

Products from urban collective gardens: Food for thought or for consumption? Insights from Paris and Montreal

Jeanne Pourias^{a*}

UMR SAD-APT AgroParisTech/INRA & University of Quebec in Montreal

Eric Duchemin^b

University of Quebec in Montreal

Christine Aubry^c

UMR SAD-APT AgroParisTech/INRA

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Abstract

Among the various forms of urban agriculture that have emerged and been developed over the past 15 years in countries of the global North, collective gardens (CGs) are one of the most significant. In Montreal and Paris, their numbers have increased rapidly in the past 20 years. Previous research has shown that food production is an important motivation for urban dwellers to engage in gardening activities, but the food function of CGs, that we define as the quantitative and qualitative

food supply they are likely to provide to gardeners, is poorly known. This paper investigates this food function in Paris and Montreal. We carried out comprehensive interviews with gardeners, quantified production, and did plot monitoring to provide insights on the quantities of fruits and vegetables produced in CGs, the destination of garden produce, the use of space in plots, and the types of crops grown in CGs and their yields. The results show a wide diversity of practices regarding CGs' food function that has to be considered in relation to the multifunctionality of these gardens. The paper concludes with a discussion on the results and the implications of this research for garden planning and management.

Keywords

collective gardening, multifunctionality, urban agriculture, urban gardening, urban food production, Paris, Montreal

^{a*} *Corresponding author:* Jeanne Pourias, UMR SAD-APT AgroParisTech-INRA; 16, rue Claude Bernard 75231; Paris, France; +33-6-81-14-85-75; jeanne.pourias.au@gmail.com

^b Environmental Sciences Institute, University of Quebec in Montreal; Succ. Centre-Ville; C.P. 8888; Montreal, Québec, Canada; duchemin.eric@uqam.ca

^c UMR SAD-APT AgroParisTech-INRA; 16, rue Claude Bernard 75231; Paris, France; christine.aubry@agroparistech.fr

Introduction and Literature Review

In industrialized cities, growing concerns regarding food quality and the environmental and social conditions of food production are currently leading to renewed interest in urban agriculture (Evers & Hodgson, 2011; Pothukuchi & Kaufman, 1999). Two different perspectives can be found in the recent academic literature on urban agriculture: on the one hand, a range of studies describe urban agriculture by focusing on its outputs, production processes, and geographical location¹ (Algert, Baameur, & Renvall, 2014; Smith & Harrington, 2014); on the other hand, several North American authors describe the social and environmental movement driving urban agriculture (Cohen, Reynolds, & Sanghvi, 2012; Duchemin, 2013; McClintock, 2010).

Among the various forms of urban agriculture that have emerged and developed over the past 15 years in countries of the global north, collective gardens (CGs) are one of the most significant. CGs include cultivated spaces managed collectively by groups of gardeners, most often for food-production purposes and for the gardeners' own consumption, located at a place distant from the gardener's home (INRA, 2013). They include both historical forms of gardens, whose origins go back in the late 19th century (such as family gardens in France, allotment plots in the UK, or community gardens in Quebec), and more recent forms of gardening, such as shared gardens in France. As we realized that the same expression can refer to a diversity of designs, settings and statuses² from one country to another and even within a same country, we use the term "CGs" to avoid ambiguity that may arise from using a word already used in a specific context.

¹ Urban agriculture was defined by Moustier and Fall in 2004 as the agriculture located in or around a city, whose products cater for the city; urban agriculture is characterized by the conflicts or complementarity that might exist between agricultural and urban non-agricultural use of its resources (Moustier & Fall, 2004)

² For example, in France, "shared gardens" can refer to gardens that provide communal or individual plots, while "family gardens" are most often divided into individual lots, but are also evolving toward new layouts that include communal plots.

Since the early 2000s, the number of CGs and the number of urban dwellers involved in a form of collective gardening have increased rapidly in many industrialized countries. This is reflected in the academic literature, where various case studies describe the extent of CGs in the cities of the Global North. While illustrating the environmental, social, and/or economic functions that CGs have for these cities, these case studies exemplify the multifunctionality of CGs and the various benefits and motivations associated with collective gardening (Draper & Freedman, 2010; Duchemin, Wegmuller, & Legault, 2008; Evers & Hodgson, 2011; Gittleman, Jordan, & Brelsford, 2012; Pourias, Daniel, & Aubry, 2012).

During the last decade, driven by the increasing popularity of CGs, several studies assessed the potential of CGs to contribute to the urban food supply (Darrot & Boudes, 2011; Grewal & Grewal, 2012; MacRae, Gallant, Patel, Michalak, Bunch & Schaffner, 2010; McClintock, Cooper, & Khandeshi, 2013). These studies concluded that a substantial part of urban food demand could be produced within the cities' own boundaries by putting vacant land into production.

At the same time, a set of studies aimed at documenting qualitative changes in gardeners' diets; in North America, recent studies on nutrition and public health have demonstrated that people involved in community gardening have a healthier diet than nongardeners regarding their average consumption of fruit and vegetables (Alaimo, Packnett, Miles, & Kruger, 2008; Litt, Soobader, Turbin, Hale, Buchenau & Marshall, 2011). Gerster-Bentaya (2013) has argued that CGs, as a form of "nutrition-sensitive urban agriculture" have the potential to contribute to diversify diets of urban dwellers and should therefore be given more attention in public policies, especially regarding their connections with local food systems.

Regarding the individual motivations of gardeners, food production appears to be one of the most important motives mentioned by gardeners. For example, a 2000 study on 20 community gardens in upstate New York showed that the most commonly expressed reasons for participating in gardens were to access fresh foods, enjoy nature, and receive health benefits (Armstrong, 2000). In

Montreal, producing fresh and locally grown food is a very important motivation for 60% of gardeners, while saving money is a very important reason for only 18% of the community gardeners (Duchemin, 2013). Duchemin reports that, in Europe, the reasons for engaging in a form of gardening are similar to those in Montreal, despite a slightly greater interest in the social function of the gardens and a slightly lower interest in food production (Duchemin, 2013).

Therefore, according to the existing literature, it turns out that food production in CGs, especially the growing of fruits and vegetables³, is both an important motivation for participants and a promising way to enhance nutrition and availability of fresh food in cities.

However, the production levels of CGs have received little attention from researchers and very few quantified studies exist to document CGs' outputs (Algert et al., 2014; Evers & Hodgson, 2011; Gittleman et al., 2012). This knowledge gap significantly reduces the impact of recent studies that address the question of food production and consumption in CGs. For example, the positive impacts of gardening on nutrition, observed in several studies, is due to an increased consumption of fruit and vegetables among gardeners; however, it is unclear whether this increased consumption is due to a greater awareness of nutrition issues among gardeners (vs. nongardeners) or due to the quantitative contribution of the gardens themselves that led to a change in diet. This question cannot be answered without knowing the gardens products and how they fit into and their use eventually modifies gardeners' diets.

Similarly, studies investigating the potential contribution of gardens to urban food supply are based either on production data obtained in different soil and climate contexts than their field of study, or on theoretical yields calculated from yields obtained in conventional agriculture (Darrot

& Boudes, 2011; Grewal & Grewal, 2012; MacRae et al., 2010; McClintock et al., 2013). Yet it appears that the cropping practices of urban gardeners and the yields achieved in CGs differ significantly from what is observed in conventional agriculture (Algert et al., 2014).

An emerging body of literature has focused on the possibility of quantifying production rates of CGs. These studies have proposed methodologies, including participative methods, to record the amount of fruit and vegetables produced (Duchemin & Enciso, 2012; Gittleman et al., 2012; Smith & Harrington, 2014; Vitiello & Nairn, 2009). These studies highlight two important points: (a) the relatively high yields per unit area observed in CGs, which are close to the yields achieved in bio-intensive agriculture (Algert et al., 2014; McClintock et al., 2013) and (b) the very high variability of yields and quantities produced from one plot to another (Gittleman et al., 2012; Vitiello & Nairn, 2009). These recent studies have drawn attention to the need for better estimating and understanding the quantities of fruit and vegetables produced in urban gardens.

Regarding the contribution of CGs outputs to gardeners' food supply, a recent French study proposed a methodology based on surveys to assess levels of self-procurement achieved in one French family garden for each crop grown in garden plots; this study showed that gardeners achieved very high rates of self-procurement for fruits and vegetables (Mienne, Mandereau-Bruno, Isnard, & Legout, 2014).

Regarding the types of crops grown in CGs, several studies conducted in the U.S. provide lists of the most commonly grown crops in U.S. community gardens.⁴ Methodologies differ from

³ The products of CGs are diverse, and recent studies have shown evidence in urban contexts of the development of livestock and beekeeping (McClintock, Pallana, & Wooten, 2014). However, fruits and vegetables are the most common food products in CGs and we will focus on that type of production in this paper.

⁴ In available studies, we find the following crops (among others), in different orders depending on the indicator used (area, weight, preference census, etc.): tomatoes, beans, sweet peppers, hot peppers, lettuce and leafy vegetables, cucumbers, zucchinis, onions, peas, sweet corn, and radishes. It is striking that among the most popular crops in New York City community gardens, one finds "exotic" vegetables (e.g., calaloo, okra) that do not appear in the National Gardening Association survey (2009) at national level, which shows a range of crops closer to the traditional Western diet. The same range is found in French family gardens, with the notable

one study to another. For instance, in New York, Gittleman et al. (2012) based their calculation on the number of plants recorded in a sample of garden plots. In a survey on a representative sample of the U.S population, the National Gardening Association (NGA) drew up an inventory of gardeners' favorite crops (Butterfield, 2009). In France, data are available only for family gardens, and most of these data are old or poorly detailed regarding the methodology used (FranceAgriMer & Fédération des Jardins Familiaux et Collectifs [FNJFC], n.d.; Union des Entreprises pour la Protection des Jardins et des Espaces Publics [UPJ]–CSA, 2007), except for a recent survey among gardeners of one family garden in the region of Paris (Mienne et al., 2014). There is a clear need to update data on the types of crops grown in CGs and to provide standardized methods in order to allow for comparisons.

