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Potential Economic and Ecosystem Performances of Some Mediterranean Fruit Plants in an Urban Context

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Abstract: This study focuses on the possibility of using fruit tree species, from an urban area in central Italy, to evaluate their possible productive, ecosystem, and economic contribution. The realization of the food forest was conducted through the use of a web app that can evaluate the climatic and ecosystem performance of trees in the city. This simulation can provide the city's government with useful information on the ecosystem and the socioeconomic benefits of planting fruit trees in an urban park. Among the four chosen species, both *Ficus carica* and *Morus nigra* showed good potential fruit production of 1300 kg and 865 kg and a CO_2 storage of 2.5 and 1.5 tons. The production and economic potentials from selling the fruits of the selected species were evaluated, and the *Morus nigra* species showed the highest economic value over a 50-year period of about 6000 USD, with an average price of 7 USD/kg. Another positive aspect of edible food forest landscapes is their ability to give rise to an ecosystem and habitat that can attract animals, birds, and wildlife, consequently improving urban ecosystem biodiversity.

Keywords: urban food forest; fruit species; potential yield; economic value; ecosystem functions

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1. Introduction

In the literature, the "Urban Food Forest" is described as "an emerging multifunctional and interdisciplinary approach that is used to increase sustainability and urban resilience as it relates to food security" [1], to restore unproductive ecosystems in cities and to enable multiple goals [2]. Thus, its realization involves the choice of a tree species that can improve air quality, reduce air pollution, control soil erosion, provide a resource of sustainable food accessible for all, and improve human health and wellbeing. Edible landscaping is as old as gardening itself, already within ancient Persian gardens, around the 2nd millennium B.C., edible plants and ornamental plants were juxtaposed. In the Middle Ages, monastic gardens had ample space dedicated to fruit trees and vegetable gardens in which they grew vegetables and medicinal herbs [3].

The use of edible gardens, both as a place of pleasure and as a source of sustenance, was also present in the Renaissance period, when fruit trees, such as the fig and pear, and vegetables, such as cabbage, leeks, onions, fava beans, peas, zucchinis, and pumpkins were frequent, all the way to the gardens of 19th-century English suburbia, which often included edible fruits and berries. Over the centuries, however, the edible components of urban landscapes have largely been lost to shade trees. The past two decades, however, have seen a resurgence of interest in the edible landscape [4], which has been partly reintroduced within cities, called the "edible urban forest". The forest possesses a significant role in making cities more livable and better adapted to a situation of continuous climate-driven change. An important factor to consider before planting trees is to identify edible tree species responsible for possible adverse effects such as, for example, allergic reactions brought about by pollen, which involves an increasing portion of the urban population [1].

In addition, an urban food forest strengthens ties in the community bringing benefits to physical and psychological health. Several studies have shown that people living in neighborhoods with a higher density of trees have a lower risk of experiencing cardiometabolic conditions and mental illness; in fact, exposure to green spaces can promote mental health [5], reduce blood pressure, and decrease stress levels [6]. The purpose of these studies and projects involving edible forests is to promote practices that are as sustainable as possible, reducing the use of chemicals in the landscape, supporting wildlife, and creating eventual energy and economic savings through the reduced use of refrigeration systems in these areas by harvesting fruit directly from the trees at the peak of ripeness. Locally grown food can also further reduce air and water pollution, if the fruit in urban forests is grown organically, without synthetic fertilizers and pesticides [7]. Moreover, there can be several drawbacks to obtaining vegetable or fruit production in particularly polluted cities; therefore, food forests could be considered without particular health concerns for citizens especially in pedestrian zones (car-free zones).

