Innovation System Approach for Urban Agriculture: Case Study of Mexico City

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Abstract This chapter presents an innovation system approach for urban agriculture. It argues that urban agriculture is a systemic concept – agriculture intertwined with urban dynamic – but that a systemic approach is often missing. Such an approach allows identifying strengths and weaknesses of urban agriculture for a particular city, region or country, in a comprehensive way. Based on these insights, more precise and targeted policies can be designed to stimulate urban agriculture and innovations needed in its context. The chapter illustrates this through the presentation of urban agriculture in Mexico City, presented in a number of elements of an innovation system, such as system boundaries, dynamics, institutions, knowledge, and learning cultures. Cultural dimensions are as yet only rarely recognized. The chapter describes how the cultural dimensions of urban agriculture are very important in understanding the case of Mexico City, and probably in much more cities.

Keywords Urban agriculture · Mexico city · Innovation systems · Learning cultures

1 Introduction

Urban agriculture is rapidly establishing itself as a new practice in many cities worldwide (WinklerPrins 2017). In Asia, Vietnam is a country with a long tradition of urban agriculture, and in Hanoi today, 80% of fresh vegetables and 40% of eggs are produced by urban and peri-urban agriculture (Kohlbacher 2015). In Africa as well, there are various countries with extended experience in urban agriculture. In Ghana's capital Accra, around 90% of all the fresh vegetables consumed comes from production within the city (Corbould 2013). In Latin America and the Caribbean, urban agriculture equally is already widespread in 23 countries in that region. It is practiced by 40% of

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households in Cuba, and by 20% of the households in Guatemala while in 16 of the 23 countries surveyed, people earned some income from this activity (FAO 2014). In the North, urban agriculture has a long history, going back to the economic depression of the late nineteenth century. Community gardens were developed in many cities in both Northern America as well as Europe. Today, urban agriculture is seen as part of the urban ecological infrastructure, needed to meet demands of sustainability and urban resilience. Roof and vertical gardens contribute to the greening of cities as they curb air pollution, increase humidity, lower urban temperatures and reduce energy consumption as well as extreme temperature fluctuations within buildings (Dieleman 2016).

An impressive body of literature has seen the light in the past 20 years, ranging from professional reports, instructional guides and leaflets to academic articles and books. This is a positive development but, as Stefan Reyburn argues, there is a certain mismatch or imbalance in the literature. A large part of it is primarily case-based, founded on the use of mere personal observations and experiences gathered in fieldwork. Moreover, it has a rather technical orientation, focusing on one or more operational aspects of urban agriculture. As a result, Reuborn is of the view that urban agriculture has been taken in a conceptual way, even though its essence has a conceptual construct (Reyburn 2012).

The essence of urban agriculture is its location within a city, more than its set of mere agricultural activities. It is a practice taking place in the midst of, and interrelated with, a variety of urban dynamics: economic, geographical, sociological, cultural, anthropological infrastructural, and more. This is often reduced to specific problems like for instance the question of how to handle contaminated or poor soils, or the lack of knowledge among practitioners of urban agriculture, and the need of knowledge transfer. Cultural, sociological or anthropological factors, however, are always present on a fundamental and more invisible level, and co-shape the present and the future of urban agriculture.

In this chapter, urban agriculture has been discussed in a conceptual way, using the idea of an innovation system as its key concept. This aims at linking technical and operational aspects with economics and policies, as it aims at linking those with sociological and anthropological insights. Using this concept allows for really integrating the *urban* character of urban agriculture, not seeing the city as solely a context for agricultural activities, but to integrate the economic, social and cultural dynamics of a city (that what makes a city "urban") as an integral part of the agricultural activities. In developing this approach, the chapter presents urban agriculture in Mexico City as a case study, to illustrate to way the concept of innovation system is applied.

2 Towards an Innovation System Approach for Urban Agriculture

Innovation can simply be described as the invention and application of a new idea, device, product, service or method (cf. Frankelius 2009). It is a buzzword in sustainability, which makes sense as sustainability is about creating a new world with innovative ideas, practices and systems. With respect to urban agriculture, there equally

exists a considerable amount of literature touching upon the phenomenon of innovation (Cunk et al. 2017; Driscoll 2017; Pfeiffer et al. 2013; Prain and De Zeeuw 2007). The published work points at various elements of which many have been introduced in this chapter: actors, interaction of actors, institutions, industries, governmental policies, learning cultures, technological development, and more. Frequently however, these aspects are not mutually linked and seen in a systemic perspective. To understand the potentials of innovation for a new practice as urban agriculture, or for a city, region or country, it is important to see all of these factors in their mutual interrelationship. This leads us to the concept of innovation systems, a concept introduced in the beginning of the ninety eighties, by Christopher Freeman and Bengt-Åke Lundvall (Freeman 1982; Lundvall 1985).

Innovation systems initially had a rather economic perspective, focusing on the production, distribution and consumption of new products, devices or technologies. The perspective gradually broadened, and the mere economic factors became part of wider innovation system (Lundvall 1988). With variables like legislation, education, knowledge transfer, entrepreneurial cultures and more (Lundvall 2007). These all, as a system, are supposed to make us understand better the dynamics of innovation in a particular field, country or region. There is a trend now to put ever more relative emphasize on sociological, political and – little by little – cultural factors, indicating that these are supposed to carry more weight than the mere economic factors, in explaining innovation processes (Lundvall 2016). Markatoua and Alexandroub (2015) argued that urban innovation systems should include the whole spectrum of societal challenges, as these form the unique societal aspects of cities (Markatoua and Alexandroub 2015).

A next step is to include cultural aspects and variables. As Tabellini (2010) convincingly showed, cultural characteristics of an economy are crucial in understanding the way the economy moves, functions and performs. They are equally crucial in determining the potential for change and transformation into the direction of, in our case, urban agriculture. Lundvall (2016) emphasized the importance of culture and language because culture make us "interpret identical signals in different ways", which is a starting point in creation and design. Alon-Mozes and Amdur (2010) gave an interesting example of culture in the field of urban agriculture, analyzing how the meaning of urban agriculture in Israel changed. It changed form a collective Zionist project into a personal project for people involved, allowing them to do physical exercise and stay in good physical shape through working with the soil. Redefining the meaning of urban agriculture ensured an ongoing interest, after its original meaning lost relevance. In innovation system literature, culture is very often seen as entrepreneurial cultures, and their degree of openness for innovation and change (Pohlmann et al. 2005). The example from Israel shows us that culture can also be relevant in the form of a certain national or group belief.

