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Research Paper

Differences in motivations and social impacts across urban agriculture types: Case studies in Europe and the US

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HIGHLIGHTS

- Quantitative analysis of the social impacts of urban agriculture.
- Well-being benefits are stronger than nutritional impacts.
- Motivations and benefits vary across urban agriculture types.
- Variations in social impacts and participant motivation is a key for planning.

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ABSTRACT

Urban agriculture is an increasingly popular approach to addressing negative social and health effects of cities. Social benefits of urban agriculture include improved health and wellbeing, economic opportunities, social cohesion, and education. However, the extent to which urban agriculture participants are motivated by or experience these impacts has rarely been measured quantitatively, especially across the many different types of urban agriculture. We analyzed survey data from 74 urban agriculture sites in France, Germany, Poland, the United Kingdom, and the United States to quantitatively assess the relationships between urban agriculture types, farmers and gardeners' motivations, and the social impacts of urban agriculture. Through factor analysis, we established valid and reliable measurements of participants' motivations and impacts. We identified four scales: general wellbeing impacts, nutritional health impacts, economic interests, and socialization motivations. Through multivariate analysis of variance, we document significant differences in motivations and reported impacts across types of urban agriculture. Finally, we conducted a multilevel multivariate analysis to explore the predictors of general wellbeing impacts. Participants with stronger economic interests, stronger socialization motivations, and who are owners or primary operators of their plots would be predicted to report greater general wellbeing impacts of urban agriculture. These results provide data about the impacts of urban agriculture projects that enable urban planners and policymakers to maximize the desired social benefits of urban agriculture.

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1. Introduction

Cities are responsible for significant negative environmental, economic, and health effects, particularly in Europe and the United States. Urban residents in high-income countries have experienced increasing obesity (The GBD 2015 Obesity Collaborators, 2017; World Health Organization, 2020), respiratory illnesses (Global Asthma Network, 2018), and compromised mental health (Ritchie, 2018). Separation from nature has resulted in lost ecological knowledge and skills, with negative environmental consequences (Blanco et al., 2009; Pilgrim, Cullen, Smith, & Pretty, 2008). Large cities contribute to social detachment, isolation, and economic inequality (Glaeser, Resseger, & Tobio, 2009; Holt-Lunstad, 2017), which have diminished community resilience (Townshend, Awosoga, Kulig, & Fan, , 2015).

Urban green spaces produce multifunctional benefits that can mitigate these urban ills (e.g., Arnberger & Eder, 2012; Dennis & James, 2017; McVey, Nash, & Stansbie., 2018; Saint-Ges, 2018). They provide environmental ecosystem services such as stormwater retention, urban heat island effect mitigation, food provision, cleaner air, and biodiversity (e.g., Ciftcioglu, 2017; Czembrowski, Łaszkiewicz, Kronenberg, Engström, & Andersson, 2019; Landreth & Saito, 2014; Petit-Boix & Apul, 2018). Urban green spaces that actively engage people produce physical and mental health benefits, alleviate social and economic problems, and foster community resilience (Camps-Calvet, Langemeyer, Calvet-Mir, & Gómez-Baggethun, 2016; Langemeyer, Latkowska, & Gómez-Baggethun, 2016; Shimpo, Wesener, & McWilliam, 2019; Sioen, Sekiyama, Terada, & Yokohari, 2017).

Green space that produces food (i.e. urban agriculture) provides four potential categories of social benefits: health and wellbeing, economic opportunities, social cohesion, and education (Dubová & Macháč, 2019; Olivier & Heinecken, 2017; Reynolds & Cohen, 2016). For instance, urban agriculture has been shown to improve health and wellbeing in several ways: reducing body mass index (BMI) (Kunpeuk, Spence, Phulkerd, Suphanchaimat, & Pitayarangsarit, 2020; Soga et al., 2017; Utter, Denny, & Dyson, 2016; Zick, Smith, Kowaleski-Jones, Uno, & Merrill, 2013); improving diets (Alaimo, Packnett, Miles, & Kruger, 2008; Osei et al., 2017; Wagner & Tasciotti, 2018); promoting more healthy and active lifestyles (Van Den Berg, Van Winsum-Westra, De Vries, & Van Dillen, 2010); and improving open space quality (Könst, Van Melik, & Verheul, 2018; Lee & Sung, 2017; Sama, 2016). Urban agriculture also may increase social mobility and job readiness (Cumbers, Shaw, Crossan, & McMaster, 2018; Mkwambisi, Fraser, & Dougill, 2011; Sonti, Campbell, Johnson, & Daftary-Steel, 2016; Vitiello & Wolf-Powers, 2014), provide neighborhood economic opportunities (Feenstra, McGrew, & Campbell, 1999; Poulsen, Neff, & Winch, 2017; Voicu & Been, 2008), and support livelihoods (Adeoti, Cofie, & Oladele, 2012; Gallaher, Kerr, Njenga, Karanja, & WinklerPrins, 2013; Karanja et al., 2010; Maconachie, Binns, & Tengbe, 2012), all of which benefit the economy. Urban farms and gardens have the potential to improve participants' sense of belonging, social interactions and connectedness (Rogge & Theesfeld, 2018; Soga et al., 2017), and emotional well-being and self-esteem (Dewi et al., 2017; Fulford & Thompson, 2013; Hewitt, Watts, Hussey, Power, & Williams, 2013; Joyce & Warren, 2016; Korn et al., 2018; Shiue, 2016; Wood, Pretty, & Griffin, 2016). Finally, they are often used for science and ecological education (Reynolds & Cohen, 2016).

