

# **Resolving differing stakeholder perceptions of urban rooftop farming in Mediterranean cities: Promoting food production as a driver for innovative forms of urban agriculture**

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**Abstract:** Urban agriculture (UA) is spreading within the Global North, largely for food production, ranging from household individual gardens to community gardens that boost neighborhood regeneration. Additionally, UA is also being integrated into buildings, such as Urban Rooftop Farming (URF). Some URF experiences succeed in North America both as private and community initiatives. To date, little attention has been paid to how stakeholders perceive UA and URF in the Mediterranean or to the role of food production in these initiatives. This study examines the promotion and inclusion of new forms of UA through the practice of URF and contributes to the nascent literature on the stakeholder and public perceptions of UA. It seeks to understand how those perceptions shape the development of new urban agriculture practices and projects. Barcelona (Spain) was used as a Mediterranean case study where UA and URF projects are growing in popularity. Through semi-structured interviews with 25 core stakeholders, we show that UA is largely perceived as a social activity rather than a food production initiative, because the planning of urban gardens in Barcelona was traditionally done to achieve leisure and other social goals. However, several stakeholders highlighted the potential to increase urban fertility through URF by occupying currently unused spaces. As a result, the positive valuation of URF depends on the conceptualization of UA as a social or food production activity. In turn, such conceptualization shapes barriers and opportunities for the development of URF. While most UA-related stakeholders (e.g., food co-ops, NGOs) preferred soil-based UA, newer stakeholders (e.g., architects) highlighted the economic, social and environmental opportunities of local and efficient food production through innovative URF.

**Keywords:** Rooftop farming · Rooftop greenhouses · Urban self-sufficiency · Local production

## **Abbreviations**

NGO	Non-governmental organization
RF	Rooftop Farming
RTG	Rooftop Greenhouse
UA	Urban Agriculture
URF	Urban Rooftop Farming

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## **Introduction**

Urban agriculture (UA) experiences have spread over recent decades in cities in the Global North (Howe and Wheeler 1999; McClintock 2010; Mok et al. 2013; Smith et al. 2013). Consequently, sustainable urban production has become a growing field of interest among academics and professionals (Caplow 2009). UA has even become an extensive land use type in some cities. For instance, in Chicago (USA), a total area of 26.5 ha is devoted to food production in both residential (45.1%) and other types of urban gardens (e.g., community gardens) (Taylor and Lovell 2012).

Traditionally, the most important growth in Urban Agriculture has occurred during times of exceptional crises, such as during food shortages and wars (McClintock 2010; Mok et al. 2013). In North America and Western Europe, *War gardens* (WWI) and *Victory gardens* (WWII) fed people during the war periods with fruit, vegetables, and herbs that citizens planted at private residences and parks across the country. *Relief gardens* were an important contributor to food production during the Great Depression (Bassett 1981). More recently, during the collapse of the socialist bloc between 1989 and 1993 (the Special Period), UA produced a large amount of fresh food in Cuba and still continues to feed a significant number of people in Havana (Altieri et al. 1999; Cruz and Medina 2003).

Recently, UA has increased as a response to the current economic crisis in the Global North, such as in North America (Carney 2011; Taylor and Taylor Lovell 2012). Vacant land and community spaces are being used for UA by activists, community members, non-profit organizations, and local governments to increase food production in cities (McClintock et al. 2013). This trend emerged from the reshaping of urban development and land use by the financial and housing crises, with foreclosures and vacant properties opening up new spaces in cities and increasing food production opportunities (McClintock 2010). Additionally, UA activities respond to limited access to healthy food during economic crisis (Carney 2011). As a result, potential local production in the vacant lands of cities such as Oakland (California) represent as much as 30% of the city's food demand (McClintock et al. 2013). Other cities, such as Detroit, demonstrate the increasing reuse of abandoned urban land for producing food through both community-based initiatives and larger entrepreneurial investments (Dewar and Linn 2014).

In this sense, the primary goal of UA is often the production of food as a tool for achieving urban food security (Carney 2011) and promoting local production (Mok et al. 2013). At the community level, UA has played an important role in low-income communities

and “food deserts” where access to food is limited, and UA has been used as a tool towards food justice (Guy et al. 2004; Wrigley et al. 2004; Smoyer-Tomic et al. 2006; Beaulac et al. 2009; Alkon and Agyeman 2011; Block et al. 2011; Carney 2011; McClintock 2011; Tornaghi 2014). At the individual level, growing food has also contributed to food security, improved health, local production, sustainable farming, and urban self-sufficiency (Kortright and Wakefield 2010). In particular, UA has been part of a growing demand for local products that also aims to re-connect consumers with the producers (Steel 2008). Urban food production also has numerous environmental benefits, such as reducing food transportation distances, improving waste recycling, optimizing food waste, and enhancing urban biodiversity (Howe and Wheeler 1999; McClintock 2010; Arosemena 2012; Guitart et al. 2012; Sanyé-Mengual et al. 2013; Smith et al. 2013).

In response to the growth of UA, decision makers have included UA in planning and policy regulations and local ordinances about land use. For instance, in December 2013, the Boston Zoning Board approved urban farming guidelines that legalize and regulate urban agriculture in the city. In 2010, Chicago published the *GO TO 2040* regional plan to enhance sustainable policies in the metropolitan area. Local food production has an important role in the *GO TO 2040* plan, where local food is promoted by means of supporting urban agriculture, expanding farmland protection and increasing community access to fresh food (Chicago Metropolitan Agency for Planning 2010). At the national level, UA has also become an essential part of food policy in some countries where local food production is meant to be implemented on a large scale (Mok et al. 2013) and where UA-related funding programs have been promoted to support the agricultural endeavors of local producers (Taylor and Taylor Lovell 2012). Furthermore, UA is also rising as a response to the inclusion of food and climate change issues into local political agendas (Tornaghi 2014) and to the development of a food planning agenda from the national to the municipal level (Morgan 2009; Morgan and Sonnino 2010).

Finally, local UA food production is increasingly being seen as a tool for achieving urban food sovereignty (Carney 2011; Kirwan and Maye 2012), which is defined as the community’s right to define its own food and agricultural systems (Via Campesina 2002). UA activities are often related to the creation of alternative food value chains to the global market (Block et al. 2008) and a de-linking of food production from the current industrial food system (Wekerle 2004). As a result, some local food systems are sometimes developed as an alternative to the global agri-business market, which is largely comprised of

multinational grain traders, giant seed, chemical and fertilizer corporations, and global supermarket chains (DuPuis et al. 2011).

Additionally, recent studies have examined the social benefits of UA, which have often become the main motivation for the promotion of UA initiatives. Commonly, socially oriented UA is created at the community level and in the form of community gardens. The social values associated with UA are community empowerment, health improvement, social organization, social cohesion, social inclusion, and education (Howe and Wheeler 1999; Armstrong 2000; Lyson 2004; Lawson 2005; Teig et al. 2009; Block et al. 2011; Carney 2011; Guitart et al. 2012). Gardens also have healing properties at the individual level and can help participants recover from traumatic experiences (Marcus and Barnes 1999; Gerlach-Spriggs et al. 2004).

### Urban Rooftop Farming (URF)

The progressive inclusion of UA in cities has given rise to multiple forms and locations of urban food production in the urban space: from traditional sites, such as community farms, community gardens, backyard farming, and vacant lands to site situated in and on buildings (Cohen et al. 2012; Specht et al. 2014). The use of building spaces for UA has been conceptualized in the literature in different ways: Vertical Farming (Despommier 2011), Zero-acreage Farming (Specht et al. 2014), Building Integrated Agriculture (BIA) (Caplow 2009) and Skyfarming (Germer et al. 2011). Nevertheless, building-based UA forms are numerous ranging from indoor farming by means of high-tech systems to open-air rooftop farming with hand-made pots.

