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# Sustainability and Resilience in Organic Greenhouse Horticulture. Examples from Italy and the UK

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## **Abstract**

It is estimated that at least 5,000 ha of greenhouses are managed organically within the EU. One current development is the “conventionalisation” of organic practices, another is the increase of community supported agriculture and short food supply chains. In this study, we capture both ends of the organic spectrum. Sustainability and resilience have been given theoretical definitions, however the perspectives of organic growers have not been studied. The aim of the research was to connect theory and practice across Europe with two case-study countries, Italy and the United Kingdom. An online survey was emailed to organic growers in both countries, and remained open from June 2016 to June 2017, containing 17 questions on general information and 12 researching details on sustainable and resilient practices, and major influencing factors on growers’ decisions. These questions were presented as five-point Likert-scaled, so growers were asked to attribute a weight from low (1) to high (5) to issues and practices in relation to their relevance to the sustainability and resilience of their farms’ management. Results showed that ‘soil fertility management’ was rated highest in both Italy and the UK. ‘Biodiversity’ and ‘landscape protection’ were rated higher in Italy, while ‘energy efficiency’ and ‘weed management’ were rated higher in the UK. ‘Short food supply chains’, ‘product traceability’ and ‘traditional knowledge’ were equally rated. These interesting differences and similarities were further studied in detail with 20 on-farm interviews (10 in Italy and 10 in the UK), to give voice to growers’ specific perspectives on sustainability and resilience.

**Keywords:** greenhouses, organic, sustainability, resilience, short food supply chains, soil fertility management

## **INTRODUCTION**

Horticulture represents an invaluable contributor to food production, food security and agroecosystem diversity because it involves the cultivation of a wide range of high-value crops such as fruits, vegetables, nuts, mushrooms, spices and medicinal plants, which are all integral parts of a healthy human diet. This great diversity of production is globally considered a pathway to the development of more sustainable livelihoods and resilient communities, especially in poor or rural areas, for its low start-up costs, short production cycles, high yields per unit of time, land and water, and high market value (Lutaladio *et al.*, 2010).

Although organic horticulture is considered more intensive than its conventional counterpart, for the high requirements in labour and inputs employed (Raviv, 2010), there exists a blurred line between the two production systems, making it difficult to isolate one set of agronomic practices from the other. Indeed, conventional systems can be moderately input-

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intensive, just like organic systems can be managed with a simple input substitution, if permitted by regulation, thus concurring in what literature has identified as a 'conventionalisation' process (Ceglie *et al.*, 2016), which might occur more easily in greenhouse cropping, considered the most intensive production system with yields per unit area up to 10 times larger than those of field crops.

Within the European Union, a recent analysis by Tittarelli *et al.* (2017) estimated that approx. 5,000 ha of greenhouses are organically managed, with 76% of them split between Italy (2,000) and Spain (1,800); the same analysis also identified four basic types of 'greenhouse agrosystems' according to their level of cropping intensiveness (high or low) and climatic area (Mediterranean or Northern-Central European systems). However, there is a range of approaches to organic methods of cultivation within the same sector, not necessarily linked to certification standards, wider than the basic distinctions between 'conventional' and 'alternative' production systems have not wholly captured, making room for further analyses of the existing heterogeneity amongst organic practices (Ceglie *et al.*, 2016).

Since sectorial research have been working towards less resource-depleting greenhouse productions, the main intent of the present study is to understand how growers regard sustainability and resilience, in theory and practice, while identifying issues that affect their management the most and those factors that influence their decisions about improving or implementing a certain practice. The research also acts as a preliminary comparative analysis between two countries, Italy and the United Kingdom, from multiple viewpoints (historical, climatic and geographical, environmental, economic, social and political), shedding light on both common and distinguishing factors between them.