Little is known, furthermore, on the use and destination of garden produce. A few French and American studies suggest the importance to gardeners of sharing their harvests; giving away a part of the garden produce is identified as a goal in itself in production strategies (National Gardening Association, 2009; Weber, 1998). Storing garden produce also seems to be a common practice (Gojard & Weber, 1995; Mienne et al., 2014). In 1995, Gojard & Weber identified three models of consumption among French gardeners: annual consumption (small livestock and easily stored products); seasonal and diversified consumption (exclusively oriented toward spring or summer produce); and occasional consumption (fresh herbs and fresh produce in small amounts) (Gojard & Weber, 1995). These findings need to be updated and examined in greater depth today to reflect a gardening landscape that has changed, particularly since new types of CGs have emerged over the last

few decades.

Following this literature review, we identify several knowledge gaps on the food function of CGs, which we define for the purpose of this study as the quantitative and qualitative measures of food supply that CGs are likely to provide to gardeners, measured by the type of products grown in CGs, the contribution of these products to gardeners' diets, the quantities produced, the yields, and, finally, the use and destination of the garden products. This paper aims to contribute to filling these gaps while also providing insights on the food production processes in CGs. .

In the first part of this paper we provide insights on the harvest of CGs: (a) the quantities of fruits and vegetables harvested; (b) their contribution to gardeners' food supply; and (c) the use and destination of garden produce. In the second part of the paper, we apply land-use assessment methods taken from the agronomy of farming systems that were previously adapted to the context of diversified market-gardening (Mawois, Aubry, & Le Bail, 2011; Navarrete & Le Bail, 2007). These methods allow us to analyze (a) the intensity of use of surface areas in CGs; (b) the most common crops in CGs in terms of surface area; (c) the crop diversity in CGs and (d) the yields of CGs.

Methodology

The methodological framework involved two study sites (Paris and Montreal) and an original combination of quantitative and qualitative data.

Study Sites

The study was conducted in Paris and its close suburbs, and in Montreal. The choice of these two cities was based on a set of common elements and interesting differences that enabled us to perform a comparative analysis. Paris and Montreal are two global cities, i.e., cities that are strongly connected to international economic and social networks and have strategic functions on a global scale (Hales, Peterson, Mondoza Peña, & Gott, 2014; Ghorra-Gobin, 2009). Paris and Montreal have 2.2 and 1.6 million inhabitants, respectively (6.7 million in Paris including its close suburbs, namely the three neighboring districts commonly called *la petite couronne*, literally the “small crown”), for respective

difference of corn, which is not found in France, and potato, which is predominant in France but is found less often in North American gardens. This suggests that very cosmopolitan intra-urban gardens might serve a different population than home gardens or CGs in rural areas across the United States. It calls for an updated study in France on this topic in intra-urban shared gardens, whose history differs significantly from that of family gardens.

densities of 21,300 and 4,500 inhabitants per km² (55,400 and 11,700 inhabitants per mile²). Municipal programs dedicated to promoting urban gardening exist in both these cities, although the municipalities' involvement and regulatory frame-

works differ. Consequently the requirements differ as well, in terms of prohibited crops and recommended cropping practices (minimum proportion of the plot devoted to food crops, whether utility buildings are allowed, whether consumption of garden produce is encouraged or discouraged, etc.).

The study was conducted in 11 CGs (Table 6, Appendix): seven were located in Paris and its close suburbs, and four in Montreal. In Paris and Montreal the study sites were selected to represent the greatest possible diversity, based on the following criteria: type of garden, geographical location, garden age, size, and number of plots, internal organization (communal plots vs. individual plots), member or not of a municipal program and/or federation. In both cities, gardens exclusively dedicated to flower production, which are unusual but do exist, were excluded.

In Paris, our sample of gardens consisted of three family gardens and four shared gardens (Figure 1). The AJOAC garden, the Pointe de l'Île garden, and the Bd de l'Hôpital garden are family gardens, created in 1942, 1954, and 2002, respectively. They are all divided into individual plots; however, the size of the plots varies significantly from one garden to another. The AJOAC garden and the Pointe de l'Île garden are both old gardens that are organized according to the "traditional" design patterns of French family gardens, and they offer plots between 200 and 300m² (2,153 and 3,229 ft²). The Bd de l'Hôpital garden is a more recent family garden, located in a very dense neighborhood of Paris. It offers plots from 20 to 30m² (215 and 323 ft²). Among the four shared gardens of our sample, three offer individual plots that are on average 4m² (43 ft²) for the Ecobox garden, 22m² (237 ft²) for the Jardin aux Habitants, and 150m² (1,615 ft²) for the Jardin des Bordes. The latter

Figure 1. Map of Gardens Selected in Paris

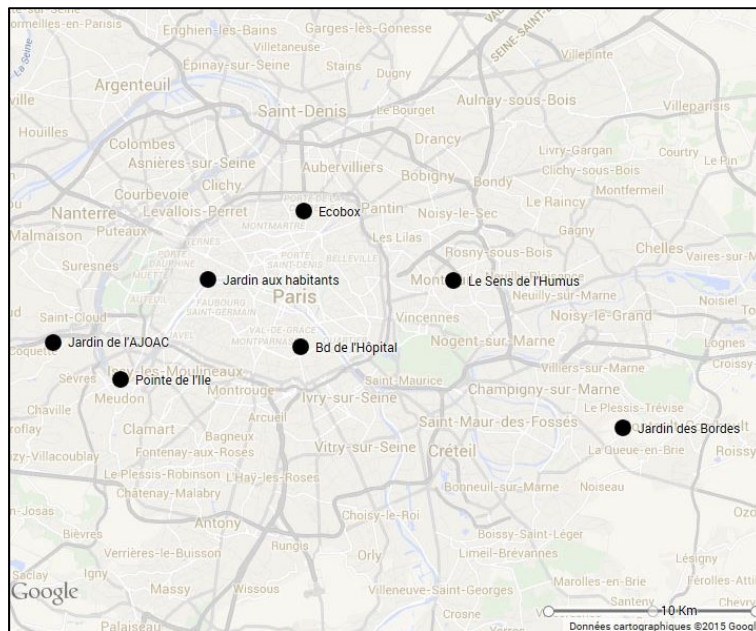


Figure 2. Map of Gardens Selected in Montreal



Source for both maps: Google Maps. (2015). Jardins [Custom maps]. Retrieved from <https://www.google.com/maps/d/edit?mid=zLe0X46YqMWI.k0H0MfHM7rp8>

is located in a periurban park, on former agricultural land, while Ecobox and the Jardin aux Habitants are located on a parking lot and along a street, respectively, within Paris. The last shared garden, the Sens de l'Humus garden, consists of one single communal plot of 500m² (5,382 ft²).

In Montreal, our study sample consisted of four community gardens (Figure 2). All were located in the city of Montreal and offered individual plots of 15 to 18m² (161 to 194 ft²). The Basile-Patenaude garden was probably created in the 1980s and is located in the district Rosemont-Petite Patrie. The George-Vanier garden and the Pointe-Verte garden were created in 1985 and 1984, respectively. The garden de Lorimier is one of the largest community gardens in Montreal, as it offers 120 plots; it's located in the district Plateau-Mont Royal, the densest district in Montreal.

Within each garden, we selected a sample of gardeners using the method as follows. In Montreal, we took advantage of the occasion of garden general assemblies, which take place in every garden at the beginning of the growing season, to present the ongoing study and ask gardeners to leave their contact details if they were willing to enroll in the study. If we had more than four gardeners on the contact list for one garden, we randomly selected four gardeners for the interview; if we had fewer than four gardeners, we contacted all the gardeners who left their contact details. In Paris, as there were no general assemblies, we first contacted gardeners on the recommendation of a reference person in the garden (for example, the president of the garden association) and then proceeded step by step to meet other gardeners, with the aim of interviewing

four gardeners per garden if at all possible.

Data Collection from the Garden Survey

The set of data we worked with includes quantitative data of harvests in the gardens as well as qualitative data from questionnaires and interviews with gardeners and from our observations of the plots.

Interviews

In the end, 23 gardeners in Paris and 14 gardeners in Montreal were interviewed from 2012 to 2013. Each gardener was interviewed twice during the growing season.

At the beginning of the growing season, a semistructured individual interview was held regarding (a) the gardener's visits to the garden (time spent in the garden, frequency of visits, distance from his or her home, etc.) and the functions he or she attributed to the garden; and (b) his or her point of view on the importance of the food function of his or her plot (importance of the garden in the gardener's overall food supply, use and destination of the produce, etc.).

