Social perception of urban agriculture in Latin America: A case study in Mexican social housing.

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Abstract

The topic of food security has a critical place in the government agendas of developing countries. In Latin America, urban agriculture (UA) offers an interesting alternative to ensuring a sufficient, safe and nutritious food supply for urban populations. However, Latin American urban contexts have been subject to radical transformations in the last decades, most apparently through the expansion of social housing. The main objective of this research is to analyze the social perceptions and feasibility of UA in Mexican social housing neighborhoods.

The city of Mérida was used as a representative case study. Structured interviews were given to 65 key stakeholders across different categories (residents, urban government officials and technical experts). The results indicate a nonexistent perception of UA in Merida, despite the secular agriculture tradition of the Yucatan region. Nevertheless, respondents agreed in their interest in potentially developing UA activities to improve diets, increase green areas, support local economies, and reduce CO₂ emissions. The main perceived barriers for UA are the prevalent model of housing that has a very limited floor area and the current approach to urban planning, which lacks non-built-up areas. Significantly, large artificialized zones create suitable areas to implement UA on extended rooftops.
Finally, stakeholders demand the intervention of authorities at different levels (Federal [national], State [regional] and local) as a requirement to develop UA properly. The main pathways for this support should be to prepare new urban and housing policies and introduce economic incentives.

Keywords: food security, green rooftop, stakeholders survey, urban planning, Mérida, Yucatán.

Abbreviations:
- DIF  System for Integral Family Development of Mexico
- ECLAC  Economic Commission for Latin America and the Caribbean
- FAO  Food and Agricultural Organization
- LAC, Latin America and the Caribbean
- RTG  rooftop greenhouse
- SAGARPA  Secretary of Agriculture, Livestock, Rural Development, Fisheries and Food of Mexico
- SEDESOL  Social Development Secretary of Mexico
- SEMARNAT  Secretary of Environment and Natural Resources of Mexico
- UA  urban agriculture
- UN  United Nations

1. Introduction

More than 50% of the world population lives in urban settings (United Nations, 2014). The problem of urban food security, especially in developing economies that cannot cope with rising food prices, is exacerbated in growing cities dependent on food supplies from rural areas (Wadel et al., 2010). According to the Food and Agriculture Organization of the United Nations (FAO, 2014), many urban residents face difficulties accessing the food they need.

Limitations to food access in cities are both physical and economic. Long-distance transportation between agricultural areas and urban markets lead to 10-30% losses in product. Food prices and household income are major constraints (FAO et al., 2015). In Latin America and the Caribbean (LAC), the inflation of food prices affect the ability of the most vulnerable households to purchase healthy food. In LAC, poor urban households spend 60-85% of their income on food (Ilbery, 2010; Mougeot, 2005). For the poor in developing countries in particular, the relative welfare impact of changing food prices or decreasing income is more significant than for poor people in developed countries (Prakash, 2011).

In face of this situation, urban agriculture (UA) offers innovative solutions to safeguard the environment and economic sustainability of food supplies within urban settings and encourage healthier diets (Nadal et al., 2017). While UA in developing countries is a historical reality (Dubbeling et al., 2010; Renting, 2013), it has been poorly analyzed, particularly in regards to social perceptions,
opportunities and barriers (De Bon et al., 2010; Orsini et al., 2013; Poulsen et al., 2015; Ruel et al., 1998; Warren et al., 2015).

There are no studies analyzing the relationship between UA and the city development in the context of Latin America’s rapid urban transformations, described in further detail below. For these reasons, a better understanding of UA, its perception among public and private actors and its potential for further development in cities is urgent.

With this in mind, this study examines the social perception of UA in a Mexican “social housing” neighborhood in Mérida, Yucatán, as an example of the typology of housing built throughout the country. Specifically, the aim is to identify and understand the relationship between the role of UA in Mexican “social housing” neighborhoods and stakeholder perceptions about current and future UA development. Two specific objectives guide the study. The first objective is to expose the perceptions and motivations for UA, as well as the barriers, benefits and relationships that urban agriculture presents in built environments. The second one is to identify the main trends in feeding and logistics and health related to vegetable consumption.

Four “social housing” neighborhoods of Mérida (Yucatán, México) were chosen as representative cases of Mexican urban developments during the last 10 years, using criteria such as location, housing typology, urban plan and neighborhood design and year of construction. We combine quantitative and qualitative research methods involving different stakeholder groups (residents, government officials and technical experts) that have the greater potential to be involved in UA developments.

After this introduction, a background section outlines the state of UA, particularly in Latin American and Mexican contexts. After that, the study area and the quantitative and qualitative methodology used in the study are presented, followed by the results and discussion of the structured interviews, divided into four sections. Finally, we present the conclusions and future perspectives regarding the social perception of UA in the social housing neighborhoods of Mexico.

1.1 Background. Urban agriculture and changing Mexican cities

UA comprises growing food plants and raising livestock within and around cities (FAO, 2011). The variety of UA forms can be classified in various ways, depending on its actors, purpose, land use, scale, location, property, technology and production system (Fig 1). As UA is easily adaptable to built environments, it is an essential ally in cities’ quests to secure adequate food. UA may manifest
through different typologies (such as green walls, urban orchards, green roofs, rooftop greenhouses, facades, balconies, backyards, basements), scales, orientations and purposes (Nadal et al., 2015).

Fig 1 Classification of UA, based on Nadal et al. (2015).

The multiple benefits of UA (Table 1) include the following: tackling food production constraints; providing direct access to of nutritionally richer and more varied diets according to local culture and food preferences; increasing the stability of household food consumption; and generating revenues through the sale of production surplus (Armar-Klemesu, 2000; FAO, 2011; Zezza and Tasciotti, 2010).
Table 1 Primary benefits of UA

