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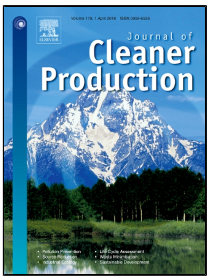

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What is the contribution of food self-provisioning for environmental sustainability? Case study of active gardeners

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Abstract

Food self-provisioning, also labelled as household food production, is a traditional activity persisting in the countries of the Global North. Recently, it has become an object of sustainability oriented research due to the positive social, health and environmental outcomes. However, little is known about the rate of self-sufficiency of the food self-provisioners and about environmental context of this kind of food production, including its actual potential for the reduction of greenhouse gas emissions. To clarify these topics, we analysed sociological data from a quantitative research study carried out in the Czech Republic in 2015. The data from 775 food growing households were used. The combined rate of self-sufficiency of the households was calculated as the share of home grown fruit, vegetables and potatoes in the overall consumption of the household. The rate of self-sufficiency (33%) was then compared with average food consumption and multiplied by the different values of greenhouse gas

emissions reduction potential of home grown food. This led to the reduction of 42–92 kg CO_2eq/person/year, which constitutes 3–5% of overall food emissions of Czech households. The research shows that positive environmental effects are not negatively counterweighted either by excessive use of industrial fertilisers or by car transportation to the gardens. Environmental motivation is unimportant for gardeners. Our findings give support to "quiet sustainability" and "sustainable materialism"; two recently advanced concepts highlighting the importance of considering everyday practices in the quest for sustainability.

Keywords

alternative food networks; carbon footprint; food self-provisioning; gardening; greenhouse gas emissions; self-sufficiency

1. Introduction

Food self-provisioning (FSP), also labelled as household or home food production, is increasingly recognised as an important form of alternative food networks (Round et al. 2010; Schupp and Sharp 2012; Smith and Jehlička 2013) which are viewed as a response to negative environmental, social and health consequences of the conventional food system. In contrast to market-based innovative forms of alternative food networks such as Community Supported Agriculture, farmer's markets and box schemes, FSP is a largely non-market and often well-established food alternative, both in the Global South and North (Alber and Kohler 2008; Kumar and Nair 2004; Schupp et al. 2015). While FSP is often considered an environmentally favourable way of food production and consumption (Taylor and Lovell 2014; Kumar and Nair 2004), less is known about the actual impact of this practice on the environment.

In general, FSP contributes to the decrease of greenhouse gas (GHG) emissions from food production (Cleveland et al. 2017), additionally, gardens also provide space for various ecosystem functions (Cameron et al. 2012). However, the research suggests that the extent of FSP impacts on the environment depend on the specific garden management method used, which in turn might have negative consequences in terms of the overuse of fertilisers or the GHG emissions generated by transportation to the garden (Dewaelheyns et al. 2013; Smith and Jehlička 2013). Furthermore, the actual decrease of GHG emissions from home grown food relates to the amount of food produced in the gardens, which may significantly vary as several studies show (Rose and Tikhomirov 1993; Sovová 2015 Smith and Jehlička 2013).

Our research, therefore, aims to fill the knowledge gap through findings gathered from a case study of Czech gardeners which focused on the analysis of the amount of produced food, on the potential of gardening for the reduction of GHG emissions and on the environmental context of garden management. This includes an inquiry into the environmental motivation of gardeners, which can be seen as important (Kortright and Wakefield 2011; Larder et al. 2014) or unimportant (Smith and Jehlička 2013), and raises the question as to what extent is the deliberate motivation of pro-environmental behaviour relevant. Conceptually, this research makes a timely contribution to the emerging literature on two concepts which discuss the role of values and motivation in such cases. These include "sustainable materialism" (Schlosberg and Coles 2016) and "quiet sustainability" (Smith and Jehlička 2013). Both terms denote a shift of focus from individualistic and consumerist, value change-based responses towards everyday practices around material and energy flows (Schlosberg and Coles 2016), strengthening positive social relations and resilience of communities while, mostly unintentionally, decreasing the human impact on the environment (Smith and Jehlička 2013). In a sharp departure from the dominant understanding of pro-environmental behaviours as emanating from post-materialist change, this new conceptualisation of these behaviours does not presuppose value change primacy.

FSP is an activity of one's own food production performed by growers who are not professional farmers. The products are most often consumed by the producers themselves but may also be shared by barter or gift (Acheson 2007; Smith and Jehlička 2013). The most common products of FSP are fruit and vegetables, followed by eggs, meat and honey. FSP may be practised in many forms, using various types of land, both in urban and rural areas: home gardens, allotment gardens, community gardens, gardens at weekend houses (cottages) and containers or roof tops (Duží et al. 2014; Kortright and Wakefield 2011; Southworth 2006).

Researchers of various specialisations advocate for FSP due to its positive consequences and strong sustainability potential. Apart from the already mentioned environmental aspects (Cameron et al. 2012; Cleveland et al. 2017), FSP is also linked to health and psychological benefits of gardening activity (Van den Berg et al. 2010; Waliczek et al. 2005; Zick et al. 2013); potential for the strengthening of resilience of the urban food system (Barthel, Parker, and Ernstson 2015; Toth, Rendall, and Reitsma 2016); solution to economic hardship (Caskie 2000, Schupp and Sharp 2012); cultural reproduction (Taylor and Lovell 2014); and capacity for resistance and empowerment of citizens (Larder et al. 2014; Taylor and Lovell 2014).

