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Local Environment

The International Journal of Justice and Sustainability

ISSN: 1354-9839 (Print) 1469-6711 (Online) Journal homepage: www.tandfonline.com/journals/cloe20

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Anna R. Davies, Monika Rut & Jane K. Feeney

To cite this article: Anna R. Davies, Monika Rut & Jane K. Feeney (2022) Seeds of change? Social practices of urban community seed sharing initiatives for just transitions to sustainability, Local Environment, 27:6, 784-799, DOI: 10.1080/13549839.2022.2077714

To link to this article: https://doi.org/10.1080/13549839.2022.2077714

Published online: 20 May 2022.

LOCAL ENVIRONMENT
2022, VOL. 27, NO. 6, 784–799
https://doi.org/10.1080/13549839.2022.2077714

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RESEARCH ARTICLE

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Seeds of change? Social practices of urban community seed sharing initiatives for just transitions to sustainability

Anna R. Davies [a], Monika Rut [b] and Jane K. Feeney [b]

[a]Geography, School of Natural Sciences, Trinity College Dublin, Dublin, Ireland; [b]Geography, School of Natural Sciences, Trinity College Dublin, Dublin, Ireland

ABSTRACT

The sharing of seeds is a practice with ancient roots. However, the structures of global agri-food trade in late modernity have drastically reconfigured practices of exchange and reshaped matters of legal ownership, resulting in constrained access to seeds for many. Scholars and activists are increasingly concerned about the negative impacts these changes are having from a justice and sustainability perspective. To date, seed sharing research has predominantly occurred as one element of wider seed sovereignty debates, and particularly in relation to farmers in low- and middle-income countries. Seed sharing beyond these contexts has received limited attention. To broaden understanding of seed sharing and its diverse practices, this paper provides a foundational landscape level analysis of urban community seed sharing initiatives from 100 urban locations globally. It outlines the rules, tools, skills and understandings that shape seed sharing practices and teases out commonalities with, and differences between, these urban activities and those that currently dominate the landscape of seed sharing research. In conclusion, further research is proposed to build on these foundations and establish the contributions, actual and potential, that urban seed sharing provides for just transitions to more sustainable urban food systems.

ARTICLE HISTORY
Received 15 September 2021
Accepted 28 April 2022

KEYWORDS
Seed sharing; sustainability; justice; governance; social practice theory

Introduction

A plethora of reports have outlined the unsustainability of the global food system (IPBES 2019; Benton et al. 2021; SAPEA 2020). These reports identify the negative impacts currently created from food production right through to its disposal, highlighting the need for radical transformation in order to reorient practices towards sustainability. Seeds – and the ways they are acquired, stored, used and exchanged – form a fundamental element of the food system and concerns about how global agri-food trade and its associated rules and regulations regarding the patenting, ownership and transfer of seeds are widespread (O'Grady Walshe 2019). A coalition of concerned voices has led to the emergence of an expanding seed sovereignty movement calling for attention to matters of social justice, agrobiodiversity and community resilience in relation to seeds (Kloppenburg 2010). Although often loosely defined, seed sovereignty is generally taken to mean the right to save, replant, breed as well as share seed and to participate in shaping seed policies (Kloppenburg

CONTACT Anna R. Davies daviesa@tcd.ie Geography, School of Natural Sciences, Trinity College Dublin, Dublin, Ireland

2014). Within seed sovereignty movements, seed sharing is seen as a practice of exchange that can help achieve social justice and sustainability (La Via Campesina and GRAIN 2015; PBS Food 2014).

Although there is no common definition of seed sharing in existing academic literature, for the purposes of this paper we modify a definition of food sharing established by Davies (2019) as follows: seed sharing involves the process of collecting, saving and exchanging seeds (and other generative material such as cuttings, pseudostems or tubers) with others in a non-commercial (but not necessarily non-monetary) manner. Under this definition we include different modes of exchange, including seed swapping, bartering, collecting, and selling (on a not-for-profit basis). These practices may involve reciprocal and non-reciprocal transactions, reflecting a wide conception of sharing that can be both economic/transactional and social/relational (Davies and Evans 2018).

As there has been limited specific examination of seed sharing as a collective practice, this paper provides foundational work by examining first how existing research engages with seed sharing and then by conducting empirical analysis of an emergent arena of activity, urban seed sharing. While studies of food (and by association seed) sovereignty movements have predominantly focused on rural areas of low- or middle-income countries, such activities are also occurring within urban locations (Davies 2019). This is unsurprising given that more than half of the world's population is already urban (FAO 2018). While urban areas are major sites of food consumption, they often also incorporate some degree of food production. The COVID-19 pandemic has stimulated increased interest in expanding the productive capacity of urban areas to ensure less reliance on imported food with long food chains, which have been shown to be fragile in the face of global shocks. There is also increasing consideration of the role that emerging technologies, such as information and communication technologies (ICT), might play in enhancing food resilience amongst communities through greater transparency, connectivity and traceability, particularly in urban locations (Lang 2020). Despite this, deliberation on urban seed sharing of any kind is, to date, limited. In response, the aim of this paper is to expand consideration of seed sharing into the urban realm. Specifically, the landscape of urban seed sharing which utilises some form of ICT, such as websites, apps, platforms and social media to mediate its sharing, will be interrogated and the place of justice and sustainability within those practices delineated. This sub-sample of urban seed sharing activity is selected for practical and empirical reasons. Practically, such activities leave a digital trace for empirical analysis across multiple locations internationally, allowing for interrogation of whether such mediation provides novel characteristics to seed sharing practices. Specifically, two questions are addressed: (a) What are the social practices of ICT-mediated urban seed sharing? And (b) What do these practices mean for justice and sustainability?