<table>
<thead>
<tr>
<th>Area</th>
<th>Benefits</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social</td>
<td>Food security</td>
<td>(Barthel and Isendahl, 2013), (Kirwan and Maye, 2012), (Carney, 2012), (Maxwell et al., 1998), (Moustier and Danso, 2006)</td>
</tr>
<tr>
<td></td>
<td>Social cohesion</td>
<td>(Sanyé-Mengual et al., 2016), (FAO et al., 2015), (Novo and Murphy, 2001), (Smit and Bailkey, 2006), (Orsini et al., 2009), (Díaz-Albertini, 1991), (Oths, 1998), (FAO, 2016)</td>
</tr>
<tr>
<td></td>
<td>Food justice</td>
<td>(Alkon and Mares, 2012), (Block et al., 2012)</td>
</tr>
<tr>
<td></td>
<td>Human right to food</td>
<td>(Moustier and Danso, 2006)</td>
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<tr>
<td></td>
<td>Healthier diet</td>
<td>(Gockowski et al., 2003), (Smith and Eyzaguirre, 2007)</td>
</tr>
<tr>
<td></td>
<td>Environmental and nutritional education</td>
<td>(Mezzetti et al., 2010), (FAO, 2005), (Smit and Bailkey, 2006)</td>
</tr>
<tr>
<td>Economic</td>
<td>Local production</td>
<td>(Mok et al., 2014), (Zezza and Tasciotti, 2010)</td>
</tr>
<tr>
<td></td>
<td>Job opportunities</td>
<td>(Agbonlahor et al., 2007), (IIED, 2011)</td>
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<tr>
<td></td>
<td>Economic savings</td>
<td>(Moustier and Danso, 2006)</td>
</tr>
<tr>
<td></td>
<td>Affordable food</td>
<td>(Kirwan and Maye, 2012)</td>
</tr>
<tr>
<td></td>
<td>Food sovereignty</td>
<td>(Moustier and Danso, 2006)</td>
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<td>Environmental</td>
<td>Urban biodiversity</td>
<td>(Konijnendijk and Gauthier, 2006), (McClintock, 2010)</td>
</tr>
<tr>
<td></td>
<td>Less food transportation impacts</td>
<td>(Cerón-Palma et al., 2012a), (Arosemena, 2012), (Jones, 2002), (Sanyé-Mengual et al., 2014)</td>
</tr>
<tr>
<td></td>
<td>Less emissions</td>
<td>(Cerón-Palma et al., 2012a), (Arosemena, 2012), (Jones, 2002), (Sanyé-Mengual et al., 2014)(Harris and Manning, 2010)</td>
</tr>
<tr>
<td></td>
<td>More sustainability</td>
<td>(Pearson et al., 2010), (Holdsworth, 2005), (Smit and Nasr, 1992), (La Rosa et al., 2014)</td>
</tr>
<tr>
<td></td>
<td>Closed cycles in urban food flows</td>
<td>(Cerón-Palma et al., 2012a), (Coffey and Coad, 2010)</td>
</tr>
<tr>
<td></td>
<td>Urban multi-functionality</td>
<td>(Arosemena, 2012), (Aubry et al., 2012), (Zasada, 2011)</td>
</tr>
</tbody>
</table>

Worldwide interest in self-growing vegetables is increasing, and 25–30% of urban dwellers are involved in the agri-food sector (Orsini et al., 2013). However, research and information regarding the role of UA in developing countries are limited (Orsini et al., 2013; Poulsen et al., 2015; Warren et al., 2015).

The past three decades ago in Latin America have seen a tendency toward the segregation and division of urban structures with a diffuse or extensive form called a "city of islands" or “urban archipelago". This new structure inherits some classic characteristics of Latin cities, combined with the following four new areas: *islands of wealth* (gated communities for the upper and middle classes), *islands of production* (industrial production in suburban areas located in peripheral industrial parks), *islands of*
consumption (construction of numerous malls) and islands of precariouslyness (social housing neighborhoods and informal settlements located on the edge of the city). These trends erode social cohesion and lead to an increase in instability, violence and insecurity (Janoschka and Glasze, 2003).

In Mexico, this structure is partly the result of the current housing policy, encompassing “social housing” for lower-income populations. The Mexican Federal Government promotes housing of reduced dimensions on the city outskirts comprised of three types of social housing: economical (with a cost of up to 118 times the monthly minimum wage (mmw) in Mexico City), popular (from 118.1 to 200 mmw) and traditional (from 201 to 350 mmw). The main difference between these types is the size of the dwelling in square meters (m²) (Cerón-Palma et al., 2013; SHF, 2015), which varies from 30 to 62.5 m² (CONAVI, 2010) in plots with dimensions of 8x20 m, 10x20 m or 10x25 m (Romero, 2007). Construction materials are conventional, e.g., beam and vault slabs, concrete, and either hollow block walls, concrete walls or clay bricks (Cerón-Palma et al., 2013).

Direct subsidy funding programs in support of this housing require a down payment of approximately 15% and 25% of household incomes. Affordable home ownership plans (e.g., reduced deposits) have led to more widespread home ownership and a massive expansion of social housing, which now represents 34.7% of the total housing stock in Mexico. The target buyers are workers with individual or family income of 1-3.9 times the mmw (González, 2006; SHF, 2015).

However, the ‘Satisfaction index of Mexican housing’, which evaluates physical, spatial, functional and environmental adaptations and transformations of housing characteristics, and the ‘Satisfaction index of complex housing and Mexican cities’, which evaluates the location, perception, equipment and services in the housing complex and the city, were both unsatisfactory in 2014 (SHF, 2015). This leads residents to remodel and extend their homes to fit their needs.

Based on own observations and other references (García-Huidobro et al., 2011), we identified a pattern in the trend of modifying the original typologies of social housing in Latin America. The original or basic social housing model, with its small size and limited number of rooms, undergoes an architectural transformation that typically includes the following three states:

a) Establishment: the family makes minor modifications to ensure the safety of the property and provide individuality to the image of the house.

b) Densification: the family grows and incorporates new spaces, demanding the greatest constructive effort; mainly bedrooms and bathrooms are built. The process of change is mainly self-engineered and depends directly on the family’s funds.
c) Consolidation and diversification: family housing becomes a conglomerate of aggregate functions and social values.

From the construction perspective, these changes occur progressively along four steps (Fig 2). These were identified through an on-site tour of the neighborhoods to document the structures, their specific locations and constructive and formal characteristics. Reference data for areas obtained by Cerón-Palma et al. (2013) were used to generate the plot area, constructed area, available plot area and roof area of each step, also indicated in Fig. 2 as follows:

1. Original configuration, without modification or change.

2. Construction of a front or backyard annex. This is usually a two-car garage that covers the entire facade of the house and means the loss of space from the front garden. This annex involves the construction of a roof (approximately 43 m²). A backyard annex usually consists of the construction of a new bedroom and/or porch. The covered area of the house increases and limits the backyard space. This annex involves the construction of a roof (approximately 37 m²).

3. The housing has a bedroom and a porch built in the backyard, which further limits the free space on the ground.

4. Construction of spaces on the second level of the house. Usually, no buildings of three or more levels are implemented.