Recent research has shown that FSP is relatively common not only in the Global South but also in industrialized countries of the Global North (Brown et al. 1998; Schupp and Sharp 2012; Teitelbaum and Beckeley 2006; Vávra et al. in press).

The majority of quantitatively oriented studies of gardening are concerned with the proportion of the population that is involved in this activity rather than with the volume of food produced (Brown et al. 1998; Jehlička et al. 2013; Schupp and Sharp 2012; Teitelbaum and Beckeley 2006; Vávra et al. in press). Except for the research on the 1990s post-communist economic transformation, little is known about how much food is really produced by the gardeners (e.g. Caskie 2000; Rose and Tikhomirov 1993). One of these rare studies, carried out in the Czech Republic in 2005, shows a relatively high level of self-sufficiency (Smith and Jehlička, 2013). More recent research conducted by Sovová (2015) revealed that the amount of food produced may vary considerably even in gardens in the same site and with a similar area.

The general research question of this paper asks "How significant are the positive environmental impacts of FSP?" To answer this question, we formulated five research sub-questions focused on (1) the amount of produced food and (2) its potential for GHG emissions reduction, (3) the use of fertilisers, (4) transportation to gardens and (5) gardeners' motivations. These questions stem from the literature review and are included at the end of the sub-sections of the review. The research conducted to answer these questions was based on unique data on the amount of food production and the environmentally significant aspects of FSP of 775 food producing households from the Czech Republic obtained in 2015 through questionnaire survey. We see the added value of this paper in merging together the robust quantitative sociological dataset with the calculation of GHG emissions' reduction potential. This brings new knowledge regarding the environmental impact of FSP and relates the knowledge to current sociological and policy debates concerning the importance of environmental motivation.

The rest of the paper is structured in the following way. The literature review starts with an overview of the ecological aspects of gardening, including the potential of GHG emissions reduction. This is followed by a section on social participation in FSP and the amount of food actually produced. Later, research on two factors potentially limiting the positive environmental impacts of home gardening are presented (fertilising, transportation) and the review concludes with a brief section on the various motivations for FSP and their importance. Methods include a description of sampling, data collection and analysis. The results and discussion section assesses the rate of self-sufficiency of the food self-

provisioners, its potential for GHG emissions reduction and the environmental context of food production (fertilising, transportation, motivations). Strengths and limitation are discussed at the end of this section. The paper is concluded with the summary of the results and their embedding into contemporary theory.

2. Literature review

2.1. Environmental aspects of food self-provisioning

Food production is accompanied by serious environmental impacts caused by all parts of the process, starting from production itself, through to the processing and transportation to distribution centres and consumption. Industrial farming has severe impacts such as the overuse of pesticides and fertilisers, the dependence on fossil fuels and loss of biodiversity (Antonini and Argilés-Bosch 2017; Woods 2005). The environmental pressure of food production is also stressed by the study of US GHG emissions (Weber and Matthews 2008). The environmental importance of transportation and processing (e.g. freezing, packaging) is highlighted by the Swiss case study of Jungbluth, Tietje and Scholz (2000). Similarly, Canning et al. (2010) pointed to the increase of energy needed for food processing in the US. From the consumer's perspective, GHG emissions of the whole food chain comprise a significant part of the overall household carbon footprint. According to the summarization of Schächtele and Hertle (2007), the estimates of food related GHG emissions range between 11 and 20% of emissions of German citizens. Furthermore, research on energy relevant behaviour of households in the Czech Republic revealed GHG emissions related to food accounted for 25% of the total GHG emissions of households (Vávra and Lapka 2013), which was a higher figure than emissions generated by their car transportation or electricity use.

Given the importance of food in the overall GHG emissions of households, FSP can be viewed as a promising activity which may lower the emissions related to food. Cleveland et al. (2017) analysed the potential of home vegetable gardens for the reduction of GHG emissions of households. Their calculations considered the effects of lawn replacement, consumption of home grown vegetables instead of purchased ones, composting of organic waste, amount of organic waste exported outside households and use of grey-water. The replacement of purchased vegetables with home grown ones itself led to a decrease of 0.97 kg CO_2eq per kg of vegetables. If other effects were included, the overall GHG emissions reduction base line effect was 2.1 kg CO_2eq per kg of vegetables. However, this overall effect was very sensitive to the way in which gardens are managed (yield, composting in garden, organic waste processing outside the garden, etc.). The range of the potential reduction was

between 1.5 and 3.6 kg CO2eq per kg of vegetables.[1] Although fruit was not included in the analysis, authors argue that fruit can have a high GHG emissions reduction potential, partly due to carbon sequestration which was not considered in the case of vegetables.