In this paper, we focus on Rooftop Farming (open-air) (RF) and Rooftop Greenhouses (protected) (RTGs), which all come under the umbrella term “Urban Rooftop Farming” (URF) (Figure 1). Both systems are placed on rooftops and devoted to horticulture through different technologies. RF is an open-air system that usually consists of soil cultivation techniques, although soil-less techniques can also be used for specific plants (e.g., hydroponic growing for lettuce). RTG is a protected horticulture system based on the use of a greenhouse structure, and it is mainly implemented through soil-less growing systems (e.g., substrate) (Cerón-Palma et al. 2012). As a result, there are notable differences between the two systems. On the one hand, RF is commonly cheaper than RTG to implement, although the management of structural loads and water is more complex. On the other hand, RTG yields

greater productivity because the climate is controlled, and soil-less systems increase resource use efficiency. However, the expense and complexity of soil-less techniques often render them unattractive options for non-commercial agricultural endeavors.

URF systems have been implemented in North America and Europe. Rooftop Farming (RF) is used both in non-commercial and commercial activities, such as in “Food from the sky” (London, UK) (Local action on Food 2012) and Brooklyn Grange<sup>1</sup> (New York, USA). RTG projects are mostly concentrated in North America and are run by local production companies. As an example, Gotham Greens<sup>2</sup> (Brooklyn, NY) has been producing greens in a 1,400 m<sup>2</sup> RTG since 2011, and Lufa Farms<sup>3</sup> (Montreal) cultivates greens and different varieties of tomatoes, cucumbers, peppers, and eggplants in a 2,900 m<sup>2</sup> RTG.

<Figure 1>

## Research on Urban Rooftop Farming

Literature around URF has dealt with the quantification of environmental and economic balances, agronomic aspects and the theoretical background. Attention has been paid to the potential implementation and contribution of URF to the domestic vegetable production (Astee and Kishnani 2010; Whittinghill et al. 2013; Orsini et al. 2014; Sanyé-Mengual et al. 2015a), the environmental savings of substituting imported products by local URF vegetables (Sanyé-Mengual et al. 2013), and the environmental and economic burdens of local production through Rooftop Greenhouses (Sanyé-Mengual et al. 2015b). Thomaier et al. (2014) reviewed current URF projects focusing on their sustainability aspects.

The barriers and opportunities related to URF have been also identified in the literature. Specht et al. (2014) performed a literature review on opportunities and limitations of building-based agriculture, which they conceptualize as Zero-Acreage Farming (ZFarming). They identified multiple positive impacts in the three pillars of sustainability (society, economy, environment), although only at the theoretical level. Cerón-Palma et al. (2012) paid attention to the barriers and opportunities associated to Rooftop Greenhouses that

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<sup>1</sup> <http://brooklyngrangefarm.com/>

<sup>2</sup> <http://www.gothamgreen.com>

<sup>3</sup> <https://lufa.com/>

technical focus groups (e.g., architects, engineers) identified, thereby providing a comprehensive feasibility analysis. However, there is a lack of studies around the perceptions of current and potential stakeholders involved in UA and URF projects.

## Research objectives

Despite nascent recent URF literature, little research has been conducted to analyze the potential role of URF in urban agriculture. To date, there is a lack of studies—particularly qualitative critical ones—analyzing the relationship of URF with Urban Agriculture from the point of view of the various public and private stakeholders involved in their development and of the perception-related, policy, and contextual constraints behind the development of URF. More research is needed to understand the relationship between the multiple roles played by urban agriculture, stakeholder perceptions of these roles, and the potential of further URF development.

To address these gaps, this paper explores the following research questions:

- (a) How are UA and URF systems perceived in cities where UA has been growing and has been institutionalized?
- (b) Is food production the main driver in the development of UA in such cities? Does URF promote food production in UA?
- (c) What are the perceptions of implementing URF systems in those places? What types of barriers and opportunities are identified by the different stakeholders? How do these perceptions vary among different stakeholder groups?

In other words, this study examines the promotion and inclusion of new forms of urban agriculture through the practice of urban rooftop farming and contributes to the nascent literature on the stakeholder and public perceptions of urban agriculture. It seeks to understand how those perceptions shape the development of new urban agriculture practices and projects. We use qualitative research (semi-structured interviews) applied to a case study of a Mediterranean city—Barcelona (Spain)—with a growing and institutionalized presence of urban agriculture.

## Research design

## Case study selection

The city of Barcelona (Catalonia, Spain) was chosen as a single-case case study (Yin 2008) based on the following criteria. First, Barcelona is a representative case of a Mediterranean city—conceived as a city with a welcoming climate for agricultural production—where both open-field rooftop farming and rooftop greenhouses can be easily implemented. Its sunny and hot climate offers a strong potential for the development of new agricultural practices and techniques such as URF. Rooftop greenhouses could also be useful in order to increase the production of summer crops, such as tomatoes, and offer a winter production without requiring an energetic input to heat the greenhouse, in contrast to European Atlantic or Continental cities. Second, urban agriculture in Barcelona is both developed and growing, and there is much public and private interest in increasing the role and place of urban agriculture in the city. Additionally, there is an increasing institutional and citizen awareness around UA, as well as political support from a variety of municipal programs, including local food coops and community gardens.

To date however, large-scale URF projects have not been planned even though URF can become a key strategy for promoting UA because Barcelona is a densely populated area with limited soil availability (as stated in Dubbeling [2011]) and because discussions on URF have been initiated at the pilot projects level, such as the research oriented RTG in the new ICTA-ICP building (Bellaterra, Barcelona). Moreover, local and ecological production is increasingly valued (Giacchè and Tóth 2013). For example, the metropolitan area of Barcelona consumes 75% of the production of the Baix Llobregat Agricultural Park (BLAP), which is a protected agriculture area of 2,700 ha situated 10 km to 15 km away from Barcelona city (Paül and McKenzie 2013). Moreover, the agricultural production area of Maresme, which represents 17% of total agricultural production in Catalunya (DARPMA 2012), is a source of local produce because it is situated only 30 km to 40 km away from the city. Finally, Barcelona is a focal point of the Southern European food market due to the activity of Mercabarna (food distribution center).

## UA stakeholders in Barcelona

*Current trends and stakeholders involved in the development of urban agriculture in Barcelona*

Our data collection reveals that large-scale urban agriculture (UA) in Barcelona is promoted by the municipal administration through the program *Barcelona Urban Gardens Network* (Xarxa d'Horts Urbans de Barcelona), which is managed by the municipal Department of Environment.<sup>4</sup> Within this program, three types of urban gardens have been developed: urban gardens, school gardens and supported community gardens. Prior to these projects, UA was limited to the development of individual gardens in occupied vacant lands in the outskirts of the city (Ajuntament de Barcelona 2014).

Official UA initiatives in Barcelona began in 1986 with the creation of the urban garden *Hort de l'Avi* (Old men's garden) as a response to the demands of elderly citizens in Barcelona (Giacchè and Tóth 2013). Today, there are 2.5 ha devoted to 13 urban gardens throughout the city. However, these plots are dedicated to a certain group of the population (>65 years old) and are awarded individually. That said, the last urban garden, created in 2011, includes some plots for entities working with people at risk of social exclusion. In addition, the administration supports school and community gardens. Thus far, 315 school gardens have been created as educational urban gardens and as tools for implementing the Schools Agenda 21, which encourages schools to promote sustainable development locally (Ajuntament de Barcelona 2002). Finally, the city hosts community gardens supported by the administration that used to be squatting gardens. These gardens were accepted by the administration after citizens mobilized and implemented strong community building processes. For instance, *l'Hortet del Forat* in the Old Town began as a meeting point between residents who mobilized against the lack of public investment in their neighborhoods and against land speculation (i.e., they began calling the meeting's square *El forat de la vergonya*—the hole of shame), and the garden eventually gained the support of the municipality (Anguelovski 2013).

Apart from the municipality-supported initiatives, other community and individual urban gardens were created during the last decade. “Squatting community gardens” are common. These gardens occupy unused empty spaces (e.g., empty space left after the demolition of an old building). Today, there are 43 squatting community gardens in Barcelona.<sup>5</sup> These gardens are usually managed by a group of young people who clean up the spaces to produce food but also to claim social space and improve the quality of life of the

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<sup>4</sup> <http://w110.bcn.cat/portal/site/MediAmbient/>

<sup>5</sup> <http://www.bcn.cat/agenda21/horts/index.htm>

neighborhood. However, these actions are not supported by the public administration, and squatters often encounter obstacles, such as fines (Giacchè and Tóth 2013). Additionally, Barcelona has many individual urban gardens used as food production spaces in households (i.e., backyard, terrace, indoors).