The willingness of participants to engage in urban agriculture is driven by a broad range of motives, including personal desire for high-quality food and health reasons but also political, environmental, and economic motives (Diehl, 2020; McClintock & Simpson, 2018; Sonti et al., 2016; Zoll et al., 2018). Despite substantial research on the motivations for participating in urban agriculture, this literature is often limited in scope by reliance on small samples or qualitative case studies. For example, Hirsch et al. (2016) analyzed responses from a sample of 29 German gardeners whose strongest motivations included being in nature and growing safe food, with the weakest being food self-sufficiency. Interviews of 23 volunteers in Melbourne community gardens identified passion for gardening and political reasons as the strongest motivations (Kingsley, Foenander, & Bailey, 2019). Ruggeri, Mazzocchi, and Corsi (2016) found that social motivations were driving the activities of three community gardens in the metropolitan area of Milan. A study by Pourias, Aubry, and Duchemin (2016) of 23 community gardens in France and Canada found that food production was the primary motivation. Dubová, Macháč, and Vacková (2020) identified the spending of leisure time, social contact and relaxation as the key drivers for participation in community gardens. Urban farmers who engage in urban agriculture for a salary, to learn skills, or to run a profitable enterprise may be motivated by financial or professional objectives. A sample of 62 urban farmers in the US and Canada (McClintock & Simpson, 2018) and another sample of 10 urban farmers from one US city (Kirby, Goralnik, Hodbod, Piso, & Libarkin, 2020) demonstrated relatively strong economic motivations for urban farmers compared to other urban agriculture participants. A study conducted by Diehl (2020) focused on commercial urban farms and concluded that beside their commercial motivation, all farms provided multi-functional services to the urban system—including social activities ranging from cooking classes to filling a gap in migrant food demand. Reynolds and Cohen (2016) documented the use of farming activities and urban farm spaces to advance social justice, with food production often a secondary motivation.

Empirical data on the social benefits provided by urban spaces devoted to urban agriculture has been limited. A particular gap in the existing literature is that it does not document the complex relationships between participant motivations, benefits, and urban agriculture type. While some authors have suggested that farmer motivations are key drivers in farm development (Turner, 2011), little empirical work has been done to test this. Other studies analyzing motivations of a larger sample of farmers have been limited by their focus on only one type of urban agriculture, such as private urban gardens (Kirkpatrick & Davison, 2018) or urban agriculture businesses (McClintock & Simpson, 2018). Another quantitative study on urban agriculture motivations and benefits considers only farmers and community gardeners in a single city in the Midwestern United States (Kirby et al., 2020). This study addresses this gap in quantitative research on farmers and gardeners' motivations and benefits across multiple types of urban agriculture.

Understanding the relationships between motivations of farmers and gardeners, types of urban agriculture, and the benefits they report is key to measuring the impacts that urban agriculture generates (Turner, 2011). In previous studies different types of urban agriculture have been operationalized as attributes of their form and function (Diehl 2020) or distinguished by motivations and social aims (Krikser, Piorr, Berges, & Opitz, 2016; McClintock, 2014). Farmers and gardeners' specific motivations are related to their agricultural practices, barriers experienced in urban agriculture, and demographics. Gardeners interested in social change are more likely to use organic or permaculture methods (Kirkpatrick & Davison, 2018). Urban agriculture participants with stronger community building and justice motivations report experiencing more difficult institutional barriers for engaging in urban agriculture (Kirby et al., 2020). Higher education and income levels among farmers and gardeners are linked to stronger motivations for self-sufficiency, environmental sustainability, and access to quality produce (McClintock, Mahmoudi, Simpson, & Santos, 2016). It is not clear whether or to what extent similar differences exist across different types of urban agriculture. While participants are likely to choose to engage in types of urban agriculture that align with their motivations, there is a lack of quantitative data confirming this trend. With increased interest in the social dimensions of urban agriculture, practitioner motivations and measured impacts of their activities are key to evaluating urban agriculture's broader significance.

To contribute to quantitative research on the relationships between motivations, urban agriculture types, and reported social benefits, this paper reports the results of a multi-national study of urban farms and

gardens. Our analysis of the study data answers three research questions: (1) What are urban farmers' and gardeners' reported motivations and social impacts from urban agriculture engagement? (2) How do motivations and impacts of farming and gardening differ based on the urban agriculture type? and (3) Which characteristics of participants and urban farms and gardens maximize participants' wellbeing?

2. Methods

2.1. Case studies and participant selection

The research was carried out in the context of an international research project known as "FEW-meter." The project aims to measure the Food Energy and Water (FEW) nexus of urban agriculture and explore how humans can influence this nexus. The full methodology developed to measure the nexus is documented in a dedicated paper (Caputo et al., 2021).

We invited urban gardeners and farmers from the five countries in the FEW-meter project to participate, specifically recruiting case studies representing different types of urban agriculture in the process. The scale, design, and operational characteristics of the urban agriculture cases in the FEW-meter project vary within and between countries, and range from allotment gardens composed of individual spaces gardened by one individual to large urban farms managed by external organizations and farmed in common. The geographic locations varied from central-city sites to *peri*-urban spaces.

Enrollment for the project was carried out in 2018 with the help of local organizations of allotment gardens, community gardens, and community farms. The organizations supported the project in recruiting participants by inviting their members to informative workshops about the research project. For example, in the UK, the FEW-meter team recruited community gardens in the Greater London area and a call was launched via the project partner organization, Social Farms & Gardens. Thirty community gardens expressed an interest, of which nine later committed to collaborating in the research project. Additional participants were recruited through word of mouth. Ultimately, gardeners and farmers from 74 case studies completed social impacts surveys (Fig. 1). Detailed information for each of the involved case studies (including photos of the sites, descriptions and resource profiles) can be found on the FEW-meter website via http://www.fewmeter.org/en/data-collection/.

2.2. Characteristics of urban farms and gardens

To develop our analysis, we established a typology of spaces for urban agriculture based on three factors that strongly characterize the relationships of the participants to each food growing space as identified by prior literature: (1) participant roles (McClintock, 2014); (2) food distribution methods (Krikser et al., 2016); and (3) site connectivity (Pearson, Pearson, & Pearson, 2010). Participant roles were based on whether a respondent was the owner or primary operator of a plot, a volunteer, or an employee. The roles relate to the categories of management and labor used by McClintock (2014) to sort urban agriculture types, but are directly related to the participants' experiences of the farm rather than the overall organization of the farm. We defined food distribution methods as whether produce was primarily consumed by the individual participants, primarily sold or donated to non-farm participants, or a mixture, thus acknowledging that food availability may influence individual motivations and perceived impacts. Site connectivity included three categories: individual plots on private land; individual plots in larger garden complexes; and areas farmed in common. Site connectivity may affect the level of social interactions in each farm space by influencing the degree to which participants work alone or together. This also allows us to investigate the relationships between

