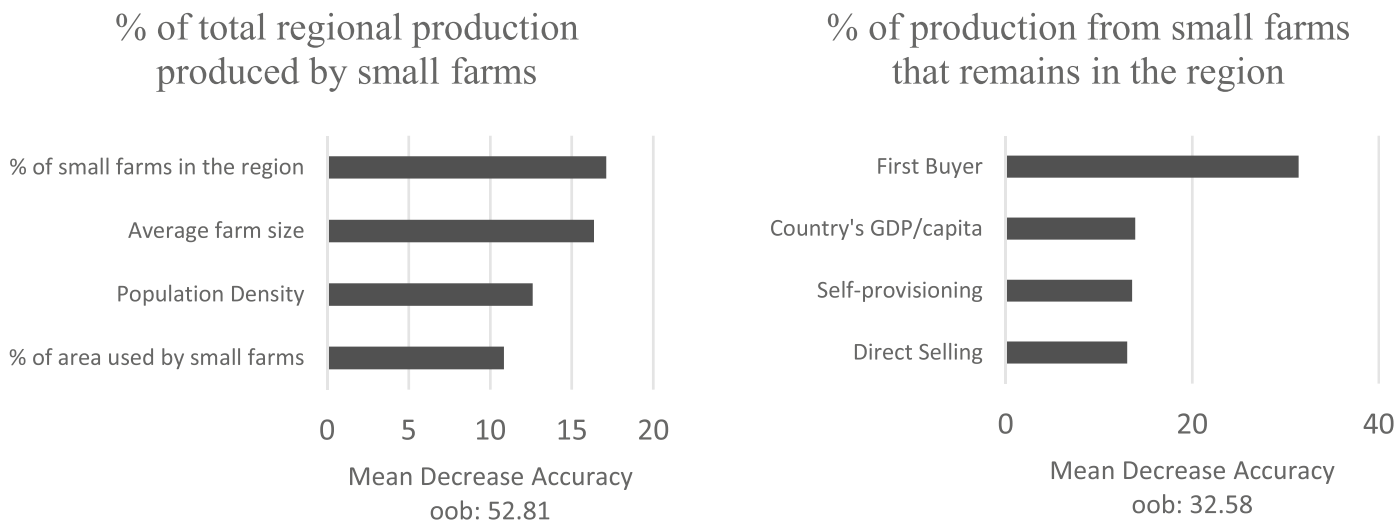


**Fig. 4.** Results of random forest analysis showing the four most important predictors explaining the variability of % of total regional production produced by small farms (left) and % of production from small farms that remains in the region (right).


**Fig. 5.** Distribution of the top 4 predictors for the share of small farms in regional production, by system type: a) proportion of farms in region that are small (low = less than 40%; medium = 41–60%; high = more than 61%); b) proportion of regional utilized agricultural (UAA) occupied by small farms (low = less than 10%; medium = 11–30%; high = more than 30%); c) average farm size (using size classification in Eurostat (2018): small = less than 20ha; medium = 20 - < 100ha; large= >100ha); and d) population density (low = lower tertile; medium = middle tertile; high = upper tertile).

production in regions with higher population density. A similar trend has been observed in Malawi (Ricker-Gilbert et al., 2014) and Kenya (Muyanga and Jayne, 2012), and has been attributed to population pressures on landholding, i.e. to more people competing for the same amount of land. It is unclear from our data whether similar pressures are operating in Europe, although land fragmentation associated with inheritance and succession may also be at play (Davidova and Thompson, 2014).

Unlike the share of production coming from small farms, which appears to be associated mostly with region-level variables, the share of small farms' production that stays in the region appears to be shaped by the features of the product-specific value chain, and especially by the market linkages of small farms. The random forest analysis suggests that the first linkage to the system is particularly important. Fig. 6 shows that this first linkage of small farms in our sample is diverse. It includes large intermediary market actors like cooperatives and wholesalers, but it also includes the farm itself, i.e. when most of the farm's production is directed to self-provisioning, as well as final consumers, i.e. when the farm sells to consumers without intermediation (what we call direct selling).

The relative makeup of these first links varies from one quarter in our matrix to the other. Cooperatives and processors play a dominant role in product-specific food systems in quadrants A and C (as shown in Fig. 2, section 3.1), i.e. those in which less of small farms' production stays locally, and the portfolio of first links appears to be more diverse. This is the case, for example, of Mediterranean fruit and olive systems, which are commonly organized around cooperatives, and dairy systems across Europe, where processing is a typical first link. For systems in quadrants B and D, i.e. those where a larger share of the small farms' production stays local, self-consumption by farms and direct sales to consumers are by far the most dominant. Some of these systems represent products grown for household food consumption, e.g. fresh vegetables across regions, or cereal that is used to feed farm animals, as is common in some parts of Eastern Europe. Food systems in these quadrants also have fewer types of first links.