At the end of the growing season, a second, shorter interview was held to assess what had actually happened during the past season. The gardener was asked to give an opinion on his or her actual presence at the garden, the expected and actual yields, problems encountered during the season, and changes to be made for the following year. He or she was also asked to select from a series of situations the one that best characterized the plot's contribution to his or her food supply. This gradient of situations (Figure 3) was built on the basis of preliminary interviews conducted in 2011 in Paris,

Figure 3. Gradient of Collective Garden's Contribution to the Gardener's Food Supply

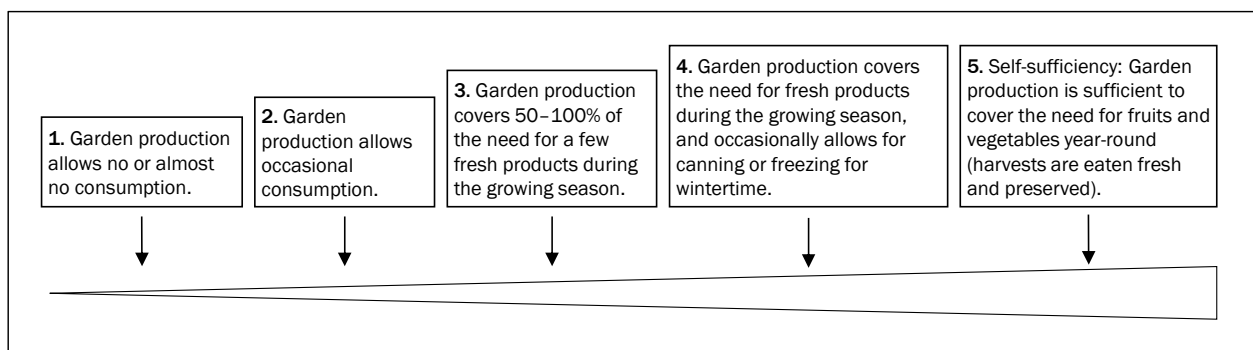
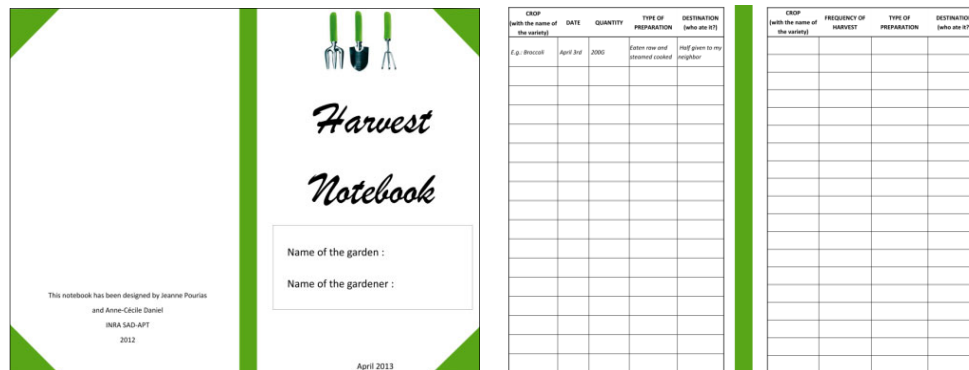


Figure 4. Harvest Booklet: Front and Back Covers and Inside Pages



before the beginning of the study, with experts from local organizations and municipal authorities. It was tested on seven urban gardeners (not included in the sample above). This gradient defines five situations that cover the various ways the garden can contribute to the gardener's diet by providing fresh fruit and vegetables, from no or almost no food production to complete self-sufficiency.

Quantification of Productions (Harvest Booklet)

At the end of the first interview, if the gardener was willing to continue the study we gave him or her a kitchen scale and a harvest booklet (Figure 4). The booklet included tables with the following headings: (a) type of crop; (b) date of harvest; (c) quantity harvested (in grams or units); (d) use of the crop (eaten raw or cooked, preserved or immediate consumption); and (e) destination of the crop (gifts outside the close family).

In Paris, 14 gardeners out of the 23 interviewed (approximately 60%) agreed to fill out the booklet during the 2012 season, nine of whom (approximately 40%) continued until October 2013. In Montreal, 14 gardeners (100%) agreed to complete the booklet throughout the 2013 season.

Plot Monitoring

The plots of gardeners who had been interviewed and who gave their agreement to open their plots to our visits were monitored monthly during the growing season of Paris (March to October) and Montreal (June to October). This monitoring was done in order to analyze the choice and organization of crops by gardeners in space and time. In

Paris, the monitoring was conducted on 19 plots in 2012; in 2013, five gardeners decided to stop the study and four new gardeners were enrolled, so the monitoring was conducted on 18 plots in 2013. In Montreal, the

monitoring was conducted over one growing season (2013). At each visit, a plan of the plot was drawn up with the help of the gardener, on which the following items were recorded: (a) newly planted crops and the corresponding surface areas; (b) growing plants; and (c) harvest in progress. Gardeners were asked to describe what they had recently planted and to explain the choice of crops. This monthly monitoring was also an opportunity to verify that the gardeners had no problems when weighing their crops and filling out their harvest booklet.

Data Analysis

We used agronomical concepts such as cultivated area and developed area to analyze and interpret field observation data, and statistical tools to process quantitative data.

Surface Areas

Three levels of garden surface areas are used to describe the land use: S_t , S_c and S_d (Figure 5). The plot size (total surface S_t) was recorded at the beginning of the season. S_t is likely to vary from one year to another for gardens in containers and/or when the gardener is given an additional whole plot or section of a plot.⁵

The cultivated area (S_c) was also recorded at the beginning of the season. S_c is the area allocated to food crops, i.e., S_t once the area used by fixed

⁵ For example, in case of a gardener who leaves or drops out during the season, the plot is temporarily assigned to other gardeners.

elements is subtracted. These fixed elements may include garden furniture, storage sheds, cabins, pathways, permanent flowerbeds, lawns, or area dedicated to other uses (e.g., a rest area, bowling pitch, or other recreational uses).

The developed area (S_d) takes into account the cropping cycles. As a single bed is likely to be cultivated several times during the season, S_d is the “cumulative area of all the areas cultivated during the various cycles” (Mawois et al., 2011); consequently, a row or a bed seeded twice during the season is counted twice (Figure 5).

The plans drawn up with the help of gardeners were entered in a Microsoft Excel file to automatically calculate newly planted areas. This Excel file was designed to visualize the land occupation throughout the season (surface areas under each crop) and the cumulative area for each crop at the end of the season so as to calculate S_d .

Quantities Harvested

Harvest booklets were collected at the end of the growing season and the data entered into an Excel file. Where gardeners had reported quantities in units (counts), a chart of correspondence between the units and the mean weight of each vegetable was used to convert these units into grams. The chart used was built on the basis of data collected on the Internet, and was calibrated with the help of several gardeners who volunteered to indicate in their booklet both the number of units and the weight in grams of their harvests. This allowed us to obtain average data on the weight of produce harvested in the gardens; however, it remains imprecise in the case of produce with highly variable harvest weight, such as zucchini. The amounts reported in the booklets were compared with the gardeners’ assessment during the second interview.

Yields

The global yield (Y_g) is defined as the sum of the amounts of fruit and vegetables produced on the plot during a growing season, divided by S_c .

The yield per crop is defined as the sum of the quantities produced in crop i , divided by the sum of developed areas (S_d) planted during the growing season for crop i .

Statistical Tools

We used the software R to perform basic statistical analysis on our data, in particular to test the significance of differences between average number of cultivated species, quantities harvested and yields on the plots surveyed.

Results

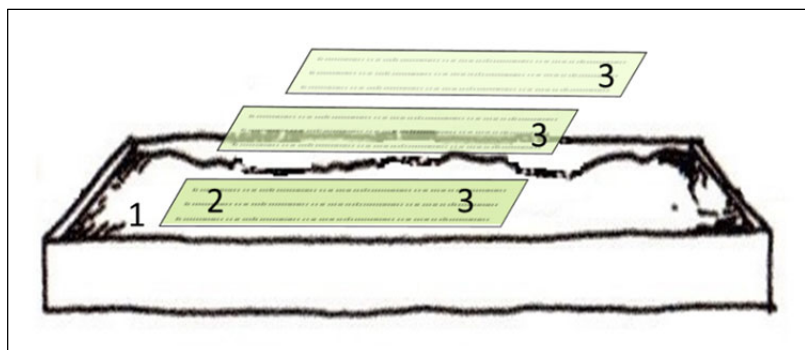
The results section has been divided into three parts: (a) results of harvests (quantities, contribution to gardeners’ food supply, destination and use of garden produce); (b) results of the use of plots (production area and intensity of plot use, type of crops, and crop diversity); and (c) the yields achieved in CGs, which brings together the results on harvest and the results on land use.

Harvests

We first present the quantitative data on harvests obtained through the harvest booklets, then the results on how garden produce contribute to gardener’s food supply, both in quantity and in quality (destination and use of the produce).

Figure 5. Different Levels of Surface Area Analysis

1. Total plot surface area (S_t); 2. Cultivated area (S_c); 3. Developed area (S_d). In this example, three crops are planted successively during the growing season.



Wide variability in the quantities harvested

The total amounts of fruits and vegetables produced in the gardens vary considerably from one plot to another. Among the plots surveyed, the quantities produced during one season ranged from 8.3 kg on a plot of 18 m² (18.3 lb. on 194 ft²) to 392.7 kg on a plot of 200 m² (865.7 lb. on 2,15 ft²) (Table 1). The highest amount of food are produced in the biggest plots; however, some big plots (>100m² or >1,076 ft²) produce less than small plots (<20m² or <215 ft²).

Contribution to gardener's food supply

In Montreal, three gardeners out of 14 (20%) said they were in situation 2 (see Figure 3), i.e., the harvest allowed for occasional consumption, and 11 gardeners (80%) said they were in situation 3, i.e., the garden produce covered 50% to 100% of their needs for a few fresh products during the growing season. In Paris, one gardener out of 14 said he or she was in situation 1, i.e., his or her garden produce no or almost no food; two gardeners were in situation 2; six were in situation 3; four were in

Table 1. Quantities of Fruits and Vegetables Harvested in Sampled Gardens

City	Type of garden	Plot	S _i (m ²)	Mean S _c (m ²) (Paris 2012 & 2013; Montreal 2013)	Quantities 2012 (kg)	Quantities 2013 (kg)	Mean quantities (kg)
Montreal	Community gardens	Plot 13	15	14	—	9.2	9.2
		Plot 14	18	16	—	10.5	10.5
		Plot 5	18	16	—	17.7	17.7
		Plot 8	18	15	—	22.4	22.4
		Plot 3	15	12	—	23.7	23.7
		Plot 7	15	14	—	23.7	23.7
		Plot 12	18	16	—	25.0	25.0
		Plot 6	11	10	—	25.7	25.7
		Plot 2	18	14	—	28.0	28.0
		Plot 9	18	17	—	30.5	30.5
		Plot 4	18	17	—	39.4	39.4
		Plot 10	18	18	—	42.0	42.0
		Plot 1	18	17	—	51.3	51.3
		Plot 11	15	13	—	56.2	56.2
Paris	Family gardens	Plot 10	28	18	8.3	—	8.3
		Plot 2	391	226	29.3	—	29.3
		Plot 13	300	141	37.9	26.9	32.4
		Plot 12	200	137	132.1	75.0	103.6
		Plot 8	200	144	155.3	159.8	157.6
		Plot 4	178	105	223.1	245.4	234.2
		Plot 9	200	116	392.7	257.7	325.2
	Shared gardens	Plot 10	500	200	12.1	—	12.1
		Plot 1	75	40	12.3	—	12.3
		Plot 6	6	5	13.8	—	13.8
		Plot 7	15	8	18.8	23.3	21.0
		Plot 4	22	16	24.8	33.1	28.9
		Plot 3	129	109	38.2	53.1	45.7
		Plot 2	129	111	105.6	155.0	130.3

