Renewable Agriculture and Food Systems

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Productive function of urban gardening: estimate of the yield and nutritional value of social gardens in Prato (Italy)

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Research Paper

Cite this article: Baldi A, Gallo NL, Lenzi A (2024). Productive function of urban gardening: estimate of the yield and nutritional value of social gardens in Prato (Italy). *Renewable Agriculture and Food Systems* **39**, e4, 1–12. https://doi.org/10.1017/S1742170523000479

Received: 15 June 2023
Revised: 13 October 2023
Accepted: 14 November 2023

Keywords:
multifunctionality; nutrients; self-consumption; socialization; urban agriculture; vegetables

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Abstract

The impact of urban gardens on food production and nutrient supply is widely recognized in the literature but seldom quantified. In this paper, we present the results of a semi-structured interview conducted in the 'social gardens' of Prato (Italy), i.e. areas of land assigned by the Municipality to individual pensioners or unemployed people for the cultivation of vegetables intended for domestic consumption. Some demographic and socio-economic aspects, the cultivated crops and the related areas were investigated. Starting from the areas, the total production of vegetables and their minerals and vitamins contents were estimated. The typical gardener was male, retired, with an average age of 74, and a low level of education. Gardening enabled pensioners to utilize their free time, facilitated physical activity, promoted socialization, and stimulated self-esteem. A 50 m^2 plot cultivated on 40% of the area produced an estimated amount of 90 kg of vegetables per year, equivalent to approximately 61.5% of a person's fruit and vegetable needs. Tomato, by far the predominant species, occupied more than 80% of the cultivated area. The highest contributions to nutrients intake concerned Vitamin C and Vitamin A, the lowest Ca and Na. A higher yield and a greater and more balanced nutrient supply could be easily obtained through better use of the land (reduction of uncultivated area and greater assortment of vegetables). In our view, raising gardeners' awareness of this aspect and involving them in training programs on agricultural practices, vegetables composition, and nutrition, could be helpful for increasing the nutrient productivity of the plots and, ultimately, for strengthening the productive function of social gardens.

Introduction

The term 'urban gardening', although lacking a univocal definition due to a variety in purposes, forms, and functioning (Ernwein, 2014), mainly refers to the cultivation of food crops for home consumption within and on the fringe of an urban area (Mougeot, 2006; Chalmin-Pui et al., 2021). This definition applies to gardening practiced both on private land, e.g., backyard gardens (CoDyre, Fraser and Landman, 2015), and on public land made available to private citizens (Bonow and Normark, 2018). This work focuses on the second category. All over the world, the origin of urban gardens was often related to people migration from rural to urban areas, looking for work in the factories (Tei and Gianquinto, 2010). In that context the urban gardens created on land made available by municipalities, factory owners, or religious communities, helped to alleviate poverty, malnutrition, and social alienation of workers. At the same time, gardening was considered a safe occupation to keep people busy and so to maintain public order (Dubost, 1997). Over time the productive function of urban gardens (gardens as a source of food) has been more or less relevant depending on the period and the geographic location. Predominant during periods of war or famine, like in Europe during the two world wars (Keshavarz and Bell, 2016) or, in the present day, in conflict areas such as Gaza (Zurayk et al., 2012), it is crucial for food security especially in developing countries (Zezza and Tasciotti, 2010). But even in high-income countries there are poor people experiencing food insecurity, recently further exacerbated by the COVID-19 situation (Carrillo-Álvarez et al., 2021; Music et al., 2022), and urban gardens can help alleviate it. Since their origin, the social function of urban gardens has been evolving, going to include the integration of different disadvantaged people (immigrants, disabled, unemployed, elderly people, etc.), the intercultural and intergenerational exchanges, and the development of a sense of community (Duchemin, Wegmuller and Legault, 2008; Draper and Freedman, 2010). Besides, urban gardens are largely recognized to have ecological-environmental, recreational, educational, and even therapeutic functions (Tei and Gianquinto, 2010).

Nowadays, urban gardening is increasingly promoted by local administrations, who make land available either as plots each assigned to single people or family (allotments gardens) or as

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an undivided area to be collectively managed by a group of city dwellers (community gardens) (Armstrong, 2000; Bell et al., 2016). In Italy, urban gardens in public areas are mainly organized in individual plots and are also referred to as 'social gardens' (in Italian: *orti sociali*) since they are aimed at specific categories of disadvantaged people, mainly the elderly. From 2011 to 2018 the area covered by the social gardens has more than doubled nationwide, reaching over 200 ha (allocated for 66, 21, and 13% in Northern, Central, and Southern Italy, respectively) in 80 municipalities of provincial capitals (ISTAT, 2019a).

Vegetables are the most common component of urban food production thanks to characteristics that make them particularly suitable for cultivation by non-professional growers and for the urban areas, such as ease of growing, short cycles, fresh consumption, high nutritional value, high price; they require small areas and are suitable for soilless cultivation systems, which allows them to be grown even in the absence of cultivable soil; besides, being rapidly perishable produce, they take advantage of the proximity between production and consumption (Orsini et al., 2013; Eigenbrod and Gruda, 2015). In the book 'Cities farming for the future' (van Veenhuizen, 2006), where more than 30 case studies all over the world are presented to debate different aspects of urban agriculture, the word 'vegetable/vegetables' recurs 409 times, *vs* 'fruit trees' (15 times), 'cereal/cereals' (14 times), 'milk' (98 times), 'dairy' (82 times), 'poultry' (67 times), 'eggs' (20 times), supporting a higher frequency of vegetables in urban areas.

The importance of vegetables in the diet is widely recognized: diets high in fruits and vegetables are strongly recommended for their health-promoting properties while, on the contrary, insufficient vegetable consumption is seriously detrimental to human health (Keatinge et al., 2011; Slavin and Lloyd, 2012). According to FAO/WHO guidelines (2005) the recommended daily consumption of fruits and vegetables for adults is at least 400 g per capita divided into a minimum of two servings of fruits and three servings of vegetables. A recent review, based on data of 162 countries, reported a global average daily vegetable intake of 186 g per capita (Kalmpourtzidou, Eilander and Talsma, 2020).

