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BRIEF REPORT

Grow your own food security? Integrating science and citizen science to estimate the contribution of own growing to UK food production

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Societal Impact Statement

Own-grown fruit and vegetable production in urban areas is increasingly assumed to increase food security, however, the evidence-base to support this assumption is lacking. By integrating remotely sensed Geographic Information System data, field-work, and a citizen science project (MYHarvest) we will estimate the current levels of UK own-grown fruit and vegetable production and how this could be increased if more urban land was made available for own-growing. This will provide the first comprehensive UK dataset on own-grown production for use by research scientists, policy-makers, and the public, and will highlight the importance of urban horticulture to local and national food security.

KEYWORDS

food security, citizen science, own-grown food, urban horticulture, urban agriculture, MYHarvest, allotments, urban ecosystem service

Urban agriculture is increasingly recognized as an important contributor to the sustainability and resilience of cities by policy-makers from local through to transnational levels of governance. This stems from increasing evidence that urban agriculture provides multiple benefits, including improving physical and mental health and well-being, reconnecting urban dwellers with primary food production, and it is widely assumed to increase food security (Goldstein, Hauschild, Fernandez, & Birkved, 2016; Martin, Clift, & Christie, 2016). Initiatives such as the 2015 Milan Urban Food Policy Pact, now signed by 165 cities, include specific goals to “*promote and strengthen urban and peri-urban food production*” as part of an overarching aim to develop more sustainable food systems and promote healthy diets. However, the extent to which urban food production contributes to local and national food security and healthy lifestyles and diets now, and its potential to do so in future, is not well understood. Such knowledge is important for the development of local or

national policies on urban food growing to improve food security and public health.

It is estimated that 25%–30% of urban dwellers practice some form of agriculture globally (Orsini, Kahane, Nono-Womdim, & Gianquitno, 2013), and urban and peri-urban agriculture has played a significant role in food security, especially in low-income countries, contributing 15%–20% of total world food production in the 1990s (Pearson, Pearson, & Pearson, 2010). Unlike conventional commercial food production, for which high quality global datasets are maintained, there are no systematic records kept for small-scale urban food production, severely hampering the development of reliable assessments of the contribution of urban agriculture to food security. Notably, the scale and importance of urban agriculture for food production in the Global North now, and its future potential, remains very poorly understood, although it is known that urban greenspaces in these regions are most suited to production of horticultural

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fruit and vegetable crops (Mok et al., 2014; Orsini et al., 2013). The last UK estimates of own-grown food production were during World War II, when as a result of the Dig for Victory campaign it has been estimated that 18% of the fruit and vegetables produced (by value) were grown in gardens and allotments (DEFRA, 2017). However, the UK population was only about 49 million then, compared to 65 million today, and the national emergency of the war ensured exceptional engagement with own-growing (Lang & McKee, 2018). Post-war the scale of own-grown fruit and vegetable production declined significantly and this is reflected in the decline in UK allotment provision from approximately 1.5 million plots to 300,000 at present (Speak, Mizgajski, & Borysiak, 2015). However, over the last couple of decades there has been resurgence in interest in own-growing, with more than 75,000 people on allotment waiting lists in the UK (Campbell & Campbell, 2013).

Although there is an increasing body of evidence supporting the value of own-grown fruit and vegetable production in terms of both environmental benefits (e.g., see Edmondson, Davies, Gaston, & Leake, 2014; Speak et al., 2015) and health and well-being (e.g., see Kortwright & Wakefield, 2011), there is a lack of quantitative data to enable realistic estimates of the contribution own-growers currently make to food security at a national scale. Understanding both current levels of own-grown food production and potential to increase production within existing greenspaces is the key to provide the evidence-base necessary to highlight the importance of urban own-grown horticulture in local and national policy agendas. Our ongoing research aims to provide this evidence-base by working with own-growers across UK to quantify current fruit and vegetable production in allotments and identify how this could be increased if the space was used more effectively, or if more dedicated urban greenspace for own-growing was made available. Here, we discuss the methodologies we have developed to achieve these aims and discuss the preliminary insights into this ongoing research.