Coenen and Díaz López (2009) conceptualized an innovation system constructed around a number of key variables that all are non-economic by nature, such as System Boundaries, Activities, Actors and Networks, Institutions, Dynamics, drivers and barriers, Knowledge Transfer, Learning Cultures. Inside of these variables, economic processes certainly play a role, but they are not seen as the constituting elements of the system as such.

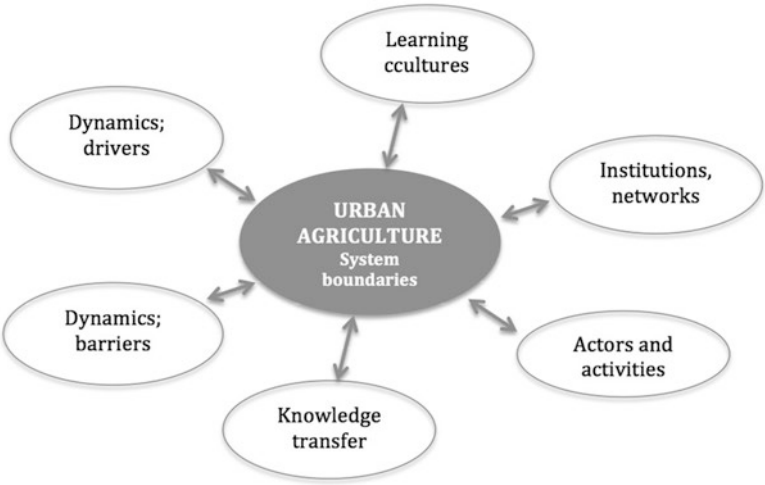

Fig. 1 Schematic representation of the key variables of the innovation system of urban agriculture

This chapter is structured with the elements mentioned by Coenen and Diáz López in mind (see Fig. 1). First it presents what urban agriculture actually is in Mexico City (system boundaries). In this description, the relevant actors, networks and institutions in urban agriculture in Mexico City are introduced. Then, it will focus on the drivers within the system (Dynamics), and will do so from a point of view of particularly social and cultural dynamics. This is inspired by an earlier work carried out by Dieleman, in which he interrelated ecological, economic, social and symbolic aspects of urban agriculture in Mexico City (Dieleman 2016). This work highlighted the relevance of cultural values. Both positive dynamics (drivers) are presented, as negative dynamics (barriers). Finally, the chapter interrelates all of those in an attempt to show how the innovation system approach sheds new light an urban agriculture, in the case of Mexico City.

3 Urban Agriculture in Mexico City; System Boundaries, Actors and Institutions

Mexico City is located in the Valley of Mexico, in the midst of the Mexican highlands. The city area is approximately 1479 km^2, with an average altitude of 2238 m above sea level, surrounded by mountains of up to 3880 m (Torres-Lima Pablo et al. 2000). The main soil types are litosoles, andosoles, feozem, regosoles and solonchak, and the climate is moderate, with a dry winter and a wed summer season. The mean temperatures range from 18 to 24 °C, and average annual rainfall is between 100 and 1400 mm (CETENAL 1977).

Urban agriculture in the Valley of Mexico is, seemingly paradoxical, older than the city itself. Before the colonization process, the center of what currently is Mexico City was the Aztec city called Tenochtitlán, build on an island located in a big lake that stretched throughout most of the valley. The Aztecs developed floating gardens around their city (the so-called *Chinampas*) to cultivate food for the inhabitants. Near the edges, around the lake, many communities existed with each having its own agricultural production. The cultural, symbolic meaning of these facts plays a significant role in the way urban agriculture is perceived today, something that will be analyzed in detail in this chapter. The Spanish conquistadores dried out the lake to create Mexico City, converting freshwater into land and later into urban space. This process reached its almost total completion long after the colonization period was finished, in the last three decades of the previous century. Near the end of the last century, the valley almost completely changed into urban area, due to mass migration from rural Mexico to the capital. Agricultural activities stayed and transformed into urban agricultural activities.

The response to the historical process of urbanization has been unplanned and rather chaotic, with little governmental organization or guidance, and with frequent violations of the few regulations that existed (Torres Lima et al. 2000). As a result, urban agriculture in Mexico City is far from a homogeneous or well-structured activity. The city usually is seen as composed of three zones with distinct features: a peri-urban, suburban and urban zone. Underneath this zone-division however, a diverse mix of activities take place, while the distinction of the peri- and suburban zone is far less clear than the difference of these two with the urban zone. In the description of the zones in this chapter, the peri-urban and suburban zones are combined.

3.1 The Peri- and Suburban Zone

Both the peri-urban and the suburban zones are in the south of the city (Fig. 2). The peri-urban zone has a total of 300 km^2 of farmland, which is divided in small plots that range in size from 1 to 3 ha (Torres-Lima and Rodríguez-Sánchez 2008). The zone consists of various small, traditional and indigenous communities such as Milpa Alta, San Mateo Xalpa, San Salvador Cuauhtenco, Magdalena Contreras and Cuajimalpa, and parts of Tláhuac. The suburban zone is found in lowland areas, particularly in the neighborhoods of Xochimilco and parts of and Tláhuac. These communities, as their names indicate, equally are pre-Hispanic and still maintain much of their traditional ways of working and living. The suburban zone used to be peri-urban but has been locked in by the ongoing urban sprawl, making them now part of the suburban zone of the city.

The communities of the peri-urban zone cultivate a variety of crops, including nopal, oats, potatoes, broccoli, carrots, lettuce, maize, tuna (fruit) and amaranth. To give an image of its magnitude, the 2012 harvest was valued at more than US$100 million and included 336,000 tons of nopal, 147,000 tons of forage oats, 12,500 tons