## **METHODS**

Greenhouse cropping is a specific production system within a specific farming sector like horticulture, so there is a limited availability of data on single farms, specialised or not. For this study, a mixed methods approach through surveys and interviews have been chosen: data collected through surveys will be analysed and interpreted, followed by face-to-face interviews to add to and integrate the survey information. Therefore, the first 'quantitative' stage has focused on a set of closed-ended questions to be sent to an initial sample of growers, while the second 'qualitative' stage concerned a range of open-ended questions for an in-depth semi-structured interview for a smaller sample of producers employing protected structures on their farms, among those who completed the survey and following their suggestions to include other participants.

The initial survey has used organic producers as a reference population, whose contacts were collected through ICEA ([www.icea.bio](http://www.icea.bio)) in Italy and Soil Association ([www.soilassociation.org](http://www.soilassociation.org)) in the UK, the two certification bodies enlisting the largest number of producers in their respective country. The survey has been created through the Bristol Online Survey software and then sent to both samples of producers through e-mail, aiming for an average response rate of 10%, as suggested by literature (Pullman *et al.*, 2009).

The core of the survey was split in two sections: the first section enclosed 17 closed questions concerning business operations and general information on the farm, such as geographical location, farm size, area covered by protected structures, type of structures employed, total turnover and percentage represented by protected crops, and channels of distribution; the second section comprehended 12 questions, both five-point Likert-scaled and open-ended, regarding growers' views on sustainability and resilience and the importance given to them in relation to their management, their current practices (Table 1) and eventual

implementation or improvement, the factors that might have an influence on the improvement or eventual implementation of practices, and the perceived benefits of it.

Table 1. List of sustainable practices and issues (environmental and socio-economic) used in the survey.

<b>Environmental Practices and Issues</b>	<b>Socio-economic Practices and Issues</b>
Weed management	Profits
Soil fertility management	Financial survival
Waste recycling / reusing	Financial benefits
Wildlife protection	Events sponsorship
Energy efficiency	Short food supply chain
Use of renewable energy	Local community engagement
Water conservation	Landscape and heritage protection
Carbon emissions	Public access to farm
Environmental auditing (LCA, footprinting)	Products traceability
	Job training, education and development
	Work safety
	Traditional knowledge

The Italian survey was opened on 18/07/2016 and emailed to all 905 contacts the following day; the British survey was opened on 27/10/2016 and emailed to all 54 contacts the following day. The official survey closing date, also marking the end of fieldwork, was set on 30/06/2017, thus giving growers 9 to 12 months to respond. To collect a higher number of responses, particularly in the UK, the survey was sent out a second time on 09/01/2017 (UK) and 23/01/2017 (Italy).

On the survey's official close date, the completed questionnaires from Italian producers were 42, which means that the response rate was 5.7%, still distant from the literature-based 10%, while the completed questionnaires from British producers were 10, meaning that the response rate was 20%; if considering the average response from both groups of respondents, the general rate of 12.9% has surpassed the 10% threshold, therefore no further questionnaires were sent out.

## **RESULTS AND DISCUSSION**

### **General information**

For Italy, 33 respondents were in the North, 6 in the Centre, and 3 in the South. Aside from three exceptions covering sizeable areas, 26 respondents had a farm whose size is under 10 hectares, with 19 of them under 5 ha. However, the calculated farm size average for Italian respondents was 27.36 hectares, close to the average size of organic farms given by the latest available data (SINAB, 2017), reported to be 28 hectares. For the United Kingdom, the 10 respondents were from England (9) and Scotland (1). Aside from two exceptions, which are part of much larger farms, 6 respondents' businesses had less than 10 hectares and 5 of them less than 5 ha. In this case, the calculated farm size average for all British respondents was 146.52 hectares, registering a higher value than the one showed by the latest available statistics (DEFRA, 2017), which is 80 hectares at national level.

