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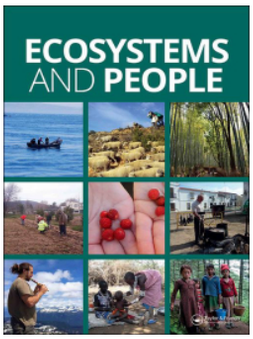
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Perceptions of perennial crops among urban agriculture growers in England

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ABSTRACT

Given increasing evidence of the unsustainable nature of conventional intensive agriculture, alternative methods of food production must be considered. Urban agriculture (UA) is one proposed mechanism for increasing food system sustainability, given the potential to provide social and ecological benefits while increasing access to nutritious food. In conventional farming, the incorporation of more perennial crops has been proposed to increase sustainability through reduced soil disturbance, increased water retention and supporting higher biodiversity than annual cropping. However, little research has explored the possible benefits associated with perennial cropping in UA, or whether perennial crops incur any novel costs in urban settings. To answer these questions, we interviewed eleven managers of UA growing sites in England. Thematic analysis identified four key themes in respondents' answers 1) issues faced by growers due to their urban locations, 2) negatives and 3) positives associated with perennial growing and 4) the alternative growing practices utilised. The soil, water and biodiversity benefits associated with perennial crops in conventional agriculture are also perceived to be present in perennial UA. The previously reported health and social benefits for people of UA persist in perennial UA, and the permanent structures perennial crops create can enhance the benefits of these sites as community spaces. However, growers identified novel social and ecological costs associated with growing perennials, including their widespreading and long-lasting nature. Growers' experiences of the social and ecological benefits and costs of perennial UA highlight the need for management of urban growing spaces to consider multiple perspectives.

KEY POLICY HIGHLIGHTS

- Lack of knowledge among urban growing communities and the wider public regarding perennial crop cultivation and management, suitable species for local urban environments and dietary integration were perceived as barriers to successful perennial growing. Greater investment in food systems education may help address these knowledge gaps.
- Policies that improve land tenure security for urban agriculture sites and strengthen stakeholder relationships are needed to maintain the perceived benefits of urban perennial agriculture, as perennial crops can be long-lived and may require several years to establish and reach full productivity, necessitating long-term investment and continuity of land access.
- Increased biodiversity was perceived as a positive of perennial crops in urban agriculture, providing benefits for ecosystem services, environmental education and wellbeing, whilst simultaneously creating challenges through increased pest pressures. This illustrates the multifunctional nature of perennial urban agriculture, where ecological, social and practical outcomes are interconnected; policy and funding frameworks should recognise these connections.

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Introduction

Conventional agricultural systems, typically characterized by large-scale industrial production, are increasingly recognized as ecologically unsustainable. Intensive management practices degrade soil and water quality, contribute substantially to greenhouse gas emissions and drive biodiversity loss through habitat destruction (Pretty and Bharucha 2014; West et al. 2014; FAO 2025). Beyond these environmental concerns, the current global food system will not be able to provide the world's growing population with the nutrients required for a healthy life in the future, a challenge intensified by rapid urbanisation, global pandemics, rising conflict and climate change (UN 2019; HLPE 2020). In response, the Food and Agriculture Organisation of the United Nations (FAO) has identified the expansion of urban agriculture (UA) as a method for enhancing food system sustainability, given its demonstrated links to improved food and nutrition, climate change

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mitigation, poverty alleviation, and increased urban biodiversity (FAO, Rikolto & RUAF 2022). Throughout this study we follow the FAO's definition of urban agriculture as '*the production of food and other outputs and related processes taking place on land and other spaces within towns, urban centres, cities and surrounding regions*'.

Urban agriculture is practiced around the world, across an estimated 67.4 mha of urban and peri-urban land and is most prominent across South and East Asia, Africa and Latin America (Zezza and Tasciotti 2010; Thebo et al. 2014). Within Europe, urban agricultural production has fallen since its peak during WWII when up to 18% of fruit and vegetable consumption was attributed to home growing during the 'Dig for victory' campaign in the UK (DEFRA 2017). Post–World War II declines in urban growing spaces provisioning are likely due to a rapid increase in urban populations, reduced land available for cultivation, and the development of globalised, less seasonal diets (Edmondson et al. 2020). Within the UK, a recent resurgence in public interest in UA has led to pressure on local governments which typically administer the renting of publicly owned 'allotments' (small plots of land, typically 250 square metres in size) for food growing. For example, in 2019 17,424 people were reported to be on an allotment waitlist in London, a fourfold rise from 2006 (Fletcher and Collins 2020).

Recent studies have shown that small urban growing spaces have the capacity to produce crop yields at a comparable rate to, or higher than, conventional commercial agriculture, with minimal reliance on agro-chemicals (McDougall et al. 2019; Edmondson et al. 2020; Nicholls et al. 2020). However, this productivity has been shown to vary according to location, management practices and growers' motivations (Caputo et al. 2023; Dorr et al. 2023a). Furthermore, the resource efficiency of UA systems has been questioned. For example, McDougall et al. (2019) found that the average value of labour and material inputs exceeded the market value of the crops produced in UA sites in New South Wales, Australia. Common inputs within UA include organic materials such as topsoil, compost and manure, as well as, municipal water and non-renewable materials, often reflecting limited access to infrastructure that would support more sustainable practices, such as rainwater harvesting (McDougall et al. 2019; Caputo et al. 2023; Dorr et al. 2023a; Manente et al. 2025). As with productivity, both the use and cost of these inputs have been reported to vary substantially across different urban growing contexts (Guitart et al. 2015; Dorr et al. 2023a; Manente et al. 2025).

In addition to being productive food growing spaces and improving access to healthy and nutritional food for urban residents (Gulyas and Edmondson 2024), urban growing provides a myriad of additional benefits to growers, including improved physical (Audate et al. 2019), and mental health due to enhanced social networks, access to a stress relieving refuge, cultivating personal development and improved connection to nature (Genter et al. 2015; Soga et al. 2017; Cano-Verdugo et al. 2024; Gulyas et al. 2024). Alongside the benefits for people, UA and other urban greenspaces are discussed as areas that increase 'urban biodiversity', defined as *the variety and richness of living organisms and habitat diversity found in and on the edge of human settlements* (Muller et al. 2010). For example, a study in four UK cities found allotments and residential gardens to be 'hotspots' for pollinators, having significantly higher bee and hoverfly abundances than the rest of the city (Baldock et al. 2019). While the evidence base regarding the productivity, biodiversity and wellbeing benefits of UA is growing, there has been limited research on the intersection between ecological and social benefits of these agricultural sites and the specific management strategies used to optimise growing, nor on the possible disadvantages associated with urban growing (Church et al. 2015).