Moreover, a study [8] highlighted the possible economic benefits derived from urban forests, in which the four ecosystem services provided by urban area vegetation are estimated to have a global value on the order of 33 billion USD per year. A potential annual food production of 100 to 180 million tons, energy savings ranging from 14 to 15 billion kilowatt-hours, nitrogen sequestration between 100,000 and 170,000 tons, and the avoidance of stormwater runoff between 45 and 57 billion cubic meters per year are expected. In addition, it is estimated that food production, nitrogen fixation, energy conservation, pollination, climate regulation, soil formation, and biological pest control could be valued at up to 160 billion USD per year [8]. Results from other work showed significant country-to-country variability, where developed countries provide profitable agricultural production, contribute to reduced warming or cooling in temperate areas, and mitigate storm runoff in tropical locations. In developing regions, urban agriculture can be fundamental to survival or to the necessary adaptation to climate change. In developed and temperate countries, agriculture increases access to the recommended daily consumption of fresh fruits and vegetables [9]. The recommended consumption of vegetables for the urban population can be met almost entirely through urban agriculture [10], leading to a reduction in emissions from the transportation of agricultural products [11] and a decrease in food waste. Among the ecosystem services assessed, food production provides the most returns [8]. As urban populations grow and climate change progresses, it becomes increasingly complicated to ensure food security for all people. Food security or “food safety” refers to physical and economic access to sufficient safe and nutritious food that meets people’s dietary needs [12]. This need has become one of the greatest challenges of the 21st century. One of the main advantages of growing fruit trees in cities is the presence of many volunteers, people, businesses, schools, food banks, supermarkets, hospitals, and other congregations willing to help by taking care of the area and harvesting the fruits. However, there are not always communities of citizens and volunteers who know how to harvest the fruit, and more importantly, there is no knowledge of how to proceed due to lack of relationships with local authorities. As a result, there is often a loss of the fruit that is not being harvested by anyone, which ends up falling to the ground and being lost. For this reason, when creating a food forest, it is essential from the outset to obtain and remain in touch with those who can help manage both the harvesting and the storage of the fruit in the best possible way. Large-scale production of fruits in the city will require the appropriate planning, staffing, and funding for maintenance, harvesting, storage, processing, and redistribution by citizens; in this way, it will be possible to create a healthy and productive food forest [1]. Planting urban food trees on public land could greatly increase local fruit production and may be able to theoretically provide the entire recommended fruit requirement for the population. An example of an edible urban forest is City Fruit [13], a project started in Seattle in 2008, within which the great value of fruit trees in cities is emphasized, and which aims to promote fruit growing in urban landscapes, build community, and protect cities from climate change. The project also works by preserving urban tree canopies, encouraging proper tree management, and involving more city neighborhoods to harvest fruit. City Fruit also sponsors pruning courses and has produced a series of quick guides on topics such as fruit tree care, identification and control of common fruit tree pests, and fruit drying [14]. In 2016, the City Fruit initiative collected 25,000 kg of unused fruit from Seattle's urban fruit trees and donated 13,600 kg to food banks and community organizations, with an estimated value of 60,000 USD [13]. The following paper takes up the themes already addressed in our previous work [15], analyzing in this case the productive potential of four fruit tree species in the urban environment, focusing on fruit yield, potential economic value, and CO_2 sequestration during a 50-year time period through a dynamic evaluation considering specific plant growth equations.

2. Materials and Methods

2.1. Species Selection

Fruit trees chosen for planting in urban areas include the following: *Arbutus unedo* L., known by its common name, Strawberry, possesses good resistance to cold, down to −17 °C, can tolerate pollutants, and has the peculiarity of reacting to fire with a high emission of suckers and recolonizing surfaces destroyed by fire; the dispersal period of its pollen is from October to January. *Ficus carica* L., its common name being the Common Fig, is a very drought-resistant fruiting species that can adapt well to all types of soil; in April and August it disperses its pollen into the air. *Morus nigra* L., known by the common name Black Mulberry, is a hardy plant that is adapted to poor soils, resistant to cold temperatures and tolerant to periods of drought. Finally, the fruiting species *Prunus avium* L., common name Sweet Cherry, was chosen, which is also very hardy, resistant to cold temperatures down to −20 °C and has high vigor. Both *Morus nigra* and *Prunus avium* disperse their pollen from the months of April and May. All of the fruit trees were also evaluated according to the allergological risk that dispersing their pollen in an urban environment would cause. No scientific evidence has been found to state that pollen from *Arbutus unedo*, *Ficus carica*, and *Prunus avium* can be responsible in any way for allergic sensitization with or without clinical significance; therefore, urban planting of this species does not appear to pose a risk for respiratory allergies. There is moderate evidence, on the other hand, that *Morus nigra* pollen may be responsible for possible allergies with clinical relevance; therefore, planting of this species in cities should be limited to a few specimens and should avoid sensitive locations [16].

Moreover, the species were also selected considering their aesthetic aspect, which is particularly important in an urban environment. *Arbutus unedo*, *Morus nigra* and *Prunus avium* with their flowering capabilities make urban areas more pleasant, while *Ficus carica* may be useful as it is also a reservoir of pollen and a 'nursery' for pollinating insects that breed in its syconia.

2.2. Virtual Planning of an Urban Green Area

Fruit trees, belonging to the species *Prunus avium*, *Ficus carica*, *Morus nigra*, and *Arbutus unedo*, were virtually placed in an urban green area, more specifically within the Chico Mendez Park in Perugia, Umbria (Figure 1), through the use of an online platform called "Lifeclivuttreedb". The planting area was selected on the basis of a potential population presence around the simulated food forest, furnishing the municipality administration with some information on the ecosystem and socioeconomic benefits derived by fruit shrubs and trees planted in a very crowded park.

These four specific tree species were chosen because they were already treated in a previous work [15] and their productivity and potential economic value were known. *Arbutus unedo* in particular was chosen because it is a native species and of biodiversity interest. These species were selected for their ease and availability of production and economic data and their traditional presence as ornamental species in urban areas of southern Europe.