Steps 3 and 4 of this process result in the initial available land area of the house (104 m²) shrinking to approximately 20-24 m². The remaining space is usually used for air-drying clothes on clotheslines or drying racks. At the same time, rooftop areas expand.
According to the National Institute of Statistics and Geography of Mexico (INEGI), 78% of the 119.5 million inhabitants of Mexico lived in urban areas in 2015. This corresponds to 31.3 million households with an average of 4 members (INEGI, 2015). The need for housing increases as the population grows. This causes a decrease in green areas as the percentage of surfaces covered with pavement, houses, parking areas and roads increases (Grimmond, 2007). The development of UA in Mexico is bounded by this context, which is largely shared with the entire Latin American region.

In addition to the benefits already mentioned, UA provides a strategy for combating obesity, another major concern. As the urban area expands, traditional diets tend to become “more urban” (i.e., based on food with high sugar, salt and fat contents). This increases the incidence of chronic degenerative diseases (overweight, obesity and diabetes) (Perez-Izquierdo et al., 2012). In Mexico, almost 50% of household purchases are processed foods. The consumption of fruits and vegetables fell by almost 30% between 1984 and 1998, while the consumption of refined carbohydrates and sodas rose by...
nearly 8% and 35%, respectively, (NU-CEPAL, 2013). According to data from the 2012 National Survey of Health and Nutrition, 34% of the urban population is obese (INSP, 2012). More than 70% of the adult population was overweight (FAO, 2013).

In this context, between 2007 and 2012, 15,700 inhabitants of México city received US $24.6 million in public investments for horticulture, floriculture and crop and livestock production, and US $37 million for the conservation and sustainable use of natural resources in primary production (FAO, 2014). However, the conditions for the development of UA are unfavorable. For instance, the Mexican National Development Plan (2013-2018) does not include or promote UA as a strategy for improving health, urban planning and family economy (SEGOB, 2013).

Despite the novelty of this topic, there is limited literature on agriculture UA in Mérida and the classification of vegetable species in orchards in peri-urban or rural areas: J. S. Flores and Ek (1983), Jiménez-Osornio et al. (1999), Domínguez Santos et al. (2011), A. González (2012), Mariaca (2012). Agriculture in the urban environment and within the social field, specifically regarding the perception of residents of the city, remains neglected as a research area. The present paper fills this gap, helping to expand the scientific literature on UA in Latin America.

2. **Study area and methods**

Fig 3 summarizes the methodological procedures in this paper, outlining the research stages and associated approaches and tools. They will be explained in detail in the following sections.
Fig 3 General methodology.

Case study selection: Social neighborhoods in Mérida, México.

The case study was conducted in Mérida, the capital city of Yucatán province, in southeast México. In line with the objectives and the reviewed literature, the criteria used to select the case included the following: presence of consolidated areas of social housing with a high percentage of artificiality; loss of the traditional diet; adequate climatic conditions for the development of UA; culturally rich agricultural heritage; and high incidence of chronic food-related diseases. Due to the reasons that follow, Merida fits the following requirements perfectly:

a) Merida is a large city with residential segregation (García et al., 2012), reflecting the current model of a “city of islands” common in Latin America (Castañeda, 2007; Janoschka and Glasze, 2003; Rodríguez and Arriagada, 2004).

b) Many areas of social housing built during the last 10 years may or may not have implemented UA. There is limited information on how plots in social housing have been used for food production.
c) The sunny weather and year-round warmth provides a strong potential to develop UA through collective gardens, commercial installations, small private gardens or vertical gardens. The climate in Merida is warm and humid, typical of the tropical regions, with rain in the summer, an average annual temperature between 24.5 and 27 °C, annual rainfall of 805.4 to 1120.5 mm and an average global solar radiation of 5.0 kWh/m²/day (García, 2004; UADY, 2016).

d) The city has a pre-Hispanic history and a heritage of growing fruits and vegetables. Yucatecan people have an extensive agricultural background. Traditionally, the vernacular dwellings have a garden in which vegetables and fruits are grown. Home gardens (Mayan solar in Spanish or “Ich-tankaab” in the Mayan language) (J. Flores and Ek, 1983; Gómez-Pompa, 1987) are a key point of livelihood for the Yucatán population during times of crisis, as they provide the minimum inputs necessary for a family’s survival (Jiménez-Osornio et al., 1999).

e) Mérida is an example of the chronic degenerative disease crisis currently present in Mexico. In 2013, the prevalence of diabetes was 9.2%. 35.5% of the population was overweight and 44.8% obese (IDF, 2013).

Mérida is a dense and expansive city with a population of 830,732 inhabitants in 2010 (INEGI, 2010), representing 42.5% of the total population of the state of Yucatan. It is spread over an area of 883.40 km², equivalent to 2.19% of the state (SEDUMA, 2006). It has experienced great spatial growth in the last 50 years. Like most Latin American cities, this growth is characterized by a tendency to concentrate economic activities such as trade, infrastructure, education and health services (Bolio, 2007a, 2007b, 2006; García et al., 2012). This occurs especially to the north and west of the city, generating significant changes in the spatial organization.

The city expansion is mainly based on the construction of economical housing in succession with traditional buildings. A total of 229,635 new private housing units were built in 2010, the equivalent of 45.3% of the total housing in Yucatán (INEGI, 2010). Nevertheless, 8% of the total population (72,019) lived in homes with poor quality materials and inadequate spaces in 2015. Additionally, 10.6% lived in homes without basic services, which means that housing conditions are not adequate for 95,093 people. Moreover, 18% (161,189 people) had problems with access to food (SEDESOL, 2015).

Four social neighborhoods are used here as a sample as follows: Villa Magna II, Tixcacal Opichen, Ampliación Tixcacal and Las Magnolias (Fig 4 and Table 2). These four neighborhoods are representative of the “social housing” neighborhoods in Mérida in 2010 (a total of 209), as they have
the most important characteristics of housing typology and urban planning. Specifically, they were chosen because of the following characteristics:

a) Location: they are situated in the north and west axes, following the current trend of increased urban growth of Mérida.

b) Housing typology: they have common features relating to the type or housing design, house size and socioeconomic status. Generally, the houses have a similar spatial distribution and number of spaces, built area and average household of 3.6 people.

c) Urban plan and neighborhood design: these “social housing” neighborhoods were built by construction companies (not by the owners). Generally, the blocks have an orthogonal trace of 150 x 40 m, with 38 houses each.

d) Year of construction: all neighborhoods were built between the years 2000-2010; thus, they have been occupied for at least 5 years, which is enough time for residents to have completed the appropriation stage. Therefore, it is possible to evaluate the evolution of the uses of housing spaces, built or otherwise.