Health benefits of vegetables originate from their content in vitamins (especially vitamins C and A), minerals (especially electrolytes), fiber, and phytochemicals that often have a strong antioxidant activity, so protecting humans from the risk of cancer and many chronic diseases (Dias, 2012). Moreover, when vegetables come from urban gardens the short interval between harvest and consumption can avoid the loss of nutrients occurring in conventional products during the time necessary to reach consumers (Baudoin et al., 2017). Thus, urban gardening contributes not only to food security by ensuring access to food, but also to nutrition security by providing a variety of compounds crucial for the nutritional status of gardeners and their families. However, some caution is needed in the case of polluted soils due to possible accumulation of contaminants, such as heavy metals, in the harvested vegetables (Antisari et al., 2015; Baldi et al., 2021).

Both food and nutritional security are crucial for low-income people (Gerster-Bentaya, 2013), but may have a significant impact even when the affordability of food is not a key issue (Kortright and Wakefield, 2011). A possible approach to quantify the contribution of urban gardens in terms of nutrient intake can be referred to the FAO 'Nutrient Productivity' concept (Baudoin et al., 2017), which combines crop yield with nutrient composition of products and relates them to the nutritional needs (DRI – Dietary Reference Intakes) of humans (Charrondiere et al., 2016). The main aim of this research was to estimate the nutrient supply potentially provided by the vegetables grown in the social gardens of Prato Municipality (Tuscany, Italy) based on the Nutrient Productivity concept. Some additional information was also given, e.g., on the profile of the gardeners, the motivations that brought them to join the initiative, and the satisfaction drawn from the gardening experience.

Materials and methods

The gardens

The subject of this study was the three social gardens of the Municipality of Prato (Tuscany, Italy). The gardens, named Toscanini, Guado, and Gualchiera (Fig. 1) consist of 39, 33, and 33 plots, respectively, each assigned to one gardener. Each plot covers an area of 50 m^2. The gardens, as well as every individual plot, are fenced and accessible through entrance gates. Each plot is provided with water from the municipal aqueduct. Shared warehouses and toilets are available to the gardeners.

The plots are assigned by the Municipality of Prato to resident pensioners or unemployed people after participating in a call for applications issued every three years. The number of family members, the ISEE value (Indicator of Equivalent Economic Situation), and the age of the applicants are considered as priorities for the assignment.

An annual fee of 35 EUR is required from the allotments' assignees to cover the use of water and the maintenance of the communal facilities. The gardeners are also required to stipulate an insurance policy and to respect some rules, including organic cultivation.

The interviews

Semi-structured interviews were carried out in June–July 2018 at the three social gardens of Prato. The authors, introduced to the gardeners by the Municipality of Prato personnel, arranged an appointment for interviews with the gardeners until a sample considered representative was reached (15 gardeners per garden). Gardeners were face-to-face interviewed at the gardens on cultivated crops, areas covered by each crop, and yield. For crops grown at the time of the interviews, cultivated areas were also verified through measurement by the authors together with the gardeners; for species cultivated at other times of the year the values reported by the gardeners were considered. Furthermore, gardeners were questioned on some demographic and socio-economic aspects. Four questions included the possibility of an open-ended answer by choosing the option 'Other' (Table 1).

Assessment of yield and nutritional value

The yield and nutritional value of the gardens were determined on a plot basis considering the averages of the 45 plots managed by the interviewed gardeners.

Garden yield was calculated as the sum of the total yield of each crop (TY_x; kg). The nutritional value was expressed as the contribution of the produced vegetables to an individual's annual needs of vitamins (thiamin, vitamin B_1; riboflavin, vitamin B_2; niacin, vitamin B_3; vitamin C; vitamin A) and minerals (sodium, Na; potassium, K; calcium, Ca; phosphorus, P; iron, Fe) according to Nogeire-McRae et al. (2018). As gardeners were not able to quantify the harvested amounts of vegetables, TY_x (1) was

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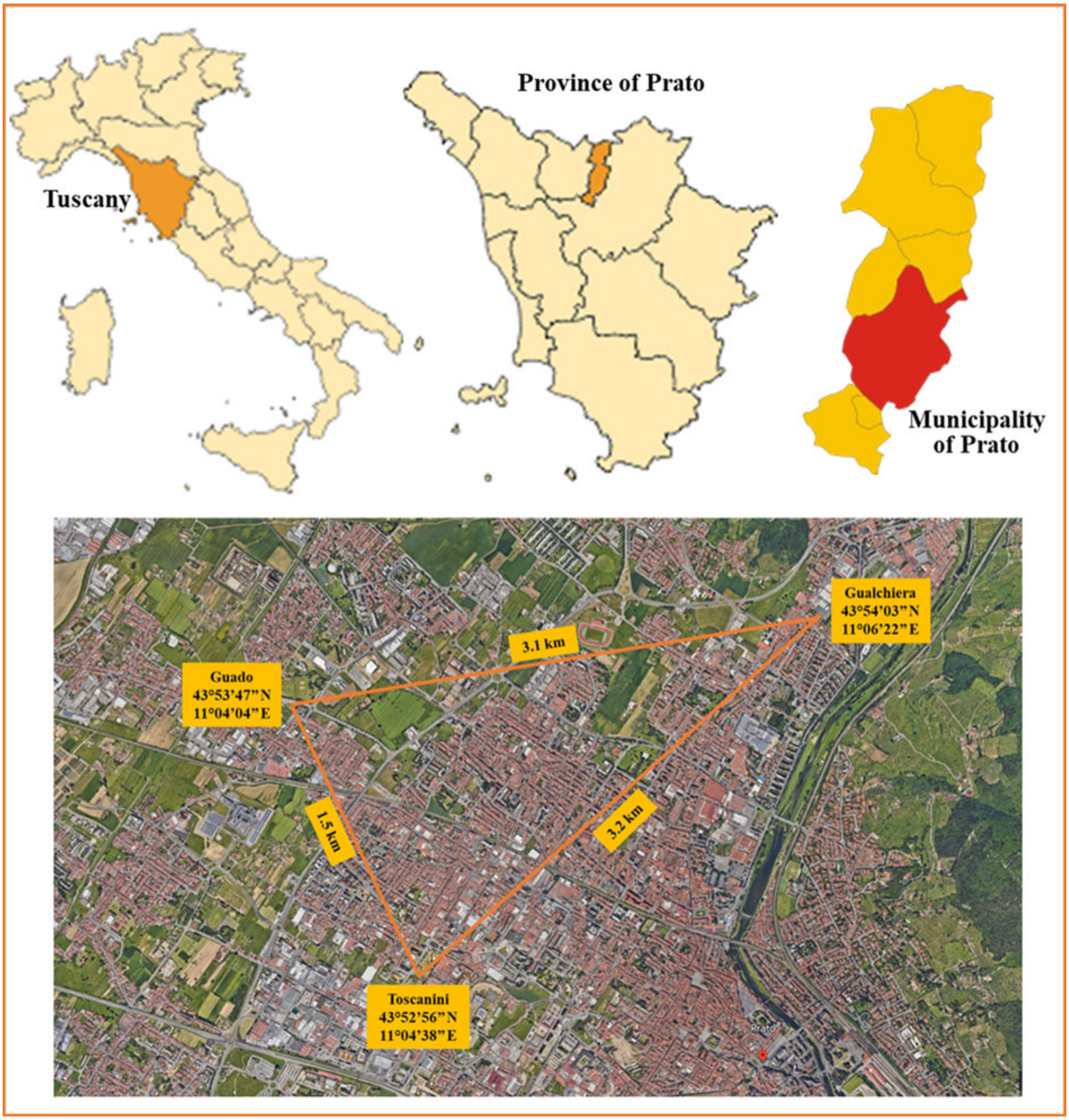