Alongside increasing UA, another method suggested to increase the sustainability of food production is to increase or switch to perennial crops (Asbjornsen et al. 2014). Perennial crops are defined as '*crops that are planted and do not need to be re-planted or fully harvested annually to obtain goods*'; and include woody fruit and nut trees, fruit shrubs and herbaceous grasses (Ledo et al. 2020). The cited benefits of perennial growing in conventional agriculture include nutrient uplift and regulation (Power 2010; Asbjornsen et al. 2014), increased soil organic carbon (Ledo et al. 2020; Shang et al. 2024), decreased greenhouse gas emissions (Power 2010) and increased biodiversity, including beneficial insects (pollinators, pest regulators) (Kreitzman et al. 2022). However, little to no research has explored whether the benefits associated with perennial crops are also present in urban systems. This is important, given processes associated with perennial cropping, such as decreased surface runoff arising from improved soil structure (Asbjornsen et al. 2014), may be even more beneficial in urban spaces where there are large areas of impervious land cover. Finding ways of increasing urban resilience against flooding events is important in countries such as the UK, which is predicted to have more extreme precipitation events under climate change (Ekström et al. 2005; Kendon et al. 2023). Moreover, perennial growing within urban landscapes may alleviate urban-specific issues such as the heat island effect, a phenomenon which may in turn affect crop growth and the provisioning of ecosystem services required for urban food production, e.g. pollination (Lin et al. 2018; McDougall et al.

2022). It is therefore critical to explore whether the benefits of perennial cropping are applicable to UA and whether any novel positive or negative impacts arise from growing perennials for food in an urban setting.

A complication in research on urban agricultural systems is that they differ in type, management needs, and desired outputs, with 23 different defined types of UA identified globally (Cilliers et al. 2020). Furthermore, within the different UA types, a wide variety of crops are grown, ranging from mostly annual crops to mostly perennials. For example, one type of urban growing which is common in the UK and parts of Europe is allotment growing (Genter et al. 2015), where commonly grown crops are predominantly annuals such as tomatoes, lettuces, beans of varying varieties, peppers, cucumbers, courgettes, carrots and squashes (Gregory et al. 2016; Woods et al. 2016; Edmondson et al. 2020; Dorr et al. 2023b). Alternative growing methods exist, however, such as food forests comprising multilayer agroforestry systems which produce edible perennial crops at the ground, shrub and tree layers (Albrecht and Wiek 2021; Oncini et al. 2024). Due to these differences in crop diversity, studies often consider the different types of UA independently within research outputs.

While independent studies have quantified the positive and negative impacts of perennial growing in conventional agriculture (Power 2010; Asbjornsen et al. 2014; Ledo et al. 2020; Kreitzman et al. 2022; Shang et al. 2024) and the benefits of UA more generally (Genter et al. 2015; Soga et al. 2017; Audate et al. 2019; Cano-Verdugo et al. 2024; Gulyas and Edmondson 2024), limited research has been conducted to see if these impacts also apply to perennial UA. While the positive impacts to biodiversity within perennial UA are beginning to be explored (Horák et al. 2017; Arnold et al. 2019), very little work has focused on other potential ecological impacts, such as soil organic carbon storage (Edmondson et al. 2014). Moreover, with the more recent acknowledgement of the high value of urban food growing sites for facilitating socio-cultural interactions and improving health and wellbeing (Fletcher and Collins 2020), more research is needed to evaluate whether there are any positive or negative impacts unique to perennial urban systems.

To resolve these knowledge gaps, we conducted semi-structured interviews and questionnaires with eleven managers of a range of different types of UA in England, including sites of different ages, sizes and geographical regions. The aim of this research was to explore the question 'what are the views of UA managers towards the growth and management of perennial crops?' The intention is for the results to highlight the key perceived positives and negatives of growing perennials within UA, encompassing both social and ecological dimensions. This qualitative exploration allows for the collection of nuanced data covering a wide range of topics surrounding the perceptions and lived experiences of perennial UA. People involved in urban growing are privy to knowledge of the benefits and issues surrounding crop yields, biodiversity, human health and community cohesion which are all from experience imbedded in the practice; knowledge which would require great interdisciplinary effort to collate independent of the growers. Finally, the utilisation of knowledge and experience of those involved in perennial urban growing allows for information to be exchanged, leading to transformative research which is beneficial to both scientists and growers (Streit Krug and Tesdell 2021).

Methods

To explore the perspectives of urban agricultural managers on perennial crop growing, we asked the participants to complete a questionnaire and conducted semi-structured interviews. The questionnaire consisted of six questions designed to establish quantitative data on the age, size and type of each UA site, along with the inputs used within the management of the site (see supplementary materials) and took five minutes to complete. Questionnaires were completed before the interview commenced as the answers helped guide the interview questions. We used semi-structured interviews because they allow for the drawing out of a wide breadth of knowledge and the flexibility to focus on specific details in more depth, gaining large amounts of data (Newing et al. 2011). The interviews occurred *in situ* during a tour of the interviewees' urban growing site, lasting ~50 minutes. The guiding questions were curated to answer the key question 'What are the views of UA managers towards the growth and management of perennial crops'. The questions were designed to elicit in-depth responses towards the key perceived negatives and positives of growing perennial crops, alongside the main barriers to the implementation of perennials and the individual site variables that may affect this (see supplementary materials for interview guide). Interviews were carried out in English from January to November 2024. Within interviewee quotes spelling and grammatical errors have been corrected to improve comprehension of the text; ellipses within the quotes indicate the removal of superfluous text.