Fig 4 Location of Mérida, delimitation of the city and location of the four “social housing” neighborhoods of the sample.
The four neighborhoods all have basic infrastructure (electricity, potable water, sanitary drainage, sewage system, paving, sidewalks, etc.) and three types of roads (avenues or primary streets, collectors or secondary streets and local or tertiary streets). For urban equipment, the neighborhoods have elementary schools, urban parks, sports fields and shops.

The original or basic housing model (Fig 5) is similar in each of the four neighborhoods. Each house has a plot area of 160 m² with 56 m² of construction on one floor. The basic housing model has a usable flat floor of 50 m². Additionally, 72.8 m² of the plot area is used for green space, and the rest is comprised of the house entrance, paths, etc. (Cerón-Palma et al., 2013). The single family home has one bathroom, two bedrooms, and a living room with a kitchen and is usually occupied by young families (Cerón-Palma et al., 2013; Gil et al., 2012).

<table>
<thead>
<tr>
<th>Name</th>
<th>Year of construction</th>
<th>Location</th>
<th>Total area (ha)</th>
<th>Housing per block (m²)</th>
<th>AVG Housing area (m²)</th>
<th>Total housing</th>
<th>Housing typology</th>
<th>Average household size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Villa Magna II</td>
<td>2007</td>
<td>West</td>
<td>18</td>
<td>38</td>
<td>825</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tixcacal Opichen</td>
<td>2004</td>
<td>West</td>
<td>62</td>
<td>38</td>
<td>1944</td>
<td>332</td>
<td>Social housing</td>
<td>3.6 people</td>
</tr>
<tr>
<td>Ampliación Tixcacal</td>
<td>2007</td>
<td>West</td>
<td>30</td>
<td>38</td>
<td>56</td>
<td>332</td>
<td>Social housing</td>
<td>3.6 people</td>
</tr>
<tr>
<td>Las Magnolias</td>
<td>2005</td>
<td>North</td>
<td>20</td>
<td>34</td>
<td>569</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

a Constructed area of the original typology
The construction system consists of a stone foundation, walls made of concrete blocks reinforced with steel casing armed at the corners, a concrete roof with a joist and beam and a compression layer of concrete. All “social housing” has a flat rooftop with a minimum load resistance of 200 kg/m², which usually has no use.

Stakeholders in Mérida

The identification of stakeholder categories who may play a prominent role in the implementation of UA in Mérida was based in the study of Sanyé-Mengual et al. (2016). The selection was carried out using our knowledge of current UA experiences in México and brainstorming with initial key stakeholders.

The actors involved in UA in Mérida will be characterized with respect to their role in promoting UA at the local level. The analysis will consider the basic steps of UA (design, construction, production and consumption) and areas of change in the city (design, construction, use and management). In this respect, UA plays an important role in bringing different actors and areas of implementation together. The resulting map (Fig 6) focuses on the following key actors and groups relating to UA:
• Urban government officials: employees of government institutions related to the urban development of the city
• Technical experts: professionals with expertise in various disciplines that complement the development of agriculture in the city
• Residents: people living in social housing neighborhoods that make up the sample.

The government is related to design by regulating the activities and efforts of the city. Technical experts influence design and construction areas, and residents are the users of the city. Finally, all actors are connected to the common good of the city. In addition, these actors are classified according to their degree of commitment to addressing AU. Within this classification, we have the following two types of actors:

• Direct (Residents): this group has an important role in the process, as they can help strengthen UA in Mérida on a large scale in a short time. They are the ones who develop the activity.
• Indirect (Technical experts, organizations and persons who maintain specific links with UA): they support programs, projects or policies. Urban government officials include government institutions related to the development of UA through an institutional mandate and skills.

**Fig 6** Map of potential stakeholders involved in the different steps of implementation of UA and urban changes in the city.

*Data collection*
For this study, we used quantitative and qualitative research through a multilevel concurrent nested design, which provides a broad overview of the research problem and a thorough exploration of various types of data (Hernández Sampieri et al., 2006). For the collection of information, we conducted structured interviews with 65 participants.

The interviewing process was conceived as an exploratory study. Standardized questions indicate the magnitude of the different processes under analysis rather than seeking statistical significance. At the same time, open-ended questions provide qualitative information that supplements the narrative and was subsequently coded.

Interviewees were distributed as follows: 5 residents (local people) from each of the 4 neighborhoods, 20 urban government officials and 25 urban planning, environment, construction and health technical experts (Table 3). These groups provided information about aspects of UA, social perceptions, urban planning, housing, and food health. We chose multidisciplinary groups and city dwellers in order to gain insight on their views and experiences concerning UA, their expectations about its benefits, problems facing the development of UA and their opinion about actual feeding habits.

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Group</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residents</td>
<td>Villa Magna II neighborhood</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Tixcacal Opichen neighborhood</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ampliación Tixcacal neighborhood</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Magnolias neighborhood</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Urban Government Officials</td>
<td>Urban planning</td>
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</tr>
<tr>
<td></td>
<td>Architecture</td>
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<tr>
<td></td>
<td>Construction</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Technical experts</td>
<td>Urban planning</td>
<td>7</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Environment</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Health</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>65</strong></td>
<td></td>
</tr>
</tbody>
</table>

The interviews were organized around the following two topics: perceptions of and motivations for UA, and logistics and feeding. Each interview lasted approximately 30 minutes and was conducted in January 2016, including a pilot interview with a technical expert in agronomy. The questions posed
to urban government officials (urban planning, architecture and construction) and technical experts
(urban planning, environment, construction and health) were adapted for local non-experts with
barriers to technical or specific vocabulary that limited understanding of the issues. In the case of the
neighborhood resident, we interviewed people older than 18 years with a minimum of 5 years living
in the neighborhood. Moreover, interviews were restricted to homes located in the middle of blocks
(lots located in the corners have greater dimensions).

All interviews had the same structure (Fig 7). The first part dealt with general perceptions of UA, its
meanings and definitions of its concept, practice, technology, typology and development. The specific
topics of UA technology and typology were discussed only with technical experts. Other topics were
related to urban planning and housing, the potential for urban public gardens, home gardens and
places inside the houses where UA could be implemented. There is also a focus on the benefits and
barriers facing the development of UA in Mérida.