Figure 1. Location of the three social gardens of the Municipality of Prato (PO, Italy).

calculated by the following formula:

$$TY_x = Area_x \times Yield_x \quad (1)$$

Where, $Area_x$ is the average area per plot occupied by each crop (m^2) and $Yield_x$ is the Italian average crop yield per unit area (kg m^{-2}) (ISTAT, 2019b).

The minerals and vitamins supply ($Y_{vit/min}$; mg or µg) (2), and the nutritional value (*NV*; %) (3) were calculated as follows:

$$Y_{min/vit} = \sum_{1 \ldots n}^{x} TY_x \times NC_x \quad (2)$$

Where, NC_x is the vegetables concentration (mg kg^{-1} or µg kg^{-1}) in sodium (Na), potassium (K), iron (Fe), calcium (Ca), phosphorus (P) and vitamins B1 (thiamine), B2 (riboflavin), B3 (niacin), A (retinol) and C (ascorbic acid) as reported by Italian Council for Agricultural Research and Economics (CREA, 2021). For black cabbage, not reported by CREA, we referred to Šamec, Urlić and Salopek-Sondi (2019).

$$NV = \frac{Y_{min/vit}}{\text{PRI } or\ Ai \times 365} \times 100 \quad (3)$$

Where, PRI is the *Population Reference Intake* (for Fe, Ca, P, and vitamins) and *Ai* is the *Adequate intake* (for Na and K) for Italian population as reported by the Italian Society of Human Nutrition (SINU, 2014). Considering the age of the gardeners, *PRI* and *Ai*

Table 1. Demographic and socio-economic aspects investigated in the study

Aspect investigated	Response
Age	<65 years old: 6.6% 65–74 years old: 42.2% >75 years old: 51.1%
Gender	Male: 93.4% Female: 6.6%
Employment status	Pensioner: 97.7% Unemployed: 2.2%
Education	Primary school: 66.6% Secondary school: 24.4% High school: 6.6% University: 2.2%
Origin of agricultural know-how	School: – Personal experience: 97.7% Internet: – Information exchange: 2.2% Other: –
How the gardeners learned about the municipal initiative	Word of mouth: 100% Media: 2.2% Other: –
Motivations that led to join the initiative	Economic: 4.4% Social: 93.3% Health: 93.3% Environmental: 15.5% Other: –
Time per week dedicated to gardening	<5 h: 6.6% 5–10 h: 8.8% 10–20 h: 66.6% >20 h: 17.7%
How much the garden produce cover the household vegetable consumption	Totally: 36% >50%: 64% <50%: –
Habitual consumers of the garden products	Family: 91.1% Relatives and friends: 8.9% Other: –
Gardening costs (annual fee of 35 EUR included)	From 50 to 200 EUR
Level of satisfaction drawn from the garden experience from a social, health, and economic point of view (expressed with a score from 0 = no satisfaction to 5 = maximum satisfaction; average scores are shown)	Social: 4.7 Health: 4.7 Economic: 4.6

values for male and female population in the age group over 75 years were used.

Statistical analysis

Data of the areas per plot dedicated to each species were analyzed using the CoStat statistical software (CoHort, version 6.45, Monterey, CA, USA) and subjected to analysis of variance. The means of the three gardens were compared with LSD Test per $P \leq 0.05$.

The R software (version 4.3.1) was used to calculate the Cramer's V for assessing the following associations:(1) hours per week spent in the garden vs number of crops grown in the plot; (2) hours per week spent in the garden vs how much the garden products cover the household vegetable consumption (%); (3) number of crops grown in the plot vs how much the garden products cover the household vegetable consumption (%); (4) social satisfaction vs hours per week spent in the garden; (5) health satisfaction vs hours per week spent in the garden; (6) economic satisfaction vs how much the garden products cover the household vegetable consumption.

Results and discussion

Demographic and socio-economic aspects

The profile of the gardeners and the socio-economic aspects investigated are shown in Table 1. No gardener chose the open-ended answer option. The results of the interviews were comparable for the three gardens, therefore aggregated data are presented. The typical gardener of the social gardens of Prato was male, a pensioner, 74 years old on average, with a low level of education. Only three out of the 45 respondents were female. Different authors report that in Italy urban gardening is mainly a male activity (Ruggeri, Mazzocchi and Corsi, 2016; Glavan et al., 2018; Cucchi, Gambino and Longo 2020). A low number of female gardeners are also found in other European countries, like Spain (Langemeyer et al., 2018), while urban gardens seem to be more inclusive with regard to gender in Northern Europe (Barthel, Folke and Colding, 2010; Glavan et al., 2018). In developing countries, where food production is the major aim of gardening, it is typically women who are engaged in it (Moustier and Danso, 2006). The age of the gardeners ranged from 55 to 88, but more than half of them were over 75 years old. Food gardening is thus confirmed to be largely practiced by the elderly, who find multiple psychosocial and physical benefits in this activity also leading to a more positive aging self-perceptions (Wright and Wadsworth, 2014; Scott, Masser and Pachana, 2020). Italian gardeners seem to be, on average, older than those of other countries, and, as a consequence, more often retired (more than 85% in Milan) according to Glavan et al. (2018). In Prato, although both unemployed people and pensioners could apply for a garden plot, all but one of the respondents were retired, consistently with their age. The level of education was low: even 30 out of 45 gardeners had an elementary education only, 11 had attended the middle school, three had obtained a high school diploma, and only one had graduated. We believe that this does not indicate an inclination of low-education people for gardening, but the fact that these people presumably belong to a lower income bracket, with less chance of having land of their own to devote to gardening. All respondents learned about the social gardens' initiative by word of mouth; only one was also informed by the media. According to the idea that gardening is associated with an increased self-esteem in the elderly (Scott, Masser and Pachana, 2020), the respondents appeared to be proud of their cultivated plot and their ability to manage it. All of them attributed their agricultural know-how to their personal experience. Similarly, the study of Glavan et al. (2018) revealed that for 180 urban gardeners from the three cities of Ljubljana, Milan, and London, gardening was mainly based on the principle of 'personal trials, errors, and observations'. However, the same study also highlighted other sources of skill and knowledge. In Prato, only one respondent (2%) admitted that also exchanging information with the other gardeners was important. But, in fact, we had