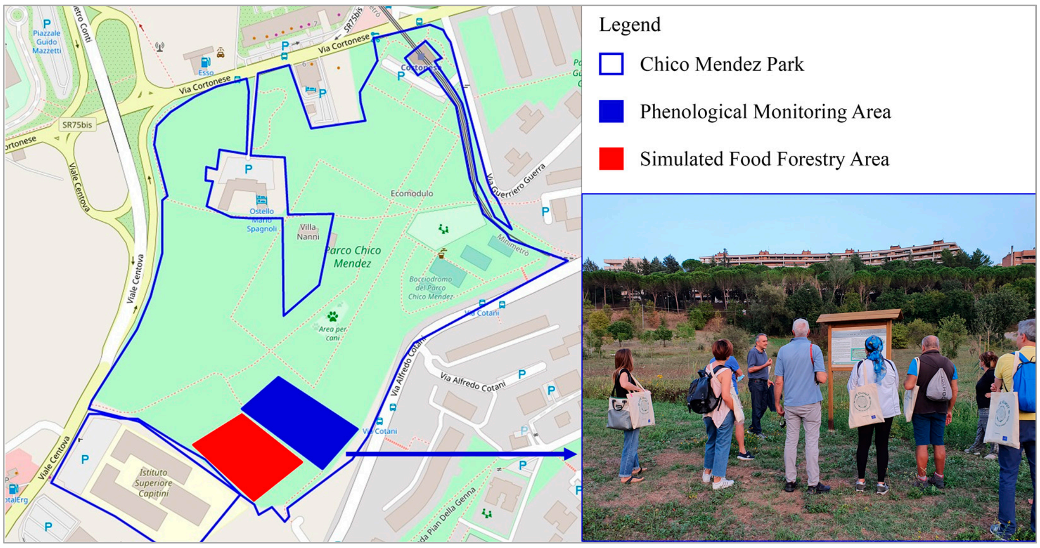

Figure 1. LIFE Clivut Project activities with citizens in Chico Mendez Park and potential location of simulated Urban Food Forestry.

In selecting fruit species for planting in the city, the tree diameter speed of growth, the maximum and minimum temperatures the plant can withstand, hardiness, ability to adapt to climate change, potential production yields, and the allergological risk from the dispersal of their pollen were considered.

The open-source software environment "Lifeclivuttreedb" (https://lifeclivut.treedb.eu/, accessed on 21 March 2021) is based on a fully web-based architecture and can be used on the Internet network from any device, whether stationary or mobile. "Lifeclivuttreedb" was implemented as part of the Life Clivut project, "Climate value of urban trees", operating in four cities in the Mediterranean area such as Perugia and Bologna in Italy, Thessaloniki in Greece, and Cascais in Portugal (https://www.lifeclivut.eu/, accessed on 21 March 2021). The project was created with the aim of planning and managing urban greenery and natural spaces to increase resilience to climate change, having as its basis the knowledge of the tree stock in the four cities and its evaluation in terms of climate and ecosystem performance [17]. The dendrometric data considered by the Web app are DBH (tree diameter at 1.30 m), tree height, height at first branch stage, size, shape and transparency of the crown. The species of the tree as well as its phytosanitary status is also recorded, which are useful in identifying any issues for its management. Within the Web app, the "planting" of nursery plants belonging to the considered fruit species was simulated, using four plants for each species. Plants have arbitrarily defined morphological characteristics considering the representative average values derived from the technical/scientific literature.

2.3. Evaluation of Urban Tree Growth Curves

The present analysis was based on Clivut project expertise, and a series of allometric equations were used to interpret the woody plant growth of the tree species, derived from the analysis of empirical observations carried out by the "U.S. Forest Service" [18]. In particular, among the various equations created by the U.S. Forest Service, we considered those developed in climatic zones similar to the Mediterranean ones that we had considered. The equations most closely matching the characteristics of the plants involved in the study were then chosen. The different allometric equations tested included four polynomial models (linear, quadratic, cubic, and quartic), as well as logarithmic and exponential equations. The parameters predicted by the models include the use of tree age to predict DBH and the use of DBH to predict tree height, crown height, crown diameter and leaf area.

Some corrective criteria were applied to better interpret the behavior of woody plants in urban areas and to estimate their morphological performance outside the application ranges of the equations. Moreover, in order to establish the fixed relationships between the different parameters (AGE, DBH, Crown Diameter, Height, Leaf area) and to eliminate abnormal growth values, "Growth Matrices" were defined from the selected equations to predict a dependent variable on the basis of an independent one. The first two matrices, for assessing tree volume development during the years, provided DBH values based on plant age (AGE predicts DBH) and height values based on DBH (DBH predicts HEIGHT). As far as the AGE and DBH ratio is concerned, it was decided to work with a single matrix that would make it possible to predict the DBH based on the age of the plant and to carry out the reverse procedure, i.e., to obtain the age value based on the DBH of a given species.