The second part discussed the frequency, place, distance and means of transport used to acquire
vegetables. This part focused on current eating habits in urban Mérida, e.g., variety and daily amount
of vegetables consumed, and variety of crops that residents would like to cultivate. For health
perceptions, we focused on the health benefits derived from vegetables and the reasons why growing
vegetables can improve consumers’ quality of life.
Analyzing the influence of “social housing” in urban agriculture

In analyzing the data, we tried to identify new categories of variables for future studies. Directly comparing results from quantitative data collection with results from qualitative data collection, we formed new variables or datasets (Hernández Sampieri et al., 2006). Data collection and analysis was complemented with secondary data collection.

Given the background information on the characteristics and evolution of social housing in Merida, an argumentation is made about the potential development of urban agriculture in Mérida. This is presented and considered in the discussion section.

3. Results

The results are presented in the following four sections: general perceptions of UA; urban planning and housing; eating habits and health perceptions; and benefits and barriers.

Perceptions and motivation for urban agriculture

We examined whether stakeholders know and can define the concept of UA (Table 4). Generalized awareness of UA is limited to groups of government officials and technical experts. In contrast, only...
5% of residents reported awareness of UA. In trying to define UA, stakeholders generally focus on urban space (86%), while only 14% consider the peri-urban space. Poultry, livestock and fish were mentioned by 10% of the interviewees. The remaining definitions were restricted to growing fruits, vegetables and fruit trees.

Table 4 Results of general perceptions of Urban Agriculture in Mérida, according to the different stakeholder groups

<table>
<thead>
<tr>
<th>Urban Agriculture</th>
<th>Details</th>
<th>Residents</th>
<th>Urban government officials</th>
<th>Technical experts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept definition</td>
<td>Known</td>
<td>5</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Unknown</td>
<td>95</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Practice</td>
<td>Practice</td>
<td>5</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Not practice</td>
<td>95</td>
<td>80</td>
<td>60</td>
</tr>
<tr>
<td>Typologies</td>
<td>Private gardens</td>
<td>^b</td>
<td>25</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Collective gardens</td>
<td>^b</td>
<td>25</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Green roofs</td>
<td>^b</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Edible landscaping</td>
<td>^b</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Pots</td>
<td>^b</td>
<td>25</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Do not know the topic</td>
<td>^b</td>
<td>35</td>
<td>56</td>
</tr>
<tr>
<td>Technology Concepts</td>
<td>Hydroponics systems</td>
<td>^b</td>
<td>25</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Sprinkler irrigation technologies</td>
<td>^b</td>
<td>25</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Aquaponics systems</td>
<td>^b</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Leeds</td>
<td>^b</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Compost</td>
<td>^b</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Do not know the topic</td>
<td>^b</td>
<td>35</td>
<td>40</td>
</tr>
</tbody>
</table>

^a Categories were indicated by stakeholders
^b This category was not surveyed in this group of stakeholders

As for the social character of UA, 8% of all respondents recognized that UA is an activity that should be performed in conjunction with neighbors and not individually. Some professional stakeholders, including urban government officials, defined UA as follows:
It is a necessary discipline for the reintegration of subsistence food sources, given the loss of natural agricultural production capacities (Urban government official).

Urban agriculture is a practice [that is] part of the cities and [...] peripheries, [...] a good exercise for generating healthier food for urban populations [...] especially in those neighborhoods where urban agriculture is not performed individually [...] there is no space (Health specialist).

Growing plants and raising animals inside and around cities provides us with different types of food products, such as poultry, livestock and non-food products (ornamental plants, aromatic and medicinal plants) (Environment specialist).

The practice of UA reported by the residents is irrelevant or residual (only 5%) compared to the perception of the implementation level by urban government officials (20%) and technical experts (40%). For the types of UA, the five forms identified with the greatest potential for implementation are private gardens, collective gardens, green roofs, edible landscaping and pots.

Although all urban government officials and technical experts know the concept, 35% of urban government officials and 56% of technical experts could not identify any form of UA. Among urban government officials, private and collective gardens are the most popular forms, with 25% of respondents indicating each. In the group of specialists, 44% reported knowing a typology of UA in which private gardens, collective gardens and green roofs together represent 36%.

Similar to what we observed with UA typologies, 35% of urban government officials and 40% of technical experts reported having no knowledge of the cultivation technologies in urban areas. The rest identified the following five types of technologies of UA: hydroponics systems, sprinkler irrigation technologies, aquaponics systems, lees and compost. The sprinkler irrigation technology was best known (24% of all respondents). Within the group of government officials, hydroponics systems and sprinkler irrigation technologies are the main technologies, with 25% each. For specialists, sprinkler irrigation is the most known technology with 44%. In sum, the knowledge of UA technologies and typologies is limited. Most people still believe that agriculture must be done in the traditional way but are aware of the limitations currently facing its implementation and are open to accepting other forms of UA.

The next block of responses was related to the question, ‘Is today’s Mérida a city with UA? (Fig. 8). Most stakeholders (residents 85%, urban government officials 60% and technical experts 76%) consider Mérida to be a city without UA development. The explanations for this perception include the following: loss or lack of traditional agricultural knowledge (social approach), lack of public and
housing spaces (environmental approach) and a lack of government support (economic approach).

These results coincide with the high percentages presented in Table 3 concerning the number of people who do not develop any UA activity.

Urban government officials are more optimistic and supportive of the development of UA in Mérida (40%), followed by technical experts (24%) and residents (only 15%). Generally, the reasons identified by stakeholders are older people and children cultivate (social approach), crops are grown in some gardens (environmental approach), and when a vegetable is expensive, people cultivate it (economic approach).

All stakeholders agree that the lack of space in houses and public spaces is the main constraint for the development of UA in Merida. Meanwhile, the fraction of stakeholders who consider Merida a city with UA does not agree on a particular set of reasons to support their view.
Regarding the motivation to practice UA in Mérida (Fig. 9), urban government officials and technical seem the most committed (100% and 96%, respectively), but only 55% of residents expressed interest. All stakeholders agree that parks are the most viable option (80-82%) for collective forms of UA, but they also see potential in the vacant land (18-20%). Backyards seem the preferred location for individual forms of UA (residents 65%, urban official government 60%, technical experts 84%), followed by front gardens (residents 10%, urban official government 40%, technical experts 12%). 25% of residents reported their preference for potential cultivation on the roof due to the lack of a better space.