It is challenging to develop the datasets required to make these assessments, requiring an interdisciplinary approach spanning the use of remotely sensed Geographic Information Systems (GIS), fieldwork and citizen science data collection. This paper provides an overview of the methodologies we are using and the key findings to date. GIS is necessary to determine the area and location of allotments within the UK, and to analyze the areas of urban greenspace potentially suitable for allotment style own-growing. The fieldwork will establish how much of a given area of land own-growers use for food cultivation, the areas of land used for different crops and how this changes spatially across UK. This fieldwork will span the 2017 and 2018 growing seasons in ten UK cities (including: Edinburgh, Newcastle, Leeds, Liverpool, Nottingham, Leicester, Milton Keynes, Bristol, Cardiff, and Southampton) at 40 allotment sites in 200 individual plots. The final element necessary to estimate own-grown food production is to understand the yield achieved by own-growers for typical UK fruit and vegetable crops. This is possibly the most challenging aspect of the work as it relies entirely on the own-growing community working with research scientists. However, without this we would be reliant upon yield data from the commercial horticultural sector (e.g., DEFRA Horticultural Statistics) which may

vary significantly from yields achieved by own-growers and may not reflect own-grown crop varieties used.

1 | MEASURE YOUR HARVEST (MYHARVEST)

MYHarvest (<https://myharvest.org.uk>) is a UK-based citizen science project, launched in April 2017, designed to collect yield data from people growing in gardens, allotments, and other spaces (e.g. community gardens). Participants provide initial details about where they are growing and their management practices. To calculate yield (kg/m²) we require participants to record the area used to grow a specific crop and the total crop weight. To ensure data quality, MYHarvest was designed iteratively during a pilot project that ran for 2 years (2012–2013) with a small cohort of growers as recommended by Kosmala Wiggins Swanson and Simmons (2016). This enabled us to develop clear guidelines for participants, for example detailing how to prepare an individual crop prior to weighing (specific guidelines are detailed on the MYHarvest website: [MYHarvest.org.uk](https://myharvest.org.uk)), and ensure the design of a data entry website that is straightforward to use, for example by providing drop-down lists for crop types rather than free text. Statistical modeling tools will also be used to mitigate any data quality issues or systematic bias in the sample (Kosmala et al., 2016). The challenge of the project is to collect enough crop yield data to enable us to understand how yields vary across the UK by soil type, climate, and management. To do this we are collaborating with the National Allotment Society (membership >120,000 people) and the Royal Horticultural Society (membership >480,000 people) using their magazines and newsletters to publicize the project. We also had stands at the Harrogate Flower Show, The Great Yorkshire Show and BBC Gardeners' World Show, and have publicized the project on 15 local BBC radio stations and on BBC Breakfast in April 2018. While recruiting participants to the project we have made it clear that we are interested in both the successes (high yields) and failures (low or no yield) from specific crops, however, we acknowledge that the citizen science approach used may result in systematic sample bias.

During 2017 more than 800 people signed up to the project, but only 269 people actually submitted harvest data with 55% from allotments and 43% from gardens (the remaining 2% were other growing spaces). Participants provided a good geographical spread across the UK, with most data points centered around urban areas (Figure 1). MYHarvest collected data on 25 crop types (e.g., see Figure 1c) during 2017 and these can be split into fruits (strawberries, raspberries, gooseberries, currants, apples, plums), vegetables (onions, carrots, courgettes, squashes, cabbages, lettuces, broccoli, tomatoes, climbing beans, runner beans, broad beans, peas, beetroot, leeks, parsnip, sweetcorn, Brussel sprouts, turnips) and potatoes. We received data for >3,150 harvests that will be converted into yields; 16% from fruits, 49% from vegetables, and 7% from potatoes, which were the most commonly harvested crop (Figure 2a). A further 28% of harvests were entered into the "other" crop category. In total the harvested crops covered 4.7 ha and weighed more than 32 tonnes,