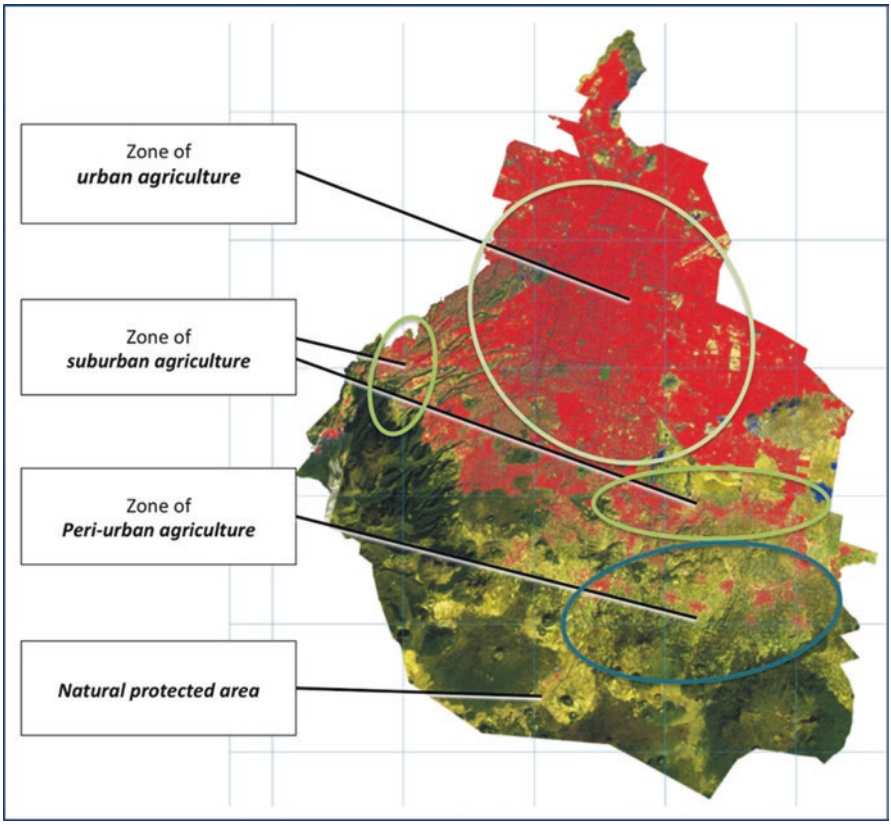

Fig. 2 Map of Mexico City with different urban agricultural zones

of potatoes and 15,000 tons of broccoli, carrots, lettuce, maize, tuna (fruit) and amaranth. Farms also raise livestock such as sheep, rabbits, pigs, horses and poultry. The animal population is estimated at some 6.650 head of cattle, 30.000 pigs, 10.000 sheep and 220.000 chickens (FAO 2014). Spaces inside the villages are used for milk and meat production in stables and to keep animals for work and transport (mules, donkeys and horses). The backyards are used for hens, turkeys, ducks, rabbits, pigs and birds of prey while the family orchard is used for the production of vegetables, fruit trees, and medicinal, ritual as well as ornamental plants. The space immediately around the village is dedicated to the intensive production of nopal, surrounded by a circle designated for the cultivation of maize, chile and beans (Losada et al. 2011).

For the communities and farmers in especially the peri-urban zone, it is not easy to generate sufficient income. Only 49% of the farmers in Milpa Alta and 25% of the farmers in Tlalpan can make a fulltime living from their agriculture (Torres-Lima and Rodríguez-Sánchez 2008). The others commute to the city center to find additional means of income, often in the informal economy. They tried to increase

Fig. 3 Impression of Aztec Chinampas, and an image of a modern Chinampa

and intensify production, but mainly with adverse effects. As a result, they now face, especially in the cultivation of nopal, an increasing amount of plagues, a new problem related to a more modern and intensified way of cultivation. Even though the use of agrochemicals to fight the plagues is legally prohibited, the enforcement of this law is very weak (FAO 2014). Moreover, the city government promotes a style of agriculture that is difficult to practice without the use of such chemicals. As a result, it remains very difficult for most of the farmers to generate a stable income. Later in this chapter, we will come back to that (Fig. 3).

The dominant production in the suburban zone is horticulture and floriculture, with some maize, using treated water for irrigation. On a yearly base 17,600 tons of flowers and 3,635,000 potted plants are cultivated. Sheep, rabbits, birds, horses and pigs are still raised in backyards and in some small (dairy) farms (Losada et al. 2011). Xochimilco is the municipality where the cultivation in the traditional *Chinampas* or floating gardens is still present. However, farmers are little by little changing towards the use of greenhouses. In the last two decades, the use of plastic greenhouses for flower and horticultural production has increased considerably, causing the abandonment and transformation of *Chinampas*. In 2006, the area of *Chinampas* in production in Xochimilco was estimated at 262 ha, with an annual loss rate of 31 ha, compared with 244 ha of greenhouses, with an annual growth rate of 14 ha (Merlín-Uribe et al. 2012). This has considerable environmental effects. It involves a loss of the lacustrine environment, which integrates water, trees and wetlands. This in turn has a negative effect on the water quality in the area. Furthermore, *Chinampa*s use less agrochemicals than greenhouses. Merlín-Uribe et al. show that 94% of the greenhouse farmers use chemical pesticides, while this is practiced by only 68% of the *Chinampa* owners. Twenty-six percent of them use purely organic measures, and 6% combines the two (Merlín-Uribe et al. 2012). Here as well various challenges present themselves that we will come back at later in this chapter (Fig. 4).

Some 20% of the food consumption of Mexico City is produced in the peri- and suburban zone of the city combined. The farmers transport every day 30.000 tons of products to the central market (the ‘Central de Abasto‘), that extends 328 ha of surface), while the food is distributed from thereon towards approximately 312 smaller markets in all parts of the city, the so-called “*Tianguis*” or mobile markets, that

Fig. 4 Huerto Romita en the downtown area of La Rome, Mexico City

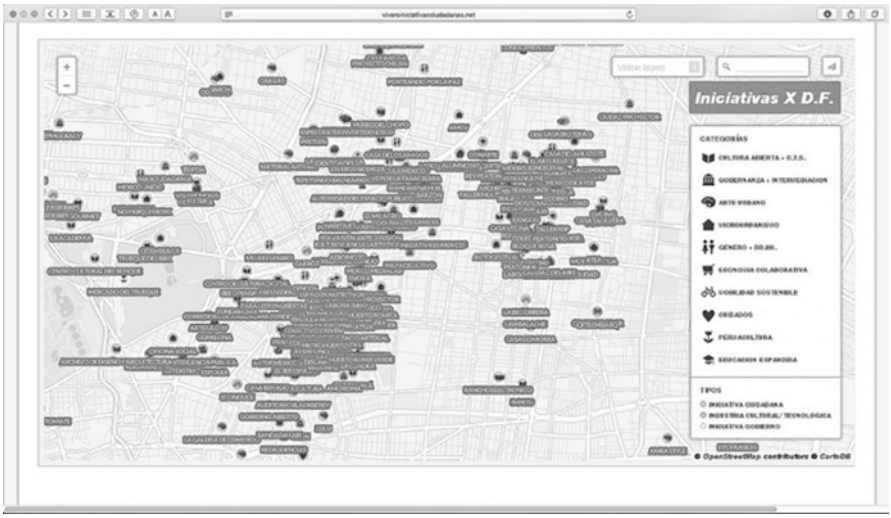

Fig. 5 Google map of citizen initiatives in Mexico City

equally have their roots in pre-Hispanic times (Soriano Robles 2005). In terms of employment and income generation however, urban agriculture is far less important. About 30.366 inhabitants of the city are involved in urban agriculture, in a total of 450 rural localities, in both the suburban (17.006 inhabitants) and the peri-urban zone (13.360 inhabitants). This corresponds with not more than 0.3% of the city's population (Fig. 5).