The outputs of the study of Cleveland and colleagues are supported by a comparison of products of urban community organic farms and conventional agriculture in the UK done by Kulak et al. (2013). Despite there being obvious differences between home gardening and urban farming, their results show a relatively broad range of GHG emissions reduction potential of organic local production as well. All outdoor grown community farm products had a lower global warming potential than conventional farming. The reduction in GHG emissions ranged from 0.12 kg to 10.33 kg CO_2eq per kg of food depending on type of product. While carrots (0.12), potatoes (0.27) or apples (0.62) found themselves on the bottom of the range, tomatoes (1.08), lettuce (1.25) were in the middle and courgettes (2.35) and peppers (2.47) reached a higher potential. Their research also included a positive outcome for outlier beans, with 10.33 kg of CO_2 per kg of food. Kulak et al. (2013) emphasize the importance of GHG emissions from the processes of transportation and distribution (retail lighting, heating, ventilating, air conditioning) which do not apply to home gardening and make it more environmentally friendly.

Various health recommendations of fruit and vegetable daily intake summarized by Aune et al. (2017) range from 400 to 800 grams per day. Given the GHG emissions reduction potential of home grown food, hundreds of kilograms of CO_2eq could be saved by the FSP of one family. The exact amount depends on the emission decrease per 1 kg of food, amount of consumed fruit and vegetables and the rate of self-sufficiency (for further estimations see Results and discussion).

The positive aspects of FSP in gardens might be negatively balanced by various factors such as the overuse of fertilisers, use of pesticides, the introduction of invasive species, excessive water demand, and carbon emissions from garden machinery or transportation to distant plots (Cameron et al. 2012; Dewaelheyns et al. 2013; Smith and Jehlička 2013). Whether FSP is a burden or benefit for the environment ultimately depends on the type of garden management.

However, there are other positive ecological functions of gardens which defy quantification, including biodiversity promotion or species conservation (Calvet-Mir et al. 2011; Vogl and

[1] Cleveland and colleagues (2017) also mentioned possible increase in GHG emissions production from the vegetable garden if the in-garden composting effect was compared with a very efficient land-fill and energy processing of the household organic waste.

Vogl-Lukasser 2003), air cooling, water retention as well as observed positive social, health and psychological aspects (e.g. Cameron et al. 2012; Larder et al. 2014; Taylor and Lovell 2014; Van den Berg et al. 2010; Zick et al. 2013). Thus we can conclude that FSP have a strong potential for environmental sustainability. Our paper will ask to what extent is this potential used.

2.2. Food self-provisioning and the amount of food produced

So far, research on FSP prioritised the countries of the Global South; among the countries in the Global North attention was paid mostly to the countries undergoing economic transformation (e.g. post-communist countries of Central and Eastern Europe) or to the community gardens in the US and Western Europe (e.g. Clarke et al. 2000; Galhena, Freed, and Maredia 2013; Okvat and Zautra 2011; Rose and Tikhomirov 1993; Taylor and Lovell 2014). However, many recent studies have shown that FSP in its traditional way of home gardening is still common in many countries of the Global North, including Canada, the US, and countries of the European Union. About half of the population is often involved in FSP in some regions of the countries. Namely, the numbers include 48% of respondents in the Ohio case study (Schupp and Sharp 2012), 42% of the population of rural Canada (Teitelbaum and Beckeley 2006); 52% of rural and 31% of the urban population of Aberdeenshire in Scotland, 58% of rural and 32% of the urban population in the Potsdam area in Germany, but only 27% of rural and 13% of the urban population in the Assen area in the Netherlands (Vávra et al. in press). National representative surveys revealed that 43% of the inhabitants of the Czech Republic and 54% of Polish citizens (Smith and Jehlička 2013) participates in FSP.

Quantitatively oriented scholarship aimed at establishing the social profile of home food producers and concerned with their geographical distribution and socio-demographic characteristics has confirmed that the most important enabling factor of FSP is access to land which is often linked to a rural residence (but with a high share of urban population growing their food as well); other characteristics, such as age, education or income, show a relatively high variability across time and countries (e.g. Rose and Tikhomirov 1993; Schupp and Sharp 2012; Smith and Jehlička 2013; Vávra et al. in press).

The assessment of FSP's actual environmental effects needs to establish the volumes of food that is produced. Research concerned with the quantity of production was often framed in the terms of economic motivation during the post-socialist transformation, typically as a survival strategy of social groups most affected by the transformation process. Rose and Tikhomirov

(1993), in their quantitative study focused on Bulgaria, Czechoslovakia, Poland and cities in Russia, found that except for Poland, the majority of food growers produced "some" or "not very much" food. The amount of food defined as "most that is needed" was selected by a range of respondents from 14% of food growing respondents in Bulgaria to 31% in Poland. Caskie (2000) cites Russian market research stating that in 1996, 38% of all households did not produce any food or did not know, 37% of them grew less than one half of consumed food, 17% one half to ¾ and 9% of household produced more than ¾ of consumed food (p. 202). Given the fact that these data include all households, the rate of self-sufficiency is on average relatively high. More recent results from other Russian research were reported by Sharashkin (2008, 183): two thirds of food-provisioning households produce less than 40% of their food consumption, while 14% of food growing households produce more than 60% of food. Although this research is not representative for the whole Russia, it suggests a decrease in the volume of food self-provisioned.