In this paper, we first examine the existing landscape of research interrogating seed sharing internationally. We consider this research through the lens of social practice theory in order to delineate first what it means to share seeds for those involved and the skills and knowledge needed to meet their sharing goals, and second how those goals and performances are in turn shaped by the tools and technologies employed and by social and political rules and regulations. We then outline our methodological approach for identifying and analysing ICT-mediated urban seed sharing initiatives and the results of applying that approach within a sample of 100 urban areas internationally. Findings from this empirical study are then compared to existing research, with conclusions drawn about commonalities and differences in practices and the potential of urban seed sharing in achieving just transitions to sustainable urban food systems. Finally, a prospective agenda for deeper consideration of urban seed sharing and its role in transforming the food system are outlined.

Seed sharing in practice

Existing literature in which mention of seed sharing appears was initially identified through advanced keyword searches of the Web of Science database using the terms: "seed sharing"; "community seed bank*"; "sharing seed*"; "seed exchange"; "seed sav*"; "seed swap*"; "seed librar*", where the asterisk is used in the Boolean search in order to capture all relevant terms (e.g. librar*

= library, libraries; sav* = savers, saving etc.). The review process revealed that multiple terms related to seed sharing are often used in papers – including seed exchange, seed transfer, seed circulation, seed saving, and seed swapping – sometimes interchangeably, often loosely, and without definition. We considered papers that utilise all these terms to ensure coverage of the landscape of seed sharing research.

The broad term exchange is used widely in the literature when referring to seed networks (Pautasso et al. 2013) and is defined by Chambers and Brush (2010, 306) as "the movement of plant reproductive materials, including seeds and cuttings, from farmer to farmer and between and across landscapes". Abizaid, Coomes, and Perrault-archambault (2016) and Bertacchini (2008) both make a distinction between seed exchange as an explicitly reciprocal practice, and broader terms of seed sharing or seed transfer that are not restricted to reciprocal relations. Additionally, the term seed saving, defined as "the practice of selecting, collecting, drying and storing seed for subsequent generations of plants" (Pottinger 2017, 217), appears frequently in the literature alongside mention of seed sharing (e.g. Bohn et al. 2016; Pottinger 2018; Curry 2019).

The term seed swapping also appears in the literature, generally referring to organised events where gardeners gather to exchange seeds and knowledge (Pottinger 2017; Campbell 2012), although it is not always the case that the means of exchange are explicitly prescribed, allowing for variable practices in this regard. Seed saver groups often encourage people to save, harvest and share their own seeds in order to build a stronger and more secure food system (Seed Savers Exchange 2021). In a study of Californian seed libraries (institutions that offer seeds to people as "borrowers", following the model of book lending), Soleri (2018) found that developing a culture of sharing without commercial profit was a primary goal. Sharing saved seed allows growers to diversify the range of plants cultivated and adapt to changing conditions, as well as to share knowledge and growing tips (Campbell 2012).

In the analysis of academic literature on seed sharing, we found papers discussing seed sharing practices on all continents except Antarctica. The majority of these focus on low- and middle- income countries, with a notable focus on Sub-Saharan Africa and Latin America and on rural areas, generally among smallholder farming communities. These papers primarily examine farmer-to-farmer seed exchanges or exchanges via community seed banks, seed libraries or seed swaps, as opposed to commercial seed systems involving the seed industry and national seed distribution programmes. Non-commercial seed exchange remains vital for seed supply; it is the source for over 80% of farmers' seed for key crops in many areas of Africa, Asia and Latin America (Bertacchini 2008; Bonnave et al. 2016; Mcguire and Sperling 2016; Rodier and Struik 2018). Studies of seed systems in smallholder communities reveal a diversity of seed sources and modes of exchange (collecting, gifting, bartering and selling) and the co-existence of local landraces and commercial seed (Almekinders, Ronner, and Van Heerwaarden 2020; Bohn et al. 2016; Dedeurwaerdere and Hannachi 2019).

Two studies conducted in semi-rural communities, one within Argentina (Eyssartier, Ladio, and Lozada 2013) and another in Bangladesh (Oakley and Momsen 2007) both found that seed sharing was more prominent in communities with less access to an urban centre and market economy, where there was a higher dependence on agriculture and greater preservation of traditional customs. However, a few studies have examined seed sharing among urban and peri-urban dwellers in high-income countries, such as suburban gardeners in the UK (Pottinger 2018) and seed libraries and seed saving networks in the US, where seed sharing represents a central part of their activities (Campbell and Veteto 2015; Soleri 2018).