Note: 1m²=11 ft²; 1 kg=2.2 lb; 1kg/m²=0.2 lb/ft²

Table 2. Four Models Regarding the Use of Garden Produce

Models	Length of harvest	% of crop preserved	Example of produce
1. Seasonal production of fresh vegetables	4 to 5 months in Montreal; 4 to 7 months in Paris	0–30%	Plots strongly oriented toward the production of leafy vegetables, often with a diversity of species and some uncommon vegetables seldom found in shops or expensive (dandelion, cichoria catalonia, radicchio, watercress, etc.) and aromatic herbs.
2. Seasonal self-production with preservation of part of the harvest	4 to 5 months in Montreal; 4 to 7 months in Paris	30–80%	(A) Production of summer vegetables to make pesto, ketchup, and tomato sauce (tomatoes, basil, garlic, celery); (B) Production of fruit for jam; (C) Very specialized production of one or two types of vegetable that are seldom found in shops and/or expensive and that can be preserved for a year-round supply (e.g., African spinach).
3. Self-production year-round with most vegetables consumed immediately (little preservation)	Was not observed in Montreal; 8 to 12 months in Paris	0–30%	Production of seasonal products eaten rapidly after harvest (radishes and lettuce in spring; tomatoes, zucchinis, pepper, eggplants, beans in summer; celery, carrots, turnips, squashes in fall; leeks, cabbage, and leafy vegetables under cover in winter).
4. Traditional model: self-production year-round with storage and preservation of a large part of the harvest	Was not observed in Montreal; 8 to 12 months in Paris	30–80%	Production of seasonal products eaten fresh, plus vegetables that are easy to store to be eaten throughout winter (potatoes, carrots), and fruit for canning (jam and sauce).

situation 4, i.e., the garden produce covered their fresh produce needs during the growing season; and one was in situation 5, i.e., self-sufficiency. Self-assessment of the contribution of their plot to their food supply was consistent with the quantities harvested, as the average quantities harvested by gardeners who said they were in situation 3 (31 ± 12 kg; $n=17$) were significantly larger⁶ than the quantities harvested by the gardeners in situations 1 (12.1 kg; $n=1$) and 2 (13 ± 6 kg; $n=5$), and the quantities harvested by gardeners in situation 4 (198 ± 100 kg) or 5 (157 kg) were significantly⁷ larger than the quantities harvested by gardeners in situation 3 (Figure 6).

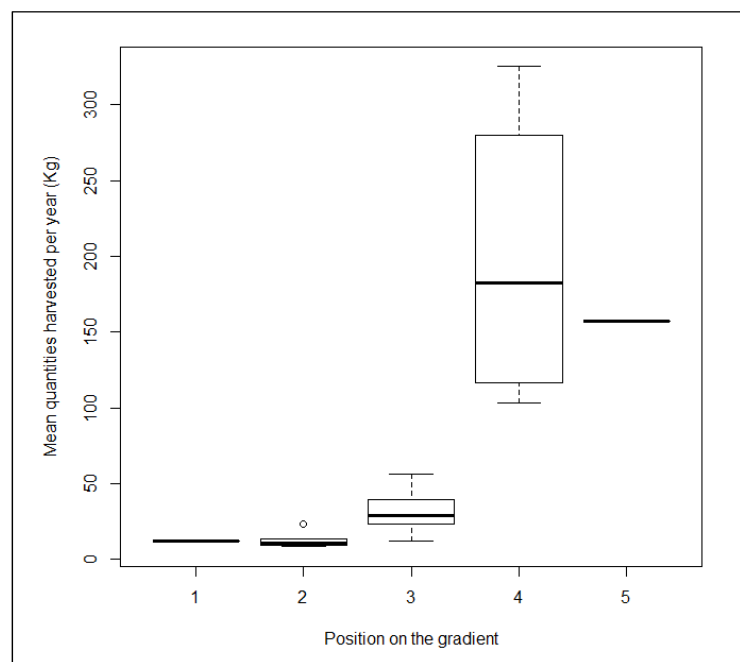
Destination and use of garden produce

Considering the variability of our sample,

⁶ Kruskal-Wallis chi squared=9.933, df = 2, $p=0.006968 < 0.05$

⁷ Kruskal-Wallis chi squared=11.087, df = 2, $p=0.003913 < 0.05$

Figure 6. Comparison of Gardeners' Self-assessment of the Importance of the Garden in their Food Supply and the Quantities Harvested, Indicating Position on the Gradient (see Figure 3)



Note: 1 kg=2.2 lb

we propose four models for the use of garden produce, based on two criteria: the length of the growing season and the percentage of the harvest preserved (Table 2). These two indicators give information on the types of crop grown and how long the garden is likely to provide a food supply. The length of the growing season varies from one garden to another. Between Paris and Montreal, differences in the length of the growing season are due to differences in climatic conditions. In Paris, harvests can range from February to December, with a peak from July to September. In Montreal, harvests can range from May to October, with a peak in August and September. Most of the gardeners in our study sample correspond to models 1 and 2. In Montreal, six gardeners out of 14 were in model 1 while eight were in model 2. Models 3 and 4 were not observed in Montreal, as winter cropping is not possible in Montreal community gardens. In Paris, nine gardeners out of 14 were in model 1, one was in model 2, one in model 3, and three in model 4. Gardeners who followed models 3 and 4 were gardeners who had relatively big plots (120 to 200m², or 1,292 ft² to 2,153 ft²).

Sharing the harvest with people outside the immediate family (those living in the same household), such as extended family, friends or colleagues, is a major destination for crops. The percentage of produce given away is not related to levels of production; gardeners who produce the largest quantities are not necessarily those who give the most, and vice versa (Figure 7).

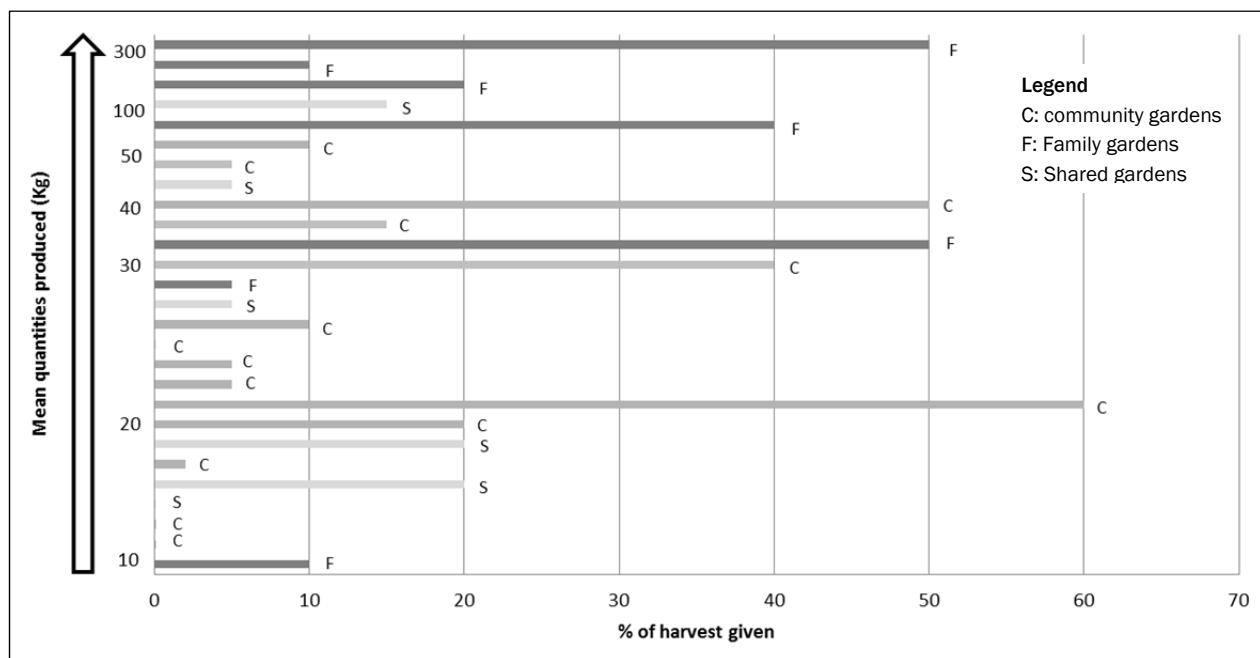
Use of Plots

Cultivated areas

When the plots were monitored over two years (Paris, $n=14$) we found that, for the same plot, the area dedicated to food production that we refer to as the cultivated area (S_c) varied little from one year to the next.

The share of the plot dedicated to food production (S_c/S_t) varies a great deal among gardeners; in our sample, depending on the plot, 40% to 100% of the total surface area of the plot is used for food production ($76 \pm 16\%$ on average on all 37 plots surveyed). In Figure 8, S_c/S_t is given for each plot of study and represented by the grey line.

Figure 7. Quantities of Fruit and Vegetables Produced According to Percentage of Harvest Given Away Outside the Immediate Family



According to our observations, two factors can contribute to explaining this variability: the size of the plot and the type of garden.

Gardeners of small plots (<20m² or <215 ft²) allocate on average a larger part of their plot to food production (88 ±11% of the plot dedicated to food crops, on average) than gardeners of medium-sized plots (20 to 100m² or 215 to 1,076 ft²; 66 ±9% of the plot dedicated to food crops, on average) or large ones (100 to 500m² or 1,076 to 5,380 ft²; 64 ±14% dedicated to food crops, on average).