Using the data from the European Quality of Life Survey, Alber and Kohler (2008, our reading of the figure on p. 117) show that the number of people whose self-production accounts for more than half of their food consumption is very low, being close to zero in the "old" EU-15 countries, approximately 3% in the Czech Republic, about 8% in Portugal and Poland, about 10% in Latvia and Hungary and almost 20% in Bulgaria and Romania (in terms of the share of the total population).

Some questionnaire studies focused on particular types of food. In a quantitative Russian survey, Varshavskaya et al. (n.d.) revealed than in 1998, 38% of consumed potatoes, 35% of vegetables and 13% of fruit were home grown. A large scale nationally representative Czech survey revealed that the food self-provisioners supply themselves with 68% of apples, 53% of tomatoes, 52% of carrots, 44% of potatoes and 41% of pears of their overall household consumption of these types of foods (Smith and Jehlička 2013). Again, these numbers could be interpreted as a relatively high rate of FSP.

While the above cited research was based on respondents' estimation, more precise information could be obtained by using mixed methods research. Sovová (2015), in a unique study based on a combination of the food logs, interviews and observation among allotment gardeners in Brno, Czech Republic, shows that on average 46% of fruit and vegetables consumed in the households are self-produced, based on the food logs filled in the six months of the production season (ibid.).

A space and yield oriented approach can also be undertaken. Research by Sovová (2015) shows large differences even in the gardens within the same allotment site and of the same area. It ranges between 4 kg of fruit and vegetables produced by the garden with the lowest productivity during a season and 411 kg from the most productive garden. Given the size of plots, 200–250 m^2, the average annual yield of 122 kg per garden (roughly 0.5 kg/m^2) is at the bottom margin of the range of 0.49–5.86 kg/m^2 reviewed by Sovová (2015) from previous studies on urban gardens. Such differences, of course, lead to very different consequences for the households' economies and for environmental sustainability, including the reduction of GHG emissions from food production.

The review reveals that even though home grown food is not the main source of nutrition (not even during the period of economic hardship), it still provides a not negligible part of the diet of food producers and for some types of food, the self-sufficiency rate reaches tens of per cent. Therefore, we phrased the first two research question:

Q1: What is the rate of self-sufficiency for food producing households?

The rate of self-sufficiency is then compared to the average consumption of selected types of food which makes the grounds for the formulation of the second research question:

Q2: What is the actual effect of food self-provisioning on the reduction of greenhouse gas emissions?

2.3. Fertilisers and transportation as two potentially serious impediments to the environmental benefits of gardening

As some of the more sceptical authors have pointed out, the garden management and transportation to the gardens may counterweight the positive aspects of FSP (Cameron et al 2012; Dewaelheyns et al. 2013; Smith and Jehlička 2013).

The majority of food producing gardeners report that they use only natural fertilisers (54% in the Czech Republic, 51% in Poland), followed by both natural and industrial fertilisers (28% and 19%) and only 3% and 5%, respectively, of gardeners use only industrial fertilisers. Fifteen per cent and 25% do not use any fertilisers at all (Smith and Jehlička 2013). About half of the gardeners in the Czech Republic and Poland do not use any form of industrial pesticides. This relatively environmentally friendly way of food production can be explained by the main motives of FSP, which include having fresh and healthy food (ibid.). In a Russian study by Sharashkin (2008), the majority of gardeners applied manure or compost and 39% of

them also applied industrial fertilisers. A Belgian case study revealed that compost, organic fertilisers or lime is used by over 30% of gardeners. Mineral fertilisers (industrial) are used by 25% of gardeners. Nonetheless, this research has also found higher pH and phosphorus levels than optimal agronomic standards in the soils in the gardens which indicate some negative effects of fertilisers (Dewaelheyns et al. 2013).

Regarding the fact that most of the gardens tend to be adjacent to gardeners' homes, there might be little need to travel by carbon intensive transportation. Previous research has suggested that in the Czech Republic 15%, and in Poland only 13% of respondents travel to their gardens by car or motorbike (e.g. to the allotment gardens or gardens located at the site of in their second homes) (Smith and Jehlička 2013). The rest either have a garden by the house or walk, bike and use public transport. The results from Russian studies, though, show slightly different patterns in distance to plots or time needed to travel, suggesting that the gardens are more often located in dachas (i.e. cottages) and that more public transportation or car use is needed (Rose and Tikhomirov 1993; Sharashkin 2008).

Previous research suggested that while industrial fertilisers are part of some gardeners' cultivation methods, they are not used by the majority of gardeners in any country for which these data are available. The use of natural fertilisers dominates among the gardeners. Modes of transportation are country specific and in Central Europe gardens by the houses which do not require transport prevail. Following the review on fertilisers and transportation, we raise two supplementary research questions to confirm the results of previous research:

Q3: How widespread is the use of fertilisers, and which types of fertilisers are used?

Q4: What mode of transportation is used to get to the plots by the gardeners?

The usage of the research questions and related indicators allows us to analyse the relationship between the rate of self-sufficiency and the environmental context of FSP as well as between individual indicators.