Consistent with the above, the random forest analysis linked the portion of small farms' production that stays in the region with the importance of self-provisioning and direct sales to consumers. As shown above, these are the two most important types of first links in product-specific systems in quadrants B and D (the more locally-oriented ones). The level of self-provisioning, i.e. the proportion of farm production that stays in the farm, is mostly medium to low across food system types (Fig. 7a), suggesting that small farms are producing largely for the market, both across regions and products. However, self-provisioning and direct selling are both higher in quadrants B and D relative to quadrants A and C (the more export-oriented ones). Self-provisioning has been found to be particularly important for small farms' livelihoods, especially among poor farmers (Davidova and Bailey, 2014; Davidova and Thompson, 2014), as it provides adaptive capacity against external shocks (Renting et al., 2012). Direct selling offers small farms a marketing channel in which both producers and consumers benefit (Gilg and Battershill. 2000). It also allows farmers to retain a higher share of the final value of the products and connects them to new segments of demand interested in local and fresh food, increasing farmers' income (Low and Vogel, 2011; Aguglia et al., 2009).

The types of products have an important bearing on the type of commercialization strategy, and therefore on the distribution of food systems across our matrix. For example, in the food systems for wine grapes and oil plants, fruit, dairy and cereals, the main buyers are cooperatives and processors. These products require some degree of processing, and their commercialization chains are generally specialized and organized, typically for export outside of the region, and fall mostly in quadrants A and C of our matrix. Other products such as eggs, potatoes and vegetables are less dependent on vertically-integrated supply chain and require less processing, making it easier for small farms to sell them through more traditional and/or alternative pathways, including direct selling (Michalopoulos, 2017). This places these product-systems mostly in quadrants B and D of our matrix.

The random forest analysis suggests that the country's GDP per capita is one of the top four predictors of the amount of product that stays in the region. The distribution of average GDP/capita across food systems (Fig. 8) mirrors that of the average fam size seen in Fig. 5c: food systems C and D, where the contribution of small farms to regional production is highest, are more frequent in countries with lower per capita income. This relationship between income levels and farm size is well established, with richer countries tending to organize production in larger farm units (Adamopoulos and Restuccia, 2014). Our data shows that GDP/capita is also related with commercialization channels. For example, farm self-provisioning and sales to processors are more common in countries with lower incomes levels, while sales to cooperatives and direct sales to consumers are more common in countries with higher GDP/capita. We have not found literature exploring this relationship between a country's per capita wealth and the commercialization channels available to small farms, but our data suggests that income levels are associated not just with the structure of production, but with the structure of markets as well.

## 4. Conclusions

Small farms play important roles in food provisioning, environmental and landscape protection, local community resilience, and rural economic viability (FAO, 2017; Fanzo, 2018; Lamine et al., 2019). However, research and policy on small farms focuses predominantly in developing countries. In Europe, small farms occupy a relatively marginal place next to agro-industrial agriculture, and the characteristics and contribution of small farms are much less well understood.

We used a comparative analysis of regional food systems to understand the diversity of roles that small farms play in Europe. Even though large-scale agriculture and corporate supply chains dominate the food system across Europe, our work found that, in some regions and for some products, small farms make important contributions both to production and to local food availability. We cannot be entirely sure whether the results here reflect the presence of small farms or rather the relative absence of larger farms. However, in all the regions included in our sample there was a considerable presence of medium and large farms, suggesting that the takeover of industrial agriculture and supermarkets is not complete, but rather dependent on local context and types of food produced.

With regard to food supply, our analysis suggests that the contribution of small farms is highest in regions where small farms are a more dominant part of the agricultural landscape. While this might seem obvious, to our knowledge this study is the first to empirically demonstrate this relationship. The contribution of small farms to regional food production is closely related to the types of products and production systems, which are in turn shaped by regional-specific climate, geography and traditions; this creates patterns which have important implications in terms of the roles of small farms within the regions. Our results show that in Southern Europe, product systems are mostly export-oriented; small farms, like farms of other sizes, are generally aiming for volume rather than differentiation or alternative markets. Products such as olives, wine grapes and citrus –all of which require some degree of processing—are typical examples of Southern European regions, while meat and dairy belong to a similar category in Northern Europe. Food systems in Eastern Europe are much less export oriented. Here small farms seem to follow different marketing paths and strategies compared with larger farms, either because they cannot access the same market channels, or because they choose not to. Common products in this region such as potatoes, vegetables, fruits or eggs require little or no processing, allowing for greater flexibility and generating different marketing opportunities that shape the product systems accordingly. Small farms within these systems play more important roles in terms of regional food production.