Participants

Participants were identified through internet searches for the term 'urban agriculture' or one of the categories of UA described in Cilliers et al. (2020) and 'England' or the name of a major town or city within

England. Inclusion criteria required sites to self-identify as a form of UA, provide publicly accessible contact information, demonstrate involvement in perennial crop growth, and be located within cities, towns or other urban centres in England. Exclusion criteria included sites located outside England or outside urban areas, the absence of documented perennial crop production, insufficient publicly available information regarding site size, age, location, or cultivation methods, and sites representing the same primary UA system as another participant within the same county. Specific sites were selected to encapsulate a broad geographical representation across England to account for potential climatic, seasonal and cultural variation. Considerations were also given to the age and size of the sites during participant selection, though this information was not always publicly available and therefore was clarified within the questionnaires. When recruiting interviewees, a manager of the site was requested for interview, when this was not possible or applicable, a core active member with knowledge of the site and its decision making was requested. Interviews were carried out with eleven participants involved in the management of urban agricultural sites which contained some form of perennial growing. At four of these sites more than one type of UA was taking place. Of these eleven participants, four managed urban allotment sites, three were involved in the management of urban orchards, four managed urban community gardens, three managed an urban food forest, one managed an urban community supported agriculture site (CSA) and one managed an urban nursery plot (Figure 1). All participants cultivated crops in open field systems, with six sites also using a small-scale glasshouse or polytunnel.

Ethics

During the initial contact with participants to request an interview for this study, urban agricultural site managers were informed of the purpose of the study and the rationale behind it. They were informed that without their consent no information on their site would be collected or reported on. It was made clear that any information collected as part of the interview or questionnaire would be stored in a de-identified manner and kept separate from their contact information and that any information was treated as strictly confidential (subject to legal limitations) and handled in accordance with the Data Protection Act 1998. Prior to the recording of any information, all participants signed a consent form (see supplementary materials) which explicitly stated that involvement in the study is voluntary, that all participants have the possibility to ask further questions pertaining to the use of their data, retract sections of their data or remove all their data (by 31 December 2024) from the study if requested. This research was approved by the University of Sussex ethics board (ER/EM682/1).

Data analysis

A thematic analysis was performed on the interview data collected in this study to identify the key perceptions of urban growers about perennial crops. Thematic analysis is a commonly used method of qualitative analysis which is flexible and can provide rich and complex analyses for a wide range of data types and topics, whilst remaining comprehensible to those not highly trained in qualitative research (Braun and Clarke 2006, 2014). This method of analysis identifies repeated and significant themes within the data, as well as how these are structured and related. Within this study an essentialist/realist approach was adopted, whereby participants' accounts were treated as direct descriptions of their lived experiences of perennial UA (Braun and Clarke 2006). Moreover, a deductive style of analysis was performed. Rather than allowing themes to emerge solely from the data, the analysis was guided by the researcher's *a priori* knowledge and the published literature, enabling the analysis to focus on the specific areas of interest within the interview data and allowing for direct comparison to previous research (Naeem et al. 2023). Within this study we were interested in the semantic themes, derived from the explicit meaning of the participants' responses.

The analysis of interview data was completed following the six-step method outlined in Braun and Clarke (2006):

(1) The audio data was transcribed and re-read prior to the initial analysis, so that the analyst was immersed within the content.
(2) Working through the entire dataset of transcripts systematically, initial codes (categories used to organise observations to help identify patterns or themes) were identified using NVivo (Lumivero 2023). For example, 'If you ask enough people, they will just list every fruit they have heard of, and they won't list any of the fruits they haven't heard of'. was coded within 'public engagement' and 'general knowledge of perennials'.
(3) The extensive list of codes was collated into potential themes, containing all the codes identified. This involved merging codes that contained the same ideas and grouping linked codes together, e.g 'general knowledge of perennials', 'crop varieties' and 'understanding of ecological principals' and were collated into the sub-theme lack of knowledge. Once a logical structure of the data was organised, all

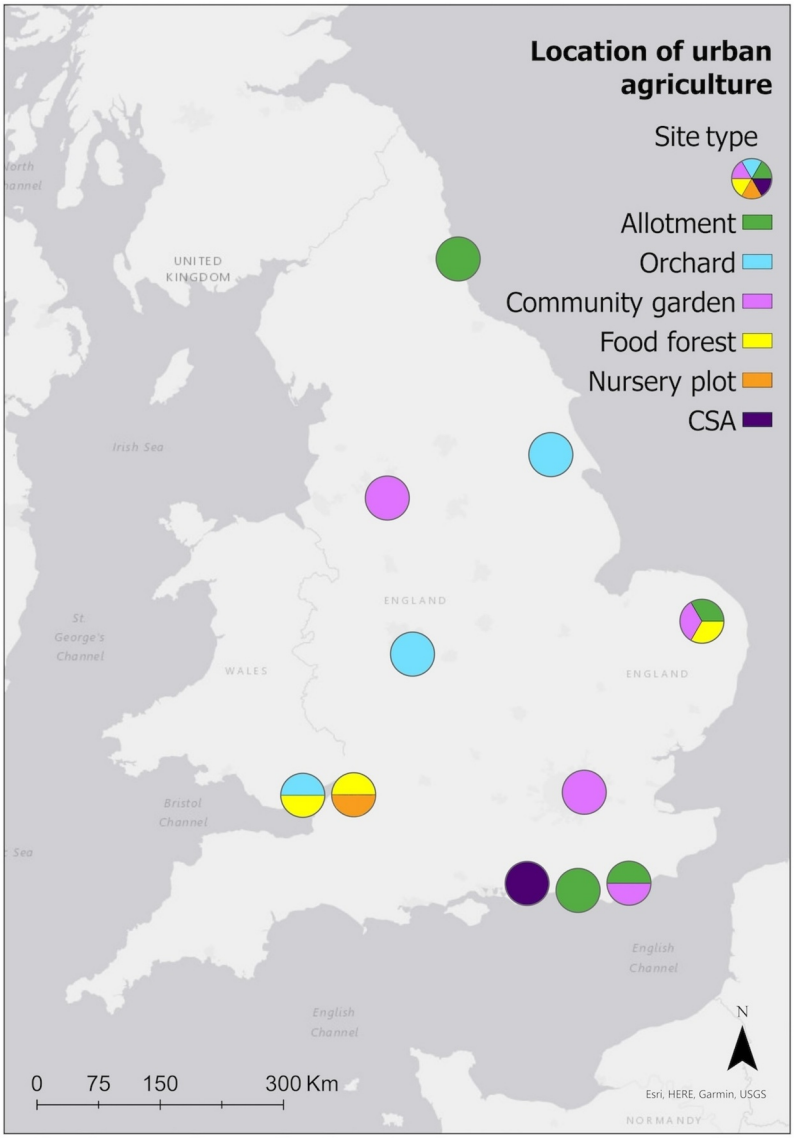


Figure 1. Map of England showing the locations of UA sites which were included in the study. Where multiple sites are located in the same city, the sites have been jittered for visualisation purposes. Colours indicate the style of UA carried out on the site. CSA = community supported agriculture.

quotes associated with these themes were compiled together.