3.2 The Urban Zone

The center of Mexico City is densely populated, with an urban infrastructure comprised of main avenues, smaller roads and streets and parks with an organic mix of domestic, commercial and institutional functions within the neighborhoods. The areas and city municipalities surrounding the downtown city center, such as the municipalities of Iztapalapa, Iztacalco or Gustavo A. Madero, were largely constructed in the last decades of the previous century. They emerged in rather unplanned ways, with hardly any space for parks or recreational areas. They are real urban jungles of endless small homogeneous little houses of usually two floors with a flat roof, constructed without any architecture or feel for aesthetics. These urban areas have rather distinct forms of urban agriculture, concentrated in specially designed public gardens, rooftops and yards.

Agricultural activities inside of the urban zone are divers as well, showing a rich patchwork of projects initiated by governments, by NGO, private firms, NGO's and households. Between 2007 and 2012, local government invested 6 million US Dollar in 2800 projects, among other gardens in houses, collective housing units, schools and governmental buildings, and reached directly 15.700 inhabitants with these projects. Some 3000 families, especially the poorer, received support from the Government of Mexico City to create gardens on their rooftops, some with simple greenhouses to protect their crops from nightly mountain chill and occasional hail (Gaceta Oficial Del Distrito Federal 2012). On top of that, the city created, between 2010 and 2014, 22.000 m^2 of green roofs/gardens on public schools, hospitals, governmental buildings and some metro stations (Gaceta Oficial Del Distrito Federal 2012). In 2015, the construction of 10.000 more m^2 of green roofs was initiated (Dieleman 2016).

The central city government encourages the city municipalities to establish a department responsible for the creation urban gardens and the stimulation of domestic small-scale urban agriculture. As a result, initiatives now come from both the central city level and the level of the municipalities. The trickling down effect from the central city level to the municipalities however is rather slow. An additional number of 140 projects were realized in 16 of the city's municipalities, in vacant lots, backyards and roofs of private and public buildings. This includes the creation of public or semi-public urban gardens in 14 of the municipalities. These gardens have educational purposes and allow for the cultivation of plants and flowers for private consumption. The distribution of the crops thus realized is however not systematically planned or organized. Volunteers take what they want, and sometimes crops are not harvested at all.[1]

[1] This is, as far as I know not well documented, the statement is base don personal observations realized in various visits.

In 2015, a new public urban garden of 700 m^2 was opened in the rather poor municipality of Iztapalapa, within a public secondary school. The garden received the explicit label of being a "productive urban garden", where the students can work and take their share of the crops collectively produced to their homes. The garden focuses on the cultivation of cilantro, parsley, chile, chamomile and lavender, which all form part of the regular Mexican cuisine. The Cuauhtémoc municipality, the most central and downtown area of the city, is one of the most active in urban agriculture (Gaceta Oficial de la Ciudad de Mexico 2016). Since 2009, it is training citizens in becoming certified small-scale sustainable urban farmers. By now, some 500 citizens were certified. This municipality uses its public urban garden to give the training for the small-scale sustainable urban agriculture program. The municipalities of Miguel Hidalgo and Coyoacán initiated various projects for migrant families and single mothers, integrating in these projects the concept of microcredit in the form of small grants (1000–3000 Mexican pesos corresponding with or 50–150 US dollar) that enable them to invest in equipment to grow vegetables, to compost and to capture and use rainwater (Gaceta Oficial Del Distrito Federal 2012).

Besides the initiatives and policies generated by the government, Mexico City must be characterized by its large number of private initiatives, coming from NGO's, private industries, start-ups of young, recently graduated academics, and rather small-scale spontaneous bottom-up initiatives in neighborhoods and communities. One of the well-known communal gardens "*Huerto Romita*" (Romita garden) located in the fancy neighborhood of 'La Roma' (part of the Cuauhtémoc municipality).[2] It exists since 2007 and even though it is very small in surface (it has a 56 m^2 gardening center), it is very active in giving training in organic community vegetable production and in teaching permaculture techniques. It also helps in starting up school gardens and installs home and community gardens for city residents. *Huerto Romita* is well-known, and just one of many similar initiatives in the city.

The private sector as well shows various initiatives. Well-known is the urban planners group, "*Efecto Verde",*[3] who's imaginative and bold proposal is to cover 40% of the city's urban surface by 2030, with low-maintenance vegetation. The group is engaging in many projects that all partially contribute to their big objective, but a comprehensive plan to realize the 40% still has not been accepted by the city government. Besides this well-known company, many small startups enter the 'market' of urban agriculture as well. A nice example is the startup "*Solution Culture*", a company of three recently graduated industrial designers, who design green roofs, gardens and walls, primarily for companies located in Mexico City.[4]

Overlooking the entire spectrum of urban agricultural activities in Mexico City, one can only conclude that it is extremely divers, with many actors and institutions involved, and with a diverse range of activities. The indigenous farming communities are trying to maintain century-old traditions, agro-industries selling (especially

[2] http://www.huertoromita.com/centro-romita

[3] https://connectamericas.com/company/simbiosis-urbana-efecto-verde

[4] http://www.solutionculture.mx/nosotros

flowers), startups of young university graduates involved in the design of fashionable green roofs and green walls, NGO's, governmental agencies, many citizen initiatives and thousands of individual households and/or persons, in one way or other active in urban agriculture. This diversity reflects the complexity of the Mexican society, and is both a positive driver for urban agriculture, as it is also a potential barrier, as will be shown in the following sections.

4 Positive Drivers for Urban Agriculture in Mexico City

The diversity of urban agriculture in Mexico City reflects the complexity of the Mexican society in general. Yet, urban agriculture also has the capacity to unite the otherwise very divided country. This is an important driver for urban agriculture in Mexico City.