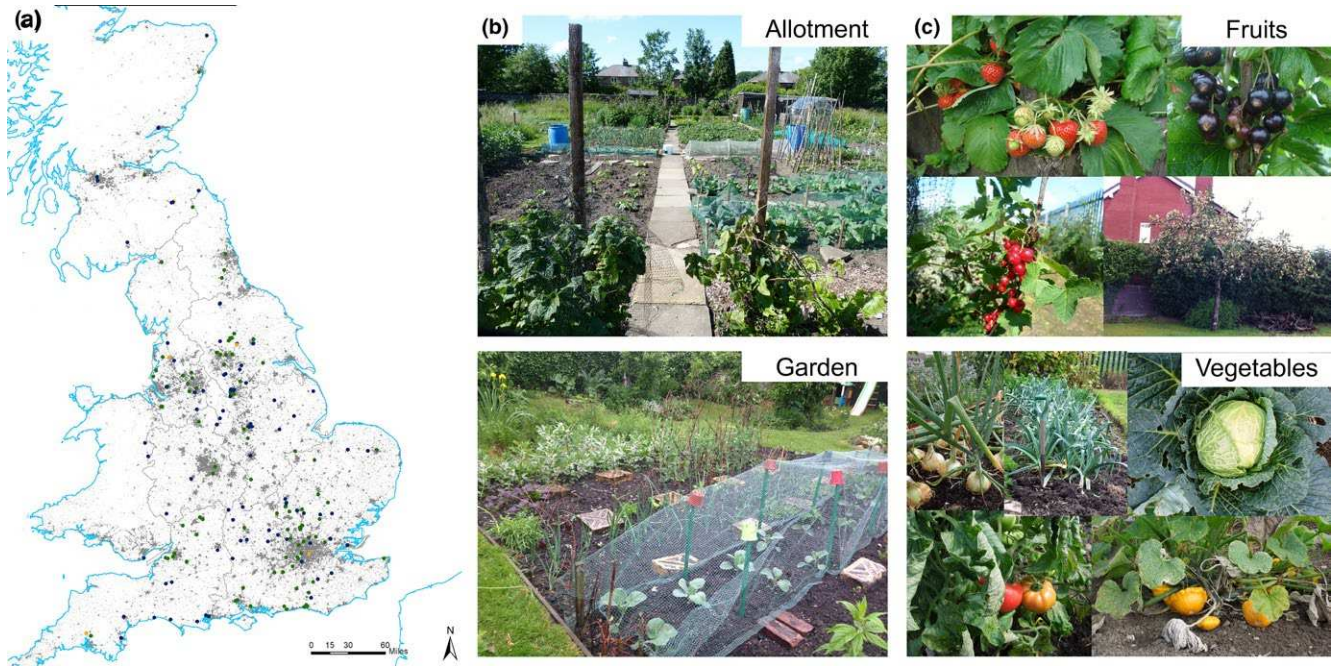


FIGURE 1 (a) Geographical spread of active MYHarvest participants in allotments (green dots), gardens (blue dots), and other growing spaces (orange dots) (urban areas shaded grey using Land Cover Map 2017); (b) images of an allotment plot and garden; (c) images of typical own-grown UK fruit and vegetable crops

with 2.2 ha and 18.2 tonnes of vegetables, 1.5 ha and 8.5 tonnes of fruit, and 0.6 ha and 5.4 tonnes of potatoes (Figure 2b,c).

The initial data presented demonstrates the successful engagement of a large cohort of growers from across the UK with MYHarvest during 2017. MYHarvest will run over the 2018 growing season and aims to collect data from existing participants and to recruit new growers, in order to understand annual variation in crops yields. Once completed, the MYHarvest dataset will be made openly available and will provide the first comprehensive UK dataset on own-growing production for use by research scientists, policy-makers and the general public.

2 | FOOD SECURITY ISSUES IN CONVENTIONAL HORTICULTURE: A GREATER FUTURE ROLE FOR SUSTAINABLE URBAN FOOD PRODUCTION?