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the feeling that sharing skills and experiences among gardeners was more common than admitted since what emerged from talking with them was that, first of all, the garden was perceived as a place to meet other people. The social aspect was indicated as a motivation for joining the initiative by 42 out of 45 respondents. The same number of gardeners declared to have health motivations. From this point of view, what the interviewees particularly appreciated about gardening was practicing physical activity in the open air and the possibility of having safe and natural vegetables thanks to the fact that they themselves controlled the production process. Some of them even recognized the garden as a kind of 'antidepressant', claiming beneficial effects on mood. The social and health aspects are recognized to be essential in most studies investigating the motivations for engaging in gardening activities. For example, Ruggeri, Mazzocchi and Corsi (2016), Lewis, Home and Kizos (2018), and Home and Vieli (2020), who investigated urban gardeners' motivations in Milan (Italy), Lausanne, Bern, and Zürich (Switzerland), and Temuco (Chile) respectively, found that the wellbeing aspect and the social component were more important than the mere 'food function' of the gardens. On the contrary, according to Church et al. (2015), the dominant motive for gardening across Europe, except the UK, appears to be economic to reduce household expenditure due to food purchase. In our research, only two gardeners (4.4%) were motivated to engage in gardening for economic reasons. Besides, most of the interviewees (84%) seemed not to be aware of, or not interested in, the repercussions of the gardens on the environment, as they did not mention ecological-environmental motivations for gardening.

Over 60% of the gardeners said to devote 10 to 20 h a week to gardening, eight spent more than 20 h a week, and seven less than 10 h. No association between the time spent in the garden and how much the garden products cover the household vegetable consumption was found (Cramer's $V = 0.24$; P-value = 0.46). Sixty-four percent of the interviewees stated that the vegetables grown in the garden covered more than 50% of the consumption. In the study by Glavan et al. (2018) the percentage of urban gardeners participating in the interviews who covered more than 50% of their household needs for vegetables was 46% in Ljubljana, and only 17% in Milan and London. In Prato, 36% of the respondents even claimed to be capable of reaching self-sufficiency for the vegetables consumed by the family (mostly composed by two people). Only four gardeners out of the 45 shared their produce with relatives or friends, which was a lower percentage than that found in other studies (Zainuddin and Mercer, 2014; Glavan et al., 2018).

Finally, the gardeners of the social gardens of Prato were satisfied with their gardening experience from any point of view (social, health, and economic) regardless of the weekly time dedicated to gardening and the percentage of coverage of household vegetable consumption, as revealed by the calculation of Cramer's V (data not shown). Although profit was not the main motivation for gardening, they considered the expenses incurred for the garden (which ranged from 50 to 200 EUR) to be well repaid.

Cultivated crops, dedicated areas, and yield

Food gardens usually host a wide variety of crops (Grafius et al., 2020).However, the size of the garden may limit the number and the sort of cultivated species. Smaller gardens may be unsuitable for crops, such as squash, that require large space to grow (Glavan et al., 2018). The presence of water and composting tanks, tool sheds, etc., or relaxation areas, which are common in the allotment gardens (Cucchi, Gambino and Longo, 2020; Edmondson et al., 2020), reduces the net production area, with a greater incidence the smaller the plot is. For 33 garden colonies in the Metropolitan City of Milan (Italy) the unproductive area was estimated from 10% to even 70% depending on the size of the plots, the gardeners' expertise (which makes the wasted surface smaller), and the availability of water for irrigation, since in the case of use of rainwater only, an important portion of the lot is devoted to water collection (Cucchi, Gambino and Longo, 2020). In our study, in one individual plot (50 m^2 in total) the crops covered an average of 30 m^2, and as much as 40% of the plot area was occupied by paths, chairs and small tables, nursery, and sheds for tools, fertilizers and other materials useful for cultivation. It is interesting to notice that, despite the presence of a shareable warehouse, gardeners opted to store their own material in their own plots in order to have the complete availability and care of it. No rainwater collection tanks were present since the Municipality makes the water from the aqueduct available to the gardeners.

Individual plots hosted from 5 (one plot) to 14 (2 plots) crops; the most frequent number of crops grown in a plot was 10, and the average was 9.6. The number of crops per plot was weakly associated with the weekly time dedicated to gardening (Cramer's $V = 0.54$; P-value = 0.059), but, surprisingly, it did not show an association with how much the garden produce covered household vegetable consumption (Carmer's $V = 0.49$; P-value = 0.28). This seems to indicate that there were gardeners consuming a limited sort of vegetables. Overall, 27 different vegetable crops were detected, with a frequency (number of plots cultivating that crop) shown in Figure 2. Tomato was the most frequent species, which was found in all 45 surveyed plots. A high frequency (at least 10 plots as the average of the three gardens) was noticed also for lettuce and eggplant (14 plots each on average), pepper, zucchini, and cucumber (13), onion (12), and green bean (10). Potato, cauliflower + broccoli, black cabbage, celery, garlic, hot pepper, and parsley were detected in all the gardens, but in a low number of plots (Fig. 2). Eleven crops (asparagus, basil, chard, carrot, savoy cabbage, bean, fennel, strawberry, radicchio, sage, and pumpkin), which were even more sporadically grown, were considered together as 'minor species', and not shown in the figure.