Across the literature, seed sharing is generally a localised activity, more prevalent among small-scale and geographically proximal networks. This is unsurprising as sharing has tended to take place amongst those with existing social relationships and involving indigenous seed varieties that are adapted to local conditions (Pautasso et al. 2013). Nonetheless, there is also evidence of the exchange of seeds between different communities and across longer distances, through translocal seed banks, and seed swaps as well as through distribution by NGOs and development institutions (Chambers and Brush 2010; Bohn et al. 2016; Zimmerer 2003). This translocalisation of seed sharing,

while potentially important for agrobiodiversity, can lead to an increased risk of spreading disease and may erode local varieties if not properly managed (Pautasso et al. 2013). Certainly, seed sharing is not necessarily a just and sustainable practice; there may be unequal access to seed within communities and a scarcity of high quality seeds. The time and workload involved in seed sharing may also be prohibitive for some, pushing growers back into mainstream commercial seed markets (Calvet-Mir et al. 2012; Rodier and Struik 2018; Coomes et al. 2015). Despite these challenges, seed sharing initiatives are operating in many locations around the globe and more research is required to identify what kinds of seed sharing offer the most potential for assisting just transitions towards more sustainable food systems. As a first step in this direction, we use a social practice lens in the following section to delve more deeply into existing literature to identify the motivations driving, and the mechanisms adopted by, seed sharing initiatives.

Social practices of seed sharing

The specific practice theory lens used in this paper is derived from recent work exploring social change for sustainability (Davies, Fahy, and Rau 2014) and, more specifically, the social practices of food sharing (Davies and Evans 2018; Davies et al. 2020). It builds on Schatzki's seminal work (1996), in which practices are conceived as "open-ended spatial–temporal manifolds of actions" (Schatzki 2005, 471), or structures of knowledge that enable a socially shared way of ascribing meaning to the world (Città et al. 2019). Social practices, in this reading, represent a routinised type of behaviour typically performed and shared by people (Reckwitz 2002). In relation to food sharing (see Davies et al. 2020), Reckwitz's categories of practice are presented as having four core elements: (1) Rules – "explicit formulations, principles, precepts, and instructions that enjoin, direct or remonstrate people to perform specific actions" (Reckwitz 2002, 79); (2) Tools, which are the mechanisms through which sharing goals are realised, including but not restricted to the technologies that mediate sharing. (3) Skills – "a range of normativized and hierarchically ordered ends, projects and tasks, to varying degrees allied with normativized emotions and even mood" (idem, 80); and (4) Understandings – "knowing how to X, knowing how to identify X-ings, and knowing how to prompt as well as respond to X-ings" (idem, 77). For brevity, these are referred to as rules, tools, skills and understandings in the remainder of this paper.

In the following section, skills and understandings are considered, which outline the meanings and mechanisms of, including motives and drivers for, seed sharing. Then the social and political rules and tools that shape and mediate seed sharing are distilled from the literature. Finally, the analysis outlines the scope and reach of existing research in seed sharing and identifies a gap in studies relating to ICT-mediated seed sharing in urban contexts.

Seed sharing: skills and understandings

Seed sharing builds skills and understandings in relation to, but also far beyond, the seed itself. Existing research identifies numerous drivers and motives for exchanging seed, which collectively outline the meanings of seed sharing practices. These include the desire to improve crop yields, to obtain particular plant characteristics, to experiment with new crops and varieties, or to replace lost or failed seeds (Chambers and Brush 2010). In turn, this strengthens economic and social sustainability and socio-ecological resilience, helping cultivators to adapt to changing climate, market and regulatory conditions (Coomes et al. 2015). In this way, seed sharing can contribute to achieving enhanced social-ecological sustainability and intergenerational justice (Sievers-Glotzbach et al. 2020). Studies have shown that seed sharing is crucial to agrobiodiversity conservation, by facilitating access to seeds and maintaining crop genetic diversity (Calvet-Mir et al. 2012; Chambers and Brush 2010; Pautasso et al. 2013). Seed sharing practices, such as the exchange of seeds between neighbours, relatives and strangers, represent a deliberate form of human seed dispersal that distributes genetic material across geographical spaces (Van Heerwaarden et al. 2012). Aside from

acquiring physical seeds, another factor that motivates people to engage in seed sharing is the prospect of gaining agricultural knowledge and skills from donors and recipients (Campbell 2012; Rodier and Struik 2018).

Research indicates that seed sharing practices are also driven and reshaped by the interplay of social and cultural factors. In some cultures, seeds are gifted at special events like weddings (Dennis et al. 2007) or local festivals, with seed sharing interlinked with spiritual beliefs (Chapman 2018; Saxena 2020). The gifting and sharing of seed builds socio-cultural capital between neighbours, relations or friends, where seeds (and knowledge about them) are shared out of a sense of moral duty, love, to build a good reputation or sometimes in exchange for labour (Chapman 2018; Rodier and Struik 2018; Saxena 2020). Some authors have identified a reduction in seed sharing among family members, and in its place, the rise of organised peer-to-peer seed exchange networks (Aistara 2011). In Odisha, India, traditional community seed festivals have been revived as a result of grassroots self-organisation, with an aim of strengthening indigenous food systems threatened by industrial agriculture (Saxena 2020). Research has also identified how certain social, cultural and gender norms can influence the way seed sharing is practiced (Almekinders, Ronner, and Van Heerwaarden 2020; Oakley and Momsen 2007; Tadesse et al. 2017).

Seed sharing: tools and rules

The tools used to facilitate seed sharing are manifold, ranging from the materials for storing, packaging and transporting seeds, to the various forms of ICT employed to display seeds for sharing, exchange skills about using shared seeds and facilitate exchanges between sharers. While there are many tools involved in seed sharing, existing literature has tended to focus on the role of emerging technologies.