The space dedicated to fixed elements and recreational uses is on average more prominent in Parisian gardens. Gardeners of family and shared gardens in Paris allocate on average respectively 64 ±9% and 73 ±18% of their plot to food production, while gardeners in Montreal community gardens allocate on average 89 ±7% of their plot to food production.

Within the same class of plot size or within the same type of garden, we still observe variability from one gardener to another. As one might expect, individual choices of gardeners regarding the motivations and functions assigned to the garden also strongly influence the share of the plot dedicated to food crops.

Developed areas

S_d reflects the number of crop cycles on a given plot and the length of the growing season. As S_d is the cumulative area of all the areas cultivated during the various cycles of the growing season, the S_d/S_c ratio is frequently above 100%.

Again, this ratio varies highly from one gardener to another; in our sample of Parisian garden plots, it ranged from 18% to 176% in 2012 (average of 109% on all 19 plots) and from 36% to 130% in 2013 (average of 92% on all 18 plots). In our sample of Montreal garden plots, it ranged

Figure 8. Share of Plot Dedicated to Food Production

Plot size (class)	Plot size (m ²)	Actual production area (S_d/S_c ; in %)
Small plots (<20m ²)	4	89
	4	108
	6	79
	11	90
	15	57
	15	77
	15	84
	15	88
	15	92
	18	76
	18	81
	18	88
	18	92
	18	92
	18	96
Medium plots (20-100m ²)	22	73
	25	74
	25	80
	28	68
	30	55
	30	67
	70	63
	75	53
Big plots (>100m ²)	91	58
	101	68
	129	84
	129	86
	178	59
	200	58
	200	69
	200	72
	300	47
	391	58
	500	40

Note: 1m²=11 ft²

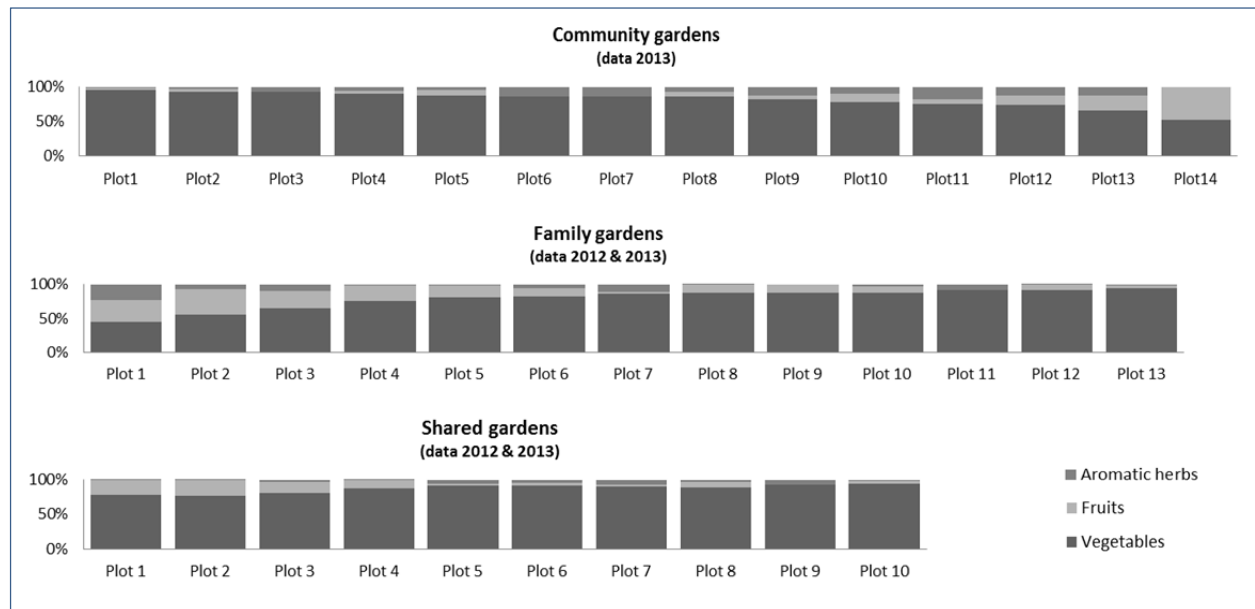
from 44% to 107% in 2013 (average of 83% on all 14 plots).

The size of the plot does not seem to influence this ratio. The major factor that explains the variation, aside gardeners' individual choices, is the length of the growing season. The S_d/S_c ratio is on average lower for Montreal gardens than for Parisian gardens, as the season is shorter in Montreal, where gardens are open from May 15 to October 30, whereas they are open year-round in

Table 4. Main Crops in Montreal and Paris Gardens (mean % of total S_d)

Montreal, 2013 (n=14 plots)			Paris, 2012 (n=19 plots)			Paris, 2013 (n=18 plots)		
Crops	Mean % of total S_d	Standard deviation	Crops	Mean % of total S_d	Standard deviation	Crops	Mean % of total S_d	Standard deviation
Tomato	18.4	14.1	Lettuce	14.6	8.7	Lettuce	13.5	11.4
Bean	9.4	7.2	Tomato	8.6	11.4	Tomato	10.0	14.0
Lettuce	6.2	7.6	Beans	6.6	5.0	Beans	7.6	8.7
Garlic	4.6	6.0	Cabbage	5.9	6.3	Strawberry	7.1	5.7
Pepper	4.4	5.7	Potato	4.8	5.4	Potato	5.8	6.0
All vegetables	82.7	2.1	All vegetables	82.2	2	All vegetables	81.4	2.3
All fruits	8.2	0.9	All fruits	14.4	1.1	All fruits	16.6	1.1
All aromatics	9.1	1.2	All aromatics	3.3	0.6	All aromatics	2.0	0.6

Figure 9. Importance of Each Type of Crop (Vegetables, Fruits, and Aromatic Herbs) in Collective Garden Plots (% of total S_d)



France. From 2012 to 2013, S_d decreased slightly in most Parisian gardens plots. This can be explained by the different climatic conditions from one year to the next; the growing season started much later in 2013 than in 2012 due to an unusually cold spring. Therefore, *within a given year and for the same climate zone*, S_d/S_c reflects the relative intensity with which the gardener uses the cultivated area (S_c).

Main crops cultivated in plots of study

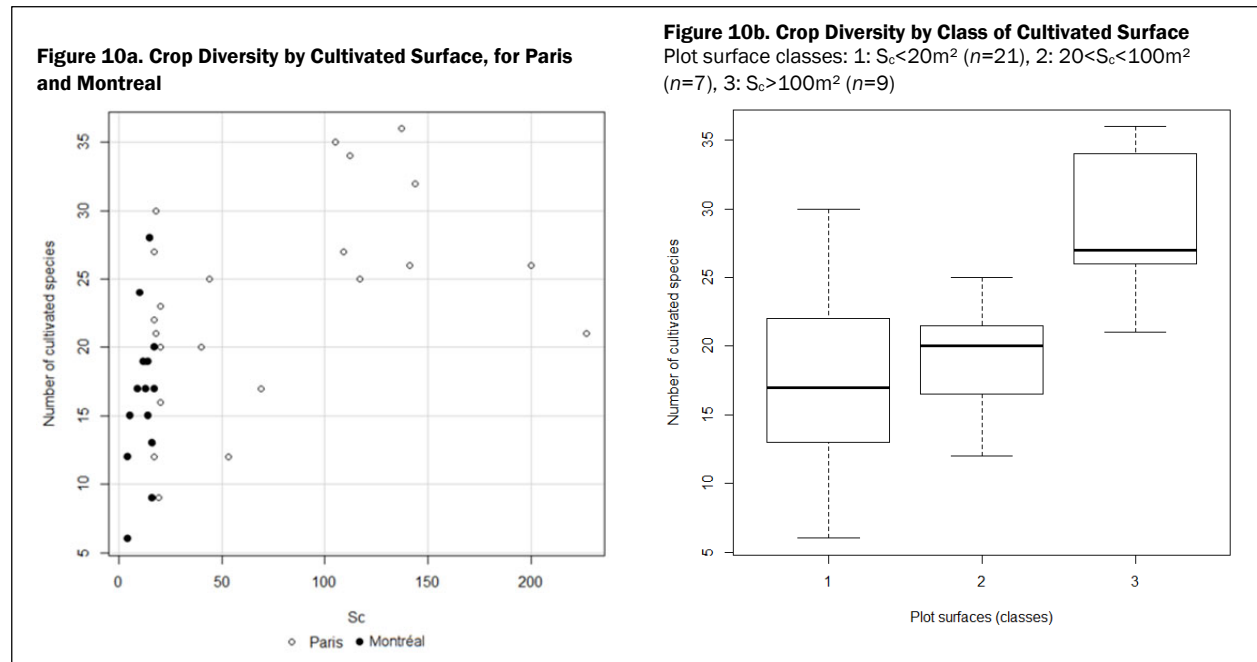
At our study sites, the three most important crops in terms of surface area are tomatoes, lettuce, and beans (green and dry beans), followed by cabbage,

potatoes, and strawberries in Paris, and by garlic and peppers in Montreal (Table 4).

For the 39 plots in the study, most of the total developed area is cultivated with vegetables (86% on average in Paris shared gardens, 79% in Paris family gardens, and 82% in Montreal community gardens). The rest of the developed area is occupied by fruits and herbs, with a variable share between the two depending on the plot (Figure 9).

Crop diversity

On the plots investigated, six to 36 species were counted for S_c of 4m² (43 ft²) and 137m² (1,475 ft²),

Figures 10a and 10b. Food Crop Diversity in Study Plots According to Size of Cultivated Area (S_c)

Note: $1m^2=11 ft^2$

respectively (Figure 10a). The size of the cultivated area appears to be poorly correlated with the number of cultivated species.⁸ However, a bigger cultivated area seems to allow a slightly higher number of cultivated species, especially when $S_c > 100m^2$ ($1,076 ft^2$) (Figure 10b).