While the types of plants cultivated in urban gardens can be easily detected, the quantity of food produced in them often remains unknown (Gittleman, Jordan and Brelsford, 2012). It is widely recognized that assessing the amount of vegetables produced in food gardens is very challenging. Gardeners do not measure the yield they obtain, and generally they are not able to provide reliable data on this aspect. That is probably the main reason why the articles focusing on the productivity of gardening are few. The data they report are often difficult to compare mainly, but not only, due to different methods used for the assessment. Some studies are based on data provided by small samples of gardeners specifically asked to weigh their production (Vitiello and Nairn, 2009; Gittleman, Jordan and Brelsford, 2012; Vitiello et al., 2010), others combine observational and/or surveyed data (e.g. cultivated area/number of cultivated plants/harvested fruits) with fixed data (e.g. standard yield per unit area or standard weight) of different origin (CoDyre, Fraser and Landman, 2015; Glavan et al., 2018; Cucchi, Gambino and Longo, 2020). In addition, variation in productivity data may be due to a combination of factors like different gardeners' experience and skill, data collection periods, and environmental conditions (Taylor, 2020). And, sometimes, it is not clear if productions are referred to

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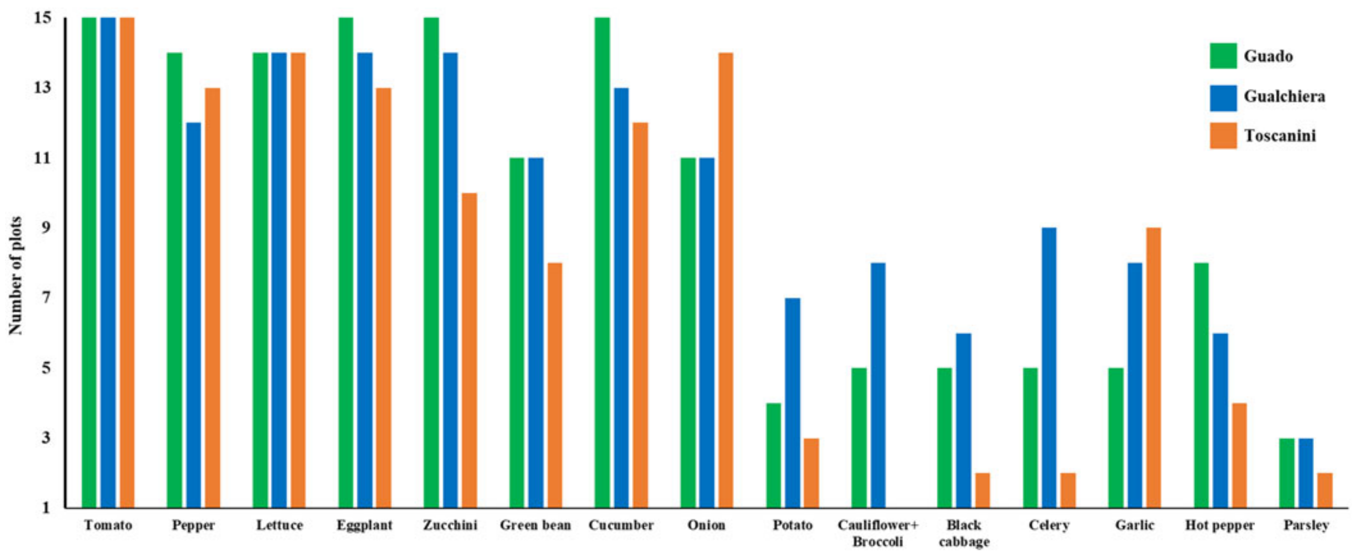

Figure 2. Vegetable crops grown in the three gardens of the Municipality of Prato (PO, Italy) and frequency (number of plots per garden).

gross or net cultivated area. In this study, both observational data and data reported by gardeners were considered for the areas occupied by the different crops in the three gardens. Regarding the yield, since the gardeners were not able to quantify the amount of vegetables harvested, we estimated crop yields based on the Italian average yield per unit area of each crop according to ISTAT (2019b), which was comparable to that found in some urban community gardens in Rome (Italy) (Dalla Marta et al., 2019).

Average areas per plot are shown in Figure 3 separately for the different gardens (minor species were considered together). As significant differences between the gardens were observed only for pepper, which covered an insignificant portion of the total cultivated area of a plot, the yield and nutritional value of the gardens were determined on a plot basis considering the averages of the 45 plots managed by the interviewed gardeners.

Tomato was by far the most important species, occupying 81.3% of the cultivated area of a lot and providing 85.2% of the total amounts of vegetables produced in that area (Fig. 4). This figure reflects the popularity of tomato in Italy, confirmed with regards to its presence in urban gardens by Glavan et al. (2018) for the city of Milan. In Italy, tomato is the first vegetable crop also in the commercial production system, in terms of both cultivated area and amount produced (CREA 2021). At the amateur level, tomato is often the most important crop in different parts of the world (Vitiello and Nairn, 2009; Vitiello et al., 2010; Gittleman, Jordan and Brelsford, 2012; CoDyre, Fraser and Landman, 2015). Very far from tomato, the second and the third crop in Prato were pepper (3.6% of the cultivated area and 2.7% of the total yield) and lettuce (3.0% and 2.2%), respectively (Fig. 4). All the other species covered a percentage of cultivated area and of yield between 1 and 2% or even below 1%.

In total, one plot produced around 90 kg of vegetables, which corresponded to a productivity of 3 kg/m^2 of net cultivated area or 1.8 kg/m^2 of gross area. Although with caution due to the considerations made above, we can say that these