The percentage of protected areas on a farm varies according to different interconnected factors such as the type of structures involved, the available volume of investments and the crops cultivated. Results from Italy showed that 37 farms have a percentage of covered crops below 10% of the total area, with a major incidence of farms with a protected area ranging from 1% to 5% (13), and farms with less than 1% incidence of protected area over farm size (13), for a general average of 5.54% across all. This shows that the incidence of protected area is not strictly related to farm size: for example, among Italian respondents, the highest percentages of land occupied by greenhouses registered were 22% and 43%, respectively on a 3-ha and a 70-ha farm. In the UK, 9 cases out of 10 had 10% or less of the total farm area occupied by protected crops, 5 had less than 5% and 2 had less than 1%. The remaining case, a 2-ha farm, had 50% of their land occupied by greenhouses, reconfirming that size does have an influence, but it is also a question of structures, investments and crops. For British farms, the average incidence of greenhouse areas was slightly higher than in the Italian case, setting at 7.85%.

In Italy, choice between structures is split almost evenly, with a total of 16 respondents employing polytunnels and 14 using multi-tunnels; the remaining 12 have listed seasonal and mobile single tunnels as their chosen structures. Only 9 producers employed a heating system to keep crops warm in the winter or to propagate their seedlings on heated beds, while the other 33 possessed unheated structures, which remain a more common solution among Italian growers, regardless of the scale of business, for the lower costs. Responses from the United Kingdom showed 70% of growers using polytunnels, usually cheaper and growers can assemble them themselves, and the other 30% employing multi-tunnels. None of the British respondents possessed heated structures, suggesting that using a heating system inside greenhouses is not exclusively related to climatic conditions, but it might also be linked to possibilities to invest in such systems, their adaptability to the structures, and businesses' choices in terms of operational scale, production and period of distribution of their produce.

In terms of total turnovers, results for the UK showed 40% of them earning more than £75k per year, while the rest was concentrated on the lower ranges (4 between £30k and £45k per year, the other two between £45k and £75k). Although it appears that the total turnover of a farm is not only linked to its size, there seems to be a sort of correlation between them in Italy's case: in fact, earnings above €75k per year interest two-thirds of farms with areas larger than 10 ha (12 out of 18), while only one-fourth of farms with less than 10 ha (6 out of 24) made it to the same class of values. Especially for smaller farms, turnovers are more spread out across the lower ranges, potentially meaning that total turnover might also be related to factors such as diversification of production in terms of both crops and enterprises.

On a general rule, most of a farm's turnover comes from open field cropping, however results showed that products grown in protected structures can still represent an important percentage of their yearly earnings, regardless of farm size and extension of protected area. For Italian producers, in 17 cases these products account for a share between 20% and 80% of the whole production, while another 8 stay between 10% and 20% and for the remaining cases (17), percentages stay below 10%, with a calculated average contribution of 27% to the total turnover. For the UK, in 9 cases, products supplied by protected structures account for a share below 20% of the whole production, with 5 between 10 and 20% and the other 4 below 10%, while in the last case, protected structures supply a share of 35% of the total production, for an average contribution of 12.5%. The fact that in general, protected products make up for roughly a tenth of the total turnover of British farms, whereas this percentage can reach up to a fourth or a third of total turnovers for Italian producers, might be relatively linked to issues like different temperatures and length of the growing season, longer and warmer in the Mediterranean area, and a higher percentage of large-scale production in the Italian sample.

Results from both countries showed that distribution of produce is greatly varied. In Italy, direct on-farm sales are the preferred and most used channel (34 preferences), followed by box schemes (16) and large distribution (11), while online sales earned the lowest number of preferences, adding other channels such as *Solidarity Purchase Groups*, self-consumption, restaurants and shops. Similarly, in the UK direct on-farm sales earned 5 preferences, followed by box schemes (4), large distribution and online sales (both earning 2 responses), integrating with market stalls, restaurants, wholesale, CSAs and processing.

### **Understanding the concepts**

In both countries, growers generally seem to have a good grasp of what sustainability is and what it means to be sustainable, revealing the largest percentage of responses in the second highest category of relevance for both Italy (48%) and the United Kingdom (80%); in Italy's case, another significant group of respondents also gave a 'very good' score to their understanding of sustainability (45%). Even though resilience seems to be slightly less popular than sustainability among growers, the general degree of its understanding is still remarkable, with the largest percentage of Italian producers (50%) and British growers (60%) showing a 'good' degree of comprehension of what being resilient means.