(4) Themes were then reviewed in relation to the coded quotes, to check that all themes and sub-themes have enough data to support them. If data were lacking, themes were either removed or merged to create a broader theme, such as the merging of sub themes 'management challenges' and 'permanent nature' into 'nature of perennials'. When this 'thematic map' was deemed satisfactory, a second review took place in relation to the entire body of data, to confirm that the themes identified accurately portrayed the participants' perceptions and that no relevant quotes were missing.

(5) Once the themes and sub-themes were finalised, they were named, defined and ordered to create a comprehensive structure of analysed data. The defined themes included a clear description of what the theme encompasses, as well as how the content of this theme fits into the context of the wider data and why this is relevant to the key question.

(6) Finally, the results were reported upon, including a clear description of each theme and the diversity within, with key extracts from the text to support each point. Themes were explored in relevance to the key question and wider literature.

Results

Questionnaires

Participants were interviewed from eleven sites in eight regions of England (Figure 1). The interviewees listed their roles within the urban growing site, the most common of which were project co-

ordinators/managers (5) and site managers (3). However, several sites did not have a traditional hierarchical management system in place and thus had roles such as a core member (1), grower (1) and biodiversity officer (1). The age of the sites, measured as the length of time the sites had been under continuous management by the current individual or organisation, ranged from less than a year old to 28 years old. The area of the sites ranged from an individual allotment plot which covers 250 m^2 to a site which held both a community garden and food forest covering 30,351 m^2 of land. The most common input to the sites was irrigation (nine sites). Topsoil and fertiliser were added to four of the sites. The fertiliser used ranged widely including; wood chip, ash, brewery waste, manure, comfrey as a green manure and compost made on site. One site indicated they have used insecticides and specified this was the use of organic slug pellets. Four sites listed alternative inputs required at the site; these include mycorrhiza, timber for bird cages and other structures, and cardboard for ground cover control.

Interviews

The results of the interviews were separated into four key themes; 1) the issues faced by growers due to their urban locations, 2) negatives and 3) positives associated with perennial growing and 4) alternative sustainable growing practices. Within the broad theme of negatives and positives of perennial growing eight sub-themes were identified (Figure 2). Within the negatives, sub-themes consist of the nature of perennials (2.1), lack of knowledge (2.2), hazards (2.3) and pests (2.4). Within the theme of 'positives of perennials', biodiversity benefits (3.1), management (3.2), longevity (3.3) and soil benefits (3.4) were identified as important sub-themes. Within the interviews each sub-theme was identified in at least three of the six unique UA site types visited (Table 1). Further supporting interviewee quotes can be found in the supplementary materials Table 1).

Theme 1 - Issues faced by growers due to their urban locations

For the perceived negatives and positives of perennial growing to be understood within the context of UA, the nuances of urban growing must be established. None of the interviewees specified crop yield or production as the sites main aim; thus, the comparison between the yield of annual and perennial crops was not discussed further within the interviews. Instead, the interviewees

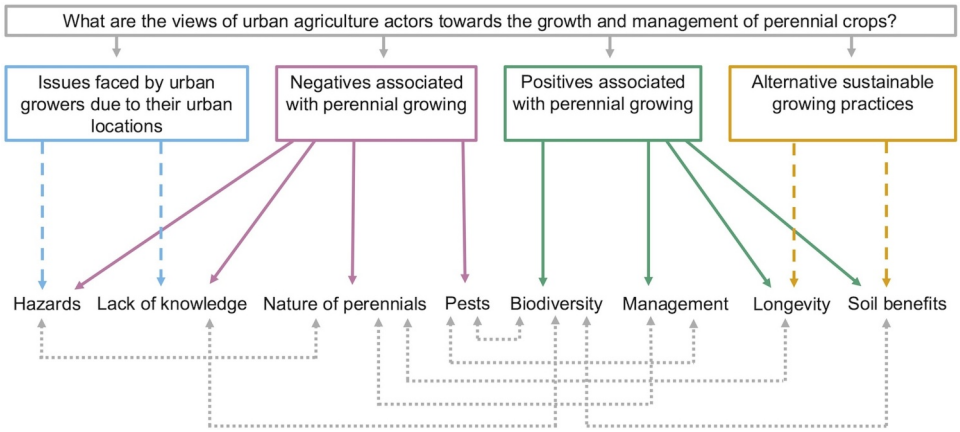


Figure 2. Thematic map, showing the key question, the four themes and the eight sub-themes developed in the thematic analysis. Solid lines show groupings of sub-themes within their themes. Dashed lines show links between themes discussed in the analysis, and dotted lines indicate links between sub-themes found during analysis.

Table 1. List of negative and positive sub-themes associated with perennial growing across the six different types of UA site interviewed, with a cross indicating that a particular site identified the sub-theme listed.

		Allotment	Orchard	Community Garden	Food Forest	Nursery Plot	Community Supported Agriculture
Negative sub-themes	Nature of perennials	X		X	X	X	
	Lack of knowledge		X	X		X	
	Hazards		X	X	X		
	Pests	X	X		X		
Positive sub-themes	Biodiversity Benefits	X	X	X	X		X
	Management			X	X	X	X
	Longevity	X	X	X		X	
	Soil		X	X	X		X

stated that creating a greenspace for the benefit of themselves and their families, or the wider community, was their key aim or biggest success of the site. One of the site managers highlighted the ability of their work to help vulnerable groups such as 'children, young people, adults with special educational needs'.