Land in the urban areas of Barcelona is not commonly devoted to agricultural use beyond those formal urban agriculture initiatives. Land uses are defined in the municipality's zoning plans. In the case of Barcelona, the spatial planning policy has different levels: "Pla territorial metropolità de Barcelona" (PTMB) [Metropolitan regional plan of Barcelona] (Generalitat de Catalunya 2010), local "Pla Director Urbanístic" (PDU) [Local urban master plan] and "Pla d'Ordenació Urbanística Municipal" (POUM) [Municipal urban planning plan]. However, only in the PTMB is the land preserved as a natural resource (i.e., protected natural spaces) or as an agricultural space (i.e., agricultural parks). In contrast, in local zoning, land is preserved for future urbanization.

The economic crisis in Spain has severely affected the country's construction industry, which has in turn increased the amount of vacant land in Barcelona because many urbanization projects were cancelled. As a short-term response to the increase in public vacant land, in 2012 the municipality launched the PLA BUILTS (Vacant Lands Plan) (Ajuntament de Barcelona 2012). The plan consists of a public offer of land to non-profit organizations with the aim of revitalizing vacant lands through community use. Nine of the 14 vacant pieces of land are now managed to create new community urban gardens (La Vanguardia 2013), accounting for an extra 0.7 ha of food production area in the city.

#### *Definition of the potential stakeholders involved in the implementation of URF*

As a preliminary analysis, we identified the potential stakeholders involved in the implementation of URF in Barcelona city. This analysis focused on the different stages of the implementation of URF and their products (i.e., food products)—design, construction, production and consumption—because stakeholders are related to different stages. We also included potential promoters and opponents. The categories of stakeholders were chosen based on the key actors that the existing literature identifies in the urban agriculture and food planning community (Morgan 2009; Morgan and Sonnino 2010; Despommier 2011; Tornaghi 2014), on our knowledge of current UA and URF experiences in Barcelona, on

snowball sampling with initial key stakeholders, and on the use of media information on existing stakeholders.

The resulting map of stakeholders (See Figure 2) combines all of the current stakeholders involved in urban agriculture (e.g., public administration, urban gardeners), the local production movements (e.g., consumers, food coops) (Giacchè and Tóth 2013) and the potential stakeholders related to the implementation of URF (e.g., architects, engineers, new producers). As part of our data collection process, we identified specific stakeholders within the same stakeholders' group who might have potential opposite perceptions. For instance, within the public administration, different offices can become supporters or opponents depending on whether they see URF as an opportunity for improving the environmental performance of products or as a problem due to, for instance, sanitary or economic factors. We also interviewed urban gardeners because of their important role in developing and promoting urban food production in Barcelona, as well as architects because of the importance of the legal and structural dimensions of using parts of buildings for food production.

<Figure 2>

Data and definitions

#### *Data collection*

We conducted semi-structured interviews with 25 participants during the course of this study. Participants represented the breadth of stakeholders' groups identified in the previous section and were chosen with the aim of understanding their experiences, points of views, and visions concerning four main topics related to URF: urban agriculture, sustainability, food systems, and urbanism and buildings. Much attention was paid to the potential implementation of URF systems, meaning that we looked closely at the opinions of the stakeholders within the city administration who could play an important future role in promoting URF (See Table 1).

<Table 1>

Interviews were conducted from May 2013 to September 2013 and lasted from 30 minutes to 2 hours. We structured the interviews around three themes: agriculture and urban environment, urban agriculture, and urban rooftop farming. The first part explored the definitions of agriculture and urban agriculture as well as the agriculture-city relation. The second section of the interview was focused on discovering the involvement and perceptions of UA projects in the city of Barcelona. The third part was devoted to urban rooftop farming and to examining the knowledge, involvement and perceptions of the stakeholders in relation to the potential implementation of Rooftop Farming (RF) and Rooftop Greenhouses (RTGs) systems. In this last section, we paid special attention to the opportunities and barriers that stakeholders associate to URF. We analyzed the data through grounded theory methods (Corbin and Strauss 1990) where the transcripts and the field notes were open coded to identify key concepts and their relationships, and to avoid imposing pre-conceived theories on the data. This data collection and analysis was complemented by secondary data collection, including maps, reports, and press releases.

### *Definitions of key concepts*

In this section, we define the concepts related to agriculture and food that we use in our qualitative analysis. During the study, we differentiate between agriculture and horticulture to specify the production type. Horticulture is a branch of the agricultural sector that includes the production of vine fruits, vegetables, nuts, aromatic and medicinal plants, and ornamental and landscaping plants, as defined by International Society of Horticultural Science. Second, the location of the agricultural activity is used to differentiate three types of agriculture in the analysis:

- Urban agriculture refers to agricultural activities performed within the city limits
- Peri-urban agriculture is defined as agricultural activities performed in the urban fringe, outside the city limits.
- Rural agriculture refers to agricultural activities not performed in urban areas, neither inside nor the fringe.

In regard to food concepts, food security (Carney 2011) refers to the access of citizens to healthy food, in quantitative terms (i.e., amount of food). By contrast, food insecurity is used when stakeholders lack of access to an amount of food that can satisfy their needs. The

right to healthy, fresh, local, and affordable food for community food security has been at the center of community advocacy for food justice (Via Campesina 2002; Hess 2009; Gottlieb and Joshi 2010; Alkon and Mares 2012). Food safety considers the quality of food, in qualitative terms (i.e., freshness, health). Food sovereignty includes the access to food and production resources (e.g., including land access, economic resources), in social and political terms. It refers to the capacity of individuals and groups to control their access to food and define their own food systems(Via Campesina 2002; Alkon and Agyeman 2011).

Finally, the analysis focuses on perceptions, conceptualizations, and drivers. Perceptions include the opinions, stories, and experiences of stakeholders (e.g., identification of opportunities). Conceptualizations are the specific definitions that stakeholders link to different elements and systems (e.g., defining agriculture). Drivers are the motivations behind decisions, thereby include the main objectives of projects (e.g., addressing social exclusion).

### **Data analysis: the potentials, opportunities, and constraints of expanding urban agriculture in Barcelona**

In this section, we show that the acceptance of URF and its potentialities in Barcelona mostly relies on shifting the driver of UA from social values to food production itself, or at least on bringing the social goals of UA with its food production potentialities together closely.

Differing perceptions and definitions of urban agriculture in contrast to experiences on the ground

In this section, we examine how UA and URF systems are perceived in Barcelona. Through our analysis, we found three main trends on how stakeholders conceptualize UA and how this conceptualization affects the perception of URF (see Figure 3). First, periurban stakeholders do not include UA in their definition of a real agriculture, producing a conceptual barrier for supporting any kind of UA activity. Second, among those stakeholders, those that define UA as a real agriculture, the purpose of the activity becomes the defining factor for supporting different types of projects. On the one hand, some urban stakeholders (i.e., urban gardeners, administration, NGOs, food coops, food managers) only conceptualize UA as a socially oriented activity. In those cases, they do not support URF because the initial investment

required for the activity is perceived as too high. Within this group, stakeholders who focus their attention on local production (i.e., NGOs and coops) value the food production function of periurban agriculture but only perceive the social functions of urban agriculture. On the other hand, when stakeholders (i.e., urban gardeners, regional administration, architects) value UA as a food production system, they usually accept the development of RTGs as yields are increased, thereby valuing the potential environmental, social, and economic benefits tied to local production within the city. This social-production conflict is further discussed.

<Figure 3>

Among the interviewed stakeholders, UA is not universally perceived as “real agriculture,” which some stakeholders define as an activity that can only be located on agricultural land and performed by professional farmers (i.e., people trained for agricultural activities that perform a paid labor). This lack of consistency when defining agriculture acts as a barrier to implementing both UA and URF in Barcelona. Such a reality is reflected in the words of some professional stakeholders involved in periurban agriculture:

There are no professional farmers and Urban Agriculture is not developed on agricultural land [...] Understanding that you can feed the citizen through UA is uncertain. There is a risk of confusion... It can be complementary but in the city it cannot be considered as agriculture [...] and it wouldn't be agriculture, which also conserves the territory and has other functions [...] Agriculture is also landscape (Managers of the Baix Llobregat Agricultural Park, BLAP).