2.4. Pro-environmental motivation of gardeners

The motivations for FSP have been the subject of a long-lasting debate. While some authors argue for the importance of economic motivations and food security (Alber and Kohler 2008; Conill et al. 2012; Rose and Tikhomirov 1993; Schupp and Sharp 2012), other stress the importance of the taste and health aspects of self-produced food, lifestyle or cultural context (Brown et al. 1998; Clarke et al. 2000; Smith and Jehlička 2013; Taylor and Lovell 2014).

Some qualitative case studies show that environmental motivation is apparent (Kortright and Wakefield 2011; Larder et al. 2014). A quantitative study by Schupp and Sharp (2012) also links FSP with another environmentally friendly behaviours. Other research points to a lack of the environmental motives and supports the interpretation of FSP as unintentional sustainability (Smith and Jehlička 2013).

Because of the high level of disagreement about the role of environmental motives for FSP, the last objective of our research is to ascertain the extent of environmental motives in the context of relatively affluent Central European society in the mid-2010s:

Q5: Is environmental motivation important for the food self-provisioners?

We find this question important not only from the theoretical point of view but also for practical reasons. If FSP has significant positive environmental consequences, its promotion and support should reflect gardeners' motivation, which may not at all be linked with their environmental awareness.

3. Methods

The main source of quantitative data used in this article was a large-scale nationwide survey, conducted in the Czech Republic in 2015. The survey was carried out within a larger piece of research of alternative economic practices and initiatives, and it covered a variety of economic practices including food growing, processing and sharing. Respondents were chosen thorough quota sampling with the following quotas: gender, age, level of education, population size of municipality, and region of residence. The sample of respondents is representative for the Czech population aged 18 and over, with professional farmers excluded. Questionnaires were filled in by professional interviewers from an opinion poll company during face-to-face interviews with respondents.

In two rounds of the survey, first in April-May 2015 and second in June 2015, a total of 2,058 respondents were interviewed. Thirty-six identical questions focused on FSP and other aspects of household informal economy were included in both rounds of the survey, plus additional questions on the socio-demographic structure of the sample population. Moreover, two questions used in our analysis (use of fertilisers and transportation to the garden) were added in the second round. Data were analysed by the IBM SPSS statistical package using Pearson's correlation, t-test and Brown-Forsythe one-way ANOVA.

From the total number of 2,058 respondents, 818 reported (40%) that their household owned or used some type of agricultural land which could be used for food production (it was defined as "a garden, field or an orchard"). Respondents were asked how much food consumed in their household was produced by themselves. The list included the following six types of food: vegetables, fruit, potatoes, meat, eggs and honey.

Technically, the combined rate of self-sufficiency is the average value of three individual indicators: the percentage of household consumption met by self-provisioning (i.e. self-sufficiency rate) in the case of vegetables, fruit, and potatoes. These three types of food were selected as they are easier to produce than, for example, meat and are also more often consumed. Consequently, 43 respondents with the combined rate of self-sufficiency value of 0% were excluded from the subgroup of active gardeners. This resulted in a sample of 775 responding households (38% of the total sample population), which is used as a sample population in the following analysis. These are the households that produce at least some of their own food consumption (represented in our research by vegetables, fruit and potatoes) and which can be labelled "active gardeners".

Comparison of the socio-demographic structure of the sample with the Czech population reveals that active gardeners slightly differ from the general population. The sample of active gardeners is slightly older with lower education levels (mutually correlated characteristics) and living more often in smaller municipalities (with easier access to land). See Table 1 for further details. Previous research from the Czech Republic confirms that gardeners tend to be in average older than the rest of population and live in smaller municipalities, however, the effect of education varied among the studies (Jehlička et al. 2013; Vávra et al. in press).

Table 1 Comparison of active gardeners and total population of the Czech Republic

	Characteristic	Active gardeners (%)	Total population (%)
Age	**<35**	21.9	27.6
	35–54	34.3	35.3
	>54	43.7	37.2
Education	**Primary**	15.2	6.6
	Lower secondary	35.1	36.2
	Higher secondary	34.3	34.9
	Tertiary	15.4	22.2
Municipality size (inhabitants)	**<5 000**	51.9	38.9
	≥5000	48.1	61.1

Note: The share of the given age category in total population aged 18+ years is presented. The education of total population shows the share of population aged 25–64 years.
Source: Czech Statistical Office (n.d.; 2016a).

Apart from the combined rate of self-sufficiency, we focus on three environmentally relevant questions. First of all, the use of fertilisers was split into categories of no fertilisers, only organic fertilisers, both organic and industrial fertilisers, and industrial only. The second question inquired about the mode of transportation to the garden (no transport – garden at the house, car or motorbike, walk, bike, or public transport). Thirdly, to ascertain the motivations for FSP, respondents were asked to choose three from the list of nine motives and to rank them according to their perceived significance. The respondents who selected their environmental motivation among the top three motives (i.e. those who prioritized the answer "By growing food, I can contribute to environmental protection") are considered as environmentally motivated active gardeners in our analysis."[2]

4. Results and discussion

4.1. Share of food self-provisioning

The rate of self-sufficiency of Czech active gardeners, measured as a percentage of yearly overall household consumption, is 35.6% of vegetables, 33.5% of fruit and 28.4% of potatoes. The average combined rate of self-sufficiency (mean of these three types of food) is 32.5 % of overall household consumption. These findings suggest that FSP is still an important source of food for the gardeners. It is in accordance with previous research from the Czech Republic (Smith and Jehlička 2013; Sovová 2015). Unfortunately, results from our research cannot be easily compared to some of the previous studies on the rate of self-sufficiency (e.g. Caskie 2000; Rose and Tikhmirov 1993; Sharashkin 2008) due to different outputs: overall share in per cents vs. segmentation of households.