In the legal sphere, there is ignorance relating to the laws and regulations in support of UA, with only 14% of technical experts reporting to know them. Despite the benefits UA can bring to cities, current urban policies in Mérida do not offer feasible options to support it. UA is not considered in the Mexican National Development Plan 2013-2018, the State Development Plan of Yucatán 2012-2018 or the Municipal Development Plan of Mérida 2015-2018.

There are no official statistics on existing urban gardens’, their production, performance or contribution to family income. Practitioners of urban gardening do not receive support from the government through the relevant secretariats: Secretary of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA); Secretary of Environment and Natural Resources (SEMARNAT); and Social Development Secretary (SEDESOL). Only in some cases does the System for Integral Family Development (DIF) donate seeds or poultry, but they do not deal deeply with the issue (Mariaca, 2012).
The main perceived barriers to the development and implementation of UA in “social housing” neighborhoods of Mérida (Table 5) are the lack of time, public spaces, housing spaces and government support. The perceived benefits are numerous and include support of food security, improvement of the quality of food, preservation of traditional knowledge, personal satisfaction, increasing green areas and cost savings.

"Lack of time" was detected as a cultural barrier for the maintenance of urban or family orchards. However, the perception of social benefits overcomes this barrier: support of food security, the quality of food, rescue of traditional knowledge and staff satisfaction. Through information provided by stakeholders, it may be noted that the benefit of preserving traditions related to Mayan solar knowledge is perhaps the most important to the development of UA in the city. In the economic field, the direct benefits of UA would be for the family and local economy: cost savings, supporting local economies and product exchange. However, there is a fear of a lack of financial support from the government because the costs of housing, food and transportation are continuous and wages are insufficient. Therefore, stakeholders perceive government financial support to be necessary for developing vegetable farming because their wages are not sufficient to cover the costs of implementing and maintaining a private or community garden.
Importantly, stakeholders perceived more benefits than barriers, coinciding with the highest percentage of motivation for cultivation in the three stakeholder groups.

Table 5. Benefits and barriers of implementing UA in “social housing” neighborhoods of Mérida

<table>
<thead>
<tr>
<th>Topic</th>
<th>Approach</th>
<th>Details</th>
<th>Residents</th>
<th>Urban government officials</th>
<th>Technical experts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Residents</td>
<td>Urban government officials</td>
<td>Technical experts</td>
</tr>
<tr>
<td>Barriers</td>
<td>Social</td>
<td>Lack of time</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Barriers</td>
<td>Social</td>
<td>Lack of knowledge of agriculture</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Barriers</td>
<td>Social</td>
<td>Mentality: &quot;It is easier to buy&quot;</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Barriers</td>
<td>Social</td>
<td>Lack of social cohesion</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barriers</td>
<td>Social</td>
<td>Vandalism in neighborhoods</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barriers</td>
<td>Social</td>
<td>It is not promoted in the development plan of the city</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barriers</td>
<td>Environment</td>
<td>Lack of public spaces</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Barriers</td>
<td>Environment</td>
<td>Lack of housing spaces</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Barriers</td>
<td>Environment</td>
<td>Introduction of exotic species</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Barriers</td>
<td>Environment</td>
<td>Increased vermin</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Barriers</td>
<td>Environment</td>
<td>Limited variety of crops</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Barriers</td>
<td>Economic</td>
<td>Lack of government support</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Barriers</td>
<td>Economic</td>
<td>Cost of implementation</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Barriers</td>
<td>Economic</td>
<td>Maintenance cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefits</td>
<td>Social</td>
<td>Support for environmental education</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Benefits</td>
<td>Social</td>
<td>Fosters social cohesion</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Benefits</td>
<td>Social</td>
<td>Supports food security</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Benefits</td>
<td>Social</td>
<td>Improves the quality of food</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Benefits</td>
<td>Social</td>
<td>Support for self-consumption</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefits</td>
<td>Social</td>
<td>Rescue of traditional knowledge</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Benefits</td>
<td>Social</td>
<td>Helps with relaxation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefits</td>
<td>Social</td>
<td>Promotes physical activity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefits</td>
<td>Social</td>
<td>Helps reduce obesity</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Benefits</td>
<td>Social</td>
<td>Personal satisfaction</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Benefits</td>
<td>Social</td>
<td>Increases the quality of life</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Environment</td>
<td>Soil enrichment</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>----------------------</td>
<td>-----------------</td>
<td>----</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reduces CO₂ emissions</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Increases green areas</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reduces heat islands</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reuse of vacant lots</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Optimization of public space</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic</td>
<td>Cost savings</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Supports the local economy</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Product Exchange</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Source of employment</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Only the source of the contribution is indicated, not the percentage.*

**Logistics and feeding**

For a better understanding of the results (Fig 10), they are divided into two categories: actual acquisition of vegetables (transportation from outside of the city) and improved acquisition of vegetables (through UA with less transportation). The first shows the information concerning frequency, location, distance and transportation used for the acquisition of vegetables. Improved acquisition is made through UA, revealing information about motivation, viability in the city, viability in housing and legal support.

In the area of real acquisition of vegetables, weekly is the most referenced category (residents 70%, urban government officials 80%, technical experts 76%), followed by daily (residents 20%, urban government officials 20%, technical experts 12%). Urban government officials and specialists use more car and public transportation for short distances to procure vegetables. Specifically, 60% of urban government officials and 68% of technical experts use a car to travel distances between 500 meters and 5 kilometers, while 40% of residents only used the car and public transport to travel distances between 500 meters and 10 km. The continued use of fossil fuel transportation generates large amounts of CO₂ and promotes a sedentary lifestyle; this lack of physical activity also promotes obesity. Only 32% of technical experts and 40% of government officials walk distances between 100 and 500 meters to acquire vegetables. Regarding the residents, 55% walk distances between 50 and 500 meters. This means that, in the four social neighborhoods studied, there are several points to purchase vegetables.
In summary, vegetables are generally acquired weekly within a radius of 1 km and large areas, such as supermarkets, causing a considerable emissions impact from the use of cars, as a considerable portion of interested groups use them for movement. Local trade in vegetables occurs through greengrocers that are usually owned by a resident of the neighborhood.

Fig 10. Logistic for vegetables acquisition in the study area.