However, the goal to provide a thriving community environment within an urban growing space leads to reoccurring stresses, particularly from lack of funding. An interviewee from every type of urban growing site found the lack of consistent funding or the expenses of running the site to be a large strain. Finding the balance between working at the site and applying for new means of funding was a clear issue and led to sacrifices such as using 'low grade materials'. Using 'cheap' or recycled materials was discussed across multiple sites, with concerns highlighted around the sources of these goods and what they may contain. Moreover, several sites discussed having to wait to build beneficial structures, due to either insecurity of their land tenancy or the cost of good quality materials and labour. Thus, leaving the sites less suitable for public use, in the case of building restrooms, and less sustainable, in the case of using rainwater runoff from the structure roofs for irrigation. The finance issue is exacerbated by the low pay or volunteer basis of these jobs, leaving people to make sacrifices of their own take-home pay.

> 'Yeah, that's the biggest, if you had a bit of money or a bit of investment to throw at it you know, we scrape by, we don't pay ourselves enough'.

This lack of funding leads to a reliance on volunteer work which was highlighted as a major worry across all types of growing, bar the CSA and allotments. Issues arise as the numbers of volunteers fluctuate either seasonally, leading to issues such as a lack of volunteers for key winter tree pruning, or yearly, especially among those who are willing to take on key roles.

> 'The hardest thing sometimes is recruiting students that want to take on more responsibility … recruiting people to the committee'.

Theme 2 - Negatives associated with perennial growing

2.1 Nature of perennials

The permanent nature of perennial crops was raised as a perceived negative for their growing success. Several interviewees mentioned the limited survival of perennials when transplanted to new locations, both between and within sites.

> Portuguese kale didn't survive. I don't think they like being moved when we transplant them out.

The concern surrounding the inability to move perennial crops once established was discussed in association with issues surrounding insecure land tenure of growing sites. Most of the site managers interviewed rent the land they grow on. With the high demand for urban space and short-term rental contracts, this has led to feelings of land insecurity, friction with stakeholders and frequent movements of locations. All of these were cited as additional struggles faced in urban growing and were noted as a concern surrounding an investment in perennial crop growing. This overlap demonstrates how challenges associated with the wider context of urban growing, particularly land insecurity, directly intersect with the specific challenges of growing perennial crops (Figure 2).

> This would be the best place for building …, and all we have is an e-mail saying … the Forest Garden site is yours in perpetuity. But there's always the danger that somebody might say … we've got other plans.

Another issue often cited was that perennial crops can be 'unruly' and difficult to manage, growing outside of the desired space or for longer than expected, leading to laborious management. The uncontrolled spreading of crops can lead to conflict with neighbours; this can occur through invasion of the crop into their property or through shading out their land. Again, this highlights the tension between the nature of perennials and the confined, shared nature of urban spaces, where proximity to neighbours, often with a different land-use, can increase potential for conflict.

> We've got quite a lot … of red currant bushes and things like that along the fence and next door always keep cutting them back because he doesn't want them. Because once they start to grow, they just grow everywhere.

2.2 Lack of knowledge

One of the limitations stopping people from expanding their perennial growing was the lack of knowledge about what crops are available. Those who have invested some time in researching perennial crops had knowledge of a variety of exotic or historic crops such as 'Pawpaw' and 'Skirret'. This was highlighted by an urban orchard manager who noted that people who had more knowledge in the area often suggested a 'wildcard' which they proceeded to grow, but that these ideas often came from people who were 'interested' in the topic and had 'read through some books'. In juxtaposition, the general public's lack of knowledge was highlighted as a limitation to the expansion of perennial growing (Table S1).

> If you ask enough people, they will just list every fruit they have heard of, and they won't list any of the fruits they haven't heard of.

A manager of an urban community garden suggested that people's knowledge of what grows does not mirror what crops we should be planting 'in the climate', especially with climate change. This concurs with others' interviews, which suggest that people want to grow recognisable fruit even if it is unlikely to thrive within the site-specific environment. This introduced environmental considerations into the perceptions about perennial crop growth, highlighting that UA managers recognise a tension between the familiar crop choices of urban residence, who do not have a strong education in agriculture, and the need to plant for a changing climate.

2.3 Hazards

Another issue associated with perennial growing was the perceived hazards they may cause in an urban environment. Being placed within public spaces means that sites often must work with landowners or the local council to ensure all their practices follow health and safety guidelines. One site described its relationship with the council as a 'battle' whilst another discussed its 'interesting relationship' with local developers. The issues raised by these enforcing bodies to the UA sites ranged from making an established public greenspace look less attractive, to the environmental effects of the crops grown. On one occasion, extreme but unlikely risks were cited as perceived issues with perennial growing, such as 'public realms don't want them because the fruit fall and then people slip and die'. These concerns highlight how the characteristics of perennial growth can intensify the challenges of growing within urban spaces, where concerns of safety, appearance and management are more present, thus demonstrating the intersection between the perceived hazards of perennials, their inherent nature and the wider challenges of urban growing (Figure 2).

2.4 Pests

Adding perennial plants into environments can increase the biodiversity, a fact which was discussed in both a positive and negative light. Some of the concerns of increased biodiversity included novel perennial fungal pests and encouraging pests which may steal the crop such as 'slugs and snails', 'birds', 'squirrels' and 'foxes' (Table S1). This can lead to measures such as bird cages and netting crops which increase the materials needed at a site and require extra management and labour time.

> 'We had hostas there, but the slugs got those this year here. We don't have hostas anymore'.

However, several people discussed finding joy in witnessing the species they had classified as pests interacting with the crops despite the loss in crop yield or productivity. This illustrates a conflict in perennials growing, where the habitat and structural diversity provided by perennial crops can increase both the presence of unwanted pests (2.4) and valued biodiversity (3.1, Figure 2). An allotment manager discussed the contrasting positives and negatives of tree cover with the benefit to 'birds and the wildlife … they've got somewhere to hide' but also providing the structure for them to 'sit when they pinch things'.

Theme 3 - Positives associated with perennial growing

3.1 Biodiversity benefits

Whilst increased biodiversity was seen on some occasions as negative, in the case of increasing pests, many interviewees highlighted the positive effect this may have, including those who also identified a negative side. One of the main positives of perennials was thought to be the lack of pest damage suffered, in direct opposition to the novel pests highlighted above.