According to the Household Budget Survey realized yearly by the Czech Statistical Office, the amount of food directly consumed in the household (excluding restaurants, canteens, etc.) was 46.6 kg/person/year of vegetables (without potatoes), 44.6 kg of temperate zone fruit and 43.1 kg of potatoes in 2015 (Czech Statistical Office [CSO] 2016b). The average consumption

[2] The other eight options included: application of knowledge/know-how; hobby; family tradition; obtaining food not available in the market; healthy food; financial savings; family obligation (help to relatives); and fresh food.

is 134.3 kg/person/year or 368 g/person/day. Given the average consumption of 134.3 kg/person/year, and the 32.5% of combined rate of self-sufficiency, which resulted from our sample survey, the amount of food produced by active gardeners is calculated at 43.6 kg/person/year.

4.2. Potential for greenhouse gas emissions reduction

To assess the GHG emissions reduction potential of FSP, we use two coefficients defined by Cleveland et al. (2017). The conservative conversion coefficient 0.97 kg CO_2eq per kg of food is based only on the effect of replacement of purchased food by home grown food. The higher conversion coefficient of 2.1 kg CO_2eq per kg of food includes other effects of FSP, such as lawn replacement, composting, reduction of organic waste exported outside the household and use of grey-water. Cleveland et al. suggest an even higher GHG emissions reduction potential (3.6 kg CO_2eq per kg of food), however, we do not use it due to the lack of information necessary to analyse the effect of garden management. The average GHG emissions reduction then ranges from 42.3 kg to 91.6 kg CO_2eq/person/year (conservative or optimistic estimation).

Such an amount of GHG emissions is in the range between 2.5% and 5.4% of average Czech food emissions, which is 1,69 tonnes CO_2eq/person/year (Vávra and Lapka 2013). When compared to the overall household emissions of 6,68 tons of CO_2 (ibid.), or even to the total emission of the country which makes 11,6 tons of CO_2eq/person/year (Ministry of the Environment of the Czech Republic 2017), the GHG emissions reduction potential of household food production is relatively low. The food production of Czech active gardeners saves 0.6–1.4% of the total emissions of the households but only 0.4–0.8% of the country's total emissions.

The results of the Czech case study can be scaled-up to the international level on examples of Europe and the US. The average combined European household consumption of vegetables, fruit and potatoes, based on a dietary survey from 16 countries, is 505 g/person/day or 184.3 kg/person/year (Elmadfa 2009). If the self-sufficiency rate of the Czech active gardeners is then applied to European consumption, the mitigation potential would be 58.1–125.8 kg CO_2eq/person/year. Another international comparison could be applied to US data.

The average food emissions of US households are 8.1 tonnes CO_2eq/person/year and average size of household is 2.6 person (Lofquist et al. 2012; Weber and Matthews 2008). Thus the average GHG emissions of food are 3.1 tonnes CO_2eq/person/year. If the combined rate of

Czech active gardeners' self-sufficiency and the average European home consumption of fruit and vegetables (505 g/person/day) is applied to the US case, the reduction would lead to 1.9–4.1% of overall food GHG emissions.

Although the GHG emissions reduction potential of FSP may be seen as relatively low, their positive contribution could be compared to many actions which are often suggested for GHG emissions reduction in households, such as having an efficient water heater, lowering apartment heating temperature or changing driving style (Dietz et al. 2009). Focusing only on the food GHG emissions, we argue that the potential decrease in the range of 42–92 kg CO_2eq/person/year is not a negligible contribution to the sustainability of food systems. Moreover, further findings suggest that this emission saving is not compensated by an increase in emissions from transportation nor from excessive use of industrial fertilisers.

4.3. Environmental context of food self-provisioning: use of fertilisers, transportation and motivation of active gardeners

Compared to modern agriculture, where the use of industrial fertilisers is almost universal, the food growing households are much more modest in the application of industrially produced fertilisers. Seventeen per cent of active gardeners from the Czech survey do not use any fertilisers, 44% use only organic fertilisers such as compost or manure while 33% use both organic and industrial, and only 6% rely solely on industrial fertilisers. Such results are in accordance with previous research on fertilisers use among Czech self-provisioners (cf. Smith and Jehlička 2013) and also correspond with the results of research from Russia (Sharashkin 2008) or Belgium (Dewaelheyns 2013). We can argue that from the viewpoint of fertilising, Czech gardeners manage their gardens in a relatively environmentally friendly way.

Most (64%) of active gardeners do not need any transportation to get to their gardens because the gardens are adjacent to their homes, and another 11% of gardeners walk. Only 25% of active gardeners use any vehicle: 5% ride a bike, 2% use public transport and only 18% use a car or motorcycle. Similarly, as in the previous research in the Czech Republic and Poland (Smith and Jehlička 2013), cars or motorbikes are used by only a small share of respondents, which implies low GHG emissions from transportation to the plots in general.