Since the Green Revolution in the mid-twentieth century, the application of technological tools to agriculture has seen the development of so-called "improved" seeds, hybrids and genetically modified organisms (GMOs), along with the use of agrochemicals and chemical fertilisers. While these developments have brought opportunities to produce disease-resistant crops and improve yields, they have also led to the expansion of monocultures, undermining ecosystems and locally-based food production systems (IPBES 2019). While such biotechnology has been promoted as a solution to poverty and food insecurity (AGRA 2021; Pew Initiative on Food and Biotechnology 2004; Wall Street Journal 2016), critics see it as a profit-driven enterprise that restricts autonomy and appropriates knowledge and genetic material while failing to address the issue of food access; with activist groups terming it biopiracy (La Via Campesina and GRAIN 2015; Moseley 2017). Indeed, research has found that seed sharing is sometimes seen as a form of resistance against their commodification, such as Zapatista corn distributed in Mexico and to solidarity growers around the world (Brandt 2014).

Key to all forms of seed sharing is the transmission of knowledge, skills and access to tools for good seed management. However, research has found that seed is more easily shared than technical know-how (Kiptot et al. 2006). Some authors argue that, in contrast to other digital sharing economies, seed sharing represents a more analogue sharing economy that involves everyday forms of hands-on engagement with material artefacts and is often offline (Pottinger 2018; Peekhaus 2018). However, others (Havinga et al. 2016) suggest that digital technologies are playing an increasingly important role in seed sharing activities. This includes collecting data from farmers and providing information on weather forecasts, crop management and seed suppliers, as explored by Vernooy et al. (2017, 2020) in India and Uganda. In research among seed saver groups in the United States, Campbell (2012) cites online seed exchanges, gardening websites and blogs that link participants and allow them to trade seeds, whilst also revealing a preference for face-to-face swapping to obtain locally adapted varieties and discuss techniques and conditions with locally experienced growers. Online and offline seed exchanges are then not mutually

exclusive, with examples combining traditional face-to-face exchanges of material objects with new technologies and digital channels to facilitate seed sharing.

Seed sharing practices are governed by a complex regulatory landscape of seed laws, including intellectual property laws (patents and plant variety protection), free trade and investment agreements, as well as regulations relating to seed certification, marketing and biosafety (see, e.g. La Vía Campesina and GRAIN 2015). Key among these is the International Union for the Protection of New Varieties of Plants (UPOV), which is shaping global rules by restricting or prohibiting the saving or sharing of privatised seeds (Alianza Biodiversidad and GRAIN 2021). In response, civil society and activist groups have been mobilising against the enclosure and commodification of seeds through laws that they argue result in the infringement of people's rights to access and use seed, forming a movement for seed sovereignty, or seed activism (Peschard and Randeria 2019). Complicated legal frameworks plus the diversity of informal seed sharing groups have meant that public policy often excludes smallholder farmers and other seed sharing initiatives such as community seed banks (Aguilar-Stoen, Moe, and Camargo-Ricalde 2009; Vernooy et al. 2020) or holds them accountable to the standards designed for commercial seed practices, making it increasingly challenging for such initiatives to operate (Davies 2019).

Community groups and advocacy organisations play a vital role in disseminating information and driving policy change to protect non-commercial seed sharing. Initiatives include the publication of resources and information on seed laws around the world (Center for Food Safety 2021; EJ Atlas 2015; Sustainable Economies Law Center 2021) and directories of bioregional companies that do not use patented seeds (Rocky Mountain Seed Alliance 2021). Seed sharing initiatives can then be a form of vocal resistance against the industrialisation of the food system and the commodification of seeds in some contexts, but in others they are a form of quiet activism carried out by gardeners through simple acts of growing and sharing (Pottinger 2017).

In summary, existing research establishes seed sharing as a social practice that involves not only the sharing of seeds but also the sharing of practical information about how to manage, save, and grow them, enhancing skills and know-how. Existing research also finds that socio-ecological sustainability and intergenerational justice are key drivers of seed sharing. However, the majority of research on seed sharing to date has focused on low- and middle-income countries, on rural areas and on farmers in agrarian communities. There is a knowledge gap in relation to understanding where, how and why practices of seed sharing are occurring beyond these locations. In response, the following section outlines the methods that were used as a means to provide a novel landscape analysis of urban seed sharing, with a focus on those initiatives which use ICT to mediate their sharing practices and which as a result leave digital traces for analysis.

Methods

This paper draws its empirical data from the SHARECITY100 database, which explored a spectrum of ICT-mediated urban food sharing activities (Davies et al. 2017a; Davies et al. 2017b; Davies and Legg 2018),[1] including seed sharing in 100 urban areas internationally. The database is not representative of the distribution of urban areas globally, so it does not provide an analysis of the global geographical distribution of ICT-mediated urban seed sharing, but it does show that urban seed sharing takes place on every continent (see Table 1).

The methodological approach to identify, select, and analyse relevant seed sharing initiatives was two-fold. First, an initial screening of the initiatives in the SHARECITY100 Database was undertaken to identify urban seed sharing initiatives. Then, content analysis of the information provided by the initiatives was conducted to gain deeper understanding of the practices associated with ICT-mediated seed sharing across diverse geographical locations.