2.4. CO_2 Stock Assessment

The online platform "Lifeclivuttreedb" made it possible to estimate the potential CO_2 stock that trees would attain in 50 years, using allometric equations in which the 2 parameters, DBH and plant height (H), are essential. The equations most responsive to the characteristics of the plants involved in this study were chosen. The "Lifeclivuttreedb" platform, based on the species identification and DBH sampling, evaluated the height and age of each tree, providing carbon storage estimates expressed in tons of CO_2 equivalent [19]. Carbon storage was based on the different ages, crown sizes, growth rates and pruning techniques for estimating tree biomass through volumetric equations (m^3/tree) from diameter to breast height (DBH in centimeters) and crown height (h in meters). Dry Weight (DW) biomass and stored carbon were calculated by applying DW biomass density factors (reported in the scientific literature) and incorporating underground biomass by multiplying DW biomass by 1.28 [20,21]. DW biomass was converted to kilograms of carbon (C) by multiplying it by the constant 0.50 [22], while stored carbon was converted to stored CO_2 in tons by multiplying it by the constant 3.67 (the molecular weight of CO_2).

The main experience on which the model is based comes from that of "I-Tree," which calculates the total carbon storage of the urban forest and of individual trees from the allometric biomass equations of forest-grown trees and adapting it to urban environment [23–25]. In "Lifeclivuttreedb" the formulas have been adapted to plants typically found in the Mediterranean area, as equations are not available for a full range of tree species and different climate areas. In order to improve the estimation of the biomass and carbon stock of tree species in the Mediterranean area, the results of an Italian research program (ri.selv.Italia) funded by the Department of Agriculture and Forestry of the Italian government were also taken into account using the equations created [26].

2.5. Production Yields and Potential Economic Value

The productivity of fruit trees can be defined by the following basic variables: high yield (in tons per hectare or equivalent); precocity (minimum young period, i.e., reaching reproductive maturity at an early age); and regular, long-term, non-altering productivity [27]. However, most fruit trees show some degree of fluctuation and alternation, particularly under suboptimal conditions and biotic or abiotic stress [28]. This is determined by the fact that the flowering and fruiting of trees in their wild and natural habitats is dominated by the environment, the surrounding wild vegetation, the availability of sunlight, water and mineral nutrients, and biotic and abiotic stresses, all of which interfere with and limit fruit production. As a result, under wild conditions, the sexual reproduction of tree species fluctuates greatly, and the full expression of fruiting potential is rarely obtained. Domestication has gradually alleviated environmental and biological stresses, reduced the annual fluctuations and increased yield. Agricultural practices such as pruning or fruit thinning may optimize the ratio between reproductive activity and ground-level vegetative growth [27]. For the chosen species in the following study, the fruit yield, during tree development, was approximated arbitrarily in order to achieve a simplified representation of reality. The production values per plant were conservatively considered to be low because these were individuals placed in urban settings, subjected to specific environmental stresses that limit reproductive activity, resulting in low and irregular productivity. Therefore, reduction coefficients were applied to the assumed yields in kilograms of fruit. In this regard, 2 potential production scenarios were imagined based on methodologies available in the literature, where S1 represents 50% of fruit trees yield commercially cultivated and S2 represents 30% of these "benchmark" yield [29]. According to the scientific literature, the fig tree (*Ficus carica* L.) appears to be capable of producing up to 100 kg/year of fresh fruit per year [30]. A production estimate of the "Edible Forest," has been also addressed for various fruit species in urban settings [31].

From the estimation of fruit productions realized in previous work [15], the plants of greatest economic interest were selected, for which a useful price history and economic data are available in the literature. After estimating the average production for each species, its potential economic value was calculated considering a time frame of 50 years. To calculate it, the estimated production (kg fruit/plant) of each species was multiplied by the current average price of the most common fruits according to Institute of Services for the Agricultural and Food market data (ISMEA-https://www.ismeamercati.it/analisi-e-studio-filiere-agroalimentari, accessed on 21 March 2021). The average prices of minor fruits were reconstructed based on the empirical knowledge of both farmers and agri-food technicians.

3. Results

3.1. Growth Curves of the Tree Species Considered

Figure 2 shows the potential growth of the diameter of the trunk of the trees examined, expressed in centimeters, over a 50-year period. Growth was evaluated every 5 years. The value of the trunk diameter is shown in the *y*-axis, while the age of the various species, expressed in years, is shown in the *x*-axis. The species that reaches a larger trunk diameter among all examined species is *Ficus carica*, reaching 50 years of age with a maximum diameter of about 60 cm, in contrast to *Prunus avium*, which only reaches below 40 cm dimensions. The growth conditions of all the species were considered without particular constraints as small tree pit, poorly permeable ground and limited soil, tree topping, or tree suffering conditions being allowed to grow spontaneously.