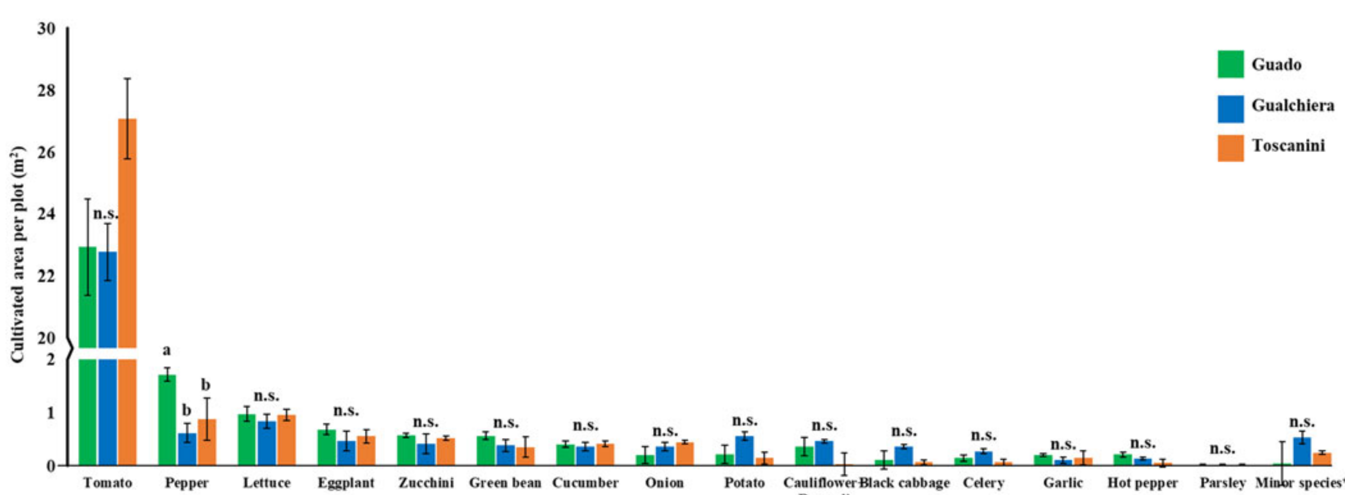

Figure 3. Average area per plot covered with different vegetable crops in the three gardens of the Municipality of Prato (PO, Italy). Different letters show statistically significant differences per $P \leq 0,05$ (Duncan Test).

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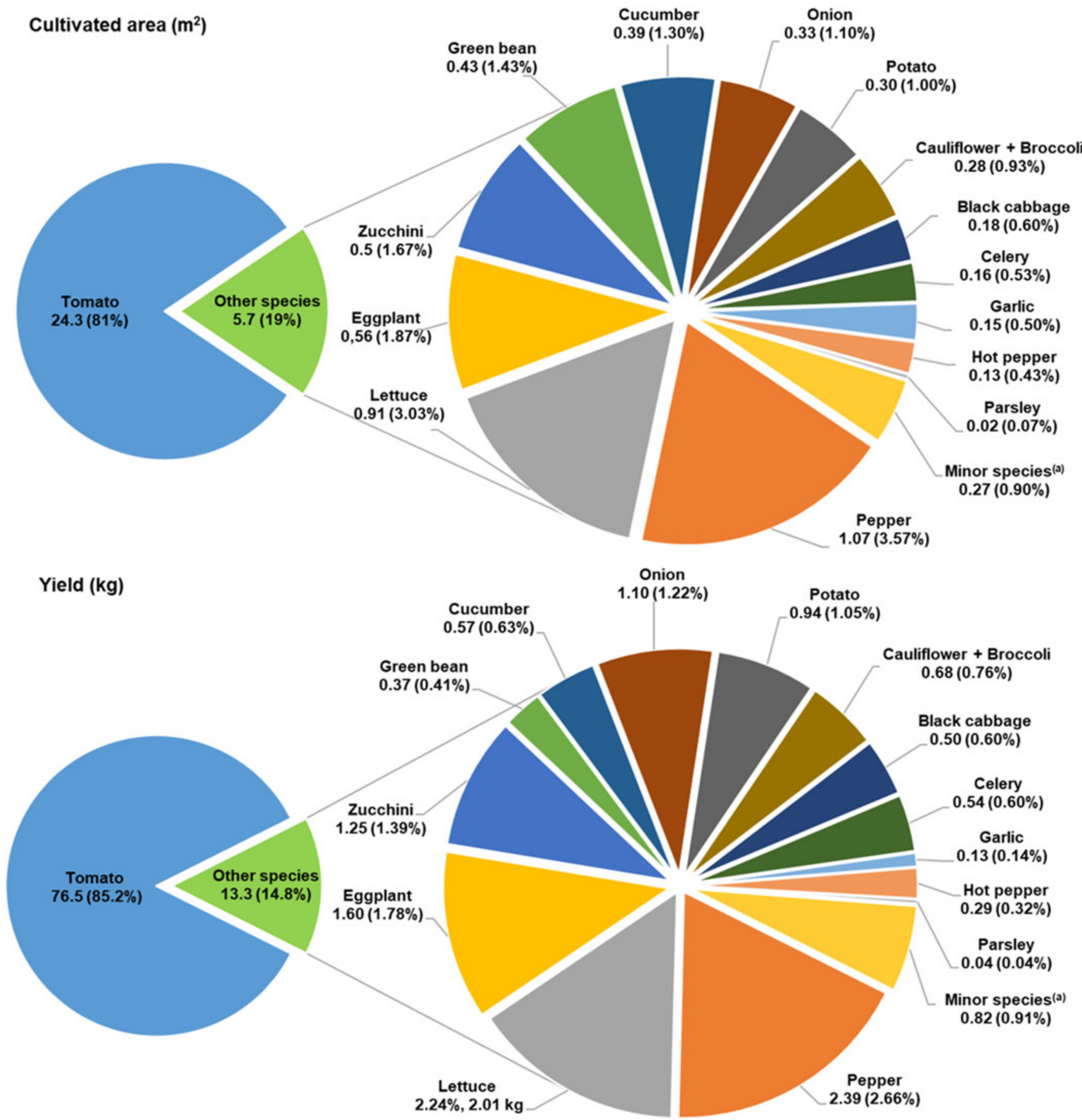

Figure 4. Incidence of different vegetable crops on cultivated area and yield [values per plot, average of the three gardens of the Municipality of Prato (PO, Italy)]. [(a)]Asparagus, basil, chard, carrot, savoy cabbage, bean, fennel, strawberry, radicchio, sage, and pumpkin.

values are consistent with those reported in previous studies (CoDyre, Fraser and Landman, 2015; Glavan et al., 2018; Cucchi, Gambino and Longo, 2020; Edmondson et al., 2020). Considering that the daily consumption of fruit and vegetables recommended by FAO/WHO is 400 g per capita (146 kg per year) (FAO 2005), one garden plot of 50 m^2 in Prato covered approximately 61.5% of one person's needs or 30.8% for both members of the typical family consisting of an elderly couple.