> We don't have a lot of insect pest problems on the fruit trees … They don't bother us really because you know, that's not going to affect the things that we grow.

Moreover, on sites where both perennials and annuals were grown in unison, one of the drivers for adding perennials was their perceived role in increasing the wildlife on the site (Table S1). In some sites, specific species of native perennial (e.g 'Alder buckthorn') were added to increase the diversity of a target taxa or individual species (e.g 'brimstone butterfly'), and as an educational tool to teach the visiting public 'about what biodiversity could look like in their own gardens'. This contrasts with section 2.2 (Figure 2) where lack of knowledge about perennial crops was identified as a barrier to their adoption, suggesting that while limited understanding can restrict their adoption, perennials themselves can provide an important educational tool for developing knowledge of biodiversity.

The biodiversity of perennial plants was also discussed at one community garden where the different beneficial roles of species were described with 'all the different layers, shrub layers and ground layers' within fruit tree guilds having a specific role such as 'pollinator attractors, pest control, nitrogen fixer, mineral accumulators'. Therefore, the increase of perennial diversity was seen to beget biodiversity and ecosystem services.

3.2 Management

One of the commonly discussed positives of growing perennial crops was the ease of management compared to annuals (Table S1), in direct opposition to the difficulty in management cited previously within the nature of perennials (2.1). One of the key benefits discussed is the ability to spend less time managing the crops, such as a crop being 'left to its own devices' and still surviving and producing food. This was highlighted as a significant benefit as it is 'less work' and is especially beneficial for community plots when 'there is no one here' to manage the crops, reinstating the reliance of urban growing sites on volunteer hours, due to lack of funding for staff, highlighted in theme 1 and how perennial growth may overcome some of these challenges. This ease in management was also seen as beneficial from a stakeholder point of view as it means less resources are needed to be put aside for long-term management or repeated planting costs.

One of the key traits of perennials which allows for ease of management is their hardiness. Managers of an urban food forest, nursery plot, community garden and CSA all independently discussed the high survival of perennial crops compared to annuals, describing them as 'stronger', 'hardier', and more 'resilient'. One of the traits linked to this resilience was being able to cope with serious weather events (Table S1), an example given was fruit bushes not rotting when they have been 'flooded so many times'. Another key aspect of this hardiness is their ability to not only manage with less watering than annual crops but also thrive in an environment where other plants experience drought damage. This again highlights the limited time needed for management of perennial crops throughout the year, even during extreme weather events.

> The Portuguese kale goes huge … And I didn't water them … for the whole summer. Just to see what would happen and they really were very, very tough and hardy.

3.3 Longevity

Another perceived benefit of perennials is that, due to their multi-year nature, they can provide year-round benefits to other crops and people. Perennial trees and bushes were described to provide shelter from weather conditions such as for shade tolerant plants, or as a shade / windbreak for people.

> it will grow up to a really nice kind of native hedgerow. Your wayfarings, your blackthorn and hawthorn and that kind of thing … bit of habitat and a windbreak for us too.

Moreover, the permanent structures that perennial plants create benefit not only crops or individuals but have become community meeting spots and sites of support or celebration, whether that be 'spreading ashes' or 'hosting a bake sale'. The permanent nature of sites which include many large perennial trees and bushes 'make a statement, this is now a community space which it wasn't before' and can be used as a site for community events. These examples suggest that perennial crops can be beneficial in urban growing spaces specifically (Theme 1), by providing permanent recognisable green spaces that can be utilised by the community for socialisation. However, to foster good community relations with all groups, careful planning of the perennials in an urban space may be required. One urban orchard discussed the issues faced with blocking the view through a fence with a hedgerow as a group of women in the neighbourhood 'wanted to have a clear view through, so they could see if there was a big gang of lads here before they take that footpath'. To keep community cohesion, but also use all the growing space available, the site used espaliered trees so 'we can train them … then you can still be able to see through'. This careful design of the site allowed the benefits of permanent structures to coincide with creating community sites which work for all those involved in the community.

3.4 Soil

The final perceived benefit of perennial growing was the benefit to the soil. Perennials were said to benefit the soil because 'you don't keep uprooting them every year' leading to less soil disturbance. Lower soil disturbance was recognised as a benefit as it means carbon and nutrients are accumulated in the soil and 'locked in'. Another advantage of having to 'very seldom dig' which was discussed by a food forest manager was the building of a 'mycelium internet under the ground', allowing nutrients to be transferred and helping a site become 'self-supporting', as well as increasing the biodiversity of the site, linking back to previous discussions about the benefit of perennial crops for the biodiversity of a UA site (3.1). Other perennial crops such as 'sea buckthorn' were planted due to their ability of nutrient accumulation: 'fixing nitrogen out of the air and make it available for other trees as well as producing fruit'. Good soil health and functioning was highlighted as one of the most important factors in food growing across the sites and thus the benefits perceived for this were of great interest to the growers.

Theme 4 - Alternative sustainable growing practices

Lastly, many of the sites discussed alternative practices which were aimed at increasing sustainability

and involved methods linked to the benefits of perennial growing whilst being separate from it. Commonly occurring examples of this were reduced soil disturbance through no dig practices, mirroring the perceived benefit of reduced soil disturbance by perennial crops highlighted above (3.4, Figure 2) and increasing environmental health through organic farming practices.

> fully no dig and no chemical inputs as well. So fully organic to an extent, not officially fully organic, but we do everything we can.

Another method often deployed was the ability to grow crops which are traditionally grown as annuals as perennials, by protecting them through the winter so they crop a second year or allowing them to self-seed so that they re-grow without having to replant by hand. This approach reflects several benefits associated with perennial growing discussed above, particularly reducing the labour and resources required for repeat planting which is a benefit to the unpredictable volunteer workforce (Theme 1) and making use of the self-sustaining characteristics associated with perennial systems (3.3).

Finally, a sustainable method cited in many of the interviews was the act of recycling. Seeds were saved and recycled through years; this was done to keep costs down but also to allow seeds to adapt to the environment. The materials used within the sites were often sourced from volunteers and recycled to 'not bring in too much or take much off site' or create 'a circular economy', be that woody material from the perennials on the site or peoples' waste for compost and mulching.