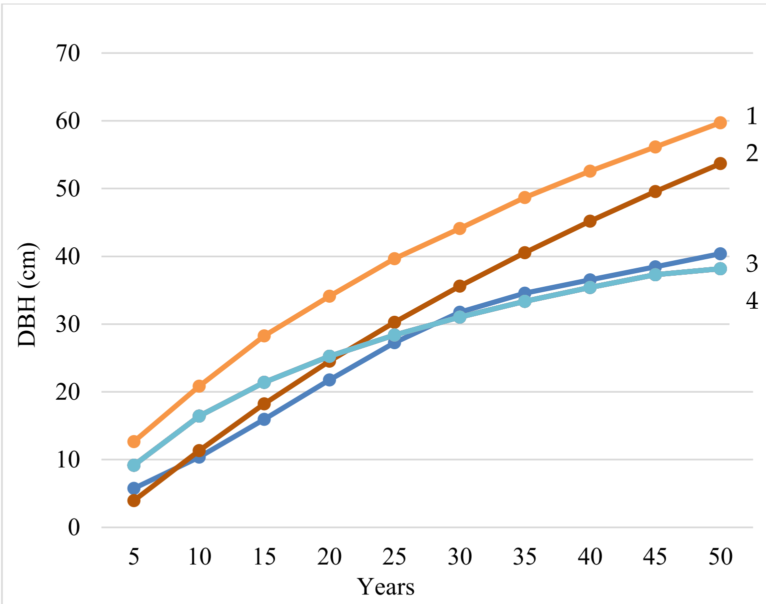

Figure 2. Fruit woody species growth curves. Age (years) predicting DBH. 1 = *Ficus carica* L.; 2 = *Morus nigra* L.; 3 = *Arbutus unedo* L.; 4 = *Prunus avium* L.

Figure 3 represents the potential height growth of trees, expressed in meters, up to the age of 50 years. Height values are shown every 5 years and are indicated on the *y*-axis, while the age of the various species, expressed in years, is shown on the *x*-axis. The growth of all species decreases over time; after the age of 40 years, for most species, they remain the same height, except *Morus nigra* which increases growth even beyond 40 years, reaching maximum heights of about 13 m. The lowest height results were from *Prunus avium*, which reaches only about 8 m.

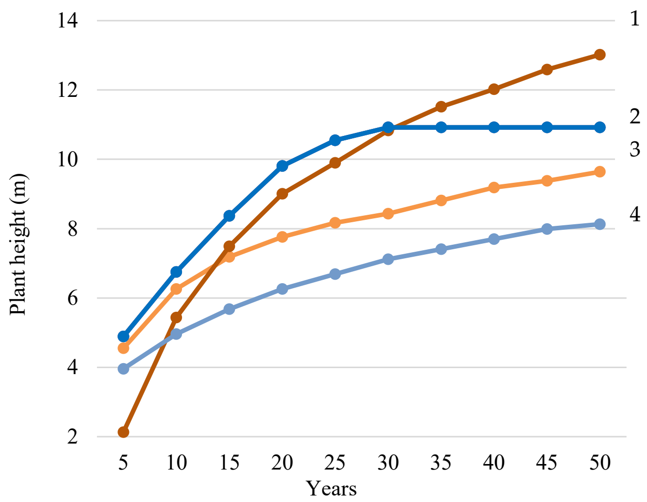

Figure 3. Fruit woody species growth curves. Age (years) predicting height. 1 = *Morus nigra* L.; 2 = *Arbutus unedo* L.: 3 = *Ficus carica* L.; 4 = *Prunus avium* L.

Estimates of the average CO_2 accumulation of the considered species from the time of edible forest establishment to 50 years are presented in Figure 4. The average CO_2 accumulation per species at the time of planting is very small, amounting to 0.07 ton. Over the years, the CO_2 storage potential of trees rises as DBH and age increase. In fact, according to the developed models, *Morus nigra* sequesters 1.27 tons of CO_2 at 30 years and increases up to 2.40 at 50 years. Among all of the species considered, *Ficus carica* is the one that is able to store the largest amount of CO_2 at 50 years, which is about 2.5 tons. The least amount of CO_2 that is stored over 50 years is below 1 ton, referring to the tree species *Prunus avium* and *Arbutus unedo*, shown in curve 3.

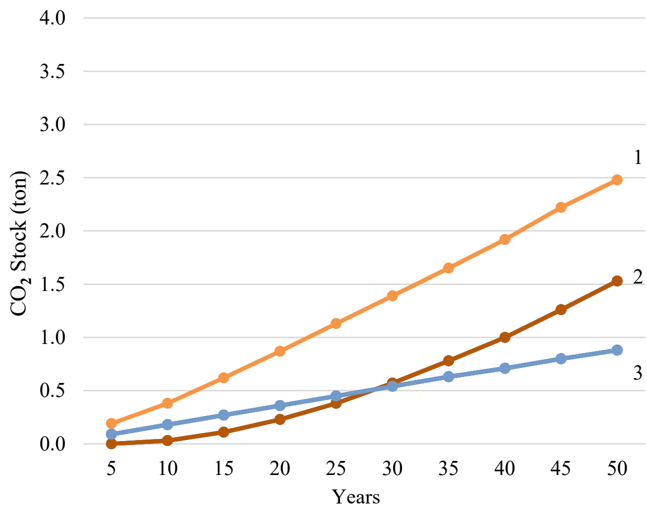

Figure 4. Fruit woody species growth curves. Age (years) predicting CO_2 storage. 1 = *Ficus carica* L.; 2 = *Morus nigra* L.; 3 = *Arbutus unedo* L.; *Prunus avium* L.