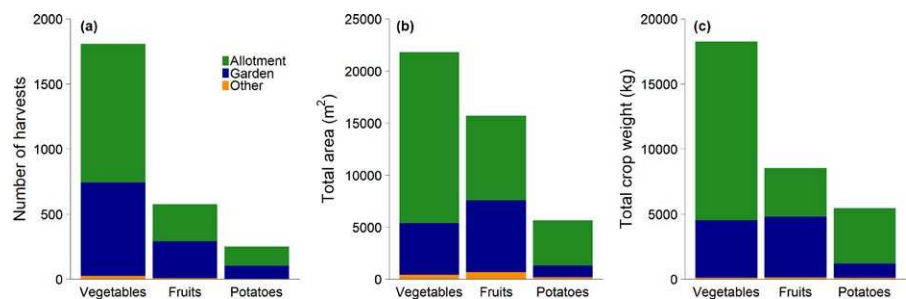
At present urban areas are heavily reliant on the import of horticultural crops from conventional agriculture, but these producers are

currently facing several challenges including a need to improve the sustainability of their farming practices and to prevent soil degradation, which is negatively affecting crop yields. For example, drained fenland peats provide 37% of the vegetable production in England (NFU, 2008), but their soil resource will be exhausted by shrinkage and oxidation within <100 years at current rates of wastage of about 1.2 cm/yr (Holman & Kechavarzi, 2011).

In addition, commercial horticulture relies on a seasonal workforce, particularly for handpicked crops. In some countries the population is unwilling or unable to carry out this work and so producers rely on a mobile seasonal workforce. For example, 99% of the UK horticultural seasonal workforce comes from other EU countries (ONS, 2018). This may present a particular challenge for the UK as this workforce may not be available post Brexit and so could threaten national food security (Lang & McKee, 2018).

Our ongoing research will produce a modern day estimate of the contribution own-growers make to fruit and vegetable production in the UK and will highlight ways in which urban greenspace could be used to increase own-grown horticulture. However, in urban areas

FIGURE 2 MYHarvest fruit, vegetable, and potato contribution to (a) the total number of harvests submitted; (b) total growing area, and; (c) total crop weight



land is the limiting resource for food production (Barthel, Parker, & Ernstson, 2015) and while own-growing typically relies on the use of greenspaces there are a variety of new production systems and technologies emerging that could complement own-growing and enable the development of more productive urban areas in the future. In particular, growing commercial horticultural products on or inside buildings (zero-acreage farming) is widely discussed as an opportunity to enhance food production (Thomaier, Specht, Henckel, & Dierich, 2015). Intensive growing technologies proposed in this context include, for example, aquaponics systems that can simultaneously provide fresh fruit, vegetables and fish (Cunningham & Kotzen, 2015).

As with own-growing, the evidence suggests that the small-scale commercial horticultural production within cities is increasing globally, but there is a relatively poor understanding of the scale of production. In addition, with both own-growing and small-scale urban commercial horticulture there is often an assumption that practices are more sustainable than those used by conventional agricultural producers, but the evidence-base to support these assumptions is lacking. Collection of quantitative data on production potential in combination with a life cycle sustainability assessment approach would enable an understanding of both the environmental and social impacts of crops grown using different urban horticultural practices.

The success of the citizen science data collection used in MYHarvest would not have been possible without the proliferation in the use of home computers, tablets, and mobile phones. The recent technological advances made in Internet of Things (IoT) in combination with the increasing availability of new Low-Power Wide-Area Network (LPWAN) infrastructure (which will form the communication backbone for IoT) could provide a platform to develop life cycle sustainability assessments for crops produced by different forms of urban horticulture from own-growing to intensive indoor growing systems. However, the collection of meaningful quantitative data will require collaboration with those producing the horticultural crops and engagement with these new technologies. When combined with more traditional field and GIS-based data collection, these analyses would facilitate policy making to develop sustainable food cities by informing schemes to retrofit both own-grown and commercial horticultural production into existing urban areas and embed it into new developments. This will require considerable investment in data, but research of this kind could result in a step-change in how and where we produce some of our horticultural crops and demonstrate how urban land can contribute to both local and national food security.

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AUTHOR CONTRIBUTIONS

J.L.E. and J.R.L. planned and designed the research. H.C. developed the MYHarvest database. R.B. manages the MYHarvest project. R.B. and M.D. conducted fieldwork. D.R.G. analysed the data. J.L.E., R.B., H.C., M.D., J.R.L. and D.R.G. wrote the manuscript.

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