The different conceptualizations of Urban Agriculture in Barcelona are built on what stakeholders see as a weak and distant relationship between agriculture and cities. There is a lack of current and real integration of agriculture in the city resulting from the long expulsion of agriculture from Barcelona due to industrialization and urban development. Additionally, many production spaces were converted into urban parks and land speculation areas. The following stakeholders describe clearly the disconnection between agriculture and the recent history of Barcelona:

The current relation is distant. We don't realize the importance of rural areas and how the city needs them [...] We are out of place, and we have little knowledge about farming (Urban garden user).

Cities have turned their back to agriculture (Environmental NGO based in Barcelona).

The relation city-agriculture is completely opposed [...] Rural area or agriculture (as opposite to city) is defined in economic terms as an area for which the price is based on the capitalization of the agricultural activity. However, prior to industrialization, the relation was different. Agriculture was integrated in cities through backyards, gardens (Architect).

On the ground, however, the spread of UA in and around Barcelona has become an emerging economic activity. For instance, in Cardedeu (Barcelona province), *L'hort d'Esbiofera* offers training courses for urban gardeners, and the community garden *Phoenicurus* commercializes its produce through a local cooperative (EU'GO Project 2014). In other countries, such as in North America, UA has generated a new sector of local production that has created green jobs (i.e., new professional urban farmers) in URF and community farming businesses (e.g., the abovementioned Gotham Greens, Lufa Farm and Brooklyn Grange). UA in Barcelona is on a similar path to developing a green economy.

Moreover, UA in Barcelona has an important effect on the urban landscape by greening urban areas and buildings. For example, the initiative “Recreant Cruilles” has turned an abandoned plot of land (abandoned due to the non-execution of public projects) into a community space with gardens while improving the plot's aesthetics and bringing green space into the neighborhood (which currently only has 1.37 square meters of green space per inhabitant).<sup>6</sup> Thus, some characteristics of UA in Barcelona may match the definition of “real agriculture” defined by some of the stakeholders. Therefore, there is a need to revisit the concepts around periurban agriculture and UA to include the reality of UA in their definitions. Even more, the definitions of UA may be geographically contextualized and may vary depending on the multiple forms that UA can take.

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<sup>6</sup> <http://recreantcruilles.wordpress.com/>

## The difficulty of making URF as a municipal priority

### *A much needed shift from social benefits to food production in UA*

Our interviews revealed that the stakeholders most closely affected by current UA initiatives (i.e., administration, urban gardeners, NGOs, coops) are largely concerned with the social values of such initiatives and therefore perceived UA more as a socially oriented activity and as a practice with healing and therapeutic goals for traditionally vulnerable groups in the city. Most UA-related stakeholders identified leisure and self-sufficiency as the drivers for current public and private horticultural experiences in Barcelona. Specifically, education is the main motivation for school gardens, where children learn earth sciences and farming and cooking skills. Additionally, therapeutic goals were also identified from working with people with disabilities. Current institutionalized forms of UA initiatives (e.g., Vacant Lands' Plan) also focus more on this therapeutic value and on social inclusion activities by including local and social organizations in the development of UA projects. This perception of UA originates in the fact that the first UA actions in Barcelona were geared toward addressing social needs (i.e., urban gardens for retired people). The promoter of urban gardens in Barcelona described the origin of urban gardens as follows:

Urban gardens are pieces of land (30–100–150 m<sup>2</sup>) assigned by the City Council for five years. The approach is a leisure form of UA initially designed for old people. The idea was to improve their health by providing an open-air space for a hobby [...] This is a social initiative rather than an economic one [...] So, they are dedicated to families and contribute to their self-sufficiency (Promoter of urban gardens in Barcelona).

In such a vision, the food production function is eclipsed by the potential social benefits of current UA activities. Therefore, although URF attempts to increase the fertile area and the associated food productivity of cities, many stakeholders in Barcelona perceive URF as a complex system with costs and obstacles largely superior to the potential benefits. Furthermore, although some stakeholders (i.e., coop users, urban gardeners, environmental NGOs) consider positively the use of rooftops for horticulture, they do not accept the use of soil-less techniques for increasing crop yields because such techniques are perceived as a non-sense option: RTGs are unnatural, detached from the land, provide low quality products,

and require the use of an expensive technology. As a representative from the Network of Cities for Sustainability explains:

The needed infrastructure... and the soil-less techniques... RTGs are related to an important investment that doesn't seem feasible unless driven by a private company. Then, if the social part is only complementary, the activity is not so interesting [...] A piece of land is cheap; you give it to them, labor is free... An RTG is not so cheap. In the long-term, it is more productive and makes sense, but not for a social activity (Network of Cities for Sustainability).

Beyond the perception of URF, the desired spatial distribution of food production in the city depends on the public's conception of UA. Some stakeholders who support local food promotion do not identify the city as a potential production area because UA is perceived as socially oriented agriculture. Urban gardeners, food coops and NGOs thus only see periurban farming as a source of local "urban" produce. These stakeholders commonly promote periurban farming and social initiatives in UA but pay little attention to UA projects focused on food production. This perception is also linked to the specific urban morphology of Barcelona, which is a small and compact city compared to other metropolises. For instance, the respondent from the Urban Development Agency of Barcelona valued the great potential of large industrial roofs in cities such as New York, but not in Barcelona where industries were displaced to the outskirts and replaced with residential and services buildings:

In New York, industrial buildings [that were initially placed in the urban fringe] were progressively absorbed by the city. Then, within the urban fabric there are buildings with large and resistant roofs that can be reconverted into urban gardens, rooftop gardens or even rooftop greenhouses, thereby being in direct contact with citizens and consumer" (Urban Development Agency of Barcelona).

However, when stakeholders identify food production as the main function of UA, URF is positively valued as a driver behind urban food security. A few of the UA-related stakeholders, such as some urban gardeners, consider URF as a potential change towards a more productive UA. New stakeholders involved in URF (e.g., architects) establish food production as the main motivation for promoting UA and, consequently, positively consider

URF and RTG as new UA forms. The technical solutions offering higher yields (soil-less systems) and longer crop periods through the use of greenhouses have increased interest in UFR and RTG. Therefore, URF can reshape how UA is being used and promoted in Barcelona and can transform the city into a more productive place that promotes UA to alleviate food insecurity while taking advantage of the resultant social benefits, as an urban garden user emphasizes:

I think that URF can be a very useful way towards initiatives for food production that aim at closing cycles. There have been enough community activities for social and educational purposes and, maybe, it is time to change to a real productive UA (Urban garden user).

#### *The potential of enhancing food production through local urban sustainability policy*

This social versus production dichotomy within UA plays an important role in the inclusion of local food production in the development and implementation of urban sustainability policies in Barcelona. At the regional level within Catalonia, existing sustainability programs include different aspects that can be related to URF as they seek, among others, the optimization of energy resources, the increase of local production and the development of a green economy, as outlined by the Department of Territory and Sustainability of the Government of Catalonia:

Among the sustainability policies, there are different aspects where URF fits. Broadly, the Catalan Strategy for Sustainable Development includes climate change mitigation, water, chemical products, GMOs, the green economy and the creation of green jobs. Therefore, URF could be an innovative activity for generating green jobs without increasing environmental impacts (Government of Catalonia).

Moreover, as indicated by the local administration, self-sufficiency is one of the key aspects within the 2050 Roadmap, not only at the energy level but also for reducing consumption by becoming more efficient. Thus, stakeholders identified the minimization of transportation distances through local production as an important value to consider in future urban sustainability policies. However, this opinion contrasts with the perception of other

members of the local administration who perceive local production as an unimportant target, such as staff members from the Office of Economic Promotion who center their attention on sustainable mobility. That said, both areas (urban habitat, economic promotion) have in mind similar goals for local policymaking: economic potential and climate change mitigation.

Furthermore, at the local level, although UA fits well with plans, policies, and discourses, it is still perceived as a complicated scheme for implementing on a large scale. UA matches new planning trends in Barcelona that aim at converting vacant lands or green parks into urban gardens. UA and URF are in line with the discourse that cities must be fertile again. Beyond food production, RTG responds to the need to improve the energetic performance of buildings through the interconnection of flows between the building and the greenhouse matching the energy programs of the Barcelona government, as stated by an urban planning lawyer.