Out of a total of 4,003 initiatives, 187 were found to include seed sharing in their activities. Further analysis of the database revealed that 33 of these had a primary focus on seed sharing practices in their mission statement or name (e.g. seed bank, seed library). The sample included initiatives that share

Table 1. Number and location of seeds sharing initiatives in the SHARECITY 100 Database (Davies et al. 2017b).

Region	City	Number of seed sharing initiatives	Total
Australia & New Zealand	Melbourne	1	4
	Christchurch	1	
	Wellington	2	
Asia	Manila	1	1
Central & South America	Bogota	2	5
	Mexico City	2	
	Quito	1	
Europe	Athens	1	14
	Barcelona	1	
	Berlin	4	
	Frankfurt	1	
	Istanbul	2	
	London	2	
	Madrid	1	
	Paris	2	
North America	Ann Arbour	1	9
	Berkley	2	
	Boulder	1	
	Chicago	1	
	Cleveland	1	
	Oakland	1	
	Philadelphia	1	
	San Francisco	1	
Total		33	

seeds and use one or more forms of ICT-mediation e.g. a website, a Facebook page, and Twitter. Once these initiatives had been identified, their online profiles were examined systematically exploring the "About", "Who We Are", and "What We Do" sections where they existed. A set of codes were developed to identify how seeds were shared and the motivations, drivers and goals of the initiatives for sharing. The collated information was used to establish the meanings, skills and understandings of seed sharing practices in these initiatives. Following this, reference to the material mechanisms for sharing seeds (tools for brevity) were identified and considered and finally reference to internal or external regulations (rules) were highlighted. Nearly two-thirds of initiatives (64%) in the sample were found to have no formal organisational structure or were associations. While some seed sharing initiatives adopted multiple forms of exchange, including sharing seeds for free and via monetary transactions, 22 were sharing seeds mainly by gifting, 15 predominantly by bartering, 3 by collecting and 1 by selling. The actors participating in these exchanges were not always consistently or extensively specified in online profiles, but generally included community members such as gardeners, homesteaders, urban cultivators, activists, academics, and Indigenous peoples. In the majority of cases no actors were excluded from participating in urban seed sharing initiatives, although there were often clear rules around how, when and for what purpose sharing was permitted.

Social practices of urban ICT-mediated seed sharing

As discussed earlier in this paper, seed sharing practices comprise particular skills, understandings, tools and rules, which vary depending on the social and geographical context in which they take place. In this section we use the same analytical lens of social practice theory to explore these dimensions with respect to urban ICT-mediated seed sharing.

Skills and understandings

Analysis of seed sharing initiatives' online mission statements provides important insights into the skills and understandings generated by seed sharing activities. The key goal identified amongst

the sample of 33 urban seed sharing initiatives relates to protecting and enhancing agrobiodiversity in urban settings through safeguarding seed variety types. This is allied strongly with a commitment to the right to protect, reproduce, multiply, store and preserve seeds. In particular, the preservation of local seed diversity even in urban settings is a major motivating factor; a process that often involves borrowing, sowing, and returning seeds after harvest. This is demonstrated by the Richmond Grows Seed Lending Library, as well as the Cleveland Seed Bank, both in the U.S.A., that seek to enhance capacity building for small-scale urban agricultural communities through delivery of information about locally adapted seeds as well as "cultivating the skills required for sustainable food production" (Cleveland Seed Bank 2021). Elsewhere in the sample, there are mission-driven initiatives such as the non-governmental organisations Grupo Semillas (Seeds Group – *semillas* is Spanish for seeds) based in Bogotá whose explicit goal is to build regional coalitions against corporate GMO-focused models of seed supply. The initiative is a form of collective action against such seed trade while promoting diversified local food economies.

For some seed sharing initiatives, the commitment to protect native varieties of seeds from transgenic contamination is a form of cultural practice, where seed sharing motivates participants to see themselves as guardians of biocultural heritage, carriers of Indigenous knowledge and as activists for seeds without borders. This is demonstrated by La Red de Guardianes de Semillas (The Seed Guardians Network), an NGO based in Quito that celebrates seed sharing as an ancestral practice in Ecuador. In European urban metropolises such as London and Berlin where ethnic diversity is high, seed sharing initiatives such as the London Freedom Seed Bank also bring a cultural aspect to sharing through the co-production of knowledge about urban heritage, as participants celebrate cultural diversity by sharing seeds that are native to their cultures. In Wellington, New Zealand, the Heritage Seed Collective organises seed saver exchanges aimed at preserving the longevity of heritage seeds that are in danger of genetic extinction. Regardless of geographic location, the majority of initiatives examined share a common sense of purpose related to building a more holistic view of the food system where seeds represent the transformation of society, as exemplified in Vandana Shiva's *Manifestos on the Future of Food and Seed* (2007). Indeed, this work has deeply inspired and united seed sharing practitioners worldwide in the movement for food and democracy (Kloppenburg 2014).