Mexico is a very complex country with on the one hand people living in modernity and postmodernity, and others still living in pre-modern conditions and cultures. Moreover, there is a deep sense of distrust among the various groups, resulting in a desire to minimize contact with those coming from other cultures and social-economic classes. There is in general a fear for "otherness", for people with different customs and lifestyles (Yépez 2010; Dieleman 2010). Mexico-City is not different; the situation may be even more extreme there. The city hosts many globally oriented well-educated individuals, living in the fashionable downtown area, choosing their own urban lifestyle, tailored to fit their specific wishes and desires. It hosts a modern national oriented middle class, living in often gated communities, or otherwise rather well secured neighborhoods. They live lifestyles that enroll around fixed jobs, family life, holidays and activities for children (Philip et al. coordinators (2015:2). Finally, it hosts many pre-modern oriented inhabitants, who arrived in the 1970s and 1980s, the period of mass migration towards the city. In numbers they are more than half of the city's population, living in the huge suburbs that make up almost 80% of the urban area. They still have rather regional and rural orientation, longing to continue – or return to – the way of living they lost because of their migration to the city (Dieleman 2010).

An interesting characteristic of urban agriculture is that it cuts right across all of the groups mentioned. More importantly, it has the potential to unite the Mexican society that is otherwise so very divided, as it touches upon, and mobilizes, two very distinctive features of the Mexican culture and society:

- The desire to reconnect with its largely lost pre-colonial past, and
- The longing for freedom and independence from societal institutions.

These two are key drivers for urban agriculture in Mexico City, drivers of a mainly cultural nature.

4.1 The Symbolic Meaning of Urban Agriculture

The previously mentioned *Chinampas* play a significant role as drivers for urban agriculture, as they are symbols of an almost lost past. It is important to give a short description of them in historic perspective. Around the year 1350, the Aztecs created the city of Tenochtitlán on one of the islands of what was at that time the lake of the Valley of Mexico. The city grew steadily and became the biggest urban settlement in pre-Hispanic Latin America, with at its peak around the year 1500 a population of approximately 250.000 inhabitants (Aguilar-Moreno 2007). To feed the ever-increasing population and to overcome land shortage, the Aztecs created their so-called '*Chinampas*'or floating gardens. The *Chinampas* increased the land area available for cultivation and were a model for numerous other cities in Mexico at that time (Aguilar-Moreno 2007). The *Chinampas* were constructed by staking out rectangular enclosures, ranging in size from 100 to 850 m^2, filled with mud and decaying vegetation and used for cultivation of mainly vegetables and aromatic flowers. On average 10–15 persons worked on one *Chinampa*. Cultivation was accomplished by the effective use of seedbeds, thus allowing for continuous planting and harvesting of crops (Evans 2013).

Soon after the Spanish 'conquistadores' took control of the Aztec land, however, in between 1519 and 1523, they started drying out the lake, creating land that later served as the foundation for contemporary Mexico City. Only in the suburban community of Xochimilco, the pre-colonial canals and *Chinampas* remained and still exist. In 1987, UNESCO declared them to be part of the UN World Heritage, underscoring their cultural importance, while taking a stand against their ongoing deterioration (Torres-Lima and Rodríguez-Sánchez 2008).

This history of Mexico City, combined with the previously mentioned desire to reconnect with the pre-colonial past, gives urban agriculture a positive connotation for most Mexicans today. This is not a small thing, on the contrary. Mexico is, as many other postcolonial countries, still suffering from its traumatic colonial history, resulting in a huge problem of uniting the divers and mixed population, and of creating one nation as a social whole, with a shared identity (Brushwood 1966; Hoy 1982; Yépez 2010; Dieleman 2010). Urban agriculture offers the city's inhabitants an opportunity to re-experience their past, in a symbolic way, and to be Mexican in an identity-full way, while they can at the same time be part of a global emerging movement of sustainability and food security. Urban agriculture stands for a tradition, an identity, as well as for contemporary values of sustainability and care for future generations. The *Chinampas* play a crucial role in this, as icons of a time largely gone by (Torres Lima et al. 1992).

For the indigenous farmers and communities like those of Milpa Alta or Cuajimalpa, the symbolic meaning of urban agriculture helps them in their struggle to continue living their traditional lifestyles. For the migrants of the 1970s and 1980s, as well as their second or third generation offspring, urban agriculture opens

opportunities to reestablish parts of their rural lifestyle. Finally, for the more affluent population in the urban zone of the city looks, the symbolic meaning of urban agriculture helps them integrating their postmodern lifestyle with their Mexican identity.

While the city government is interested in urban agriculture for reasons of food security in the context of climate change, and private industries are interested in combatting contamination to change the city into an attractive workplace that appeals to a foreign and well-educated workforce, they find the citizens of Mexico City on their side, though for different reasons (Dieleman 2016). This mix of mutually reinforcing drivers creates a huge potential for urban agriculture in Mexico City.

4.2 Citizen Bottom-Up Initiatives

A second potential for urban agriculture in Mexico City is the longing for freedom and independence, a desire that has a particular meaning in the Mexican context. This context is partly, again, historic and rooted in the colonial past. But it is also contemporary, and rooted in the malfunctioning of Mexican democracy, government and the juridical system. These all are all seriously plagued by corruption, brutal inefficiency and clientelism (Philip et al. 2015). Mexicans have suffered throughout history from rulers that never were really interested in the wellbeing of their citizens. This shaped a particularly deep longing for freedom, respect and independence, and resulted in an active civil society that is remarkably active today (Vargas Hernández 2010).

This civil society is relatively quiet young, and its development accelerated in the second half of the ninety eighties of the previous century. The earthquake that struck Mexico City on September 19, 1985 is seen as an important catalyst in this development. This quake destroyed a considerable part of the city and resulted in the death of approximately 10.000 persons, with 250.000 people losing their homes (Quarantelli 1992). In the days after the quake, governmental responses were very inadequate, and citizens were obliged to organize themselves. They spontaneously took up the tasks of rescuing people, distributing food and providing shelter. Without this spontaneous civil response, the effects of the earthquake would have been much more detrimental (Quarantelli 1992). Yet something else happened. The aftermath of the earthquake awakened, in the words of the Mexican poet Homero Aridjis, a social earthquake that is still roiling in Mexico City and the entire country.[5] It is the social earthquake of the awareness that the Mexicans can take the course of life in their own hands, despite of a malfunctioning government. Vargas Hernández talks about the Mexican civil society as an emergent property of a failing political and institutional system, that accelerated in 1985 and never disappeared since (Vargas Hernández 2010).