However, local decision makers outline several technical and financial constraints when they discuss the potential of URF, particularly RTGs. When compared to current soil-based UA projects, URF requires a higher technology level (e.g., hydroponics, greenhouses, rooftop adaptation). The related complexity and economic cost is the most critical aspect of URF. Since the driver in official UA projects is social rather than productive, these aspects are not balanced with the potential local food production from URF. A member of the Barcelona City Council explains:

URF is complex (e.g., rooftop's property) and requires an investment that the city cannot face in the current economic context, although it perfectly fits with the sustainability discourse [...] There are several benefits, but the cost is too high [...] Currently, we are promoting UA in vacant lands, where the public cost is only the adaptation of the land for the activity, and such activities are promoted for social activities, for local organizations [...] Regarding jobs and food production, the local administration is planning a project for social companies, which only aims at job creation for disabled people (Urban habitat, Barcelona city council).

In other words, although food production and its opportunities (e.g., self-sufficiency) can be inserted within urban sustainability policies, the potential of systems oriented toward food production (e.g., RTG) is not considered as a feasible alternative for the near future. The way in which most stakeholders in charge of decision making conceptualize UA—as a socially

oriented activity—negatively affects the creation of new UA systems designed to increase productivity in urban areas.

### *Developing URF for food sovereignty through an alternative and equitable use model*

Because URFs have yet to be implemented in Barcelona, stakeholders discussed three main use models for them: commercial use (private company), self-sufficiency use in public buildings (both community and single), and self-sufficiency use in residential buildings (both community and single). These models are important in influencing how stakeholders perceive URF because some stakeholders do conceptualize UA as a potential local food model. They seek a use model that is equitable and supports food sovereignty in Barcelona. Therefore, the ideal use model would be a self-sufficiency, community-based URF that would be independent from global markets and could take place in public buildings and in new social housing. It also would help socially fragile communities achieve greater food sovereignty since they would have control over how and where their food is consumed. For instance, food would be produced on the rooftop of social housing buildings, with the possibility of paid labor for residents and of food consumption by the residents themselves:

The commercial is not interesting... We want to close the cycles. If I produce the food in my rooftop, it should be for my consumption (Coop user).

Social housing [would be envisioned] beyond a low-cost rental, where also electricity and water costs can be low, and self-consumption and self-production can be included [through URF]. Then, self-sufficiency would be promoted (Network of Cities for Sustainability).

Thus, there is a group of stakeholders from the administration, food coops, and groups involved in UA activities (e.g., urban gardeners) that want to address social disparities and create a food production system accessible to everyone by using UA and URF as tools against capitalism and the power of agribusiness. These stakeholders support URF based on various factors, such as accessibility and users' decision making power. Their vision is meant to ensure an alternative model that guarantees the fulfillment of a basic need (i.e., food) under terms decided by community members and users. They insist on the need for a URF that

exists outside the capitalist system, which concentrates production in the hands of a minority while negatively affecting the environment, the economy, and society.

Current barriers to and opportunities for URF: coupling sustainable local production with technological complexity

Respondents reported different barriers and opportunities regarding the future implementation of URF systems. All of the respondents identified environmental, economic, and social opportunities that would positively contribute to urban sustainability. However, they also identified some barriers, particularly those regarding legal and technical constraints. A summary of barriers and opportunities is offered in Table 2.

The results varied between different stakeholders' groups, although all of them identified environmental and social opportunities. Most of the stakeholders from the administration supported RF but not RTG due to economic, legal, and technical barriers. However, some offices did positively value RTGs due to their potential to develop a green economy and the potential optimization of a closed-flows system. UA-related stakeholders also observed environmental and social benefits because they pursue socially oriented URFs rather than commercial initiatives. However, stakeholders also noted economic barriers and potential social constraints, such as accessibility. Despite this general trend, a couple of UA-related stakeholders underlined the great opportunity of RTGs to increase food production in cities and the resultant environmental, social, and economic opportunities. Architects had a common opinion on RTGs and mentioned the potential opportunity to exchange metabolic flows between greenhouses and buildings. Architects identified technical and legal barriers but considered them easy to overcome with the support of the administration. Stakeholders that promote RTGs underlined business benefits while pointing out current legal barriers, such as administrative permits for rooftop usage and for greenhouse implementation. The food distribution company found RTG a positive system in environmental and social terms but expressed doubts about its economic feasibility. Finally, the manager of a green spaces company noted logistics and management as important barriers but positively valued RTGs not only for horticulture but also for gardening and value-added products (e.g., dried tomatoes).

<Table 2>

### *Environmental aspects*

Beyond the usual environmental opportunities offered by local food production, such as the reduction of pressure on fertile soil and of food miles, stakeholders underline new environmental benefits at the urban scale and at the building scale. First, URF can improve the air quality of urban areas by sequestering carbon and other contaminants. Moreover, URF promotes the greening of urban landscapes. However, both benefits are more associated with RF than with RTG because RF is an open-air activity. Second, there are opportunities for potential energy savings due to improved building insulation. Finally, the environmental benefits associated with horticultural production are related to the optimization of water consumption and the potential recycling of organic waste. One of the most interesting opportunities observed by the stakeholders is the potential increase of crop yields due to urban air contamination:

Here [in Mercabarna] we have a treatment plant [for the food waste], which generates an important amount of air emissions... At this green point, we have a green barrier where plants grow much because of the substances in the air (such as carbon dioxide emitted during natural fermentation) (Mercabarna).

Both systems (RF and RTG) can benefit from this urban fertilization, although RTG can achieve higher yields by closing the cycles with the building (e.g., residual CO<sub>2</sub>). For instance, architects highlight the potential reduction of CO<sub>2</sub> emissions through the recirculation of residual CO<sub>2</sub> from the building to the greenhouse and the reduction in energy consumption, which also generates cost savings. In this sense, URF systems respond to the need for more productive and sustainable urban food systems. The resultant synergies are of great interest not only for horticultural production but also for the building itself:

Soon, buildings will have to achieve zero-consumption and, within this, we should add a certain productivity to the own building. The water cycle has been deeply studied, such as rainwater harvesting for non-potable uses. We need to close the flows. The more we close the cycles of a building, the better environmental profile it has: less energy, less material, less water, fewer imports (Generalitat de Catalunya).

Stakeholders identified few environmental barriers. Environmental opportunities and potential impact savings of local production were mentioned by all of the respondents as the most common opportunity of UA. Barriers were mostly related to the organic waste management of the horticultural production system, which cannot be used as fertilizer in soil-less systems (RTG). Some of the stakeholders noted that a local food system should guarantee that the organic waste generated can be absorbed by the city.

### *Technical aspects*

Respondents identified various technical constraints for implementing URF. The inclusion of agriculture in cities shows some logistical barriers regarding the transportation of inputs and outputs (resources, produce, and generated waste). In regards to crop management, the use of chemicals (fertilizers, pesticides) for food production may be restricted due to safety regulations. Several other technical barriers include water management, structural loads, integration on existing buildings, and the risk of contamination due to air pollution. Some stakeholders noted that the use of greenhouses in RTGs is unnecessary for the climate conditions in Barcelona. Finally, the Municipal Institute of Urban Landscape does not support greenhouses because they disrupt the visual image of the city. Some stakeholders describe these barriers as follows:

Is the inversion worthy? Rooftop farming needs a larger economic investment for reinforcing the rooftop, the infrastructure, and even more, when considering a greenhouse production... Soil-based urban agriculture is cheaper... You just need to prepare the soil. (Local administration)

There are some technical barriers that need to be addressed in URF projects. The structural loads... we need to check resistance or reinforce the rooftop [...] The water management can be also a technical barrier if we need to storage it... more load. (Architect)

The current legislation in Catalonia does not consider the implementation of horticultural systems on the rooftops of buildings. A respondent who attempted to install a

RTG on the top of his restaurant (to produce his own local and fresh vegetables) was declined permission due to strong legal barriers, which he did not manage to overcome even after meeting with several departments of the Barcelona City Council and adapting the project to their requirements:

Although the project was already designed, it couldn't be implemented. During 2 years (2010–2011) the project was negotiated with different departments of the city council, but the final answer was always negative. At the end, the innovation aspect of the project was not valued [...] Barriers were, first, planning, because we are located on the waterfront and zoning documentation does not consider food production as a potential use; then, the barriers changed to the urban landscape because all restaurants situated on the waterfront were all designed the same way and the local administration was unsure about changing this pattern. Finally, the barriers were related to ownership. I rent this space, and the contract expires in six years, and the city council did not guarantee the contract extension to ensure the payback of the infrastructure (RTG promoter).