Nutritional value

The impact of food gardening on nutritional security is widely recognized and often mentioned in literature. Nevertheless, the papers dealing with the nutritional function of gardens from a quantitative point of view are relatively few. Most of them are referred to poor rural areas of some Asian countries, like India, Bangladesh, and Cambodia (Schreinemachers, Patalagsa and Uddin, 2016; Singh, Singh and Singh, 2018; Borthakur et al., 2021; Baliki et al., 2022; Depenbusch et al., 2022; Singh et al.,

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Table 2. Vitamins supply per plot: contribution of the different vegetables

	Vitamin B1		Vitamin B2		Vitamin B3		Vitamin C		Vitamin A	
Species	mg	%	mg	%	mg	%	g	%	mg	%
Tomato	22.97	73.2	22.97	63.9	535.85	82.7	16.08	71.5	32.15	62.1
Pepper	1.20	3.8	1.67	4.7	11.95	1.9	3.61	16.1	3.32	6.4
Lettuce	1.01	3.2	3.62	10.1	14.07	2.2	0.12	0.5	4.60	8.9
Eggplant	0.80	2.6	0.80	2.2	9.60	1.5	0.18	0.8	Trace	-
Zucchini	1.00	3.2	1.50	4.2	8.75	1.4	0.14	0.6	0.08	0.1
Green bean	0.26	0.8	0.56	1.5	2.96	0.5	0.02	0.1	0.15	0.3
Cucumber	0.11	0.4	0.17	0.5	3.42	0.5	0.06	0.3	Trace	-
Onion	0.22	0.7	0.33	0.9	5.50	0.9	0.06	0.2	0.03	0.1
Potato	0.94	3.0	0.38	1.1	23.50	3.6	0.15	0.7	0.03	0.1
Caulifl. + Broccoli	0.68	2.2	0.68	1.9	8.16	1.3	0.40	1.8	0.34	0.7
Black cabbage	0.59	1.9	0.70	2.0	5.40	0.8	0.65	2.9	2.70	5.2
Celery	0.32	1.0	1.03	2.9	1.08	0.2	0.17	0.8	1.12	2.2
Garlic	0.30	1.0	0.09	0.3	0.95	0.2	0.01	0.1	Trace	-
Hot pepper	0.26	0.8	0.67	1.9	8.70	1.3	0.66	3.0	2.39	4.6
Parsley	0.04	0.1	0.08	0.2	0.24	0.04	0.06	0.3	0.38	0.7
Minor species[a]	0.67	2.1	0.69	1.9	7.55	1.2	0.11	0.5	4.52	8.7
Total	**31.37**		**35.94**		**647.68**		**22.48**		**51.81**	

[a]Asparagus, basil, chard, carrot, savoy cabbage, bean, fennel, strawberry, radicchio, sage, and pumpkin.

2022). These studies focus on the fact that the establishment of a food garden and the engagement of women in home gardening and nutrition training programs increased vegetables consumption and consequently the nutrient intake of the families involved. While such an increase was certain, some authors claimed that the exact quantification of nutrients, totally based on interviews, may have been affected by the difficulties in accurately measuring the amounts of vegetables (Baliki et al., 2022).

In our study, we follow the approach adopted by Nogeire-McRae et al. (2018). In particular, we provided an estimate of the potential amounts of nutrients achievable from an urban garden, based on the vegetable species we found in our case study, their chemical composition, the areas planted with each crop, and standard yield data. We also calculated the nutritional value of a plot as the percentage contribution to the recommended individual's annual intake of vitamins and minerals. Given the age of the gardeners, recommendations for the age group over 75 years were considered. Nutrition is a crucial issue for the elderly, since undernutrition and micronutrient deficiency are associated with a range of age-related diseases (Norman, Haß and Pirlich, 2021). The category over 75 years has higher DRI than younger adults for Ca and lower for Na (SINU, 2014). Old people need more Ca due to the age-related decrease in the absorption of this element, responsible for osteoporosis (Gennari, 2001), while Na adversely affects calcium balance through the promotion of urinary calcium loss and contributes to hypertension (WHO, 2002).

The total production in vitamins and minerals of a plot of the social gardens in Prato and the contribution of the different vegetables are shown in Tables 2 and 3, respectively. For both categories of nutrients, tomato, obviously due to the largest cultivated area (Fig. 4), provided the highest quantities, with percentages ranging from 62% (Vitamin A) to around 83% (Vitamin B3) for vitamins, and from 55% (Na) to 86% (K) for minerals. The other species covered very small amounts, from even less than 1% to not over 5%, but with some interesting exceptions. For example, lettuce (3.0% of the cultivated area, Fig. 4) provided 10% of Vitamin B2 and 9% of Vitamin A, and pepper (3.6% of the area) 6.4% of Vitamin A and 16% of Vitamin C, of which it is one the richest vegetable (151 mg/100 g *versus* 21 mg/100 g in tomato) (Table 2). An even higher Vitamin C content is typical of hot pepper (229 mg/100 g) and parsley (162 mg/100 g), whose contribution to the intake of these vitamins, however, was low due to the very small invested area. Nearly 9% of Vitamin A derived from minor species, that overall occupied only 0.9% of the cultivated area of the plot. This percentage is explainable considering the high Vitamin A amount of carrot (1148 μg/100 g), pumpkin (599 μg/100 g), and radicchio (542 μg/100 g). Celery, being particularly rich in Na (140 mg/100 g), provided 18% of the total Na production of a plot (Table 3) although grown on a surface of only 0.16 m^2 (Fig. 4). For Ca, lettuce (45 mg Ca/100 g) provided 7% of the total amount, and black cabbage (150 mg Ca/100 g) 6.3%; due to sage (600 mg Ca /100 g), minor species reached almost 5% of the total amount of this element.

Finally, the nutritional values are shown in Table 4. The highest contributions interested Vitamin C (58.7 and 72.5% of the recommended individual's annual intake for males and females, respectively) and Vitamin A (20.2 and 23.7%), followed by K (18%) and Fe (11%). For vitamins of group B and for P the contribution ranged between 6.2 and 9.9%. What was less covered were the requirements of Ca (3%) and Na (about 1%). A similar pattern was reported by Nogeire-McRae et al. (2018) for a garden

https://doi.org/10.1017/S1742170523000479 Published online by Cambridge University Press