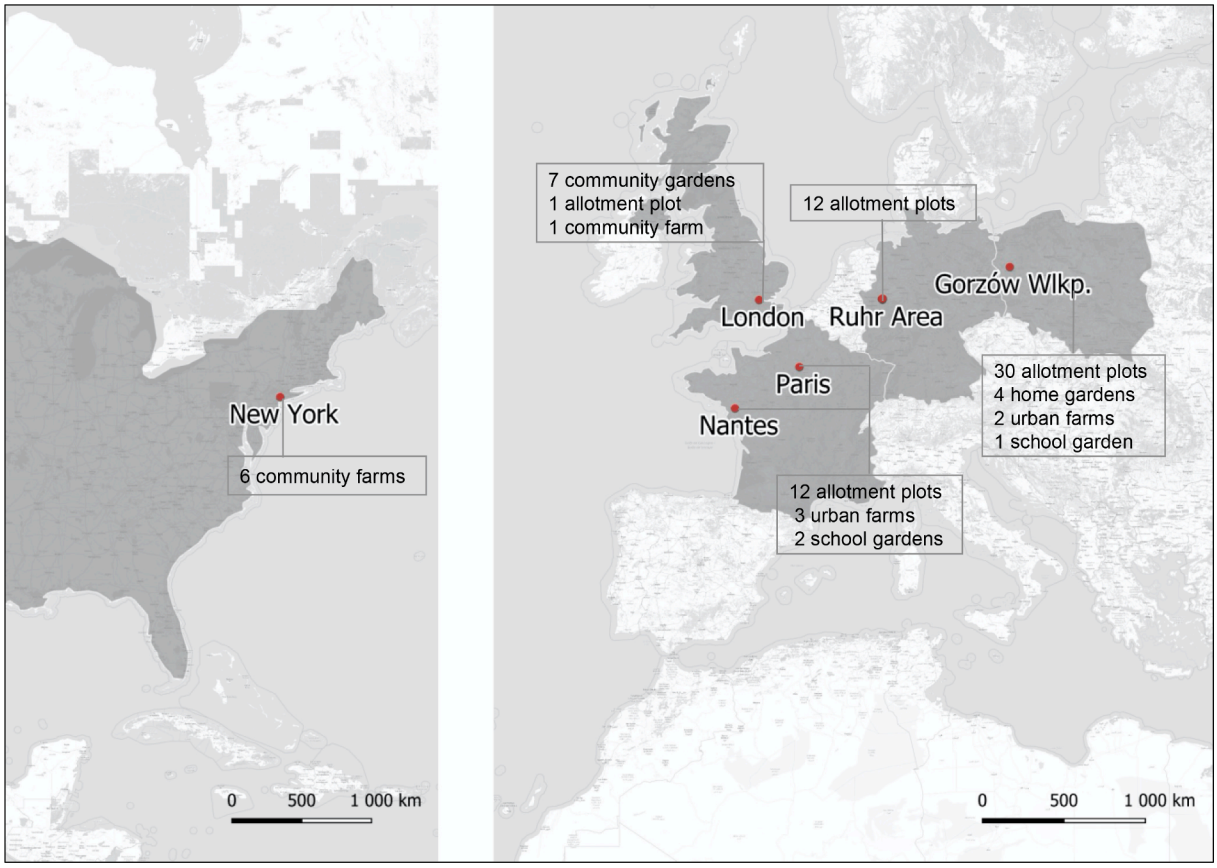

Fig. 1. A map displaying the locations of urban agriculture case studies.

urban agriculture's physical context and its social impacts, an understudied component of urban agriculture (Pearson et al., 2010).

The resulting nomenclature for our typology aims to be consistent with the general terms used for urban agriculture sites, recognizing that these terms vary across countries and publications. For example, sites where an individual or household rents a plot in a garden complex primarily to grow food for personal consumption are usually called allotment gardens in the UK, jardins familiaux in France, Kleingärten in Germany, ogrody działkowe in Poland, or community gardens in the US. In our nomenclature, "gardens" are growing spaces with food distribution that includes consumption by participants. We define urban "farms" as sites that include produce distribution (either given away or sold) to those other than the individuals engaged in food growing. We include "hybrid" projects where food distribution is consumed by participants and non-participants. Gardens and farms are further distinguished by their modes of production, with those in private spaces considered "home" projects, those with common production and volunteer labor "community" projects, and those with common production and employees considered "working" projects. We acknowledge that some urban agriculture projects cross typologies (e.g., urban farms primarily growing food for food pantries may allow farmers to consume some of the crop; allotment gardeners may donate some or all of their produce).

A variety of attempts in the literature have prescribed typologies of urban agriculture, typically at the site level. Because our unit of analysis is the participant, our classification scheme allows some sites to have participants in different categories. For example, students in a school garden are volunteers, and are included in the "community garden" category, while school garden instructors are employees and thus sorted into the "hybrid working farm" category. While this is counterintuitive in the development of a typology, this flexibility more accurately reflects the relationship of farmer or gardener to growing space, a relationship at the core of this analysis. Respondents were assigned to the eight types of urban agriculture identified through this process (Table 1).

2.3. Survey design and administration

The survey was designed to identify the socio-economic profile of the respondents, their involvement in urban agriculture, their motivations for engaging in urban agriculture, and the self-reported impacts of urban agriculture engagement (Supplementary Material). Motivation and impact questions were designed to capture the four areas of social benefits identified in the literature: health and wellbeing, economic opportunities, social cohesion, and education. From participants, we collected information on the size of the farm/garden, their role in the farm/garden, gender, education level, income, years of experience farming or gardening, and years of residency in their current country.

The original survey was developed by the research team in English and pre-tested in April 2019 on participants in one allotment garden in Germany (in a German translation). Following the pre-test, the English version was revised and finalized, and the final version was then translated into French, German, and Polish. Surveys were administered in the first half of 2019 via email, postal mail, in-person during visits to the gardens or at workshops organized for this purpose, and orally (in France only), varying by site based on survey participants' needs.