3.2. Potential Production Yields

In Table 1 the potential yields for the considered fruit tree species were reported on the base of the scientific and technical literature. It can be shown that during the first 4 years of rooting, all of the species examined were in a non-productive stage. From the fourth year onward, they all entered the production phase (indicated in gray), producing an average of 1 kg of fruit each in the first few years. Over time, the quantity increased. *Arbutus unedo* is the species with the lowest productivity, averaging 10 kg of fruit per year; at 40 years of age it needs replanting, and after 50 years it reaches a total of 395 kg of fruit produced. According to the considerations made in terms of production, replanting would also be advisable for *Prunus* *avium* trees after 40 years. Instead, *Ficus carica* would seem to be the species with the greatest productive potential, on average producing 36 kg of fruit during the peak production years (shown in gold color) for a total of 1299 kg over 50 years. The species of fruit trees whose potential use in urban areas was evaluated will not necessarily be managed and cultivated for production purposes but may predominantly grow wild without the use of specific care and may be subjected to various environmental stresses. So, new potential fruit productions, on the base of the considered reduction coefficients (30–50% of the commercial yields), were calculated (Figure 5). As an example, the productivity of *Arbutus unedo* (Strawberry) in non-urban areas ranges from 7 to 10 kg/plant/year. Therefore, the assumed productivity values for Strawberry trees under urban conditions were 5 kg/plant/year (S1) and 3 kg/plant/year (S2).

Table 1. Full production (kg) by species from planting until their 50th year.

Years	*Arbutus unedo*	*Ficus carica*	*Morus nigra*	*Prunus avium*
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	1.0	0.0	0.0	0.0
5	3.3	2.0	2.0	0.4
6	5.5	3.7	3.1	3.8
7	7.8	5.4	4.2	7.1
8	10.0	7.1	5.3	10.5
9	10.0	8.8	6.4	13.9
10	10.0	10.5	7.5	17.3
11	10.0	12.2	8.6	20.6
12	10.0	13.9	9.7	24.0
13	10.0	15.6	10.8	24.0
14	10.0	17.3	11.9	24.0
15	10.0	19.0	13.0	24.0
16	10.0	20.7	14.1	24.0
17	10.0	22.4	15.2	24.0
18	10.0	24.1	16.3	24.0
19	10.0	25.8	17.4	24.0
20	10.0	27.5	18.5	24.0
21	10.0	29.2	19.6	24.0
22	10.0	30.9	20.7	24.0
23	10.0	32.6	21.8	24.0
24	10.0	34.3	22.9	24.0
25	10.0	36.0	24.0	24.0
⋮	Years with constant values			
40	10.0	36.0	24.0	24.0
41	0.0	36.0	24.0	0.0
42	0.0	36.0	24.0	0.0
43	0.0	36.0	24.0	0.0
44	1.0	36.0	24.0	0.0
45	3.3	36.0	24.0	0.4
46	5.5	36.0	24.0	3.8
47	7.8	36.0	24.0	7.1
48	10.0	36.0	24.0	10.5
49	10.0	36.0	24.0	13.9
50	10.0	36.0	24.0	17.3
Total	395	1299	873	822.6

White: Plant not productive stage; grey: Start production; yellow: Maximum production.