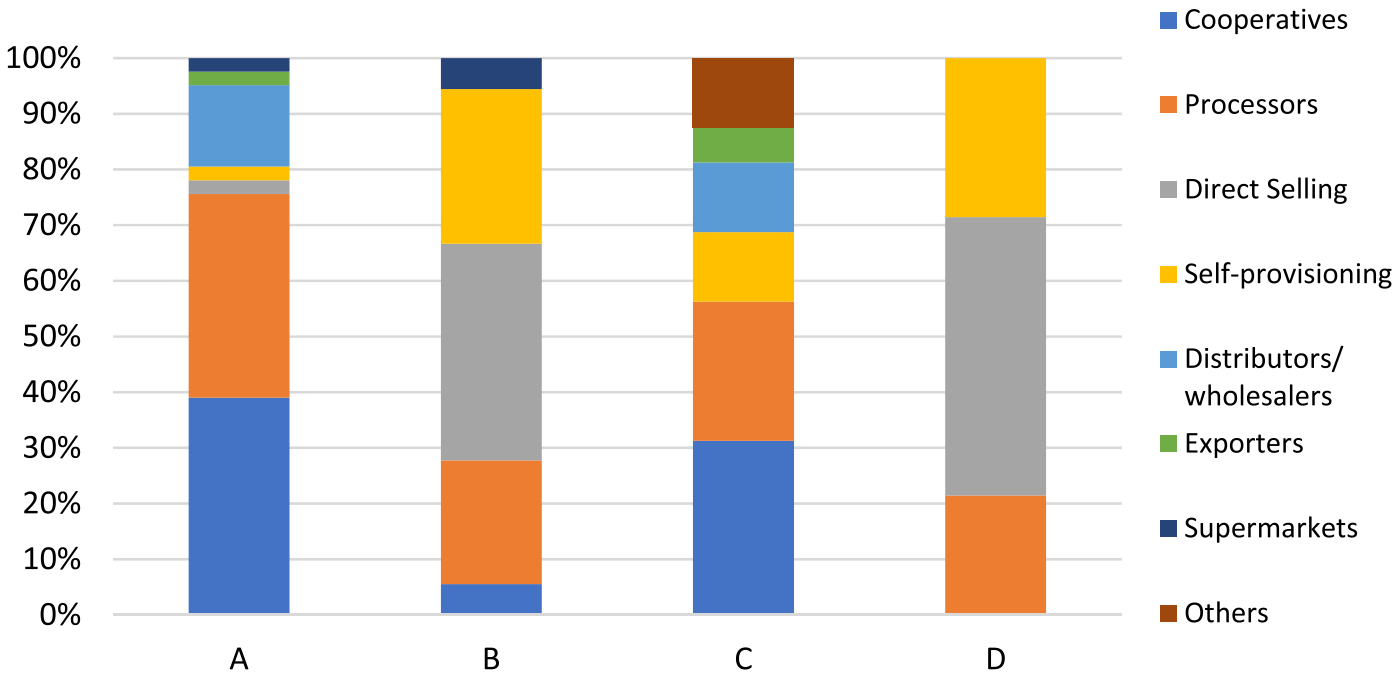


**Fig. 6.** Main first linkages for small farms. The graph shows the percentage of product-specific food systems in each quadrant in which small farms are connected to different main first links. The main first link is the direct recipient or buyer of the largest share of small farms' production in each food system.