The number of respondents from each case study reflects the type of urban agriculture participants engaged in. Usually, case studies cultivated by individuals (allotment plot, home garden) returned one survey. In some cases, two surveys were completed separately by each user (e.g. in the case of a couple). In community gardens and community farms, gardeners and volunteers who happened to be in the garden during the visit of the research team were asked to complete the survey. All participants who were asked to complete the survey did so. A total of 155 surveys were completed and recorded in a common relational database. The resulting sample of respondents is therefore a convenience sample, and we do not seek empirical generalization to urban agriculture in all contexts or even all urban agriculture in Europe and the US. Instead, like many case study research efforts, we seek theoretical generalizability (Tsang, 2014; Yin, 2009). In other words, we do not seek to argue that certain characteristics of our sample are "typical of a population," but rather we are concerned with our ability to draw conclusions about relationships between variables that are relevant to populations aside from our cases (Tsang, 2013), such as the relationship between certain farm and garden characteristics, participant motivations, and social impacts of urban agriculture.

Table 1
Characteristics of urban agriculture types and number of respondents per type.

Type	Participant role	Food distribution	Site connectivity	Respondents
Allotment garden	Owner or primary operator	Consumed personally	Individual in larger complex	54
Home garden	Owner or primary operator	Consumed personally	Individual, private	3
Home farm	Owner or primary operator	Both consumed personally and sold/donated	Individual, private	3
Community garden	Volunteer	Consumed by participants	Common land	9
Hybrid community garden	Volunteer	Both consumed personally and sold/donated	Common land	8
Community farm	Volunteer	Sold or donated to non-participants	Common land	32
Hybrid working farm	Employee	Both consumed personally and sold/donated	Common land	5
Working farm	Employee	Sold or donated to non-participants	Common land	41

2.4. Data analysis

2.4.1. Descriptive statistics

We used descriptive statistics to summarize the demographics of the respondents, their self-assessed motivations for growing food, and the self-assessed impacts of urban agriculture on their lives. We calculated the mean of respondents' active hours working in the farms/gardens per week, and years of experience farming or gardening. Monthly income data was collected in binned categories based on the currency used in each country, with the following bin options: <500, 500–1000, 1001–1500, 1501–2000, 2001–3000, 3001–4000, and > 4000. For rescaling, we used the midpoint for bins with a range of incomes (e.g., for 500–1000, a value of 750), a value of 500 for the lowest option, and a value of 4000 for the top option. To compare income levels across countries, respondents' reported income was divided by the country's average monthly household income for the 2017 year as reported by the Organisation for Economic Cooperation and Development (OECD 2020) to demonstrate the relative income of respondents compared to the country average.

2.4.2. Exploratory factor analysis

We conducted exploratory factor analysis to create valid and reliable scales from the survey data on participants' motivations and impacts. After removing surveys with missing responses on items used for factor analysis we were left with 142 valid surveys for factor analysis. Kaiser-Meyer-Olkin values and the significance of Bartlett's test of sphericity were calculated to ensure the data were appropriate for factor analysis (Bandalos & Finney, 2018). Factors were extracted using the fa function

in the psych package in R, with weighted least squares regression to account for the ordinal nature of the data, and oblimin rotation (Revelle, 2020). The number of factors extracted was determined through eigenvalues greater than one and scree plot analysis (Bandalos & Finney, 2018). Items were removed iteratively based on factor loadings, with low loadings removed first followed by split loadings. Scale scores were developed for each factor by averaging each individuals' responses on a 1–5 Likert scale (Distefano, Zhu, & Mîndrilã, 2009). Final scores closer to 5 indicate a stronger motivation or more positive impact.

2.4.3. Multivariate analysis of variance

Multivariate analysis of variance (MANOVA) of the resulting scales was conducted across the different types of urban agriculture to answer our second research question about how motivations and impacts differ across urban agriculture types. Significant differences were investigated via Tukey's Honestly Significant Difference (HSD) tests to determine whether there is an association between farm types and differences in participant motivation and impacts. Since our small sample size of several agriculture types violated traditional rules of thumb for MANOVA (Van Voorhis & Morgan, 2007), we created two binned categories for this analysis: Hybrid/Working Farm, a combination of Hybrid Working Farms and Working Farms; and Home Farm or Garden, a combination of Home Farms and Home Gardens.

2.4.4. Multilevel model

To determine characteristics of individual participants and farms that maximize wellbeing for participants, we analyzed a linear multilevel model using maximum likelihood estimation with the lme4 package in R (Bates et al., 2015). We used individual farm or garden sites as our cluster variables, and individual respondents as our individual variables. We used the general wellbeing impacts scale as the outcome variable (see our factor analysis results for details). For the multilevel model, we imputed data for all demographic variables: education level, years of experience gardening, income, age, weekly working hours on the farm or garden, social motivations, and economics scale score using the Amelia package (Honaker et al., 2011). We did not impute data for the outcome variable of general wellbeing impacts; thus, we report on a resulting sample size of 137 respondents across 62 clusters, for an average cluster size of 2.2 with a minimum of 1 and a maximum of 33. Our sample size satisfies the recommendation to have at least 30 clusters in multilevel models (McCoach, 2019). Independent variables were rescaled to fall between 0 and 1. We tested for the presence of multicollinearity and model fit using the performance package in R (Lüdecke et al., 2020). Where sample size allowed, we tested for the presence of random effects. We developed three models: a null model run using only the outcome variable to determine the intra-class correlation (ICC); an individual-level model run using only variables related to individual respondents; and a full model including individual-level variables and site-level variables.

3. Results

3.1. Respondent demographics

We received responses from 155 participants on 74 farms and gardens. Sites averaged 1,748 m^2 (std dev = 4,496 m^2), with a median size of 402 m^2. The demographic and economic characteristics of respondents are reported in Table 2.

3.2. Motivations and impacts

We asked respondents about 13 possible motivations for engaging in urban agriculture, illustrated in Fig. 2. Most reported having multiple motivations. The three rated very important most often were "improving the environment," "having access to fresh vegetables, fruits, or herbs," and "relaxing or releasing stress." The least important motivations overall were "saving money," "gaining employment skills," and "sharing knowledge with others." Most respondents reported that most motivations were fairly or very important to them.

Respondents reported positive impacts of urban agriculture on items relating to social cohesion, health and wellbeing, economic opportunities, and education. The strongest positive benefits were reported in participants' overall moods and physical wellbeing. The fewest participants reported benefits to their employment prospects from urban agriculture. Few reported negative impacts on any of the six items in Fig. 3.