The most important reasons for gardening, as declared by active gardeners, is the obtaining of fresh food (mentioned among the top three motives by 77% of respondents) and of healthy food (69% of respondents). Environmental motivation is, in the perception of active gardeners, the least important reason for home production of food, with only 7% of

respondents mentioning environmental protection among the top three motives. Research by Jehlička et al. (2013) revealed similar results with only 6% of respondents mentioning environmental protection among the top three motivations (the second least preferred option). This supports the interpretation of FSP as "quiet sustainability", which unintentionally leads to environmentally positive outcomes (Smith and Jehlička 2013). This contrasts with the results of qualitative studies from Australia (Larder et al. 2014) or Canada (Kortright and Wakefield 2011) which suggest that environmental motivation is more important for the gardeners.

The results suggest that the positive environmental impact of FSP is not negatively counterweight by the use of fertilisers or the use of gas engines for transportation. The next step in the analysis was to examine the relationship of the variables (combined rate of self-sufficiency, use of fertilisers, transportation mode and motivation) to find out how the environmental context influences self-sufficiency. For the purpose of this analysis, dummy variables were created from the following indicators: fertilisers use (0 = no fertilisers or natural only; 1 = natural and industrial, and industrial only); mode of transportation to garden (0 = public transport, walk, bike, other or no transport; 1 = car or motorbike). Environmental motivation already has a dummy variable (0 = environmental motivation not important; 1 = important).

Table 2 shows the results of the correlation analysis of the combined rate of food self-sufficiency and the three indicators. The analysis proved that the variables are independent, without any significant relationships among them, with the exception that the gardeners with higher environmental motivation produce less food. This is confirmed by the mean production of the two groups: a 26.3% combined rate of self-sufficiency of environmentally motivated gardeners compared to a 33.0% rate for those without this motivation ($t_{(773)} = 2.047$; $p = .041$). This could be interpreted as an interesting paradox supporting the hypotheses about the unintentional "quiet" sustainability of the majority of gardeners as argued by Smith and Jehlička (2013). It is not just that environmental motivation is unimportant to the gardeners as a group, but that those gardeners who explicitly find the environmental motivation unimportant, tend to produce more food and generate greater savings of GHG emissions. Our findings are equally significant for and supportive of the recently advanced thesis about the shift away from a reliance on individual action underpinned by the post-materialist value change as a basis for sustainable behaviour and towards everyday "sustainable materialism" (Schlosberg and Coles 2016). Everyday practices such as those at the centre of this paper –

informal food production, distribution and consumption – are an example of material flows which "embody alternatives rather than just support values, policies, or candidates" (Schlosberg and Coles 2016: 178).

Table 2 Correlation of surveyed indicators

Indicators	Self-sufficiency	Industrial fertilisers	Car transportation	Environmental motivation
Self-sufficiency	1	-.004	-.094	-.073*
Industrial fertilisers		1	.036	-.067
Car transportation			1	-.057
Environmental motivation				1

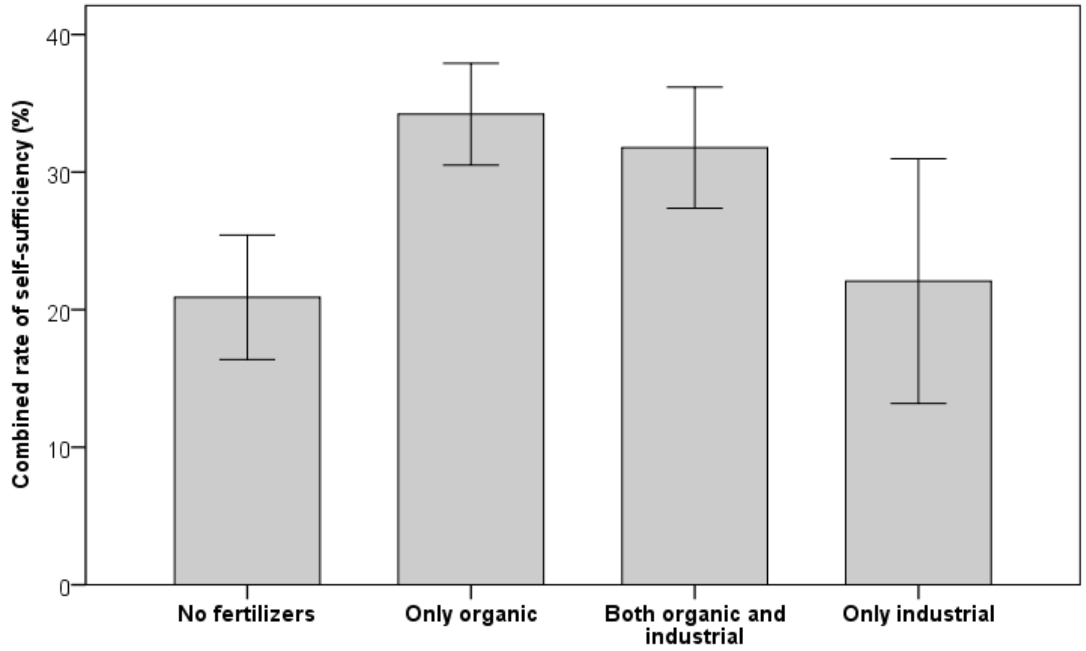
Note: Pearson's correlations. For Self-sufficiency and Environmental motivation N = 775; for Industrial fertilisers and Car transportation N = 378. * $p < .05$.