Table 3. Minerals supply per plot: contribution of the different vegetables

	Na		K		Ca		P		Fe	
Species	g	%	g	%	G	%	g	%	mg	%
Tomato	2.30	54.9	222.00	86.3	8.42	65.6	19.90	79.1	306.20	75.8
Pepper	0.05	1.1	5.02	2.0	0.41	3.2	0.67	2.7	16.73	4.1
Lettuce	0.18	4.3	4.82	1.9	0.90	7.0	0.62	2.5	16.08	4.0
Eggplant	0.05	1.2	3.04	1.2	0.24	1.9	0.32	1.3	3.20	0.8
Zucchini	0.01	0.3	3.63	1.4	0.23	1.8	0.69	2.7	6.25	1.6
Green bean	0.01	0.2	1.04	0.4	0.13	1.0	0.18	0.7	3.33	0.8
Cucumber	0.07	1.8	0.80	0.3	0.09	0.7	0.10	0.4	1.71	0.4
Onion	0.11	2.6	1.54	0.6	0.28	2.1	0.39	1.5	4.40	1.1
Potato	0.07	1.6	5.36	2.1	0.09	0.7	0.51	2.0	5.64	1.4
Caulifl. + Broccoli	0.05	1.3	2.38	0.9	0.30	2.3	0.47	1.9	5.44	1.4
Black cabbage	0.21	4.9	2.65	1.0	0.81	6.3	0.50	2.0	7.94	2.0
Celery	0.76	18.1	1.51	0.6	0.17	1.3	0.24	1.0	2.70	0.7
Garlic	0.01	0.1	0.40	0.2	0.02	0.2	0.14	0.6	1.56	0.4
Hot pepper	0.02	0.5	0.67	0.3	0.05	0.4	0.05	0.2	1.45	0.4
Parsley	0.01	0.2	0.27	0.1	0.09	0.7	0.03	0.1	1.68	0.4
Minor species[a]	0.29	7.0	2.18	0.9	0.62	4.8	0.36	1.4	19.80	4.9
Total	**4.18**		**257.30**		**12.84**		**25.16**		**404.11**	

[a]Asparagus, basil, chard, carrot, savoy cabbage, bean, fennel, strawberry, radicchio, sage, and pumpkin.

Table 4. Nutritional value per plot: contribution (%) to the recommended annual individual intake of vitamins and minerals

Vitamin or mineral	Annual yield (mg or *g*)	PRI or *Ai*[a,b)] (mg day^{-1})	Recommended annual intake[b] (mg or *g*)	Nutritional value[b] (%)
Vitamin B1	31.37	1.2/**1.1**	438/**402**	7.2/**7.8**
Vitamin B2	35.94	1.6/**1.3**	584/**475**	6.2/**7.6**
Vitamin B3	647.68	18	6570	9.9
Vitamin C	*22.48*	105/**85**	*38*/***31***	58.7/**72.5**
Vitamin A	51.81	0.7/**0.6**	256/**219**	20.2/**23.7**
Na	*4.18*	*1200*	*438*	0.95
K	*257.30*	*3900*	*1424*	18.0
Ca	*12.84*	1200	*438*	2.9
P	*25.16*	700	*256*	9.8
Fe	404.11	10	3650	11.1

[a]PRI, population reference intake; *Ai*, adequate intake; data are referred to people over 75 years old.
[b]Values in regular referring to male, values in bold referring to female.

plot of 9.3 m^2 in Fort Collins, Colorado, USA. Despite the differences in crop combination and in reference yield data and recommended intakes considered, even in that case study the nutrients produced in the garden mainly contributed to the requirements of Vitamin C and Vitamin A, while Ca and Na were the most uncovered. Overall, the nutritional values reported in that study, multiplied by 3.22 to refer to a cultivated area of 30 m^2, were substantially comparable to ours. Some differences concerned Vitamin B3, K, P, and Fe, whose values were higher in our case study, and Vitamin A, whose recommended intake, on the contrary, was less covered by our gardens. To increase Vitamin A production, gardeners in Prato could simply devote a larger area to some crops they already grow, but on very small areas, like carrot and pumpkin. Analogously, an increase in the cultivated areas of some other vegetables already present in the gardens or the introduction of new species could lead to higher nutritional values for specific vitamins or minerals. For example, to increase the intake of Ca, whose requirement was poorly covered, a larger area should be cultivated with lettuce, black cabbage, and sage, or vegetables like rocket (309 mg Ca/100 g) should be introduced in the plots. On the contrary, the low nutrient productivity for Na is to consider an advantage in our case study, given that hypertension is frequent in the elderly (Lionakis et al., 2012) and dietary sodium intake is often high (Espeland et al., 2001). Finally, considering that each gardener has an area of 50 m^2 available, of which even 20 m^2 are not cultivated, the nutrient productivity of a plot could be achieved through a better use of land. For example, the gardeners could be sensitize to share the common space made available by the municipality to keep their own materials.

Conclusions

The investigation carried out in the social gardens of Prato confirmed that the typical profile of the Italian urban gardener is an elderly man. The provision by the Municipal Administration of areas of land to cultivate has allowed people to practice gardening who probably would not otherwise have been able to due to lack of owned land. The initiative has proven to be effective in facilitating the use of free time and the physical activities of pensioners, as well as in promoting socialization. The assignment of a plot of land to be fully responsible for stimulated the gardeners' self-esteem. The gardeners declared themselves satisfied with their experience, nevertheless the data on cultivated areas and crops highlighted possible margins for improving the production and nutritional value of the gardens.

A plot produced an estimated annual yield of about 90 kg, equivalent to approximately 61.5% of one person's needs for fruits and vegetables. Since a large area of the plot (40% over a total of 50 m^2) was uncultivated, yield could be easily increased through a better use of the land. Besides, a larger assortment of vegetables, at present dominated by tomato, would be recommended to obtain a higher and more equilibrated nutrient supply. In particular, vegetables rich in Ca, which is a crucial nutrient for the elderly but whose requirement was poorly covered, should be cultivated on larger areas or be introduced in the gardens. In our view, conveying this information to the gardeners and involving them in training programs on agricultural practices, vegetables composition, and nutrition, could be helpful for increasing the nutrient productivity of the plots and, ultimately, for strengthening the productive function of social gardens. A commitment from the Municipality in this educational activity and in promoting greater sharing of common spaces would be desirable.

Data availability statements. The data that support the findings of this study are available on request from the corresponding author, A.L.

Acknowledgements. The authors are grateful to Dr. Lorenzo Marini for his support in the statistical analysis. Special thanks to the Municipality Administration of Prato (Italy) for the information provided and for introducing the gardeners, and to the gardeners interviewed for their helpfulness.

Authors' contribution. Ada Baldi: Conceptualization; Formal analysis; Investigation; Methodology; Visualization; Writing – original draft. Nicolas Lucio Gallo: Formal analysis; Investigation. Anna Lenzi: Conceptualization; Formal analysis; Methodology; Supervision; Visualization; Writing – original draft; Writing – review & editing.

Funding statement. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Competing interest. None.

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https://doi.org/10.1017/S1742170523000479 Published online by Cambridge University Press