Table 2
Gardener/farmer characteristics and farm/garden activities.

Gardener/Farmer Characteristic (n = 155)	Measure		Percentage
Gender	Male		53%
	Female		46%
Education	Basic school		5%
	High school		33%
	Vocational training		16%
	University degree		41%
	No response		5%
Participant role	Owner or primary operator		39%
	Employee		30%
	Volunteer		31%
Years living in country	1–10 years		4%
	10–20 years		11%
	>20 years		21%
	Always lived in current country		60%
	No response		4%
	Average	**Min-Max**	**Std Dev**
Active hours farming/gardening per week	12.6	0–112	13.1
Years of experience farming/gardening	15.2	0–72	16.7
Age	43.3	13–79	20.2
Income (as ratio compared to country average)	0.86	0.14–3.0	0.61

3.2.1. Exploratory factor analysis

We validated our survey instrument through factor analysis and developed measurement scales for motivations and impacts. Four factors explaining 49% of the variance in the data were extracted from the 25 items used for factor analysis (Table 3). Communalities for most items (10 out of 14 factored variables) were greater than or equal 0.5, which indicates that our sample size of 142 is appropriate given the relatively low number of factors (MacCallum, Widaman, Zhang, & Hong, 1999). The first factor, explaining 17% of the variance, contained items related to general wellbeing impacts ($\alpha = 0.761$). The second factor, explaining 11% of the variance, was related to nutritional health impacts ($\alpha = 0.647$). Factor three, which explained 11% of the variance, comprised a "socialization motivations" scale ($\alpha = 0.688$), with items that indicated respondents engaged in farming for interactions with others and for social cohesion. Items that loaded onto the fourth factor, explaining 10% of the variance, were related to economics ($\alpha = 0.659$). Distinct factors with multiple items loading at > 0.40 indicates that we are reliably measuring constructs related to health and wellbeing, social cohesion, and economics. Education only appears with the item "gaining employment skills" as part of the economics scale.

3.3. Differences in motivations and impacts across urban agriculture types

To explore patterns in motivations, impacts, and their relationships to urban agriculture types, we present descriptive statistics of scale scores across urban agriculture types (Table 4) and the results of a MANOVA analysis (see Supplementary Material for a correlations table). Average Likert scale scores were above the neutral point for all scales, indicating that participants overall reported agreement with motivations for engaging in urban agriculture and positive impacts from urban

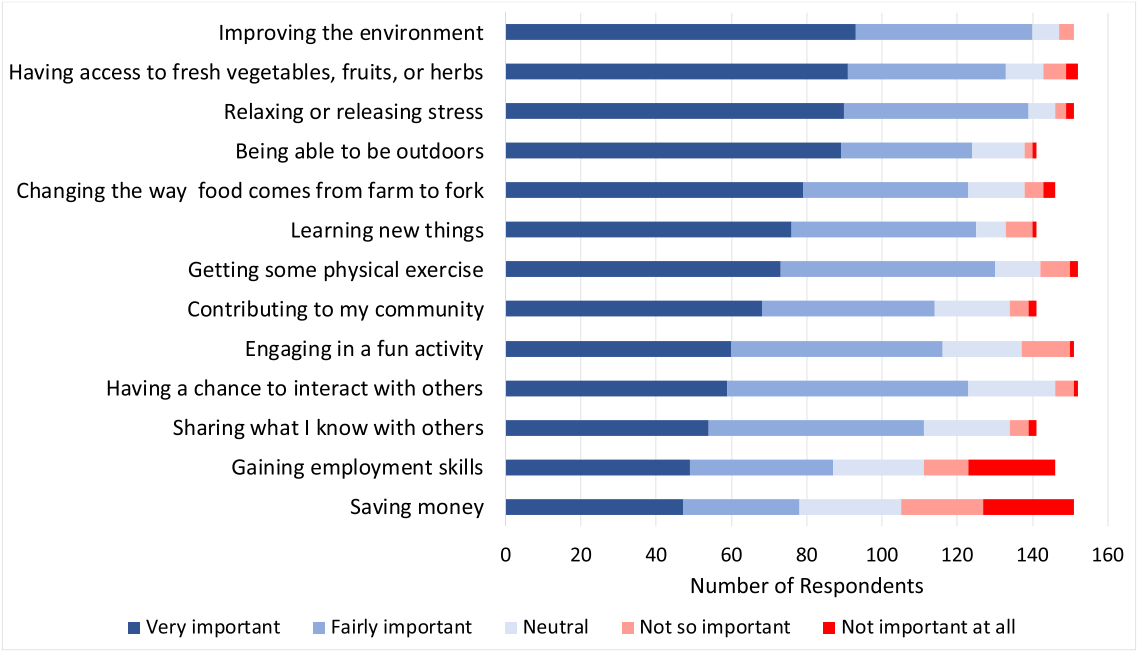

Fig. 2. Motivations for engaging in urban agriculture. Participants (n = 155) were responding to the prompt, "How important is each of the following reasons for gardening/farming to you?"