To present the results concerning healthy food and eating habits (Table 6), the process is divided into three main areas: a) real consumption of vegetables, b) improved consumption of vegetables (through UA) and c) perceived health.

In terms of current real consumption of vegetables, the five most frequently consumed vegetables are tomato, lettuce, carrot, onion and orange. Stakeholders noted that, on average, 3 pieces of vegetables are consumed per day per person. If stakeholders’ consumption data are analyzed, residents have the highest intake of vegetables (95% claimed to consume 3 to 5 or more vegetables per day). In contrast,
only 68% of technical experts achieve that amount of vegetable consumption. Despite the daily intake of vegetables by stakeholders, consumption is low and does not meet the minimum set by the FAO of 5 parts or 400 grams per day. Only 25% of residents, 20% of urban government officials and 20% of technical experts consume the minimum recommended intake of vegetables per day.

On the topic of improved vegetable consumption, the three groups of stakeholders agree on their preference of fruits and vegetables they would like to cultivate: tomato, lemon, onion, lettuce, pepper and coriander. Tomato was considered the basic plant for the development of UA. The main reason for the implementation of UA in social housing neighborhoods is consumption. The sale of crops was reported by only 15% of residents. In the case of both activities, there is an interest by 30% of residents, 20% of urban government officials and 20% of specialists, and sales would only apply to excess production.

On the topic of perceived health, all stakeholders recognize that growing their own vegetables would provide health benefits, as the products would be free from pesticides and the number and frequency of vegetable consumption would increase. Only 15% of residents foresaw no perceived benefit because they believe the vegetables they eat today provide the same benefits.

Table 6. Main results of the actual and improved consumption of vegetables in “social housing” neighborhoods of Mérida and their influence on perceived health.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Topic</th>
<th>Details</th>
<th>Stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual consumption of vegetables</td>
<td>Variety of main vegetables consumed (ordered by preference)</td>
<td>5 main crops a</td>
<td>% of respondents within each category</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Residents</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tomato</td>
<td>Tomato</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Onion</td>
<td>Lettuce</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pepper</td>
<td>Carrot</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Banana</td>
<td>Lemon</td>
</tr>
<tr>
<td></td>
<td>Daily number of vegetables consumed</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>25</td>
</tr>
</tbody>
</table>
### Health Perceived

**Why will growing your own vegetables improve your health?**

<table>
<thead>
<tr>
<th>Category</th>
<th>Yes</th>
<th>No</th>
<th>0</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pesticide-free crops (^c)</td>
<td>60</td>
<td>100</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Crops with more nutrients (^c)</td>
<td>15</td>
<td>0</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Increasing amount and frequency of consumption of vegetables (^c)</td>
<td>25</td>
<td>0</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>Increased physical activity (^c)</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

\(^a\) Categories were indicated by stakeholders and ordered by preference  
\(^b\) Ordered by preference  
\(^c\) Categories were indicated by stakeholders

---

4. **Discussion**

The results presented above led to two main interconnected findings, namely the current panorama of urban agriculture and development possibilities of urban agriculture in Mérida, which are representative for other similar urban developments in México and other Latin-America countries. They will be discussed in the following sections in the light of existing literature.

*Current panorama of urban agriculture in Mérida*
Although each day sees further promotion of UA by international institutions such as the FAO, Economic Commission for Latin America and the Caribbean (ECLAC), and United Nations (UN), this study posits that their message does not reach the entire population, but rather only groups of government workers and specialists, at least initially. This is shown in the fact that most residents are unfamiliar with UA, compared to the high percentage of familiarity among urban government officials and technical experts. Perhaps it is a matter of time before the message reaches residents. This creates a new aspect for analysis related to the lack of knowledge about UA; this includes not only a lack of knowledge of the theoretical concept but also a lack of knowledge regarding the practice of agriculture in general. Perhaps this ignorance about UA exists due to a lack of practice and development of UA in the city. It also highlights the need to develop programs that promote UA, as the initiative will be very difficult to develop otherwise.

In Mérida, we observed divergent stakeholder opinions (residents, urban government officials and technical experts) regarding the different attributes given to UA, specifically "physical limits" or geographical limits. Most stakeholder opinions show a marked penchant for considering only what develops within the city limits as UA. This trend may be attributed in part to the values, training or interests of each interviewee and the current weak link between the city and UA. This coincides with a report by Sanyé-Mengual et al. (2016) in Barcelona (Spain), where the conceptualization of UA is built on what stakeholders see as a distant relationship between agriculture and cities. Nevertheless, this constant relationship with the "physical limit" is a normal trend reported by other authors (Gumbo and Ndiripo, 1996; Maxwell, 2000; Maxwell et al., 1998; Mbiba, 1994) and is even present in the FAO’s official definition of UA (FAO, 2011).

The lack of an official definition of UA in Mérida creates an unstable starting point for its development, as evidenced by the low prevalence of UA practice (5% residents, 20% urban government officials and 40% technical experts) and most stakeholders’ failure to consider that Merida is a city in which agriculture is currently being developed (85% residents, 60% urban government officials and 76% technical experts). In this case, it is necessary to issue a formal, common definition approved by the different actors who make up Mexican society in general. This definition could provide a starting point to promote activities related to UA in which all interested parties can support its development, whether across the country or specifically in Mérida.

Knowledge about technologies and types of UA remains limited. Most stakeholders still believe that agriculture must be done in the traditional way with irrigation systems. Still, they are aware of that system’s limitations and are open to accepting other forms of UA, including vertical agriculture (green roofs and walls). In some way, this mental openness to experimentation with different types
of UA is a sign of strong interest by stakeholders to develop some of the modalities of agriculture (55% residents, 100% urban government officials and 96% specialists) and cultivate traditional crops, such as tomatoes, onion, orange, peppers and lettuce. Thus, they can acquire vegetables in a more sustainable way within the same neighborhood (or in an area not exceeding 500 m), avoiding excess CO₂ emissions generated by the use of cars for transport. This method will also help to revive ancestral knowledge about agriculture, strengthening the identity of the people and improving their current food and health conditions.

*Development possibilities of urban agriculture in Mérida*

This study found Merida to have high motivation and potential for the development of UA in the technical field. However, important limitations of a legal and political character exist. Today, we cannot consider UA to be present in Mérida, largely due to limitations in urban planning and housing characteristics that hinder its development, as reported in this study. It should be noted that the current trend in Mérida’s urban planning policy, in which urban settlements are located on the periphery due to insufficient resources for the city to grow by buying cheap land without infrastructure located in the external areas of the city. These results coincide with the statement by Aravena (2011) about social housing policy in Chile and Latin America, where there are two trends in current urban planning and housing growth, namely reducing and displacing: reducing the size of housing and moving urban settlements to the periphery. The present study affirms the existence both tendencies.