The seed sharing initiatives' mission statements and motivations are also linked to sustainability actions as the majority (94%) of seed sharing initiatives in our sample seek to achieve positive environmental impacts from their activities, more than half (61%) claim social and economic impact and just over a third (33%) of initiatives explicitly seek to achieve all three. Social impacts are discussed in terms of new relations that are created when seeds are shared, as illustrated by Social Seeds in Berlin and Ann Arbor Area Plant and Seed Exchange. Economic impacts are often framed as gaining financial autonomy for food producers to own and sell seeds that enable economic resilience in local food systems. This is demonstrated by initiatives that are aligned with food sovereignty movements such as Red de Guardianes de Semillas in Ecuador and Mexico, Peliti (which means "oak tree" in Pontic/ Black Sea Greek) in Greece and the Buğday (Wheat) Association in Turkey. Environmental goals include responding to biodiversity loss that threatens food and nutrition security. For example, Grupo Semillas (2020) in their mission statement states that they support peasant, Indigenous and Afro organisations in Colombia to preserve biodiversity and defend their autonomy, their resources and productive systems for sustainable livelihoods. The Botanical Seed Bank in Berlin and Southern Seed Exchange in Christchurch prioritise preserving wild urban plants and heritage cultivars (e.g. seeds that are not available commercially), many of which have become endangered by rapid urban growth and invasive plant species.

Translocal collaborations that comprise skills and knowledge exchange lie at the heart of all 33 urban initiatives in the sample examined. For example, Xarxa Catalana de Graners (Catalonian Seed Network), a seed sharing group in Barcelona that operates as a network of eleven subgroups, has been working with the National Program for the Conservation and Utilization of Plant Genetic Resources to preserve over 400 traditional agricultural varieties and support food sovereignty movements in Spain. Furthermore, established seed sharing initiatives whose origins are to

be found in socio-political movements against GMOs are more likely to engage in some form of transnational collaboration. For example, Athens-based Peliti collaborates with many seed sharing organisations in other countries, including the U.S.A., Bulgaria, Austria and Turkey, sharing knowledge as well carrying out advocacy actions for sustainable rural policies. Furthermore, the Seed Savers Network, whose activities are spread across Australia, has been delivering community seed bank training programmes and helping organisations in low- and middle-income locations to establish seed sharing networks and expertise.

Some initiatives, particularly those located in low-income and southern European countries, are critical of the marginalisation of native knowledges and practices that they blame, as Shiva (2016) does, on commercial seed systems, and focus on the right to seeds as a motivational force for their activities. This is exemplified by the Buğday Association based in Istanbul that started as a socio-ecological movement in 1990 and since then has been involved in monitoring seed practices and contributing to the development of national policies in Turkey, seeking to improve both seed and community food resilience. Like the Buğday Association, Peliti states that "rights should be kept by locals [farmers, peasant, communities] and not corporations" (Peliti 2021). Indeed, most urban seed sharing initiatives examined aim to disrupt global corporate seed supply chains by encouraging sharing and growing from native seeds in which pollination occurs naturally (via birds, insects, and wind) and leads to greater genetic food diversity. Sharing open-pollinated seeds is then a political process in which initiatives co-produce democratic place-based seed systems, where diverse actors (humans and otherwise) collectively participate in the ownership (and protection) of seeds; an act of sovereignty. The aspect of sovereignty has been articulated by seed sharing initiatives based in Central and South America and in Southern Europe, through their affiliation with La Via Campesina movement that recognises seeds as an "irreplaceable pillar of food production and the basis of productive, social and cultural reproduction" (La Via Campesina 2021).

Tools and rules

This section focuses on the types of tools (e.g. technologies) and the rules (e.g. internal and external governance rules) that guide the performance of ICT-mediated seed sharing practices in urban contexts. Initiatives can use multiple forms of ICT, but the vast majority (79%) of initiatives in our sample are using a dedicated website to mediate their seed sharing (as well as sharing knowledge about seeds and plants), while 51% have a Facebook page and 18% have a Twitter account. ICT is mainly utilised for (1) organising seed sharing practices (e.g. online seed sharing databases), (2) achieving transparency within seed sharing networks (e.g. seed group membership), and (3) capacity building and networking initiatives at national and global scales.

In some cases, ICT offers an online organisational structure to allow for sound seed sharing management practices. For example, the London Freedom Seed Bank has been using their website to track and record how seed passed from one grower to the next; how many of the seeds coming into the bank were from London originally; and how many generations had they been grown for. The seed database created by the initiative is interactive, with members participating in the co-production of knowledge by uploading photos and sharing information about seeds, such as cultivation methods, that promote transparency around seed sharing practices. Similarly, initiatives such as the Richmond Grows Seed Lending Library (U.S.A.) and the Southern Seed Exchange in Christchurch (New Zealand) use websites to create membership forms that require participants to share personal information such as addresses. These ICT-mediated membership systems enhance transparent seed sharing management which includes registration, labelling and background information on seed handling (e.g. where and how to grow from seeds) and a positive seed sharing ethos as participants are encouraged to take responsibility and become guardians of seeds.

Networking within and between seed sharing initiatives is also mediated by ICT, for example Google Maps is frequently used by initiatives to increase their translocal and international reach

by connecting people, spaces, and organisational practices across communities and countries. Such mapping tools have been used by the London Freedom Seed Bank, Graines de Troc (Barter Seeds, which has seed sharing hubs in France and Switzerland), and the Local Seed Network (that operates in urban and peri-urban areas across Australia), to track interactions between seed varieties, growers and guardians. It is also clear that ICT can play a key role in encouraging greater civic education and engagement in seed systems by strengthening skills and understandings about seed sharing practices. ICT has been used by initiatives to disseminate calls for volunteers, promote sustainable behaviour and educate the wider public, as many initiatives provide publications and some offer online access to educational resources including videos and manuals. An example of this is Madre Semilla (Mother Seed), a dedicated education platform of the Red de Guardianes de Semillas del Ecuador that helps to raise awareness of socio-ecological issues.