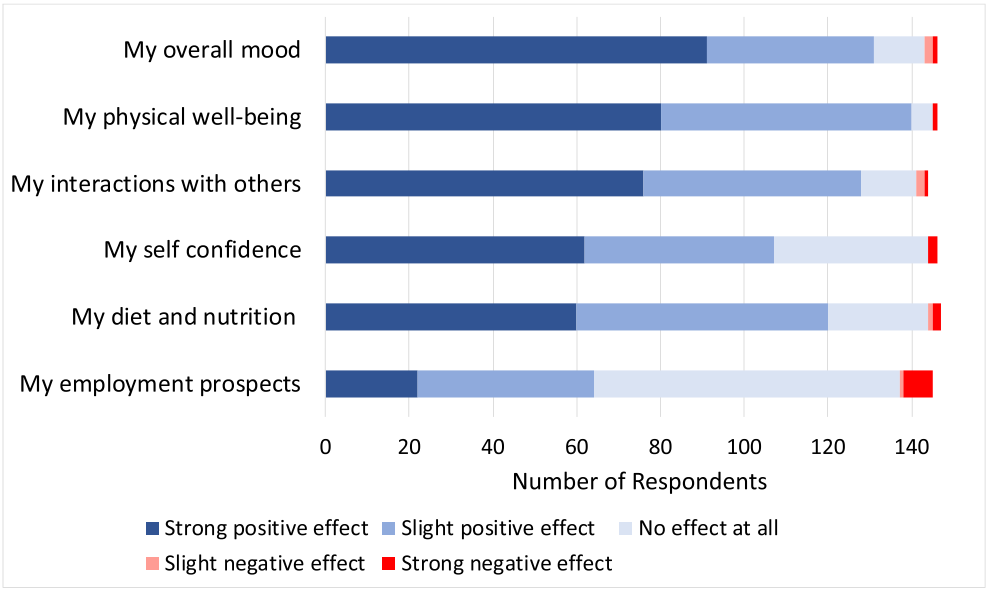

Fig. 3. Impacts of urban agriculture engagement. Participants (n = 155) were responding to the prompt, "What kinds of effects, if any, has gardening/farming had on you?"

agriculture. The economics scale has the lowest overall mean, indicating economics was the least important scale on average. Respondents from different types of urban agriculture varied in their scale scores (Table 4).

3.3.1. *Analysis of variance*

The MANOVA results indicate that participant motivations and impacts varied significantly across garden and farm types ($F = 5.9855$, $p < 0.001$). Single-variable analysis of variance (ANOVA) showed that three of four factors vary significantly by farm type (General wellbeing impacts: $F = 3.835$, $p = 0.003$; Socialization motivations: $F = 4.557$, $p < 0.001$; Economics: $F = 22.87$, $p < 0.001$). Nutritional health impacts do not vary significantly by farm type in our sample ($F = 1.374$, $p = 0.238$). To detect the direction of significant differences between garden and farm types, we conducted Tukey's HSD tests.

As Table 5 shows, general wellbeing outcomes were significantly higher for allotment gardens than working farms; socialization was a more important motivation at farms and gardens with collective production than at home farms; and economic factors were significantly more important for working farms compared to either allotment gardens or community farms.

3.4. *Characteristics that predict general wellbeing: Multilevel model*

We used the general wellbeing impacts scale as our outcome variable to determine the characteristics of urban agriculture and participants that maximize benefits. We found no evidence for random effects as

Table 3
Factor loadings for four scales developed from exploratory factor analysis. Items with loadings < 0.40 on each scale are omitted.

Survey item	General wellbeing impacts	Nutritional health impacts	Socialization motivations	Economics
My interactions with others	0.66			
My overall mood	0.71			
My physical well-being	0.73			
My diet and nutrition	0.67			
My self confidence	0.66			
Amount of vegetables I eat each week[a]		0.76		
Amount of fruits I eat each week[a]		0.77		
Number of meals I prepare at home from scratch[a]		0.48		
Having a chance to interact with others			0.49	
Engaging in a fun activity			0.84	
Contributing to my community			0.67	
My employment prospects				0.55
Saving money				0.63
Gaining employment skills				0.77

[a] Responses were on a five-point Likert scale from "decreased a lot" to "increased a lot" since beginning participation in the farm/garden.

Table 4
Mean ± standard deviation scale scores across urban agriculture type. The number of respondents per urban agriculture type is included as a range due to missing responses on some scales.

Urban Ag Type	General wellbeing impacts	Nutritional health impacts	Socialization motivations	Economics
Allotments n = 43–48	4.57 ± 0.43	3.89 ± 0.70	3.96 ± 0.78	2.94 ± 0.88
Home garden n = 2–3	4.67 ± 0.42	4.83 ± 0.24	3.44 ± 0.51	3.56 ± 0.69
Home farm n = 3	4.93 ± 0.12	3.67 ± 0.67	2.89 ± 0.69	3.67 ± 0.58
Community garden n = 9	4.27 ± 0.50	3.70 ± 0.65	4.56 ± 0.55	3.70 ± 0.90
Hybrid community garden n = 5–8	4.20 ± 0.57	3.13 ± 1.3	4.29 ± 0.73	3.10 ± 0.53
Community farm n = 30–32	4.23 ± 0.52	3.72 ± 0.73	4.30 ± 0.56	2.90 ± 0.86
Hybrid working farm n = 3–5	4.65 ± 0.30	3.78 ± 0.19	4.47 ± 0.69	4.42 ± 0.17
Working farm n = 37–41	4.08 ± 0.76	3.75 ± 0.66	4.22 ± 0.63	4.44 ± 0.51
Overall	*4.34 ± 0.59 n = 143*	*3.78 ± 0.72 n = 136*	*4.15 ± 0.71 n = 141*	*3.46 ± 1.0 n = 143*
Min-Max	*1.2–5*	*1–5*	*2–5*	*1.7–5*

demonstrated by a lack of improvement in the model's Akaike information criterion (AIC), so the resulting model contains only fixed effects. When examining the model fit, the variables related to site connectivity and participant role were multicollinear and therefore could not both be retained in the model; we dropped each separately and retained the model with the best AIC, retaining participant role. The intra-class correlation (ICC) of our null model was 0.02, indicating that only 2% of the variance in general wellbeing impacts was at the farm level, with remaining variance being explained by the individual level. We display the resulting null model, individual-level model, and full model in Table 6.

The full model is the best fit according to the AIC and log likelihood. The significant individual-level predictors of general wellbeing impacts are age, with older respondents reporting higher impacts, and economic interests, with higher economic scale scores improving general wellbeing impacts. However, age is not significant in the full model. Participant role was the only site-level variable with a significant impact on general wellbeing, with farm employees predicted to have lower general wellbeing impact scores compared to owners or primary operators. In the full model, stronger socialization motivations also become a significant predictor of higher wellbeing impacts. Overall, our multilevel model suggests that urban agriculture participants who report strong social motivations, report that economic aspects of the farm are very important, and who are owners or primary operators rather than

Table 5
Summary of significant differences among gardener and farmer motivations and impacts on gardeners and farmers among agriculture types as determined by Tukey's HSD tests. Positive values in the Difference column indicate that the farm type listed first has significantly higher values than the farm type listed second, while negative values indicate the opposite.