### *Social aspects*

Different stakeholders point to a variety of social opportunities emerging from URFs, although opportunities depend on the type of UA to be implemented in URFs. As a result, the social values attached to commercial URFs are only related to the local production of food, while stakeholders identify further social benefits for community activities, such as community building. Several stakeholders underline the current social values created by UA initiatives in Barcelona as well as the growing interest in the creation of cooperatives. These coops boost local food consumption and revitalize the local community, enhance learning, and create a meeting place in the neighborhood for socializing.

Furthermore, the increase in consumer awareness was one of the aspects of UA that interviewed stakeholders valued most. Becoming involved in UA activities enhances the valuation of seasonal, organic, and environmentally friendly food products as well as the growth of value-added products (e.g., marmalade). Several respondents highlighted that URF would allow children to learn about the origins of the foods they consume and adults to become more conscious of seasonal and quality products by participating in learning

activities in buildings just around them in the city. The increase in consumer awareness and knowledge is one of the social aspects of UA that professional farmers from periurban areas value the most:

URF can be a way for increasing the awareness and knowledge about periurban and professional agriculture. However, this “real” agriculture should also be explained when promoting UA activities (BLLAP managers).

However, stakeholders also identified different social barriers to the development of URF. Low user acceptance could lead to a lack of involvement of neighbors in community URFs, particularly when there is no real need for producing one’s own food. Several stakeholders even highlighted the potential social indifference of customers likely to keep seeking their perfect red tomatoes rather than becoming aware of the value of local products. Moreover, the occupation of the rooftops and the potential use of URFs in residential buildings could have several management barriers. For food production initiatives, the lack of trained personnel could become a constraint. Finally, when implementing RTGs, a lack of social acceptance of soil-less techniques may arise. In some cases, social disparities and a lack of financial resources can also become important constraints because RTGs require a high capital investment compared to RF or soil-based UA forms.

### *Economic aspects*

The local production of food using URF can considerably reduce costs related to food production and consumption, mainly because of the avoided distribution step, which also represents a decrease in food losses during the lifecycle of horticultural products. Moreover, the efficiency related to RTG would also mean a reduction in production costs due to a reduction in crop inputs consumption (e.g., water). Finally, an RTG that exchanges flows (i.e., water or energy) with the building would boost resource efficiency. Rooftops are currently unproductive spaces in cities (90% of roofs in Barcelona) and most of the stakeholders noted the importance of valuing these spaces as a resource. Stakeholders emphasize that growing crops on rooftops, similarly to producing solar energy on rooftops, is compatible with other land or roof uses in a city, particularly in dense cities such as Barcelona, where space is limited.

However, several respondents (e.g., NGOs, food coops, local administration, urban gardeners) perceive URF as an expensive system (particularly RTG) with economic barriers expected due to the narrow margin from sales of horticultural products. To allow urban producers engaged in URF to earn a decent salary, the price of urban produce may need to be high, thus creating affordability issues for local residents. Notwithstanding these barriers, some stakeholders noted that URF may have some added value because it may become a brand (e.g., “tomato from Barcelona”). Furthermore, URF can enhance the positive image of a company or contribute to its Corporate Social Responsibility (CSR) goals (e.g., educational programs). Different locations can be used to implement RTGs with this objective, ranging from hotels to shopping malls and restaurants. As an urban planning lawyer explained:

The topic is interesting also for the own image [of companies], such as a restaurant or a store that could sell the product that is cultivated on its rooftop (garden). This gives an added value to both the product and the company. When observing the greenhouse attached on the building of a restaurant or a shop, the consumer can directly identify them as companies that promote local vegetables [for their consumption or their retail] (Urban planning lawyer).

Finally, both UA and URF were identified as good opportunities for improving local economic trends and creating innovative and green jobs as part of the green economy and the environmental sectors. In a country such as Spain where unemployment is rampant, URF can unleash entrepreneurialism and promote new economic projects:

It can be an opportunity for addressing the current financial crisis. Unemployment rates are high and entrepreneurship is an option. Moreover, people have the time for self-organizing to access an unused space which, with a certain inversion, can return a profit (Generalitat de Catalunya).

## **Discussion**

This study has examined the promotion and inclusion of new types of urban agriculture through the practice of urban rooftop farming. It contributes to the nascent literature on the

stakeholder and public perceptions of urban agriculture and exposes how those perceptions shape the development of new urban agriculture practices and projects.

### Contrasts in the definition and values attributed to UA in Barcelona

The FAO defines urban agriculture as growing plants and raising animals within cities. However, the scholarly literature offers multiple definitions about UA, from definitions where UA is limited to horticultural activities, animal husbandry is excluded from UA, or the periurban fringe is included in UA (such as in Taylor and Taylor Lovell 2012; Giacchè and Tóth 2013; Mok et al. 2013; Tornaghi 2014). This also occurs when defining UA in Barcelona where the stakeholders we interviewed had diverging opinions of what constitutes UA, based on the values they attach to it (i.e., social or food production), the professionalization degree of gardeners (i.e., real or amateur agriculture) and the spatial situation of the plot (i.e., periurban or urban agriculture). These different views create an ambiguous starting point for further developing UA initiatives because the way UA is perceived strongly depends on the conceptualization of UA itself. There is thus a need to formulate a common definition of UA in Barcelona to alter the fact that different groups of stakeholders base their perceptions on contradictory definitions. A common definition would help establish the grounds for a growing UA in Barcelona in which a diversity of stakeholders can take part.

In developed countries, food production is generally seen as the common driver for UA activities, even in projects that address strong social needs, such as community building (Kortright and Wakefield 2010; Carney 2011; Kirwan and Maye 2012; Taylor and Taylor Lovell 2012; Mok et al. 2013; Smith et al. 2013). For example, the Growing Power project in Milwaukee, which works to enhance community access to fresh and healthy food, education opportunities, and food justice, produces a significant amount of food. Nonetheless, stakeholders in Barcelona clearly differentiate between social UA or productive UA, instead of identifying a social and productive UA. As a result, food production is not the main goal of current UA projects. This is related to three main aspects: the origin of UA, the specific urban morphology of Barcelona, and the lack of food planning priorities in the city. First, in Barcelona UA activities originated from social and therapeutic motivations, whereas in other regions of the world UA often arose as a response to episodes of food insecurity (food shortages, wars) (Kortright and Wakefield 2010). In such cases, UA is still largely a food

production activity with some additional social benefits on the side. Second, stakeholders in Barcelona do not link UA to a significant potential for food production due to the small size of land resources available in the city. Finally, although food planning is a hotspot in urban agriculture development (Morgan 2009; Morgan and Sonnino 2010), it is still absent in the Catalonian food and agriculture legislation and in the UA development framework in Barcelona.

As a result, UA in Barcelona is largely developed and promoted for its social value rather than for food production, which shapes the place given to URF in the development of UA in the city. Thus, instead of solving food problems by promoting productive UA activities, public-supported UA models can be linked to green washing practices (Tornaghi 2014). While URF aims to increase food yields and urban productivity (Despommier 2010; Despommier 2011; Germer et al. 2011; Cerón-Palma et al. 2012), most stakeholders did not view such techniques and practices positively. Therefore, the acceptance of URF and its potentialities mostly relies on shifting the driver of UA from social values to food production itself. Moreover, as perceptions of “local products” and local food production mostly concern periurban areas (whereas the city itself is not perceived as productive), institutional efforts to promote local production and consumption are concentrated on periurban farming, such as the Baix Llobregat Agricultural Park (BLAP) (Paül and Tonts 2005; Paül and McKenzie 2013), rather than on the farming of urban areas themselves.