In summary, the findings indicate that interviewees perceive perennial crops as offering substantial ecological, social and management-related benefits within UA, while simultaneously recognising several significant barriers to their wider adoption. Recurrent concerns were raised around the permanent nature of perennials, especially with insecure land tenure, limited public knowledge of perennial crops, stakeholder perceptions and pest pressures. Importantly, many of the perceived benefits extended beyond food yields, aligning closely with the aims stated by the participants, which emphasised community engagement, wellbeing and education. Furthermore, the discussion of complementary practices such as no-dig cultivation and resource recycling suggests that perennial growing is embedded within a broader system of sustainable urban growing. Across these findings, many characteristics of perennial growing were perceived both positively and negatively, with features such as longevity, management and increased biodiversity presenting as benefits in some contexts but challenges in others, depending on the discipline the grower was considering. Taken together, these findings highlight the multifaceted nature of perennial crops in UA, with growers considering ecological, social, economic and practical impacts.

Discussion

This study presents first-person accounts from managers of a range of urban agricultural site types, discussing the perceived positive and negative impacts of perennial crop growth within UA in England, alongside the unique challenges faced by urban growing and the common sustainable growing practices employed. While sites ranged in growing type, age, size and geographical location, managers held many similar opinions regarding growing perennial crops in urban areas. The key perceived positives included soil benefits, management benefits, longevity and biodiversity benefits whilst the negative perceptions focussed on the spreading and long-lasting nature of perennials, the perceived hazards of perennials, lack of knowledge and issues of increasing pests and pest damages.

Soil health emerged as a key perceived benefit of perennial growing, particularly through nutrient accumulation and carbon storage, while also underpinning the use of complementary sustainable practices such as no-dig cultivation. Poor soil quality has previously been identified as one of the largest issues facing urban growers (Gregory et al. 2016). The utilisation of perennial cropping and practices linked to perennial systems, such as reduced soil disturbance and increased crop rotations, have been associated with higher soil nutrient levels (nitrogen, phosphorus, carbon) and soil microbial biomass in both rural and urban allotments (Williamson et al. 2024). Moreover, a study from Leicester, UK, further suggests that soils under trees and shrubs can have higher soil organic carbon concentrations than those beneath annual vegetable plots in urban land, although this difference was not significant in allotments, potentially reflecting differences in site management and the turnover of growers and, thus, perennial plants (Edmondson et al. 2014). Together, this evidence suggests that, while the perceptions of soil health benefits may be similar across growing sites, the results of using these practices may be context-dependent, with site characteristics and management practices influencing the extent to which the perceived benefits are realised. Further research into the effects growing perennial crops has on soil health across different urban agricultural types, and the individual site characteristics which effect this, is needed to quantify whether the perceived benefits are in fact occurring *in situ*.

The hardiness of perennials, especially in terms of survival longevity through extreme weather conditions, emerged as another perceived positive,

particularly their ability to withstand drought, high precipitation and, in one case, severe flooding, with less intervention than annual crops. This perception of resilience has previously been identified across styles of agroforestry; however, urban landscapes were not previously included (McRae 2024). Scientific literature supports the potential for perennial systems to provide resilience to extreme precipitation, with reduced soil disturbance and extensive root systems improving soil structure and increasing the water storage capacity of the soil (Power 2010; Asbjornsen et al. 2014). However, within this study, interviewees did not readily demonstrate that scientific knowledge was the basis of these perceptions; instead, they provided anecdotal evidence about witnessing specific crops being better suited for different water conditions. This highlights the value of experiential knowledge in understanding the suitability of perennial crops to local urban growing conditions, while also demonstrating a gap in understanding how growers acquire and apply knowledge. Further research could explore these methods of knowledge attainment and how experiential and scientific collaboration could inform growers on crop selection.

Conventional agriculture has and continues to significantly negatively impact global biodiversity (Green et al. 2005; Goulson et al. 2015; Hallmann et al. 2017); for this reason, promoting and protecting biodiversity is often discussed in agricultural settings, including in UA (Clucas et al. 2018). Within this study, increased diversity was discussed as an important positive of perennial crop growing, including both increased species diversity and functional diversity. For example, while birds can cause significant crop damage, their presence was also valued by growers. This is significant within UA, where research has found that increasing bird abundance, or the perception it, increases the mental health and wellbeing benefits for visitors to urban greenspaces (Fuller et al. 2007; Cox et al. 2017). Moreover, adding perennial diversity was also discussed as an educational tool, aligning with research showing that urban greenspaces can be designed with perennials to provide opportunities for environmental learning (Lin et al. 2018) and that even brief engagement with urban biodiversity can increase both knowledge and foster positive attitudes towards nature (White et al. 2018).

Biodiversity was often simultaneously perceived as a positive and a source of conflict, with birds, mammals, fungi and molluscs commonly discussed as pests and requiring additional labour through netting and constructing cages. This broad consideration of biodiversity contrasts with the scientific literature, which typically focuses on plant and insect biodiversity, (the latter typically in the context of ecosystem services (e.g. pollination) and disservices (e.g. pest damage) in UA (Clucas et al. 2018; Arnold et al. 2019; Baldock et al. 2019; Philpott et al. 2019; Nicholls et al. 2023; Royer et al. 2023; Ellis et al. 2025). Comparatively few papers have investigated avian biodiversity (Horák et al. 2017; Exantus et al. 2021; Téllez-Hernández et al. 2023). For example, this differs from the findings in a study of community gardens in New York, where annual crops were the most common crop type cultivated, wherein 64% of growers recognise insect damage as a major concern, compared with 22% identifying mammalian pests (Gregory et al. 2016).

This dual perception of increasing species diversity being a negative, in the case of pest damages, and a positive, in the case of social benefits, highlights the need for both researchers and policy to consider UA spaces through multi-disciplinary perspectives. Considering factors pertaining to human health, sociology and ecology when researching urban growing spaces allows a higher understanding of the benefits and issues found in these spaces. Research which only factors in one of these aspects would miss the important differences found between perceptions of 'positive' biodiversity for human well-being and 'negative' biodiversity acting as crop pests. Future policy and funding frameworks supporting perennial UA should recognise the interconnected nature of the ecological, social and practical outcomes associated with biodiversity, rather than treating these as independent areas of interest, to fully support the multifunctional role of UA.