[5] https://www.huffingtonpost.com/homero-aridjis/mexicos-1985-earthquake_b_8170324.html

Houtzager and Acharya conducted an exhaustive comparable study on citizenship in and Mexico City and Sao Paolo in Brazil. They arrived at the conclusion that in Mexico City the participation in associations for self-provisioning is particularly strong. Twenty-five percent of the total population participates, or participated, in associations, initiatives or actions organized by the civil society. This participation was realized by people coming from all types of education, from lower levels up to people with higher education (Houtzager and Acharya 2010). These data reveal an image of Mexico City as a vibrant city, full of bottom-up initiatives that together constantly create and recreate the city. This is very relevant for the future of urban agriculture in the city.

In 2013, the VIC, the "*Vivero de Iniciativas Ciudadanas*" or in English the 'Nursery of Citizens Initiatives', an NGO based in Spain, started recording and mapping citizen initiatives in Mexico City, in collaboration with the Spanish Cultural Center in Mexico.[6] It registered and mapped a total of 369 citizen initiatives, in various categories as 'Care and lifestyle', 'Collaborative economy', 'Micro-urbanism', 'Permaculture' and more. Many of them are directly or indirectly involved in urban agriculture, even though they are categorized under labels as micro-urbanism, permaculture or collaborative economy. The initiatives registered by VIC only form the top of the iceberg, as only those were included who have their own website and can be found on internet. The reason for this is that VIC created a Google Map style map of the initiatives, which allows visiting each of them online.

Research carried out by VIC indicates that 91% of the initiatives consider themselves as "bottom-up" initiative without any connection to an established institution, while 87% responded that their explicit goal was to practice alternative ways of living, with keywords as ethics, social responsibility, equity and sustainability. Ninety-one percent indicated that their objective is to contribute to those values through concrete actions, instead of using political action. The combination of the historically prompted interest in urban agriculture, and the active participation of many Mexicans in bottom-up initiatives that aim at creating a better – sustainable, ethical, equal – society, creates a very fertile cultural soil for urban agriculture in Mexico City.

5 Barriers for Urban Agriculture in Mexico City

A fertile soil is not enough to make agriculture flourish, and the same is true for a fertile cultural soil. Other conditions need to be fulfilled as well, such as the availability of knowledge and capacities, certain cultural outlooks, technologies, favorable policies and structural tendencies that help urban agriculture to develop. In this section, some of those, and places them in a wider context, of modernization and some key features of the Mexican culture in general have been described.

[6] http://viveroiniciativasciudadanas.net/2015/04/20/iniciativas-x-d-f/

5.1 Structural Tendencies

Several structural tendencies form serious threats for the further development of urban agriculture, especially in the peri-urban and suburban zones. One of the problems the farmers in these zones are facing is a loss of agricultural land. This is mainly due to the urban sprawl that continues to demand more land for housing, industrial as well as recreational activities. In relation to this, a second problem is the overexploitation of aquifers, because of the increasing water demand of the city. This has led to a serious decline in water supply, water quality and to ground subsidence (SEDEREC 2017). Despite of that however, as was mentioned in paragraph 3.1, there is an ongoing trend to substitute *Chinampas* for greenhouses, even though the last are considerably less sustainable in terms of the conservation of water quantity and maintaining water quality. In the peri-urban zone, the significant increase in the cultivation of nopal – in itself a response to changing market demands – has led to an enormous increase in plagues, for which the cure until now is the use of agrochemicals, something that is strongly rejected by the farmers themselves, and goes against the objective to create sustainable urban agriculture.

The supply of seeds is a third serious challenge, for the horticulture and floriculture in the suburban zone and for the cultivation of especially nopal, maize and broccoli in the peri-urban zone. Government stopped seed production in the 1980s and as a result, seed supply is now largely in the hands of large corporations. Many of them are foreign with just a few – large Mexican companies active in this field. As the cost of certifying seeds are very high, the farmers are increasingly dependent on those private corporations (FAO 2014).

Even though farmers, especially in the peri-urban zone, are encouraged to produce for local and national markets, their access to the wholesale market is limited, a fourth critical barrier. A vision of how to integrate urban agricultural production within mainstream markets however is missing. This involves designing new producer-consumer networks and structures beyond the incidental organization of fairs for indigenous products produced in the urban context, and beyond the sale of organic products for the middle and upper classes, willing to pay higher prices than low-income groups can afford to do (FAO 2014).

5.2 Modern Thinking Regarding Politics and the Definition of Agriculture

The policies developed in Mexico City target some of the challenges mentioned, but their effect is partial and, in some cases, potentially averse. This has to do with another cultural dimension, that of modernity and modern thinking. It may sound strange to mention modern thinking as a barrier for urban agriculture, but in Mexico City this is certainly the case. In general, modern thinking tends to divide the complex reality in different parts, to then analyze those parts separately and develop

policies for each part in relative isolation (Dieleman et al. 2017). This obscures a systemic view on the whole. Moreover, modern thinking in general places strong emphasize on rationalization and individualization. In agriculture this manifests itself in an agro-industrial and an agro-entrepreneurial approach. In Mexico City this creates various concrete problems.

In territorial planning the focus on dividing and separation is very clearly present (Ruiz et al. 2014). Several years ago, the territorial planning of Mexico City declared the forests in the very south of the city to be protected natural area, and from that moment on, agricultural activities are strongly discouraged, and the use agrochemicals in this area is prohibited. It is a typical modern politics of protection by separation. The farmers in the peri-urban zone of Mexico City used these areas for centuries, respecting natural cycles without destroying nature in a structural way. The idea that agriculture stands in opposition to nature was never a reality for them, but this thinking is now imposed on them. This is even more problematic as they are pushed to increase their production, and the use of fertilizers and pesticides is stimulated, even though research programs for sustainable alternatives are put in motion.

Governmental planning in Mexico City, as virtually everywhere else, is compartmentalized in separate domains as economic policy, social policy, infrastructure, education, etc. Separate policies per sector often only very partially integrate with other policy domains. This is also true for the policy to stimulate urban agriculture in Mexico City. Economics, infrastructure, social programs, market etc. are mentioned, but largely remain a context that the urban agriculture programs don't try to influence. They are merely mentioned. There is no analysis of the structural challenges just mentioned, with the exception of the problematic of the seeds. Subsequently, there are no policies developed to curb those trends to favor urban agriculture (SEDEREC 2017). The policies mentioned are largely limited to *the subsystem of agriculture* within the city. The question is what the farmers can do, not how government can curb the trends affecting the future of urban agriculture. With respect to the problematic of the seeds, this is different. The city's Secretariat for the Environment created a system for the certification of organic production, the so-called Green Seal, and has set standards for organic agriculture in the conservation zone. Subsidies are provided to the farmers of Milpa Alta who preserve local maize varieties under traditional production systems with low environmental impact.