The current design of social housing is inadequate for the proper development of a family, both in size and number of spaces. This is reflected in the tendency to annex new areas to meet the space needs of families. Reinforcing this idea, residents think the dimensions of the plot area and housing promoted by the government are insufficient for developing an orchard. This also coincides with the views expressed by Aguilar (2012) and González (2012), who note that the current urbanization of the country has greatly influenced the decline in urban orchards. The construction of settlements on the periphery of Mérida is exposed through the construction of huge garages in social housing. This is a reflection of the neighborhoods’ bad location, which has consequences related to displacement and lack of efficient transportation systems. Users are thus forced to have a car to meet those needs.

As a way to summarize this argumentation, an outline of the potential development for UA is proposed in Fig. 11. Based on the results presented above, this figure presents a synthetic view of changing stages in the typology of "social housing" in the study area and the applicable typology of UA.
The initial typology of social housing provides support for a new image and new uses for UA. The importance of the elements’ arrangement (rehabilitation or modification) in the original design determines the possibilities for adaptation and the spatial conditions that families might generate.

In the initial typology of social housing, UA can be implemented in the modalities of the front-traditional garden, back-traditional garden, green roofs, green walls, pots inside and pots outside. As the artificialized (built) surface increases in housing, the implementation of UA becomes less traditional. Although there are different alternatives for the implementation of agriculture in housing, stakeholders have a predilection for traditional forms of agriculture. However, they are interested in green roofs for UA implementation in housing with a high level of built surfaces. Perhaps, the lack of examples of innovative forms of UA in the city conditions their predilection for traditional agriculture. They are, however, aware of the physical or space limitations of modified social housing in the implementation of UA. In this moment, the weight of traditional forms of agriculture is an important barrier for the development of UA in the city.

In this situation, we can say that renovations to housing reflect the limitations of the original design, which is not always suitable to users’ cultural and environmental needs and do not support the model of a sustainable city. Despite the above, social housing and social neighborhoods in Mérida have a high potential for implementing UA in the most innovative modalities.
Fig. 11 Architectural feasibility of implementing UA in social housing in Mérida.

Considering the amount of constructed area and the constant addition of spaces to housing, vertical farming is a viable option. The development of rooftop gardens, green rooftops and green walls can be a solution for those homes without ground space for UA. Specifically, the development of UA on roofs can revalue unproductive spaces by giving them a new use. In the case of "social housing" in Merida, the implementation of UA would be feasible and fast, as the houses have adequate characteristics: minimum resistance of 200 kg/m², flat roofs, high solar radiation, minimum roof area of 50 m² and drains to capture water for irrigation. This brings benefits to both the neighborhood and the city, as noted by Cerón-Palma et al. (2012b), Specht et al. (2013), Specht et al. (2015) and Sanyé-Mengual et al. (2016): reducing food transportation miles and emissions; naturalizing the city; increasing habitability of the buildings; improving community food security; providing education on food production; encouraging local development; and more.

Government support through urban and legal facilities is basic to UA development because most stakeholders in the present study showed a marked interest in the support of government before venturing into UA. To some extent, the lack of legal knowledge of all stakeholders is a clear reflection
of the minimal importance that the current government gives to the issue. Therefore, it is necessary
to make changes to current legislation in Mérida and Mexico. If a sustainable city and country are to
face the challenges of the future, they must have a legal framework that promotes activities supporting
food security and food sovereignty to the benefit of the population. In general, any interest or
openness to the adoption of new activities for the sustainability of the city and healthier diets must be
supported in Mexico and Latin America (and other world regions), especially for residents who are
the basis for change in the current system. Among urban government officials and specialists, UA
presents ongoing challenges to working together to achieve a multidisciplinary vision that can benefit
the city and its population.

5. Conclusions and future perspectives

This study is the first to address the topic of urban agriculture in Yucatán. It reveals through first-
hand accounts the current situation of UA in social housing neighborhoods in Mérida. We have
observed that the stakeholders (residents, urban government officials and technical experts) consider
agriculture to be undeveloped in the city, mainly due to a lack of adequate space both in homes and
neighborhoods and a lack of promotion by government institutions.

This lack of development of UA is reflected by the limited consumption of vegetables and partial
ignorance of the concept of UA, which breeds the mentality of "it is easier to buy than grow."
However, urban government officials, technical experts, and half of residents are motivated to begin
implementing urban agriculture.

The basic typology of social housing in Mérida tends to be constantly modified and thus does not
seem to meet the needs of its users. Specifically, the high percentage of constructed areas (in housing
and neighborhoods), in extreme cases artificializing 100% of the surface of the lot, is inconvenient
for developing urban agriculture in its traditional form. Nevertheless, it presents an opportunity for
UA in the form of green roofs, green walls and rooftop greenhouses (RTG). "Social housing"
neighborhoods in Mérida have characteristics suitable for the development of UA. Mérida has all of
the technical characteristics for vertical implementation: there is cultural knowledge of cultivation
methods, motivation, and understanding that traditional crops should be developed (tomato, lettuce,
onion, pepper, among others). Stakeholders uniformly believe that UA can improve the quality of
their food, improve food security, revive traditional agricultural knowledge, generate personal
satisfaction, increase green areas in neighborhoods and allow economic savings in homes.

However, for this to occur, UA must first have an official definition. The lack of clarity around the
concept makes UA a topic with important subjective nuances that can limit and/or condition its
development. To strengthen and support its development, UA should be included as one of the priority issues on the agendas and development plans of governments (national, state and municipal) and in real estate development in the state of Yucatán.

Finally, the results of this study demonstrate that more research is necessary to address UA in areas of social housing in different cities of Mexico, Latin America and other world areas. Given the gap in the literature, it is imperative to have support to guide the changes needed. In the case of Mérida specifically, it is desirable to quantify the different types of agriculture that could be developed inside housing and plot areas, but these figures have not been reported. It is also important to investigate in depth the influence of cases of housing modification as an opportunity or hindrance for the development of UA. Similarly, it would be interesting to expand the study of social and intergenerational aspects of the transmission of traditional knowledge of Mayan agriculture from the perspective of the stakeholders.

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