Most Italian growers deemed sustainability highly important in their opinion, with 71% of responses in the second top score category; British producers were equally split between the top two score categories (50% of responses in each), thus giving sustainability a 'high' and 'very high' degree of relevance. Similar results were obtained for resilience and its importance; although it is not a concept as well understood as sustainability, it is still considered relevant by most respondents from both groups, with 48% of Italian responses giving resilience a 'high' degree of importance and 80% of British growers equally split between the 'high' and 'very high' categories (40% each).

### **Sustainable practices and issues**

Most Italian growers consider *fertility management* and *biodiversity protection* the most relevant issues for their management systems, along with *short supply chains* and *product traceability*, with more than half of the responses scoring in the highest category of importance (respectively 67%, 52%, 55% and 57%), showing that maintaining soil fertility and preserving agrobiodiversity in farming systems are key to improving the sustainability and enhancing the resilience of said systems, same as focusing on maintaining a direct relationship between producers and consumers and increasing the latter's awareness of where products come from. A major degree of importance was given to *water conservation* and *weed management*, intimately linked to fertility management and biodiversity protection, both getting 47.6% of responses in the highest score category; a similar importance was given to *education and formation*, and *landscape protection*, respectively with 43% and 45% of preferences in the highest score category. A lower percentage of respondents attributed to *public access to farms* and *communities' involvement* a high relevance, respectively with 38% and 33% of preferences in the highest score category. *Work safety* and *waste recycling* got almost half of the responses in the 'high' category of score (48% and 40.5%), while *carbon emissions* and *financial survival* both got 36% of preferences in that same category. *Renewables use*, *environmental auditing* and *energy efficiency* earned their largest percentages of responses split between different categories of importance: using renewable energy got 31% of responses in both 'high' and 'very high' score categories, environmental auditing got 33% respondents considering it either highly or averagely important, and energy efficiency got more than 70% of responses equally split between the 'very high' and the 'average' classes of importance (36% each). *Profits*, *traditional knowledge* and *financial benefits* were attributed an average degree of

relevance by respectively 43% (profits) and 38% (traditional knowledge and financial benefits) of responses, while *events sponsoring* earned 38% of preferences in the lowest category of importance, making it the least relevant management-related issue for Italian growers.

For British producers as well, *fertility management* and *short supply chains* were attributed the highest degree of relevance by 70% and 60% of respondents, respectively; the same degree of importance was attributed to *product traceability* and *communities' involvement* with 40% of responses. More than half respondents gave a 'high' degree of relevance to issues like *weed management* (60%), *public access to farms* (60%), and *education and formation* (60%), followed by *renewables use* (50%), *energy efficiency* (50%) and *traditional knowledge* (50%), while *landscape protection* earned 40% of preferences in the 'high' category of score. *Carbon emissions* and *work safety* got 80% of responses equally split between the 'high' and 'average' score categories (40% each), while *biodiversity protection*, *environmental auditing*, *profits* and *financial benefits* were attributed an average degree of relevance by more than half of the respondents (50% for biodiversity protection and environmental auditing, 60% for profits and 70% for financial benefits). Less than half of British respondents gave *waste recycling* and *financial survival* an average score in terms of importance (40% both). Responses for *water conservation* were split across different categories of score, resulting in significantly differing opinions upon the matter of conserving water resources on farms, thus registering 30% of preferences in the 'very high', the 'average' and the 'low' classes of score. Also in the UK's case, *events sponsoring* confirmed to be the least relevant issue for farm management, with 60% of responses registering in the lowest score category.