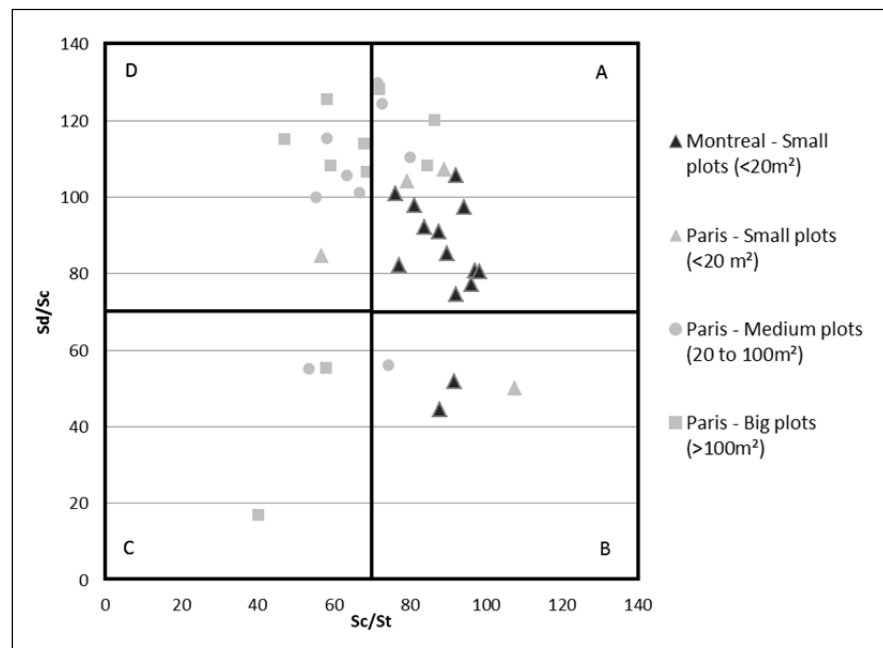
Land use intensity

Following our previous findings on the S_c/S_t and S_d/S_c ratios, we identify four classes of gardeners according to their use of space (Figure 11).

Class A refers to gardeners who use their plots very intensively for food crops (S_c/S_t and S_d/S_c are high); class B refers to

Figure 11. Four Classes of Gardeners According to Their Use of Land for Food Production (Paris, $n=23$, average for 2012–2013; Montreal, $n=14$, 2013)

Legend: A. Highly intensive use of the plot for food crops; B. Plot mainly dedicated to food crops but low intensity in the use of space; C. Non-intensive use of the plot, with priority to uses other than food production; D. Highly intensive use of the cultivated area for food crops but other uses of the garden as well.



⁸ Adjusted R-squared=0.24

Note: $1m^2=11 ft^2$

gardeners whose plots are mainly dedicated to food crops but who do not use this space intensively (S_c/S_t is high, S_d/S_c is low); class C refers to gardeners who have a non-intensive use of their plot, as they give priority to uses other than food production in the garden (S_c/S_t is low, S_d/S_c is low); and class D refers to gardeners whose plot is dedicated in part to uses other than food production but who still use the cultivated area intensively. Table 5 indicates how many plots fall into each category for each study location.

These classes of land use intensity are consistent with the data collected during interviews on the uses and functions assigned to the gardens by gardeners.

Yields

Y_g is the total quantity harvested on a plot during one growing season, divided by the cultivated area (S_c). Y_g vary considerably from one gardener to another. In our sample data, we observe no significant difference between the average yields obtained in 2013 in Montreal community gardens ($1.9 \pm 1\text{kg/m}^2$; 0.4 lb/ft^2), those obtained in 2012 and 2013 in Parisian family gardens ($1.2 \pm 1\text{kg/m}^2$; 0.2 lb/ft^2), and those obtained in Parisian shared gardens ($1.4 \pm 1\text{kg/m}^2$; 0.3 lb/ft^2).⁹ There were no significant differences in global yields in Paris between 2012 and 2013.¹⁰ However, we observe significant differences between classes of land-use intensity¹¹. Gardeners in classes A ($n=22$), B ($n=2$), C ($n=3$) and D ($n=10$) in terms of land-use intensity have respective global yields of $1.7 \pm 0.9\text{kg/m}^2$, $1.1 \pm 0.6\text{kg/m}^2$, $0.2 \pm 0.1\text{kg/m}^2$, and $1.8 \pm 1.1\text{kg/m}^2$ (or 0.3 lb/ft^2 , 0.2 lb/ft^2 , 0.04 lb/ft^2 , and 0.4 lb/ft^2). We can conclude from the observation of means and analysis of variances that gardeners in class C have lower yields than gardeners in other classes of land use intensity (Figure 12).

Figures 13a and 13b present the yields for two of the largest crops in terms of surface area, beans and tomatoes. The yield was calculated as the total quantity of beans and tomatoes harvested during

Table 5. Classification of Plots According to Land-Use Intensity

Class	Number of plots	
	Montreal	Paris
A	12	8
B	2	2
C	0	3
D	0	10

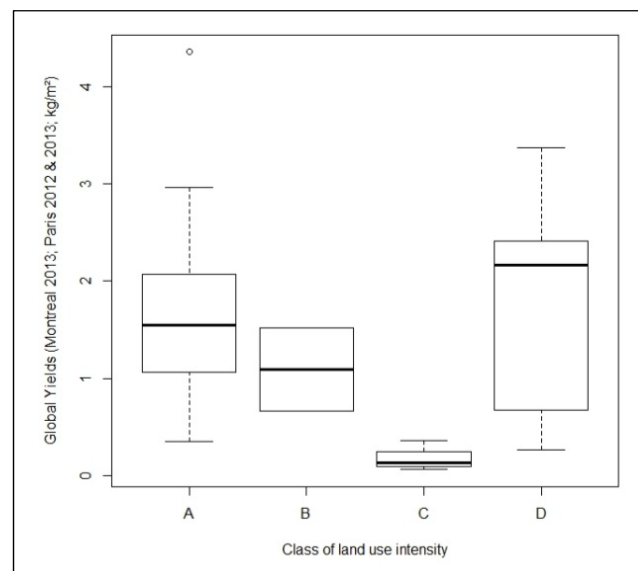
the growing season, divided by the developed surface area for these crops.

Yields per crop vary widely from one gardener to another. In 2012, yields for tomatoes ranged from 0 to 4.1kg/m^2 (0 to $.8\text{ lb/ft}^2$) in Paris. The particularly bad weather conditions in 2012 led to widespread mildew in the Paris area, which caused the loss of a substantial part of the tomato crop in gardens as well as in professional market gardening. In 2013, yields for tomatoes ranged from 0kg/m^2 to 10kg/m^2 (2 lb/ft^2) in Montreal and from 0kg/m^2 to 5.9kg/m^2 (1.2 lb/ft^2) in Paris.

Discussion

In this study, we observed an extreme variability from one study plot to another, in terms of both

Figure 12. Average Yields per Class of Land-Use Intensity

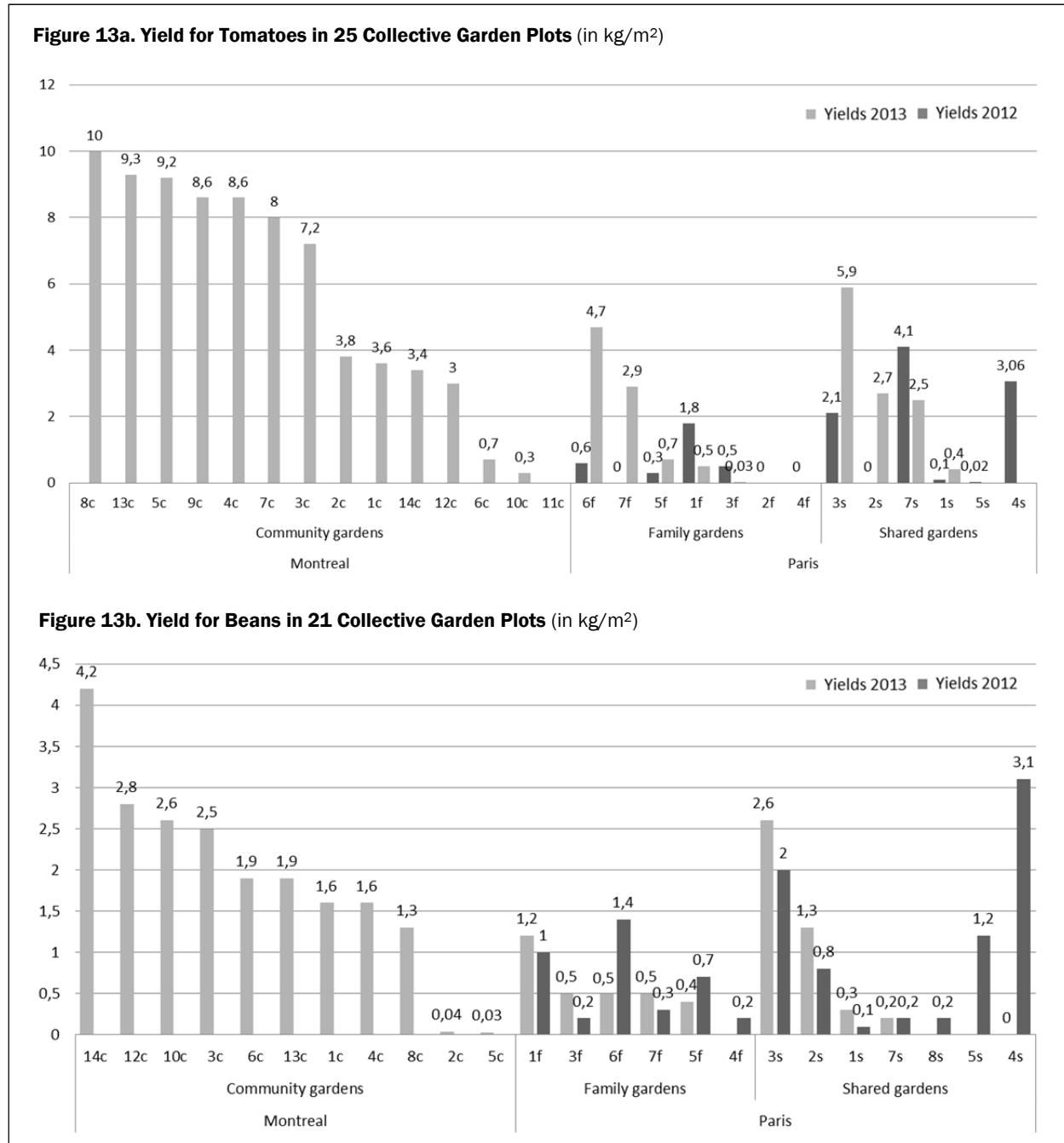


Note: $1\text{ kg}=2.2\text{ lb}$; $1\text{kg/m}^2=0.2\text{ lb/ft}^2$

⁹ Kruskal-Wallis chi-squared=3.5045, $df=2$, $p=0.1734>0.05$

¹⁰ Paired t-test $t=0.7114$, $df=8$, $p=0.497>0.05$

¹¹ Kruskal-Wallis chi-squared=9.2133, $df=3$, $p=0.04167<0.05$

Figures 13a and 13b. Yields for Tomatoes and Beans (total weight of crop harvested per plot/S_d for this crop)

Note: 1kg/m²=0.2 lb/ft²

the use of space and the quantities harvested. This variability is in part linked with the diversity of the study sample, and allows us to highlight the determinants of food production in collective gardens.