Pairing	Difference	Adjusted p-value
Factor 1: General wellbeing		
Hybrid/Working Farms vs. Allotment Garden	−0.436	0.003
Factor 3: Socialization motivations		
Home Farm/Garden vs. Community Farm	−1.41	0.014
Home Farm/Garden vs. Community Garden	−1.67	0.006
Working Farm vs. Home Farm/Garden	1.33	0.024
Hybrid Community Garden vs. Home Farm/Garden	1.12	0.035
Factor 4: Economic motivations		
Hybrid/Working Farms vs. Allotment Garden	1.50	< 0.001
Hybrid/Working Farms vs. Community Farm	1.53	< 0.001
Hybrid/Working Farms vs. Hybrid Community Garden	1.34	< 0.001

Table 6
Multilevel model results predicting general wellbeing impacts.

	Null Model		Individual-Level Model		Full Model	
	ß	s.e.	ß	s.e.	ß	s.e.
Intercept	4.41***	0.06	2.89***	0.37	3.39***	0.47
Individual-level Variables						
Age			0.70***	0.21	0.39	0.24
Education			0.03	0.15	0.06	0.15
Social motivations			0.37	0.21	0.48*	0.22
Economics			0.59**	0.20	0.70***	0.21
Active hours per week			0.66	0.41	0.79	0.45
Years of experience			0.21	0.26	0.12	0.28
Gender (female)			0.10	0.09	0.08	0.09
Years in country			0.26	0.28	0.16	0.28
Income			0.16	0.09	0.05	0.10
Site-level Variables						
Role: Employee					−0.59*	0.25
Role: Volunteer					−0.26	0.20
Food Distribution					−0.04	0.09
Variance Components						
Between-group variance	0.02		0.00		0.00	
Within-group variance	0.31		0.27		0.26	
Marginal R^2	0.00		0.22		0.26	
AIC	247.3		234.7		233.6	
log likelihood	−120.7		−105.3		−101.8	

employees, would be expected to report the most positive general wellbeing impacts from urban agriculture.

4. Discussion

4.1. Participants vary in motivations and impacts

Participants in the urban agriculture projects surveyed reported different impacts of gardening and farming, consistent with previous studies of urban agriculture's multidimensional benefits. This study adds to the existing literature by quantifying the relationships between the social dimensions of urban agriculture, farm and garden types, and participant characteristics. To do this, we used factor analysis to collapse 14 variables measuring different motivations and impacts into four fundamental dimensions: general wellbeing; nutritional health; socialization; and economic benefits. We confirm that farmers and gardeners perceive several social benefits known to be associated with urban agriculture, including improved wellbeing and nutritional health (Kingsley et al., 2019; Soga et al., 2017) and economic well-being (Kirkpatrick & Davison, 2018).

Variation in perceived impact and participant background was also reflected in varied participant motivations for continued participation in urban agriculture. Respondents reported their strongest motivations for participating in urban agriculture were to improve the environment, gain access to fresh food, and relax or release stress. Our results confirm that socialization is an important dimension of farming/gardening (Pourias et al., 2016; Rogge & Theesfeld, 2018; Soga et al., 2017), with participants motivated by the opportunity to interact with others in the farms and gardens. And while urban agriculture is often looked at as a means of stretching food budgets, generating revenue from produce sales (Hamilton et al., 2014), or improving the employability of participants (Gough & Accordino, 2013; Sonti et al., 2016; Vitiello & Wolf-Powers, 2014), these economic impacts were less important among those surveyed.

4.2. Perceived impacts and motivations varied by type of urban agriculture

Our study also showed that the impacts reported by participants differed by urban agriculture type. The role of participants, the destination of the harvest and the collective rather than individual mode of food production are associated with different motivations and impacts. We observed that participants report improved wellbeing to a greater degree when they are the owner or primary operator of a site instead of employees on a farm or garden. When the focus is on socialization, participants in commonly-farmed spaces reported higher benefits than participants on individual plots. Not surprisingly, economic benefits are perceived to be more significant in urban agriculture types in which produce is sold, rather than partially or totally shared, and where participants are paid for their labor.

Our results are partly a consequence of the goals and objectives of different urban agriculture projects, such as non-profit farms designed for workforce training or allotment gardens organized to promote leisure and social interaction. People engage in different farming and gardening practices depending on their priorities and goals (Kirkpatrick & Davison, 2018; McClintock et al., 2016). While our results are therefore somewhat intuitive in alignment between participants' motivations and self-selected urban agriculture types, the confirmation of this trend using a quantitative, multi-national sample is valuable. This is particularly important in the context of urban agriculture policy and plan development, where associations between user needs, community impacts, and urban agriculture type could lead to increased funding or access to land for particular forms of urban agriculture. Although our work did not assess differences across geographic context, it is clear that socio-demographic trends influence these individual- and community-level priorities; for example, economic motivations may prove more fundamental for urban agriculture participants in contexts other than relatively wealthy cities in Europe and the US.

4.3. Variation in social impacts and participant motivation is key for planning

Our findings can support public authorities who increasingly put food on their strategic agendas, acknowledging the relevance of urban food systems for the sustainable development of cities (Doernberg, Horn, Zasada, & Piorr, 2019). Urban agriculture offers multifold benefits related to the local economy, the environment, public health, and quality of neighborhoods (Pothukuchi & Kaufman, 1999). The relevance of perceived well-being and nutritional health impacts as reported from our sample offers evidence for urban planners and policymakers who want to include urban agriculture in food planning strategies and in programs for improving the health of citizens.