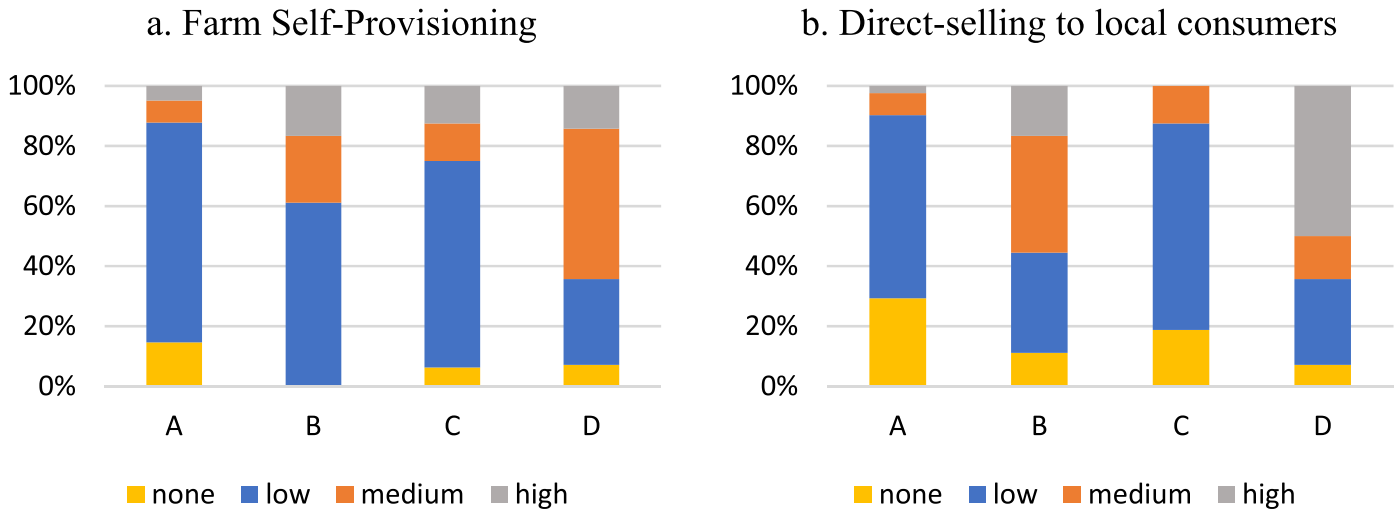


**Fig. 7.** Importance of a) small farm's self-provisioning and b) direct selling (right) within each of the food system types. (Low= < 33; Medium = 34–66; High = 67–100).

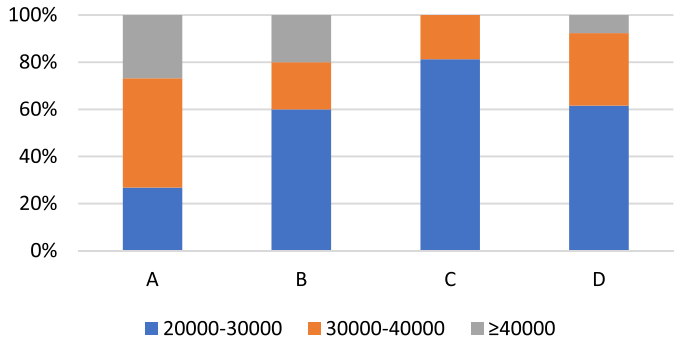


**Fig. 8.** Average Country Annual GDP per capita (USD, PPP) per food system type.

With regard to local food availability, our analysis suggests that the importance of small farms is closely related with non-market channels. In food systems dominated by supermarkets, such as those in Europe, some small farms seek alternative commercialization channels and/or rely on their own production to satisfy their consumption needs. This, in turn, means that the degree to which the small farms are able to contribute to regional food availability hinges on how much of their production is consumed in the household or sold (or given as gifts) directly to consumers.

The findings presented here have some important implications for research and policy. From a research perspective we provide a deeper understanding of how small farms are shaping food systems and the relevant factors associated with the activities and dynamics within the systems. However, to fully comprehend the role of small farms a closer more explicit look at the nutritional and consumption aspects would be required, as we don't fully know where consumers are getting their food or what proportion of peoples' diets come from different sources. Additionally, the boundaries of regions are arbitrary, and the working realities of small farmers do not correspond to administrative regions, making some flows uncertain. The regional scale of analysis allowed us to uncover some non-market food flows that appear to be crucial for the livelihoods of both farm households and consumers (see Pinto-Correia et al., this issue). At the same time, the regional scale of analysis implies a degree of generalisation that can miss differences at the farm level: different types of farms contribute differently to regional food availability (see Guarin et al., 2020). Finally, it is important to note that our data is limited to a relatively small set of quantifiable variables that allowed for a comparative study, and that we do not explicitly consider the broader regional historical, institutional, political or environmental context. Our conclusions therefore point to general trends, but the underlying drivers must be further studied with a nuanced consideration of contextual factors.

From a policy perspective we have shown that European small farms play important and diverse roles in the production and availability of food within food systems. However, this diversity of roles and strategies means that a one-size-fits-all policy approach is unlikely to be effective, and that policies to support small farming in Europe must recognize this diversity, with especially attention to regional differences. When viewed through the lens of a single key product, it becomes apparent that the interactions that shape regional food systems are comprised of more than simply relationships between producers and purchasers, but that a more complex set of strategies emerges in specific territories and in response to numerous factors from population density to consumer preferences. This regionally-specific understanding of the strategies and challenges facing small farms is essential for the design of effective mechanisms to support the continuation and development of small farms.

## Declaration of competing interest

No conflics of interest.

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