A third aspect to urban agriculture and modernization is the proposed change towards an agro-entrepreneurial approach. Many of the farmers in the peri-urban zone seek to increase their income, but for them this is never a separate objective. In their traditional way of living – and even worldview – work, family, economics, nature, agriculture all are related, within a spiritual explanation of how all fits together (hence: worldview). Being a farmer is indeed a way of *being*, far beyond a way of merely *doing* or a profession. On a yearly basis, the community of Milpa Alta, the largest in the peri-urban zone, has 43 religious celebrations and 16 pilgrimages in which the relationship between the land, the community, fertility, water and mother earth are celebrated (Losada 2005).

As Torres-Lima and Rodríguez-Sánchez (2008) rightfully observe, this risks losing the social cohesion in the communities. The challenge is to find ways to maintain the traditional culture and stimulate urban agriculture at the same time. This is as yet not fully recognized in the politics of urban agriculture. The modern agro-industrial and agro-entrepreneurial approach also favors the use of greenhouses over *Chinampas* in the suburban zone, while Chinampas are remarkably more efficient and sustainable, in terms of both the use and contamination of water.

Secondly, the policies do not really find an answer to the question how sustainability, traditions, modern techniques and practices can all go together, or be blended together in a convincing way. This is problematic, as the city government pretends to stimulate sustainability and respect indigenous practices, but sees agriculture through the standard lens of mainstream modern thinking. These various objectives do not organically go together however.

5.3 Organizational Learning Cultures

A second major barrier for an ongoing development of urban agriculture in Mexico City is the lack of appropriate organizational learning cultures among people, and especially groups, involved in urban agriculture. Organizational learning cultures do not address specific technical knowledge or skills, but focus on the way that teams, networks and organization function and collaborate. Learning cultures are oriented towards both individual capacities and group dynamics. Individual capacities are the levels of self-knowledge and capacity of self-reflection and self-discipline, and the capacities to develop personal professional trajectories, with specific ideas and visions for the long and the short term. Relevant aspects of group dynamics are capacities of effective professional communication, effectively dividing of tasks, meeting deadlines, giving feedback and collectively evaluating results.

In Mexico in general, this is a big challenge. Gordon (2010) analyzed Mexican business cultures using the dimensions that Hofstede developed in his famous cross-cultural analysis of 50 countries (Hofstede 1980). These dimensions are individualism versus collectivism, power distance, uncertainty avoidance and masculinity versus femininity. Especially the dimension of power distance is relevant in the context of urban agriculture in Mexico City. Mexico is one of the countries with the worlds' highest index for power distance, which means that people is reluctant to express a different opinion than their boss, and tend to conform to what their boss says, even when they disagree and/or know that their boss is wrong (Kesseli 2017). The Mexican macho culture makes this worse, as the macho tends to impose his ideas on others, disregarded of how the other thinks, feels or desires (Dieleman 2010). This prohibits creating more equal and open working relationships and genuine partnerships, which are essential for good teamwork. It equally discourages learning and teaching skills for teamwork, such as professional communication and collaboration skills, as they are not perceived to be that relevant.

A research project carried out with students of the undergraduate program in Environmental Sciences and Climate Change of the Autonomous University of Mexico City (Dieleman and Martinez-Rodriquez 2017), shows the relevance of these cultural phenomena for urban agriculture. The project investigated the cultures of 20 citizens initiatives included in the list of VIC. These 20 initiatives all focused on urban agriculture, as either their main activity, or as part of a broader range of activities. The research showed that organizational cultures indeed have a negative effect on the functioning of these initiatives, both in terms of their internal organization as well as in terms of their participation in networks. Many, if not most of these initiatives were founded rather charismatic persons with clear visions on how to accomplish their goals. And even though most of them favor horizontal and open working relationships, their coworkers reported that they were frequently not open for dialogues and remain closed to ideas of collaborators. This negatively impacted the motivation of various coworkers and diminishes the potentials of working with all of the energy and creativity available in a group or team. Various initiatives stayed on the level of where they started, and didn't show real development in their ways of working, and the services and products offered (Dieleman and Martinez-Rodriquez 2017).

This also affected the initiatives' participation in networks. The founders/directors often are convinced that they know very well how to organize their work, and do not expect much from the possible collaboration with others. Moreover, almost all of them expressed mistrust in governmental institutions, and avoided working with the private sector as well, to avoid entering market dynamics of profit making. This demonstrated – and is nourished by – the distrust mentioned before, and the fear for others and "otherness. It is however a serious barrier for the future development of urban agriculture in Mexico City. It is widely recognized that citizen initiatives need support from the party of local governments (Ostrom 1996; Sirianni 2009; Bakker et al. 2012; Pestof et al. 2012). Sirianni's main recommendation is that both the citizen initiatives as the government need to acquire skills and abilities to collaborate in networks, such as facilitating and moderating skills. On a personal level, this requires openness to the ideas and experiences of others and involves training in organizational learning skills to learn to co-work, co-produce and co-create.

It equally requires another view on the city, as a complex system full of bottom-up activities, action, reactions and emerging properties (Dieleman and Hernández Vázquez 2018; Dieleman 2012). Kagan et al. call this a city as a 'space of possibilities', that asks for proper stimulation, moderation and facilitation, to growth and fulfill its potentials (Kagan et al. 2018). This characteristic however is not recognized by the government of Mexico City, neither in the literature on urban agriculture. It is however a potentially very strong driver for changing the city.

6 Knowledge Transfer

In 2007, the city created a new secretary to stimulate small-scale urban agriculture, the so-called SEDEREC, the Secretary for Rural Development and Community Equality. The aim of SEDEREC is to stimulate urban agriculture, do research and development of sustainable practices and technologies and engage in knowledge transfer. The program aims at improving production planning, training, technology development, agro-processing and marketing. Through this program, the city together with Mexico's Federal Government, invested between 2007 and 2012 some US$24.6 million in horticulture, floriculture and crop and livestock production, US$37 million in the conservation and sustainable use of natural resources in primary production (SEDEREC 2017).