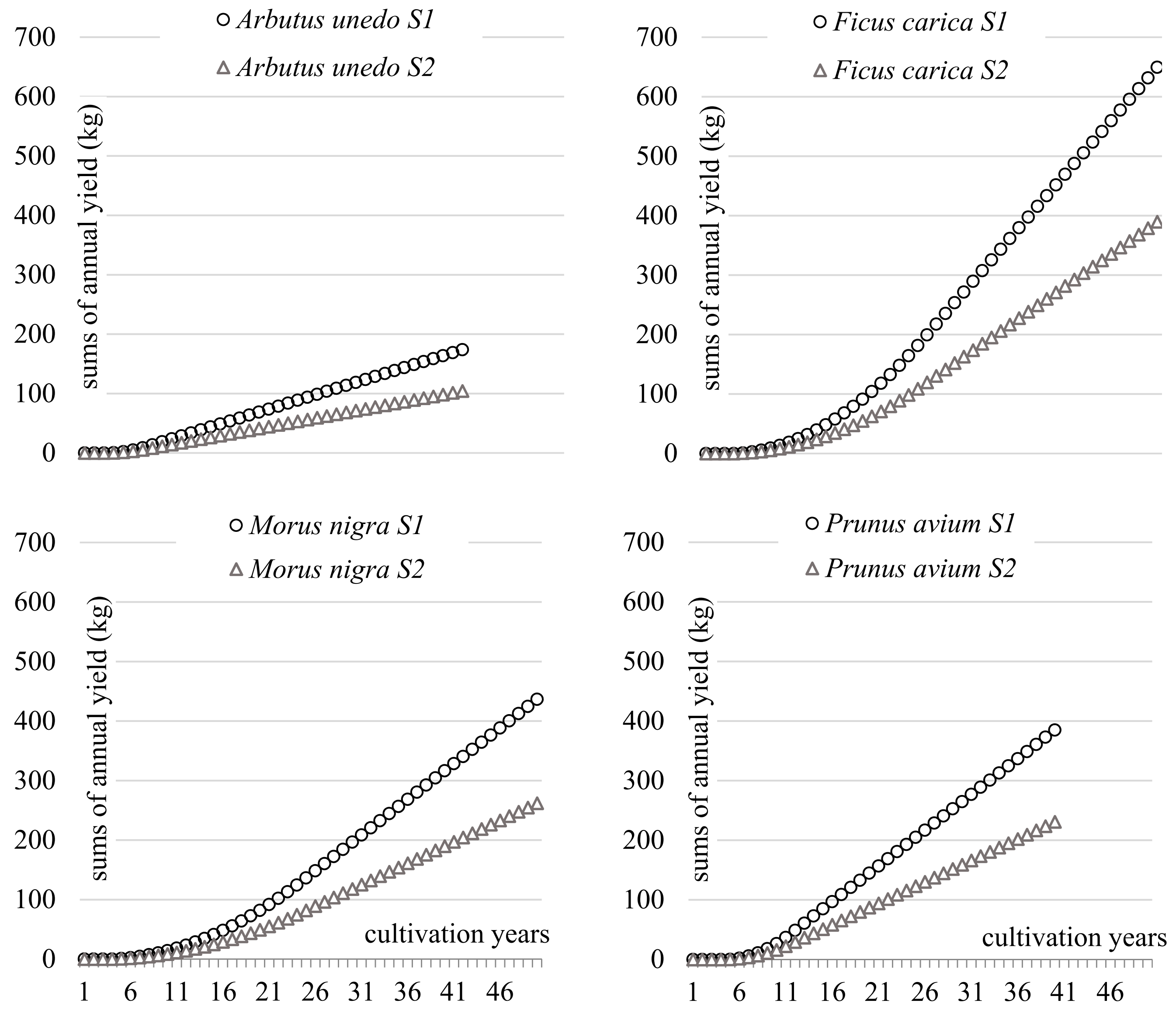

Figure 5. Potential production scenarios S1 represents 50% of commercially cultivated fruit trees yield, S2 represents 30% of the yield.

3.3. Potential Economic Value

The potential economic value, resulting from the sale of all fruits produced by the four chosen species, was calculated considering the best possible production scenario (commercial yield), as shown in Table 1. Based on the production and average price of fruit in the reference market, it was found that *Arbutus unedo* trees, potentially producing very small amounts of fruit in 50 years, about 395 kg in total, allow for a total economic value of only 2000 USD, which can be derived by considering an average price of 5 USD/kg. The species *Ficus carica* and *Prunus avium* could yield up to 2598 USD the former, respectively, considering an average fruit price of 2 USD/kg and up to 4110 USD the latter, finding its fruits at an average market price of 5 USD/kg. In contrast, the fruit species with the highest potential economic value was *Morus nigra*, with a potential economic value of about 6000 USD and an average price of 7 USD/kg. The possible total profit that could be obtained from marketing all of the fruits produced by the four species considered is around 14,794 USD total in 50 years.

4. Discussion

The realization of an edible landscape within cities allows urban areas to be improved in many ways from an environmental point of view that considers the practical benefits for citizenship. The present study focused on assessing the productive, economic, and ecosystem potential of the specific tree species planted virtually in urban settings. Data obtained using a web app allowed the analysis of woody fruit species on the basis of a range of ecosystem services, such as CO_2 storage, and allowed the calculation of their potential fruit production and economic value from the yield sale.

In various studies, the ability of some orchards to absorb atmospheric CO_2 has been determined; in particular, in an orchard in China, the results showed the great potential of an apple orchard used as a sink for atmospheric CO_2 absorption. Trees reached the maximum capacity of carbon sequestration at the age of 18 years; however, over the years this capacity has been decreasing. Net carbon uptake in apple orchards in China ranged from 14 to 32 tons and carbon storage in biomass from 230 to 475 tons, between 1990 and 2010 [32]. In another work, however, the potential carbon sequestration in 15-year-old mango (*Mangifera indica* Linn.), 12-year-old rambutan (*Nephelium lappaceum* L.), and 32-year-old santol (*Sandoricum koetjape* Merr.) in the Philippines was evaluated [33]. The results revealed that among the three plantations, the 32-year-old santol plantation had the highest value of total stored carbon with 203.62 t/ha, followed by the 15-year-old mango plantation with 122.34 t/ha, and the 12-year-old rambutan plantation with only 112.18 t/ha of stored carbon. These agrosystems behave like some forests, fixing a significant amount of carbon per ha per year, becoming relevant in climate change mitigation [33]. In the urban area of Perugia, the most frequent ornamental tree species are horse chestnut (*Aesculus hippocastanum*), holm oak (*Quercus ilex*), and lime tree (*Tilia cordata*); these are able to store an average of 2 tons of CO_2 at 30 years of age, while at 50 years of age, are able to store an average of 5 tons of CO_2 [34]. The fruit trees in the present work, stock proportionally 20% over the reference ornamentals at 30 years and 25% at 50 years. These differences are due to the fact that CO_2 uptake varies both with changing environmental conditions and with species and individual characteristics. Understanding how and to what extent the species and type of canopy conditions exchanges with the surrounding atmosphere is of great importance both for the development of productivity models and for characterizing the extent of mitigation operated by different crop areas against greenhouse gases, which are responsible for climate change.