From our findings we can distinguish individ-

ual determinants, at the scale of one plot managed by a gardener, and determinants at the scale of the garden, which have to do with the layout of the garden and the rules and regulation that apply. We will first discuss the findings of this study and link

them both with individual decisions by gardeners and with the general context of the garden.

We will then present the implications of these findings for planners interested in setting up urban collective gardens.

Discussion of Results

In accordance with previous studies, we found that quantities produced in collective gardens vary considerably from one plot and gardener to another.

The harvest booklet appears to be a reliable tool to evaluate the levels of production in gardens. However, the measurement of quantities produced per year is a tricky task that requires heavy involvement of the gardener throughout the season; weighing and writing down every item in the harvest is a tedious task.

Despite this precise measurement of the quantities harvested in the study plots, we found no direct correspondence between the quantities harvested and the quantities actually eaten by the gardeners and their immediate families; firstly, because collective gardens are often located in a densely urbanized environment, surrounded with pathways and sometimes completely open onto the street nearby, theft is frequent and is difficult to quantify. Secondly, the amounts of produce given away are irregular and variable, but represent an important destination of garden produce.

Just as consumption units and production units are not superimposed in certain types of subsistence farming (Gastellu, 1978), so too is the proportion of garden production in gardeners' diet difficult to ascertain. The sharing and/or preservation of garden produce occur even when the quantities produced are low. We found that the amounts of produce given away outside the gardener's immediate family are quite variable, and do not depend on the level of production. The fact of giving away and sharing food from the garden was previously described by Dubost (1997) as an important social practice among gardeners. In many cases, part of these donations goes to other gardeners in the same garden. In this case, at the scale of the growing season, we can consider these gifts as exchanges: gardeners frequently say that they receive produce from other gardeners in case of surplus or if they do not grow a crop themselves,

and in return they give of their own produce for the same reasons. Weber (1998) has argued that giving away a part of the harvest is an alternative to preservation in the case of seasonal production models. We do not agree with this explanation, first because having a seasonal garden does not mean the absence of preservation, and second because we observed gardeners in a year-round production model who gave a large proportion of their harvest away.

Gojard and Weber (1995) distinguished between two self-production models: a model oriented toward self-sufficiency through year-round consumption, with a significant share of the harvest preserved or stored; and a model of seasonal consumption, where most of the harvest occurs during the spring and summer months. We suggest distinguishing four different strategies for use of garden produce, depending on the length of the harvest and the percentage of crops meant to be preserved and/or stored.

Self-assessment of the garden's contribution to the gardener's fresh produce supply is consistent with the quantities harvested over the season. Additionally, these estimates are consistent with national estimates of fruit and vegetable consumption. For example, in 2013 in Paris, gardeners whose production covered a substantial part of their consumption (situations 4 and 5 on the food function gradient, Figure 3) produced on average 182 kg (401 lb). The average annual quantity of fruit and vegetables (excluding potatoes) bought by a family in France was around 167.9 kg (370 lb) in 2012 (Serrurier & Drouard, 2013).

It is worth noting that only gardeners cultivating plots larger than 100m² (1,076 ft²) reported to have significant levels of self-procurement for fruits and vegetables (situations 4 and 5 on the food function gradient), which is consistent with previous studies that showed high levels of self-procurement in garden plots of 200m² to 300m² (2,152 to 3,229 ft²) (Mienne et al., 2014). This brings us to the question of the size of the plots. It suggests that there might be a threshold in plot size regarding the possibility for gardeners to obtain a substantial part of their fresh food supply from garden production.

However, our results show that the size of the

plot in itself is not a reliable indicator of how much a plot may produce. In order to give a more detailed view of the use of space by gardeners and to ascertain how this use of space contributes to the amount of food produced in the study plots, we used three variables to describe the use of space at the scale of the plot: S_b , S_c , and S_d . All three give us different points of view on how the plot is used by the gardener, for what purpose, and how it contributes eventually to food production.

S_t is a fixed value at the scale of a gardener, except for gardens that allow gardeners to expand the surface area of their plot, which was only observed in our sample in the case of a garden in containers but may also exist in gardens without a structured organization (for example in squatted gardens, as the literature (Pasquier & Petiteau, 2001) has reported). However, at the scale of the garden, the group of gardeners and/or the managing institution can potentially extend or decrease the size of the plots. This is a common issue when a new garden is being established and is also an issue for existing gardens. In Paris many family gardens that used to offer large plots of 200 to 500m² (2,152 to 5,382 ft²) are now dividing these plots into smaller ones, with the main objective of attracting young people or families who have relatively little time to maintain large plots.

The share of the plot dedicated to food production (S_c/S_t) was very variable from one gardener to another. This variability can be interpreted in relation to the multifunctionality of the garden, as mentioned above (Duchemin et al., 2008), and to “structural data” that influence the use of land in collective gardens. For example, it is difficult to build fixed elements (pathways, storage sheds, or cabins) on small plots, while these elements are commonly found on medium-sized and large plots, which explains why the S_c/S_t ratio is higher for small plots. On large plots of more than 100m², which are found mostly in family gardens based on a model inherited from the 19th century *jardins ouvriers* (workers’ gardens), individual cabins that serve as both storage space for equipment and as living space are often prominent features, as are leisure furniture such as tables, chairs, barbecue grills, etc. The S_c/S_t ratio therefore reflects concretely the multifunctionality of these gardens, with

a high ratio revealing an important food function attributed by the gardener to his or her plot, and a low ratio indicating that the gardener also conceives of uses other than crop production on his or her plot. The workload that a large plot requires may also lead gardeners who have a large plot to reduce the area cultivated with vegetable crops, and to increase the area dedicated to other plants that are easier to maintain, for food (berry bushes, for example) or not (lawn), or else to devote the land to other purposes (picnic tables, for example). The various regulations applicable to the gardens can interfere with the individual determinants mentioned above. In Montreal, the city’s Community Garden Program stipulates that the surface area dedicated to food crops must not occupy less than 75% of the total plot area (Ville-Marie Montréal, n.d.). The same rule applies to most Parisian family gardens.

The developed surface, S_d , concretely reflects the intensity of the use of the area dedicated to food crops during the cropping season. As an indicator of the cropping systems, it is mostly explained by a gardener’s cropping practices and production strategy.

S_d , as a variable that integrates time, is meant to describe cropping systems, whereas S_c is a variable that allows us to map the plot at time t but does not reflect the complexity of gardening practices.

In order to link together our findings on S_c and S_d , we identified four classes of “land-use intensity,” which appear to be a relevant tool to situate a particular gardener’s practices in terms of land use in relation to the others. These classes of land-use intensity are consistent with the yields measured in the study plots. In Montreal, gardeners were all in classes A (“Highly intensive use of the plot for food crops”) and B (“Plot mainly dedicated to food crops but low intensity in the use of space”). This can be explained by the existing regulation in Montreal, which stipulates that flowers, herbs, and fruits all together must not occupy more than 25% of the plots, and by the relatively small size of the plots in community gardens. In larger plots like those in Parisian family gardens, the same rule exists but is very rarely followed.

Interestingly, this rule is generally complied with if we refer to the composition of the devel-

oped surface (S_d): the ratio

$$\frac{S_d \text{ vegetables}}{S_d \text{ total}}$$

is usually higher than 75%. We highlight an ambiguity in the existing regulations: they do not specify whether the rules apply at time t or across the entire growing season, which significantly changes the calculation.

Crop diversity is usually relatively high in the plots investigated. We observed a higher average number of cultivated species in our sample than in the study of Mienne et al. (2014). This can be explained by the difference in the methodology used, as the Mienne et al. study used a one-shot survey with a preset list of crops, while we used a field survey throughout the season to establish the list of crops grown.

Regarding the list of crops grown in the garden plots, most of the crops grown and harvested in the gardens are vegetables. Tomatoes, lettuce, and beans are the three most common crops in terms of surface area both in the Paris and Montreal gardens. However, among the other crops grown in the gardens, we observed significant differences between the two cities. In addition to the cultural aspects that underpin the choice of crops, rules and regulations also affect gardeners' choices: for example, potato is prohibited in community gardens in Montreal. Furthermore, interviews with gardeners revealed that many gardeners who own a small plot avoid planting crops that tend to develop widely, when the expected yields for the crop are relatively low, and/or when prices for the crop in shops are low (e.g., zucchinis and other squashes). Thus these crops are not cultivated in Montreal community gardens, nor are fruit trees (which are also prohibited in Montreal gardens as well as in some garden in Paris).

As a result of this ban in planting trees, fruits are exclusively red berries in Montreal community gardens. In the Paris area, fruits are mainly red berries in gardens within Paris, where planting trees is also prohibited, while nuts and stone fruits play a significant role in many suburban gardens.