Despite the diversity of urban seed sharing, all initiatives in our sample set out their rules for participation. These internal rules are guided by collective commitment to preserve and disseminate traditional seed varieties mentioned in the previous section. This involves a commitment from participants not to acquire, share, or support conventional seeds, seed industries or practices of genetic seed engineering and it is visibly communicated in the mission statements of most initiatives. Furthermore, some initiatives such as Red de Guardianes de Semillas del Ecuador and Buğday Association go a step further by developing a participatory guarantee system, a local quality assurance scheme for ensuring the quality, promotion and distribution of agricultural seeds based on a "foundation of trust, social networks and knowledge exchange" (IFOAM – Organics International 2019, 3). A number of seed sharing initiatives including Xarxa Catalana de Graners, Peliti, and Red de Guardianes de Semillas del Ecuador, whose work involves advocating for food sovereignty, also support agroecological principles in seed sharing (García López et al. 2019).

Seed sharing initiatives are inevitably affected by external governing rules such as national and international regulations that shape the performance of seed sharing (O'Grady Walshe 2019). Some of the most established initiatives in urban seed sharing whose mission is directed at protecting the autonomy of peasant communities and Indigenous peoples critically engage in the evaluation of external governing rules around seed sharing. In the European context, initiatives such as Peliti demonstrate high involvement in international seed governance debates. This is communicated on the initiative's website and a significant number of online publications have been published to influence the European Commission and European Union, with recommendations for revision of seed sharing legislation. A recent example includes a letter opposing the European legislation on the production and marketing of plant reproductive material including seeds (Council Decision [EU] 2019/1905) which, according to the Peliti, is limited to commercial activities, aimed at professional seed users and does not prioritise freedom of choice for cultivators, both in terms of seeds (species, varieties, populations) and production patterns (Peliti 2021). Similarly, urban seed sharing initiative Semillas de Vida (Seeds of Life) in Mexico City regularly engages in policy dialogues on seeds and food sovereignty via press releases and publications published on the initiative's website, stating for example: "we urge the Government of Mexico to jointly build a new agrifood and nutritional system-model … to remain vigilant to support the frontal warning labelling and the prohibition of glyphosate and transgenic corn, and to continue defending national and food sovereignty and our sacred plant: corn" (Semillas de Vida 2021). In this way, urban seed sharing initiatives are looking to shape the governance of seeds so that no law, public policy, market strategy or private appropriation may infringe the basic right to create, save, multiply, share, exchange, sell and freely distribute seeds (Red de Guardianes de Semillas 2019).

Discussion

In this section, the results outlined above are considered in the light of the papers' initial questions: (a) What are the social practices of ICT-mediated urban seed sharing? and (b) What do these practices mean for justice and sustainability?

Social practices of ICT-mediated urban seed sharing

The existing literature on seed sharing focuses largely on farmer-to-farmer seed exchange in rural environments and it is in these rural locations that the majority of seed sharing activities take place, since family farms produce roughly 80% of the world's food and occupy around 70–80% of farmland globally (Lowder, Sánchez, and Bertini 2021). However, as the previous section shows, urban seed sharing also exists, creating possibilities for collective seed provisioning systems in urban environments. In our sample, these urban seed sharing initiatives have predominantly been established to support and preserve more sustainable livelihoods and lifestyles in which the right to safe nutrition, the maintenance of natural diversity in urban spaces and an appreciation of farmers' efforts to protect seeds, is key. The latter in particular is an important motivational driver for the emergence of ICT-mediated urban based seed sharing networks (e.g. seed banks, libraries and swaps, as well as NGOs); as a form of solidarity with rural farmers resisting corporate agribusiness and global food supply chains that commodify food. In these seed networks, ICT plays a key role in connecting people with seeds, with other seed sharers and with biodiverse foodscapes through new socio-material relations.

In this paper, we show that ICT plays an important role in mediating seed sharing practices within and beyond the initiative itself. ICT acts as a channel for communication and mobilisation, to exchange information and build expertise and resources between different participants. In the process of knowledge sharing, ICT enables translocal and international seed sharing institutions to emerge and operate. In particular, social media is a tool often used by initiatives to build awareness and advocacy globally whilst also acting as place-based, capacity-building hubs that enhance understanding of food biodiversity through social learning. On the other hand, with ICT potentially connecting seed sharers in different locations, there are risks that need to be considered, such as the legal and environmental implications of sharing seeds across jurisdictions and geographic scales. Further in-depth research examining online seed sharing networks could offer insights into the opportunities and risks posed by digital seed sharing economies and solutions to overcome barriers. Additionally, there is an opportunity to examine the extent to which the integration of online and offline interactions, combining traditional practices and new technologies, may build resilience (Eyssartier, Ladio, and Lozada 2013).