Considering the practical benefits for citizenship, for example, urban food forestry provides a source of local food that can increase household food security and sustainability. Preserving the food security of rapidly growing urban populations is one of the greatest challenges of the 21st century [12,35–38]. The condition in which all people, at all times, have sufficient, safe, and nutritious food available to meet their dietary needs and food preferences for an active and healthy life [12] could be aggravated by climate change, transportation failures, and a host of other unexpected factors [39–41]. An urban food forest is able to make a certain amount of fruit available and accessible to every citizen. Market data available on the market intelligence with real data-driven insights (https://www.indexbox.io/store, accessed on 20 March 2021) indicate that the per capita consumption of cherries is about 2 kg/year; for figs, consumption is about 0.2 kg/year.

Based on the estimated production calculations, a *Ficus carica* tree could produce 36 kg/year in maximum production, meeting the annual consumption of figs for about 180 citizens; in contrast, *Prunus avium* with its 24 kg/year can meet the annual consumption of cherries for about 12 people.

Considering that fruit crops will be available to the citizens, special problems must be considered for soil and watershed management in urban environments and for toxic compounds that exceed thresholds (heavy metals, benzopyrene, etc.). These elements may exceed thresholds in cities, especially with active road traffic due to vehicle emissions, as well as in areas around various types of industries in large cities. Road traffic and industrial sites release heavy metals (HM) into the air, which are subsequently deposited in the soil [42]. Trees can accumulate high levels of HM, e.g., Ni have high levels in their fruits, and their consumption can have adverse effects on humans [43]. Simple symptoms such as nausea and vomiting can appear, but the fruit can also cause serious health conditions such as cancer and death [44–46]. The scientific literature explains that HM uptake occurs by foliar transfer, after the deposition of PM on leaf surfaces [47]. Foliar transfer is able to penetrate through cuticle pores, surface lesions or stomata [48,49]. In a study conducted by [50], it was determined that concentrations of Pb, Ca, Fe, Cr, Zn Cu, Ca, Ni, and Mn increased in eight plant species due to traffic density. But heavy metals were also seen to be retained differently depending on the plant characteristics [51,52]. Finally, the results of one study [53] showed that HM concentrations vary significantly not only among different species but also among different organelles of the same species. However, it is difficult to generalize, as further research and field studies are needed to explore the variability of HM accumulation and understand the mechanisms of their uptake, transfer from roots to shoots, and translocation into fruits [54]. To limit this occurrence, food forestry could be implemented in pedestrian urban areas, assuming the creation of pedestrian and green spaces for citizens, instead of streets, as is already happening in some cities in Spain. The city of Barcelona has spent years implementing a plan to take street space away from cars and return it back to pedestrians, and these are called "superilles". The purpose is to transform one-third of the streets, increasing tree cover and vegetation, limiting car traffic, creating green spaces, bicycle lanes, and favorable conditions to increase urban wellbeing [55]. The use of "superilles" is estimated to result in an average increase in life expectancy for Barcelona's adult population by nearly 200 days [56]. The creation of these spaces would greatly decrease the noise produced by cities, the urban heat island problem, and also air pollution. As a result, the fruits harvested from the trees in these areas will have a low content of toxic compounds from vehicle emissions and there will be no particular health issues for citizens.

5. Conclusions

The present study, even if realized by a theoretical point of view, may be useful for planning real models of urban greenery management that includes the use of fruit woody species. It highlights the fruit trees potential production and the economic value derived from the sale of the obtained fruits, improving the edible landscape design, and producing several benefits to the entire city community, from an environmental point of view. Moreover, the implementation of an 'Urban Food Forest' should seek to increase biodiversity in urban areas where often only ornamental species are present. The newly introduced fruit species should also increase the tolerance of the entire ecological community to extreme climatic events by enhancing the interactions between animals, plants, and citizens. For these reasons, it may be of interest to include minor fruit trees in urban areas, not only to safeguard forgotten fruit species but also because these would be able, with their genetic makeup, to develop strains that are naturally resistant to extreme weather conditions and diseases, grow quickly, and achieve good yields without resorting to the use of pesticides, being of particular interest to environmental strategies and in the context of sustainable agriculture. Another positive aspect of edible landscapes is their ability to give rise to an ecosystem and habitat that can attract animals, birds, and wildlife, and consequently improve urban biodiversity. Planting fruit trees could be of interest in the creation of ecological corridors for connecting urban and peri-urban areas. In view of all these environmental and socioeconomic evaluations, the presented survey aims to provide assessment tools for public administrations but also for private individuals, so that fruit trees compatible with the limiting conditions of the urban environment will be inserted in this particular ecosystem.

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