### **Resilient practices and issues**

In general, resilience plays a significantly important role in farming management for growers from both countries. However, Italian producers ascribed a major relevance to *crop diversification* and the *capacity to face changes*, both having earned 55% of responses in the highest score category, while *production diversification* got 43% of respondents considering it the most important issue. *Knowledge exchange* was considered of 'high' relevance by 55% of respondents, while *market diversification* earned the largest percentage of preferences in the 'high' score category (36%). Similarly, British growers ascribed a major degree of importance to *crop diversification*, with 50% of the responses in the highest class of value. *Knowledge exchange* and *capacity to face changes* both got 50% of preferences in the 'high' score category. *Market* and *product diversification* both got the largest percentages of responses in the 'average' category of relevance for farm management, with respectively 40% and 50% of responses in the middle category.

### **Identifying influencing factors**

For British producers, a major influence on their decisions regarding implementation and improvement of practices was ascribed to *costs of investments* and their *perception of benefits*, which both earned all responses equally split between the 'high' and 'average' score categories (50% each in both cases). For the other issues, the largest percentages of responses considered them having a general average weight, with *feasibility and bureaucracy* and *regulations* earning 70% of responses in the middle category, followed by *farm size* and *perception of risks* with 60% of preferences, and *consumers' demands* with 50% of responses. In this case, *subsidies* got most respondents considering them of low importance (40%) for growers' management-related decisions.

In Italy's case, there were no peaks of preferences for any of the listed issues, suggesting that all factors might contribute in the same measure to growers' decisions to implement or improve their practices. However, results showed that most responses ascribed a high degree of importance to *feasibility and bureaucracy*, which earned more than 70% of responses split between the 'high' and 'very high' score categories (36% of preferences each), *costs of investments* and *consumers' demands*, with 38% of responses respectively in the 'high' and the 'very high' score categories. *Subsidies* and *perception of benefits* followed with 33% of responses considering them highly influencing in decision-making, in both cases. For the remaining issues, the largest percentages of responses gave them an average weight, with *farm size* and *perception of risks* gathering 38% of preferences, and *subsidies* with 31% of the responses in the middle score category.

## CONCLUSIONS

The following conclusions could be drawn from the present research:

-in both countries, the majority of growers can be considered small-scale, with farms under 10 ha of size, and the average incidence of protected areas is set between 5.54% (Italy) and 7.85% (UK) of the total farmland; however, this percentage is not strictly related to farm size. Contribution of products from protected structures over total farm turnover is roughly 30% in both countries, with values ranging from less than 1% to 80% regardless of the size of the business, showing that other factors might concur in making up such percentages (i.e. growth season, channels used for distribution, level of specialisation);

-although definitions in literature are currently numerous and often difficult to translate into practice, and resilience is still relatively new and therefore less popular among practitioners than sustainability, the concepts of sustainability and resilience are shown to be well understood among growers, and the relative importance given to them in terms of management is elevated in both countries;

-in protected cropping, maintaining a healthy and fertile soil is considered a priority among growers: constant long-term care for the soil is a distinguishing feature for organic producers, and working continuously on preserving and improving **soil fertility** without it being detrimental to their income is imperative. Indeed, fertility management is considered the most important issue by most growers from both countries when it comes to sustainable farm management. Moreover, small-scale producers still represent a large percentage of the total, mostly focusing their financial and social survival on **short supply chains**: for both groups of respondents, they represent a point of transformation towards an increasingly sustainable food system, concerning not only the economic dimension of market exchange, but also the maintenance of environmental integrity and the fostering of social and ethical aspects of food production;

-**crop diversification** is another focus point for organic growers, widely recognised as a fundamental strategy to adapt to climate change and especially when it comes to horticulture, a key passage to the reduction of losses and vulnerability: fostering diversity, in terms of cultivated crops, is of utmost importance for both groups of growers, however slight differences were registered for **product** or **market diversification**, within the single farm unit and at landscape level;

-when it comes to protected cropping and the possibility to address a certain practice or issue in order to pursue an increasingly sustainable and resilient production, a major influence was ascribed to **cost of investments** (UK) and **bureaucracy** (Italy), while **consumers' demands** assumed a relevant role in decision-making for both groups of growers; issues such



as **farm size**, **regulations in force** and **subsidies** were given a relatively lower importance in both cases.

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