The role of seed sharing in just transitions to sustainability

Using a social practice lens, it is possible to identify the relational agency of seeds as necessary actants in the process of co-producing more just urban food systems across multiple-scales and levels of participation. Seeds, with their symbolic and material agency, have the potential to cross disciplinary boundaries of knowledge (e.g. agriculture, biodiversity conservation) as they circulate between farming communities, urban spaces, homes, and research institutions, and as such they contribute to a collective agency for more just urban food systems through a network of interrelationships that come into existence when seeds and seed related knowledge and skills are shared. Translocal and transnational reach of urban seed sharing initiatives as well as growing food from shared seeds at urban and peri-urban levels demonstrates this. Also, as indicated by the sample of seed sharing initiatives analysed, urban seed sharing incorporates a multitude of issues, from addressing power inequalities and sustaining traditional techniques, to biodiversity conservation approaches for sustainable food systems and seed activism (Peschard and Randeria 2019). Although, as shown elsewhere, community seed sharing networks contain their own social and political norms, structures and inequalities (Coomes et al. 2015).

In opposing technocratic discourses around food security that criminalise ancestral seed sharing practices, urban seed sharing initiatives also emphasise more-than-human solidarities through notions of seed stewardship, thus placing justice at the centre of sustainable food transitions (Tornaghi and Dehaene 2020). In fact, acknowledging that the processes of urbanisation are destructive

to biodiversity, seed sharing initiatives create a form of bio-cultural refugia; places that shelter biodiversity and where rituals and cultural memories are stored, revived and "carried forward between people and across cohorts" (Barthel, Crumley, and Svedin 2013, 1142). Previous research has already found that such places play an important role in resilience building in times of shocks (idem, 1144).

The majority of the urban initiatives we examined are committed to enhancing transparency and trust of and around seeds through a process of commoning (Bollier and Helfrich 2015); a joint action of creating things together and cooperating to meet shared goals of justice and sustainability in relation to seeds specifically, but also food more generally. While practical aspects of transparency and trust in seed commoning are reflected in how seeds are exchanged, documented, stored, and rejuvenated to preserve their biological diversity, there is also an intangible value embedded within the processes of sharing. While imperfect, and often fragile, sharing seeds between strangers in these urban initiatives creates complex, holistic interacting systems of meanings and relationships in which care is elevated (Puig De La Bellacasa 2015) and built into seed sharing relations. In particular, protection of open pollinators through seed sharing has become a prefigurative practice, a "matter of concern" (Latour 2005, 6) for demonstrating the possibilities for just and sustainable food transitions. Linked to this is a collective commitment to reconfiguring the rules governing access to genetic resources that seeds represent to place justice at the forefront; justice for people, plants and the planet.

Conclusion

In the midst of an unsustainable global food system dominated by commercial and corporate actors, practices of non-commercial seed sharing initiatives, both urban and otherwise, provide actually existing demonstrations of doing things differently. While research attention to date has been predominantly focused on rural manifestations of seed sharing as alternative practice, this paper sets out an emerging landscape of urban-based ICT-mediated seed sharing initiatives. ICT mediation allows for alternative means of connecting and communicating about seed sharing (e.g. sharing skills and understandings), providing new "tools" which can reach far greater audiences at unparalleled speeds compared to analogue means of communication. Given the focus of the initiatives on sustainability and justice it can be inferred that ICT, therefore, speeds up organising about, and advocating for, appropriate governance of seeds and their exchange, but only for those who have access to ICT mechanisms themselves. Careful attention to persistent digital divides in populations is needed when conducting the further empirical and ethnographic research that is required to understand on a more granular level both the nature of the individual actors who participate in urban seed sharing and why, and the impacts that seed sharing using ICT creates for them and for justice and sustainability. Additional research that explicitly interrogates the role of ICT-mediation in rural seed sharing would also facilitate comparative analysis between urban and rural seed sharing initiatives.

Using a social practice lens, we have been able to consider and outline the rules, tools, skills and understandings that are shaping seed sharing initiatives and compare them to their non-urban counterparts. Seed sharing practices, whether urban or rural, are seeking to preserve genetic diversity of seeds while at the same time addressing challenges that cut across a multitude of issues and scales of action, including that of power and representation in sustaining longevity of community seed sharing systems, traditions and resources. It is found that urban seed sharing initiatives demonstrate broad similarities to their non-urban counterparts with concerns about justice and biodiversity protection, but place more emphasis on enhancing bio-cultural diversity in urban food systems and practices of urban commoning.

The social practice lens adopted was particularly useful in illuminating multifaceted elements and linkages underlying seed sharing, identifying the intersection of on- and off-line activities within urban contexts and their links to similar activities beyond the urban. However, as yet there has been limited analysis of the extent to which these urban seed sharing activities are achieving their goals, in part because of the lack of impact reporting by these initiatives. In this regard,

recent developments in sustainability impact assessment specifically designed with food sharing in mind (see Mackenzie and Davies 2019) could be productively employed to explore successes and failures, as well as challenges and opportunities for urban ICT-mediated seed sharing for more just transitions to sustainable urban food systems.

Note

1. The development and population of the database took place in 2016. While annual checks have been made to remove inactive initiatives up until 2020, and to identify changes in ICT profiles, no new searches have been added to the database. It therefore represents only a snapshot of the current seed sharing landscape.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This paper was supported by funding from the European Research Council under the European Union's Horizon 2020 research and innovation programme [Grant Agreement No. 646883].

ORCID

Anna R. Davies http://orcid.org/0000-0002-3045-8552
Monika Rut http://orcid.org/0000-0001-8305-5987
Jane K. Feeney http://orcid.org/0000-0002-2550-4251

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