For the farmers in the peri-urban and suburban zone, it organizes trade fairs and exhibitions, helping them to promote their traditional food in local, national and international markets. In 2013, it signed an agreement with the Havana's Institute of Fundamental Research in Tropical Agriculture in Cuba, to establish a Program for Technology Transfer of Small Scale Sustainable Agriculture. This program is first targeted at the farmers in especially the peri-urban zone, yet also focuses on the public gardens in the urban zone and through them, on single groups and households in the urban zone. In that zone, the program helps developing training programs focusing on how to compost, use rainwater and cultivate native plants and crops in urban spaces such as rooftops and small yards. In addition, the programs developed teaching material focusing on market orientation and some basic administration. In the suburban zone, water quantity and quality is a major issue. The program focuses on increasing the capacity for rainwater harvesting and storage and treatment of wastewater (SEDEREC 2017).

For the peri-urban zone, knowledge transfer focuses on the introduction of improved technologies for processing particularly on nopal and maize. As mentioned however, the program promotes a modern agro-industrial and agro-entrepreneurial approach, which has various adverse effects on the way many farmers in the peri-urban and suburban zone envision how urban agriculture in Mexico City needs to develop itself. It contradicts the cultural orientation and wishes of many, possibly because this is hardly recognized by the city government, certainly as a driver for change and innovation. What is needed is a more comprehensive interdisciplinary or transdisciplinary program, which combines a mere agricultural approach with a cultural and historical approach. Even the FAO is recognizing this omission in the knowledge transfer activities of Mexico City (FAO 2014: 25).

This need also presents itself when reading SEDERC's 4th very comprehensive annual report (SEDEREC 2017). The document addresses virtually any aspect relevant for urban agriculture, including many of the topics presented in this chapter: technology transfer, creation of new markets, citizen initiatives, the positive

attitude towards urban agriculture in the city, the link with tradition and the past, and many more. However, all topics are presented in a rather separate way, and an overall vision behind them on the future of urban agriculture for the city, is missing.

As already touched upon, two questions remain unsettled. The first is how the city envisions integrating an increase in urban agricultural food production with maintaining traditions. How can horticulture and floriculture grow in sustainable ways with *Chinampas*, instead of replacing them by greenhouses*?* And how can the cultivation of nopal, maize and beans grow within the century old tradition of communal agricultural practices, instead of through the concept of agro-entrepreneurship? The importance of all of them is mentioned (growth, tradition ecology, sustainability), but an analysis of how they may reinforce each other, or conflict with each other, is absent. Secondly, a vision is missing on the question how urban agriculture may be integrated in mainstream economic activities in the city. It is sympathetic to organize fairs for indigenous organic products, a few days per year in the city center. But more importantly in the long run is, how these products can find their way to supermarkets and the dinner tables of those Mexicans that are less conscious and less critical in their purchases. This long-term integrated perspective still is missing.

7 Conclusion: The Importance of Seeing Urban Agriculture as a Systemic Activity

This chapter presents urban agriculture as a systemic endeavor, meaning that its success and growth depend on a fairly large number of divering variables. The innovation system approach applied in this chapter focused on System boundaries, Actors and Activities, Institutions and Networks, Dynamics, Knowledge transfer and Learning Cultures. The identification of these variables is not an exact science; it depends on the perspective one uses and the specific context one works in. The context of Mexico City, the case study presented to illustrate how a systemic approach may look like, highlights in particular various cultural aspects as drivers and barriers for urban agriculture in Mexico City. These cultural aspects do not stand alone, but have their effects on public policies, knowledge transfer and the learning cultures analyzed. The approach presented here, aims at complementing a more widely applied approach of focusing primarily on case studies from a perspective of operational aspects, practical knowhow, techniques and technologies, and rather targeted public policies to stimulate urban agriculture.

The question to answer now is, if the model applied can give us some insights into probable future developments of urban agriculture as an innovation, a new idea, device, product, service or method, in Mexico City. The answer is as follows. The chapter shows a widely present interest in urban agriculture among virtually all the different actors and groups present in Mexico City. There is an enormous potential for its further growth and development, and this is above all culturally induced. The

interest is not in the first place coming from a felt need to increase food production or improve the environmental quality of the city. Key words rather are: history, identity, independence, living a meaningful traditional and both contemporary Mexican life. For the farmers in the peri-urban and suburban zones of the city, economics do play a vital role, but many of them do not isolate mere economic concerns from cultural, social and even spiritual concerns.

The cultural relevance is recognized in academic circles and in the academic literature presented in this chapter, and it is often mentioned while talking with people in the field. Most of them however, see it as an interesting feature of urban agriculture, but not as a driver or dynamic force for the future development of urban agriculture in Mexico City. The concept of innovation changes this, and turns it into a driver, making us look at urban agriculture as a process, which can be stimulated or hampered. There is an immense potential for urban agriculture, once it is seen as a decisive characteristic of a future sustainable Mexico City. As an outstanding feature of the city that unites the past and has a promise of creating a sustainable future, while it potentially unites the divers, often antagonistic groups within the city. As a symbol, which is on the one hand based on a century old history and opens on the other hand a door to a sustainable future.

The city government is yet not recognizing urban agriculture in this way. It, somewhat implicitly, thinks of urban agriculture in terms of its food production in the peri-urban and suburban zones, and in terms of its environmental benefits and environmental education for the urban zone. It recognizes the cultural dimension, but as a mere contextual variable, not as a driver for innovation. The focus on increasing food production, even though the importance of organic production methods is recognized, tends to favor greenhouses over *Chinampas* in the suburban zone, and agro-industrial and agro-entrepreneurial practices over communal indigenous practices in the peri-urban zone. By contrast, it still underestimates the potentials of food production in the urban zone. That is why knowledge transfer was, paradoxically, characterized as a barrier for urban agriculture instead of as a driver, which it is supposed to be.

A second identified driver is the desire for freedom and independence, motivating many individuals to start producing parts of their own food on rooftops or in little yards. This also includes NGO's like Huerto Romita and others, and many private initiatives such as *Efecto Verde*, startups like *Solution Culture* and many spontaneous citizen initiatives. All of these initiatives together show an image of Mexico City as a vibrant system, and a real 'space of possibilities'. As mentioned, this characteristic again is not really recognized as such, and less as a driver for urban agriculture as an innovation process. It is however a potentially very strong driver for changing the city. Here as well however, we need to signal an important barrier. The knowledge transfer does not include training in organizational learning capacities, even though these are certainly needed to promote urban agriculture in Mexico City.

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