Despite the fact that UA and URF respond to the challenges of regional and local environmental policies, such as climate change mitigation and adaptation, such discussions are currently missing in the urban sustainability policies of Barcelona. This absence is contrary to global trends that progressively include UA in local sustainability policy (McClintock 2010; Mok et al. 2013), such as London’s zoning policy (London Assembly 2010) and Chicago’s GO TO 2040 policy (Chicago Metropolitan Agency for Planning 2010). Thus, the absence of UA in the current sustainability policies of Barcelona suggests that the perception of UA as a socially oriented activity rather than as a food production activity only slows down the process of creating UA policies and institutionalizing them through sustainability planning. There is a lack of trust in the sustainability benefits of local production. Consequently, the municipality privileges other strategies (e.g., sustainable mobility).

Our results show that defining more equitable UA forms that can help achieve greater food sovereignty, and can offer an alternative to the current food system are greatly relevant. This trend is common in UA movements (Block et al. 2011) because UA is seen as a

potential mechanism for political and social change (Cohen et al. 2012). The importance of avoiding existing social disparities present in alternative local food movements (Guthman 2008), such as reduced access to RTG products (Ackerman 2011), is a key issue for some stakeholders, mostly those who are currently involved in UA activities.

### Environmental, social, and economic barriers and opportunities for URF

In this study, we identified several barriers and opportunities, and compared them to two previous studies on the topic of URF (Table 2). In 2012, Cerón-Palma et al. (2012) analyzed the barriers and opportunities of RTGs through expert roundtables. In 2013, Specht et al. (2013) reviewed the benefits and limitations of urban ZFarming (understood as building-related urban agriculture forms).

Our study not only identified common environmental opportunities for URF, such as carbon fixation (as demonstrated by Jun Yang et al. (2008) for green roofs) but also pointed to new opportunities for RF (recycling of organic waste) and for both RF and RTG: increasing horticultural yields, enhancing closed cycles, and improving the habitability of buildings. However, environmental barriers differed from previous studies and no environmental barriers were found for RF. Finally, the integration of URF into existing buildings was noted as a technical barrier, although several other barriers were added: logistical constraints, crop management limitations, and legal barriers for rooftop usage.

In terms of social opportunities, respondents highlighted the enhancement of food security (Kirwan and Maye 2012; Barthel and Isendahl 2013), the linkage of consumers to food production and the provision of educational tools on food production (Kortright and Wakefield 2010). Beyond previous studies, stakeholders also valued community building and an increase in consumer awareness as social opportunities for URF. In addition, we identified a lack of training, user acceptance and involvement, and management (i.e., in community models) as barriers.

The valuation of unproductive spaces (defined as “wasted spaces” in Gorgolewski et al. [2011]), a reduction in costs, local development, and potential transformed products stemming from URF were the key economic opportunities that stakeholders mentioned. However, our study also revealed the importance of Corporate Social Responsibility and the positive image that companies can harness when implementing sustainable systems, such as URF. Regarding economic barriers, the narrow margin of URF products (such as in the

Catalan market), competition with other uses and investment costs (particularly for RTG) were similar to the ones mentioned in previous studies. Consumer acceptance was an economic barrier underlined in our study because some stakeholders perceived air pollution or soil-less techniques as potential constraints. In contrast to Specht et al. (2013), stakeholders did not note that URF commonly focus on the production of certain crops (e.g., vegetables) while excludes other types of food, such as rice or wheat.

## **Conclusions and future actions**

Following global trends, UA is spreading throughout Barcelona, mainly as a response to the current financial crisis that has created vacant plots of land around the city (due to the collapse of the construction sector) and an increase in demand for urban gardens. There are multiple perceptions of UA and URF in Barcelona, which reflect the plural definitions that stakeholders assign to urban agriculture. Our results show the presence of three differentiated groups. Periurban actors conceptualize urban agriculture as a false agriculture and, as a result, they do not support UA or URF. Some stakeholders (i.e., local administration, urban gardeners, NGOs, food coops) conceptualize UA only as a socially oriented activity and exclusively support soil-based UA. Last, other stakeholders groups (i.e., regional and local administration, architects, urban gardeners) do support both UA and, in particular, URF, and highlight the potential food production of these systems.

Contrary to other cities where UA has recently grown, a social-production conflict exists when supporting URF activities in Barcelona due to the origin of UA, the urban morphology, and the lack of a food planning framework. Consequently, the main driver of UA projects in Barcelona is addressing social needs rather than food production needs. However, stakeholders who support URF systems also claim that these projects can support urban food production, thereby changing the driver of the current socially oriented UA to a productive UA.

In this sense, Urban Rooftop Farming (URF) is perceived as an innovative way of producing food within city limits by using unused space on buildings. However, some stakeholders negatively perceive soil-less techniques and the use of greenhouses (Rooftop Greenhouses, RTGs) because they do not consider potential improvement in crop efficiency as an important variable in a cost-benefit evaluation. URF supporters particularly value RTGs because greenhouses and buildings can exchange residual flows (e.g., residual heat, residual

CO<sub>2</sub>) and simultaneously optimize food production and building systems. Despite the potential of URF, some barriers include economic investment, potential disinterest of users and consumers, and current legislation that already blocked an RTG project in the city of Barcelona.

Even so, various actions can help lift such barriers, particularly through the participation of the administration, research institutes, and private initiatives into the concrete planning of RTG projects. Research entities already involved in the study of URF would need to cover research gaps and determine the sustainability balance of URF (covering both potential benefits and impacts). Finally, private companies could promote URF in Barcelona by financing pilot projects or developing their own entrepreneurial rooftop farming initiatives (similarly to companies in North America). Current legislation and bureaucracy, such as zoning, should also be revisited to ease the implementation of URF. For instance, the incorporation of food production as a potential use of rooftops in the planning legislation may weaken existing legal barriers to URF. A greater endorsement of new projects by different municipal departments would also bestow a greater legitimacy to URF. These departments may play key roles in the revision of the legislation, in the development of local policies to promote local production, and in the dissemination of information on the benefits of URF.

Finally, the results of this study demonstrate that pilot projects are necessary for verifying the feasibility of URF systems, obtaining results (e.g., the potential energy savings of RTGs in a service building), and communicating the potentialities of URF to legislators and planners. Moreover, the use of pilot projects for education would help avoid the negative preconceived opinions expressed by potential urban gardeners and consumers. Thus, most of the stakeholders highlighted the need to create a new school that allows citizens to learn about agriculture by participating in workshops and initiating people into agricultural work. As stated by an urban gardener, pilot projects may allow people to “See, understand, live, and know the system.”

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**Table 1.** Interview participants: stakeholders' group, stakeholders, number of respondents and main relation to urban rooftop farming.

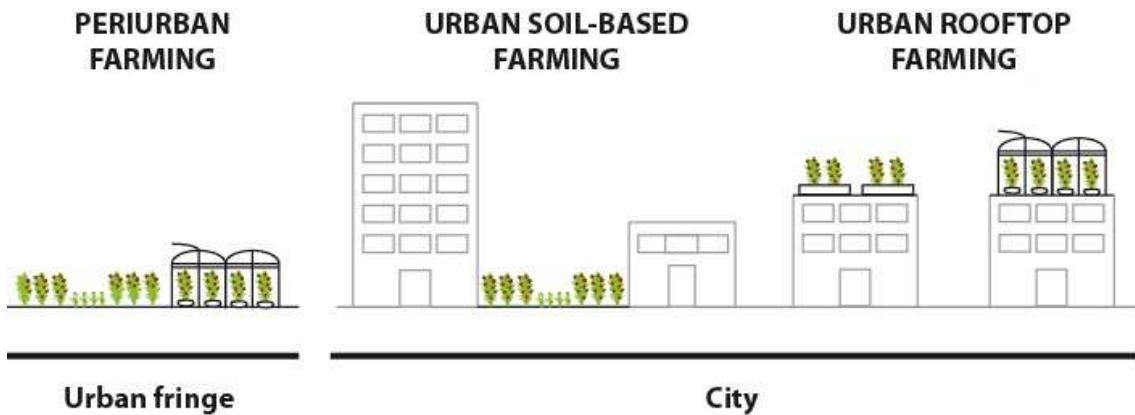
Stakeholders			Nº	Relation to URF			
				UA	S	F	B
<b>ADMINISTRATION</b>			9				
Regional	Generalitat de Catalunya (Government of Catalonia)	Department of Planning and Sustainability	1		x		
Local	Diputació de Barcelona (Barcelona Provincial Government)	Network of Cities for Sustainability	1	x			
Local	Ajuntament de Barcelona (Barcelona city council)	Economic promotion	1		x		
		Municipal Institute of Parks and Gardens	2		x		
		Municipal Institute of Urban Landscape	1				x
		Urban habitat	2	x			
		Urban development agency	1				x
<b>UA-RELATED</b>			7				
Local	Baix Llobregat Agricultural Park	Management	2	x			
	Urban gardens	Hort del Xino (El Raval)	1	x			
		Hort de Fort Pienc	1	x			
	Squatting gardening	Can Masdeu	1	x			
	NGOs	Ecologistas en acción	1			x	
<b>ARCHITECTS</b>			5				
Regional	Association of Architects of Catalonia		1				x
Local	Universitat Politècnica de Catalunya · BarcelonaTech		3				x
	Architects involved in RTG projects		1				x
<b>PLANNING LAWYER</b>			1				
Regional	Planning lawyer, with expertise in UA		1				x
<b>FOOD DISTRIBUTORS</b>			1				
Local	Mercabarna	Director of Facilities and Services	1			x	
<b>OTHERS</b>			2				
Local	RTG promoter (restaurant's owner)		1			x	
	Green spaces' company (manager)		1	x			
<b>TOTAL</b>			25	9	4	4	8