A lack of knowledge emerged as a key barrier against the inclusion of perennial crops. This was seen through limited knowledge of suitable perennial crops and varieties for the UK, how to incorporate novel crops into diets, and an overreliance on familiar crops that may be poorly suitable to UK climates or urban landscapes. Various issues surrounding gaps in public and practitioners' knowledge have been noted across the literature. Issues of growers' lack of knowledge surrounding how to grow, eat and process novel perennial crops were found in a range of agroforestry practices, in the Mid-Atlantic USA (McRae 2024). In urban settings, uncertainty around whether the fruit on trees was edible for people, and freely available for the public to harvest, was found to limit their utilisation (Colinas et al. 2019). More broadly, Gregory et al. (2016) identified knowledge gaps around sustainable growing practices, such as crop rotations, in New York community gardens, suggesting that more advanced ecological processes should be incorporated into standard garden education programmes. These findings indicate that knowledge is an important factor shaping the uptake and successful management of perennial crops. Extending this, we suggest that an investment in food systems education is needed

within the general population as well as within urban growing communities to increase knowledge of successful urban agricultural practices.

Importantly, the negative associations with perennial growing found within this study include some of the defining features of perennial crops, particularly their longevity and, in some cases, spreading nature which leads to labour-intensive management. Fruit trees and other woody perennials can require large amounts of pruning in the winter season, misaligning with the volunteer labour force of sites, who were noted to have limited familiarity with pruning practices. Similar issues around the labour and knowledge required to manage perennial crops have been identified in non-urban agroforestry systems (McRae 2024). Further concerns were raised regarding the spatial and temporal control of perennial crops. For example, certain species of perennials, such as walking onions (*Allium cepa x proliferum*) grown at an urban community garden in this study, spread through aerial bulb propagation (Crawford 2012) which is not easily controlled by the grower and thus, can be more difficult to manage than annual varieties of the crops. These challenges match those found in studies on urban fruit trees on a public bike path in Montreal Canada, where concerns were raised about the amount of maintenance required, the effort of harvest and the hazards fruit litter may cause (Colinas et al. 2019). Together, this suggests that some of the characteristics that distinguish perennials from annuals can create significant novel challenges, especially within urban environments.

The key issue raised within this study around the permanence of perennial crops was highlighted as an issue especially in sites where tenancy was not long-term. Only 18% of the sites in this study owned their land, while two had been relocated within the previous two years, one following the end of a tenancy and the other due to housing construction. These interviewees raised concerns about whether established perennial crops could survive translocation. This reflects wider concerns around land security in UA, with insecurity of future land access identified as one of the common issues facing community gardens in the USA (Guitart et al. 2012). The loss of urban growing space is a concern, especially in deprived areas where the benefits of access to fresh and nutritious food are most vital; across the UK allotment closures have occurred at the highest rate in the most at-risk areas for food insecurity, with land becoming commercial or industrial sites (Dobson et al. 2020). The replacement of urban growing sites with new development has become a point of contention in the UK, particularly following media backlash over the 2024 approval of the sale of eight allotment sites by the Ministry of Housing, Communities and Local Government (MHCLG 2025).

These wider pressures are of particular relevance to perennial urban growing because the perceived benefits of perennial crops depend on their ability to remain established over time. Studies into the legal frameworks of UA tenancy have found that the length and complexity of the current models of tenancy agreement is a significant barrier to starting community growing spaces and that the rules of spaces such as allotments limit the adoptions of agroecological process such as the use of perennial crops (Holligan and Howe 2024). The concerns associated with the uptake of perennials, due to worries around survival in the case of relocation, provide supporting evidence of the need for a wider range of tenancy models for UA to accommodate perennial growing and other sustainable growing practices (Holligan and Howe 2024). Where insecure land tenure leads to sites being closed or relocated before perennial crops can become established, the longer-term benefits of crop longevity, soil health improvement, increased biodiversity and community cohesion identified in this study cannot fully develop.

Several limitations should be considered when interpreting these findings. The sites studied were predominantly open-field systems, although some included polytunnels or glasshouses, and the study did not include more technologically intensive forms of UA. Consequently, some findings may be less relevant to these systems; for example, perceptions of soil health are less relevant to soilless systems such as hydroponics. Although interviews covered a full growing season, data were collected over only one year, which may have influenced discussions on the perceptions of weather resilience and pest pressures. Furthermore, this study investigated perceptions rather than measured outcomes, meaning reported effects may not reflect actual changes. Quantitative research across different UA systems and over multiple years would therefore be valuable for assessing the extent to which these perceived impacts occur in practice.

Conclusion

Our study of UA managers across England demonstrates a complex map of perceived impacts of perennial urban growing. Perennial crops were associated with a range of ecological, social and practical benefits, including increased biodiversity, reduced management, improved soil health and community cohesion. Simultaneously, their defining characteristics, including longevity and spreading nature

were perceived as challenges, alongside concerns around hazards, limited knowledge and pest pressures. These contrasting perceptions highlight how the same characteristics of perennials can produce both benefits and challenges within the context of urban growing.

The perceived benefits of perennial growing for soil health and functioning were highly cited within interviews, yet quantitative evidence for this remains limited, particularly in urban areas. Further research is needed to assess how perennial cultivation impacts soil health across different urban growing systems and management practices. Another avenue of future research is the susceptibility to and cost of pest damage in urban growing spaces. Growers reported diverse pest types and levels of damage, and perceived notable differences between annual and perennial crops; direct quantification of these impacts would help identify priorities for sustainable pest management.

Finally, the participants highlighted interconnecting and sometimes conflicting impacts of urban perennial crop growing that extend beyond food production. Growers considered perennial crops from ecological, social and environmental perspectives, alongside issues of education, health and wellbeing, landscape design and urban policy. The findings demonstrate that the positives and negatives of perennial crops cannot be considered separately from the specific urban context in which they are grown. The cross-disciplinary scope of these findings underscores the importance of incorporating growers' lived experiences across diverse locations and growing spaces to fully capture the complexities of perennial urban agriculture.

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Author contributions

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Data availability statement

All data created during this research is available from the University of Sussex Research Data Repository at https://doi.org/10.25377/sussex.34886247.

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