Additionally, our study illustrates a method of evaluation that can be useful for planners and policymakers looking for tailored solutions as they consider scaling up urban agriculture. Our analysis confirms that the practice of urban food growing is perceived by farmers and gardeners as a means to the amelioration of social problems that spans different types of farms and gardens across a diverse set of countries, cities, and cultures (Hamilton et al., 2014; Mok et al., 2014). While urban agriculture may be a beneficial land use, not all farms, not all organizational structures, and not all farmers and gardeners produce the same beneficial results. By measuring differences in these effects by project type and by the characteristics of the participants, our study illustrates that city planners and policymakers need to distinguish among the projects they support based on the needs and goals of the communities the farms and gardens serve as there is no one-size-fits-all solution (Horst, Mcclintock, & Hoey, 2017). For example, one of our findings is that the participants in urban agriculture projects on private lots showed significantly lower socialization motivations than other types of farms and gardens. This suggests that where socialization is a priority, such as in communities seeking to integrate immigrants and longstanding residents or older and younger populations, communally farmed types of urban agriculture are more likely to produce these outcomes than those with individual plots; this is true whether the participants are employees or volunteers. Moreover, the potential of socially-orientated types of urban agriculture as providers of a wide range of social services (e.g. community gardens) has not been fully acknowledged at an institutional level. In fact, our study supports specifying the most suitable UA types for the intended purpose and thus contributes to tangible advantages for local governments, including amelioration of the need for other social services. In order to fully utilize these advantages, Philips (2013) stresses the need to locate farms and gardens close to the town's center (rather than on the edge of the community) to make it the focal point of the community and thereby enhancing the discussion on the connection between nature, community and health.

4.4. Food access may not always drive urban agriculture

Our study also provides additional evidence that improved nutrition through access to fresh food is not necessarily the main objective, benefit, and source of perceived impact of urban agriculture. For almost all the 8 types of urban agriculture in our study, the general wellbeing benefits and social motivations were more important to participants than nutritional impacts. The farmers and gardeners in our study prioritized the therapeutic effects on their health rather than healthy food consumption *per se*. This confirms previous studies that revealed the high relevance of socio-cultural benefits of urban agriculture compared to food production or other environmental services (Sanyé-Mengual et al., 2020). While food security and access to healthy food are often-cited advantages of urban agriculture (Gray, Elgert, & Winkler-Prins, 2020; Opitz, Berges, Piorr, & Krikser, 2016), for our sample in the US and Europe it appears that the urgency of improving the quality of

life in aspects such as physical, mental, and social wellbeing are more important outcomes. While neither gender nor income proved to be significant predictors of general wellbeing impacts in our sample, a prior study reported that females and low-income participants experienced greater wellbeing benefits in gardening than males and higher-income participants (Ambrose, Das, Fan, & Ramaswami, 2020). For policy-makers this illustrates the need to ensure that support for urban agriculture projects is calibrated to the needs of a city's population, and that attention to the socioeconomic status of participants is important to achieve desired outcomes.

4.5. Participants' motivations affect perceived benefits from urban agriculture

Our study also confirmed that stronger motivations to engage in urban agriculture may result in greater fulfillment for participants. Employees in urban agriculture projects reported benefits from farming, but their assessments of the benefits were significantly lower than those who were owners or primary operators of their own plots. This suggests the need for planners to assume that the organizational structures of urban agriculture projects will affect outcomes: allotments, community farms run by non-profit organizations, and commercial farms are likely to produce very different outcomes.

Not all motivations as reported by the gardeners and farmers in the survey as displayed in Fig. 2 contributed to forming factors for further analysis. However, this does not diminish the positive motivation that gardeners and farmers perceived. While we intended to measure farmers and gardeners' motivations related to the four main areas as identified in the literature (health and wellbeing, economic opportunities, social cohesion, and education), items related to education ("learning new things," "sharing what I know with others") did not factor together to form a reliable scale for further analysis beyond descriptive statistics. One item related to education, "gaining employment skills," did factor into the economics scale. Therefore, we can only discuss the importance of educational motivations as generally positive, and cannot make conclusions about the relative importance of educational motivations in different types of urban agriculture.

The high price of urban land in Europe and the US often precludes the expansion of urban land use for food growing (Azunre, Amponsah, Peprah, Takyi, & Braimah, 2019). However, the current research has demonstrated the social and wellbeing value accrued by volunteers involved in urban growing: such an output deserves recognition. Schoen, Caputo and Blythe (2020) demonstrate the economic value of such outputs and the extent to which this value far exceeds that of any food produced in these sites. The economic contribution in terms of improved health and wellbeing as a result of garden attendance should be considered by local authorities when allocating investments for social amelioration of local communities.

4.6. Limitations and future research

Our assessment of the social impacts of urban agriculture could be improved in four ways. First, our study was based on a convenience sample of urban farms that were part of a larger study of urban agriculture in five countries. A larger census of urban agriculture spanning different populations and types of urban agriculture would produce more generalizable, less biased results. Second, our study did not include a control group, and therefore we cannot know whether self-reported benefits of urban agriculture participants were significantly different than for participants in other hobbies or community activities (e.g., sports clubs, senior organizations) that foster socialization and improve wellness. To measure whether the act of growing food causes these benefits a case controlled study is required. Third, our study design was cross-sectional, not longitudinal. Motivations and benefits are likely to change among individuals over time, and in places over time, as are the rules and structures of urban agriculture projects. A longitudinal study would help to uncover how and why motivations and impacts change over time and how the practices of farmers and gardeners shape the urban agriculture projects in which they participate. Finally, surveys can reveal self-described motivations and self-assessed impacts, but our study did not measure outcomes like mental and physical wellbeing, nutrition and health, or even the economic costs and benefits of participating in a farm or garden. Future evaluation research should incorporate measurements of health and economic impacts, such as physiological changes (e.g. decreased body mass index) and economic impacts (e.g. equivalent wage rates for farming).

5. Conclusion

While the social impacts and motivations of urban farmers and gardeners have been frequently studied, quantitative research that examines gardeners and farmers' motivations and perceived social impacts across urban agriculture types is scarce. This paper contributes to closing this research gap. Results indicate that farmers and gardeners engage in urban agriculture with multiple motivations and largely positive impacts, and there are significant differences in motivations and impacts across participants in different urban agriculture types. Economics and nutritional health are comparably weak drivers, while the strongest self-reported impacts related to a range of general wellbeing impacts. Participants in different types of urban agriculture report different motivations and impacts—socialization motivations dominate in communally farmed spaces and economic motivations dominate for employees rather than volunteers. Stronger socialization motivations and economic interests predict higher general wellbeing impacts. Different models of urban agriculture attract participants with different needs; it is therefore possible with careful planning and incentives to match urban agriculture types with local needs. For urban planners and garden organizations interested in urban food production, understanding the social impacts of urban agriculture, that is, the impact beyond the value of food produced, is essential to justify land access, funding and protection of these spaces.

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CRediT authorship contribution statement

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Appendix A. Supplementary data

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