The current expertise and involvement in URF in Barcelona of interview subjects is specified as follows: urban agriculture [UA], sustainability [S], food systems [F], and urbanism and buildings [B]. Totals derived from cells indicated with “x” and number of interviewees.

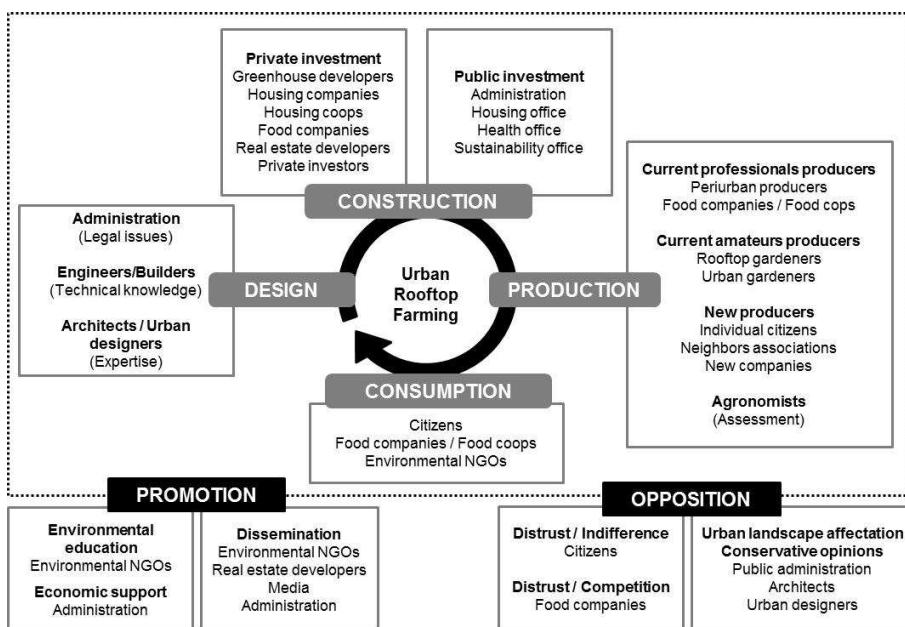
**Table 2.** Barriers and opportunities around Rooftop Farming (RF) and Rooftop Greenhouses (RTG), and comparison with previous studies on URF.

	Stakeholders	Cerón-Palma et al. (2012)	Specht et al. (2013)
	RF	RTG	
<b>Environmental opportunities</b>			
Reducing pressure on fertile soil	x	x	x
Reducing food miles and transport emissions	x	x	x
Using and recycling water resources	x	x	x
Optimizing energy consumption	x	x	x
Carbon & contamination fixation	x	x	x
Naturalization of the city	x	x	x
Recycling organic waste	x		x
Sustainable architecture and urban landscape			x
Increased habitability of the building	x	x	
Increase of horticulture yields		x	
Enhancing closed cycles	x	x	
<b>Environmental barriers</b>			
Perception of little environmental benefits		x	x
Limitations to recycle organic matter in nutrient solutions for hydroponic systems		x	x
Environmental impact of construction materials			x
Competition with solar energy			x
<b>Technical barriers</b>			
Integration in existing buildings	x	x	x
Building overloading and need of reinforcement	x	x	x
Risk of contamination (air pollution)	x	x	x
Logistic constraints in urban areas	x	x	
Crop management limitations	x	x	
Legal barriers for rooftop usage	x	x	
<b>Social opportunities</b>			
Improving community food security	x	x	x
Providing education on food production	x	x	x
Value of fresh produce	x	x	x
Linking consumers to food production	x	x	x
Community building and empowerment	x	x	
Increasing consumers' awareness	x	x	
<b>Social barriers</b>			
Need to train qualified personnel	x	x	x
Lack of acceptance of soil-less growing techniques		x	x
Social disparities in access to systems and products		x	x
User's acceptance	x	x	
Management barriers	x	x	
<b>Economic opportunities</b>			
Reduction of costs (transport, resources use)	x	x	x

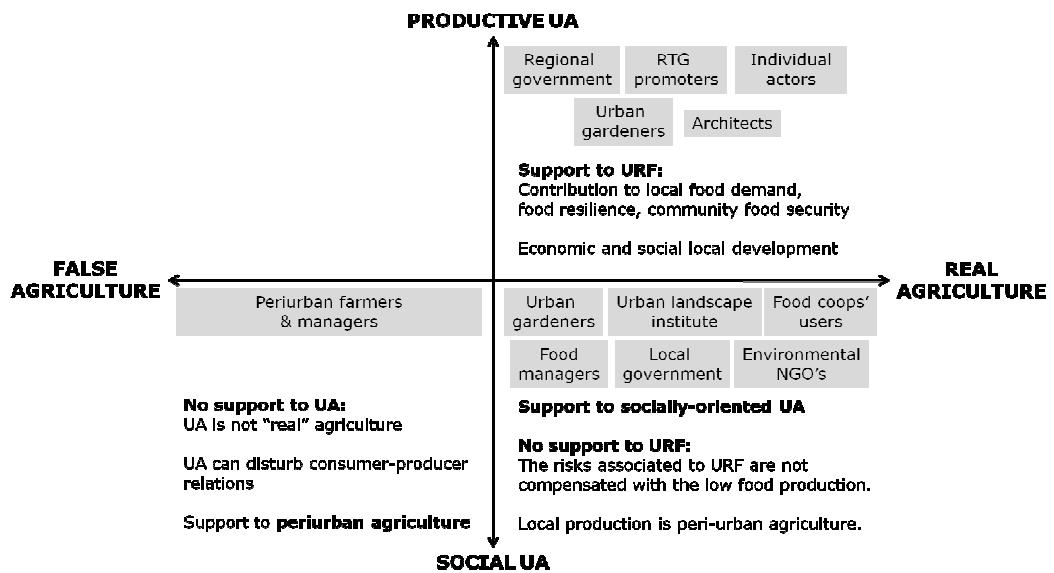
Revaluation of unproductive spaces	x	x	x	
Local development	x	x		x
Potential products and high yields	x	x		x
RSC and corporate image	x	x		
<b>Economic barriers</b>				
Competition to other uses	x	x	x	x
Investment costs (i.e., infrastructure)	x	x	x	x
Narrow profit margin for horticultural products		x	x	
Consumer's acceptance	x	x		
Exclusion of certain crops (e.g., no cereals)				x



**Figure 1.** Forms of perirurban (situated in the urban fringe) and urban farming (placed in the city). Urban Rooftop Farming can take form of Rooftop Farming (left) or Rooftop Greenhouse (right) (own elaboration).



**Figure 2.** Map of stakeholders involved in the different stages of the potential implementation of Urban Rooftop Farming (own elaboration).



**Figure 3.** Stakeholders' position on conceptualizing UA.