In several cases, we observed that aromatic herbs were absent from the garden plots. This is mostly the case on plots remote from the homes of

the gardeners, who thus prefer to grow herbs in their home garden (private garden or balcony boxes) for daily home use, reserving their garden plot for crops that require less regular harvesting. This is particularly the case of family gardens in the Paris area, as they are usually further from gardeners' homes than are shared gardens (Daniel, 2012) or Montreal community gardens, which are frequented mostly by people living in the neighborhood around the garden (E. Duchemin, personal communication, January 5, 2013).

Regulations that apply to Montreal community gardens specify that at least five species must be grown on the plot. Once again, this regulation does not specify whether this value applies at time t or across the season. If we refer to the whole season, this requirement is met in all gardens, as most gardeners wish to have a diversity of crops. However, some gardeners prefer to specialize in a few "flagship" crops, which decreases the number of cultivated species. In Montreal and in Paris, this was observed in the case of gardeners who grew one or two crops that were too rare or expensive in shops, and who preserved the harvest to have it year round (Model of use of garden produce 2 in Table 2).

Regarding the yields, our finding of wide variability from one gardener to another is consistent with previous studies (Gittleman et al., 2012; Vitiello & Nairn, 2009). Various determinants can explain this variability, among which are soil and climatic conditions, cropping systems (which in our study sample included containers), and gardeners' cropping practices (fertilizer and water supply, pest control strategies, etc.). We have not detailed these determinants in this article, but they could be investigated further in future research.

The yields per crop that we obtained may allow for future comparisons with other crop production systems, including professional market-gardening systems. For example, in outdoor conventional market gardening, the yields for tomato production are reported to range between 1.9 and 3.3 kg/m² (0.4 and 0.7 lb/ft²) (Weill & Duval, 2009) in climatic conditions close to those in Montreal. In the collective gardens that we investigated in Montreal in 2013, the yields range between 0 and 10 kg (22 lb), with an average of 5.4 kg/m² (1.1 lb/ft²) (all

plots together). In France in 2012, for tomatoes the national mean yield of open-air tomatoes was approximately 5.2 kg/m² (1.1 lb/ft²) (Arnoux, 2013) while in the collective gardens we investigated the yields ranged between 0 and 3.5 kg/m² (0.7 lb/ft²) in 2012, and 0 to 5.9 kg/m² (1.2 lb/ft²) in 2013 (averaged over all the plots). However, the observed variability in yields and quantities produced challenges for the possibility of using average quantities in global estimations.

Implications for Garden Planning and Management

The results of this study show that the size of plots is not in itself a determinant of how much food will be produced in a garden. More important are the functions attributed by gardeners to the garden. These functions will determine their use of the plots and the space they reserve for food production. We have seen that it is very common for part of an individual plot, especially when it is large, to be dedicated to purposes other than production, such as cabins, lawn, playgrounds, picnic tables, and so on.

We suggest that when designing a new garden, what matters are the functions assigned to it by both future users and garden designers (we see here the importance of prior consultation). Of particular importance is the value placed on the food function: if the goal is relative self-sufficiency or a significant contribution to the gardeners' food provisioning, it may be best to create plots of 100m² to 200m² (1,076 to 2,153 ft²). We have found that plots larger than this are not necessarily used entirely for food production. However, as our sample is quite small we may not have seen all possible situations. For example, gardening organization experts whom we met during the study mentioned plots of 500m² (5,382 ft²) cultivated by families entirely for food purposes. On the other hand, if the goal is to cultivate a few fresh herbs and garden produce, a plot of 18 to 20m² (194 to 215 ft²), as in Montreal community gardens, can yield a substantial harvest.

We have witnessed a wide diversity of expectations among gardeners. A potential response to deal with this diversity of expectations would be to avoid having homogeneous plot sizes in one CG.

The pros and cons of creating individual ver-

sus communal plots have not been discussed yet in this paper. The communal plot that we monitored during the study produced a very small quantity of produce, but provided training for gardeners through continuous exchanges between the most experienced gardeners and the newcomers. Our findings have not however yielded insights on this issue. Further investigations would be needed to assess the potential of communal plots, which would depend on the organization of the group and its objectives. We merely wish to point out that communal plots fulfill different functions than do individual plots within a CG.

Another important feature of garden design is the multifunctionality of CGs that, as we have seen in this paper, is put into practice concretely by gardeners in their use of space. If the objective of the garden is to benefit as many people as possible, the garden designers might be tempted to attribute most of the available land to garden plots. However, we believe from our findings that it is crucial to maintain a space in CGs for uses other than food production, whether individually (within plots) or collectively. The second option is probably the most appropriate for gardens located in urban environments, where the lack of space is a major constraint. Garden designers might consider planning spaces dedicated to leisure, picnics, etc., in the shared area of each CG. Devoting space to leisure, between individual or communal garden plots and collective areas, is therefore a tool available to garden planners to guide the future uses of the garden.

Another tool available to garden designers is the regulations for use of the garden. We have seen that rules and regulations within a garden, such as the requirement that a certain percentage of the space be used for crops, may influence the choice of crops and, in part, the use of space, in particular the share of the plot dedicated to food production. As a complement to an intentional garden layout, we believe that garden rules, if they are chosen appropriately and in accordance with gardeners' expectations, may help to regulate the use of the garden while strengthening its multifunctionality.

Conclusion


The methods used, and in particular the harvest booklet, are a form of participatory science in

which we see increasing interest. Apart from providing data for research, we have witnessed gardeners' enthusiasm to learn about their own production. This largely explains why they agreed to engage in this demanding exercise. The harvest booklet is thus an interesting tool for understanding the diversity and levels of production in gardens and, to some extent, the destination of the produce. It also serves as a tool for researchers to discuss their practices with gardeners. Our approach was further innovative because we used comprehensive interviews in two locations that allowed us to analyze the results from a more global perspective, and because we conducted regular plot monitoring that was essential to understanding the complexity of gardeners' practices.

We conclude that the total size of a plot is a very unreliable indicator to estimate its potential food production. The cultivated surface area (S_c) gives a much more accurate view of the allocation of space on the plot. We witnessed the wide diversity of expectations and practices regarding the food function of urban CGs. While the size of the plot influences the harvest yielded, all gardeners obviously do not have the same expectations regarding food production in their garden. For instance, a large plot may very well have only one small vegetable patch. Once again, we emphasize the multifunctionality of these gardens, which is reflected in the gardeners' practices. A take-home message for garden planners or managing organiza-

tions is that the layout of the garden and its rules and regulations are powerful tools to guide the functions of the garden and to satisfy the expectations of garden users.

Regarding food production in CGs, there are promising avenues to explore to further our understanding of how they may affect the diet of gardeners' families. However, more data would be needed on losses after harvest, on other sources of supply (namely food purchases), and on the changes in fruit and vegetable consumption before and after accessing a garden.

This study confirms the need to recognize the food function of CGs in their diversity, even in the case of small plots, and therefore to pursue the assessment of what Smith and Harrington (2014) call "community food production," embracing issues such as food security and the organization and governance of urban food systems in various geographical, institutional, and cultural contexts. 

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Appendix

Table 6. Study Sites for this Research

Garden name	Year opened	Total size (m ² and ft ²)	Number of plots	Type of plots	Mean size of plots (m ²)	Location	City program
Paris Area							
<ul style="list-style-type: none"> • Family gardens: Gardens in which families tend their own plots, yet share in the garden's overall management. In the Parisian region, they are the successors of 19th-century <i>jardins ouvriers</i> ("workers' gardens") and are predominantly located in the suburbs of Paris. Plot sizes are usually between 100m² and 500m² or 1,076 and 5,382 ft². 							
Bd de l'Hôpital	2002	5,600 (60,278)	26	Individual	28 (301)	Paris, 13th <i>arrondissement</i> ; at the foot of social housing buildings	Yes (Main Verte)
AJOAC garden	1942	53,000 (570,487)	290	Individual	200 (2,153)	St-Cloud (92); in a public park	No
Pointe de l'Île	1954 (ca. 1980)	3,500 (37,674)	15	Individual	220 (2,368)	Les Moulineaux (92) on the artificial extension of an island	No
<ul style="list-style-type: none"> • Shared gardens: Gardens that are shared by a group of citizens, usually people who live in the nearby neighborhood (Basset, Baudelet & Roy, 2008). Plots can be grown communally or individually, but are usually relatively small (with individual plots between 2 and 20m² or 22 and 215 ft²). 							
Ecobox	2009	200 (2,153)	25	Individual	4 (43)	Paris (18th <i>arrondissement</i>) on a parking lot, entirely in containers	Yes (Main Verte)
Jardin des Bordes	2004	35,000 (376,737)	51	Individual	150 (1,615)	Chennevière-sur-Marne (94); in a nature reserve	No
Jardin aux habitants	2001	500 (5,382)	13	Individual	22 (237)	Paris (16th <i>arrondissement</i>), on a street; created in 2001 by artist Robert Milin	No
Le Sens de l'Humus	2007	500 (5,382)	1	Collective	500 (5,382)	Montreuil (93), located on a former site of fruit production	Yes (On sème à Montreuil)
Montreal							
<ul style="list-style-type: none"> • Community gardens: Neighborhood gardens in which individuals have their own plots where they grow and consume their own harvest, yet share in the garden's overall management (Duchemin, Wegmuller & Legault, 2010; Lawson, 2005). In Montreal, community gardens are administered jointly by citizen organizations and city boroughs, and offer plots mainly of 15 to 20m² (161 to 215 ft²). 							
Basile-Patenaude	ca. 1987	2,000 (21,528)	76	Individual	18 (194)	District Rosemont Petite-Patrie	Yes
George-Vanier	1985	1,950 (20,990)	64	Individual	18 (194)	District Ville-Marie	Yes
De Lorimier		5,257 (56,586)	120	Individual	18 (194)	District Plateau-Mont Royal	Yes
Pointe-Verte	1984	1,000 (10,764)	51	Individual	15 (161)	District Sud-Ouest	Yes

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