Source: Own processing.

There is also an insignificant negative correlation ($r = -.094$; $p = .067$) between the use of a car or motorbike as a mode of transportation to gardens and the lower self-sufficiency. This suggests that gardens closer to homes have a higher production and this is not negatively balanced by the emissions from transportation. The detailed classification of data has confirmed the hypothesis that respondents who use a car or motorcycle as a means of transport have their gardens located at their second homes in most cases (53% of car users). In the Czech context, the second homes are not typical sites of food production, compared to gardens closer to residential housing or allotment gardens.

Detailed analysis of the use of fertilisers and the combined rate of self-sufficiency shows that there are differences between the four categories (see Fig. 1). The ANOVA results prove that the overall differences are statistically significant, Brown-Forsythe $F = 7.1557$; $p = .000$. The proportion of self-provisioned food in the total food consumption of the group of gardeners which uses no fertilisers (21%) is lower than the rate of self-sufficiency of those gardeners who uses only natural (34%) or both natural and industrial fertilisers (32%). The group of merely industrial fertiliser users is very small and their average level of self-sufficiency is the second lowest (22%). This group also shows the highest standard error of the mean due to a high variance and the low number of respondents.

Figure 1 Combined rate of self-sufficiency and use of fertilisers



Note: N = 378. Error bars show 95% confidence interval.

Source: Own processing.

If we break down the combined indicators into three types of food: fruit, vegetables and potatoes, the effect of the use of fertilisers is significant for vegetables and potatoes but not for fruit, which is expectable because of the low need of fertilising in fruit growing (see Tab. 3). In the cases of both vegetables and potatoes, gardeners who use only organic fertilisers have the highest rate of self-sufficiency followed by the users of organic as well as industrial fertilisers. The group of users of only industrial fertilisers and no fertilisers at all is characterized by a lower self-sufficiency rate. These results suggest that it is possible to produce a considerable proportion of food without using industrial fertilisers.

Table 3 Self-sufficiency rates related to types of fertilisers use

Use of fertilisers	N	Rates of self-sufficiency		
		Fruits (%)	Vegetables (%)	Potatoes (%)
No fertilisers	64	26.7	24.4	11.6
Only organic fertilisers	167	34.4	39.7	28.3
Both organic and industrial fertilisers	125	33.5	34.5	27.4
Only industrial fertilisers	22	28.0	22.6	15.7

Total	378	32.4	34.7	24.5
Brown Forsythe F		1.819	7.461	4.928
ANOVA p		.146	.000	.001

Source: Own processing.

It might have been expected that the gardeners with a stronger environmental motivation would use industrial fertilisers less. Correlation analysis has not proved this although there is a non-significant trend (r = -.067; p = .195). However, this is not surprising if we take the complexity of gardeners' perception of the environment and nature into account. Sovová (2015) illustrates this in her case study: "The respondents were generally open to ecological alternatives of garden management, but still regarded the use of agrochemicals as a necessity" (p. 20). Gardeners in her study tend to use natural fertilisers more than industrial, but as Sovová puts it: "When choosing between artificial and natural remedies, efficiency and sanitariness were the most important to consider, whereas environmental concerns were hardly mentioned" (ibid.).

Within this paper we focused on the environmental context of FSP, however, economic and health aspects are also important. Although for most respondents the motivation for FSP was not primarily economic, the importance of financial savings achieved by the consumption of garden produce of fruit and vegetables should not be entirely discounted.[3] The magnitude of potential financial savings achieved by FSP is highlighted by recent claims about significant positive health impacts associated with the increased daily consumption of ten portions (i.e. 800 g) of fruit and vegetables as compared to the current recommendation of five portions a day (400 g; Aune et al. 2017). The expected associated health gains include reduced risk of heart disease, stroke and of cardiovascular disease. However, this fruit and vegetable rich diet may be unaffordable for many families. For example, in the UK, a weekly intake of this amount of fruit and vegetables by a family of four would cost, if purchased in mainstream supermarkets, between 52.64 and 60.48 pounds (Cushing 2017). Given the estimated median household net weekly income of 460 pounds, for many families with children this level of consumption of fruit and vegetables is unaffordable.

4.4. Strengths and limitations of the research

[3] It should be said, though, that there might be some rebound effect in the financial savings due to the cost of FSP (seeds, equipment, or rent of the gardening area).

Our research provides a unique insight into the rate of self-sufficiency of Czech active gardeners using the data gathered in a representative survey. Moreover, our large dataset allows us to state some solid conclusions and show the environmental context of FSP. The selection of the Czech Republic as a case study also allows us to compare the results with previous research from this country and other European countries. This helps to validate the new results and put them into the context of research on FSP.

However, our study also has some limitations given by the quantitative nature of the research and accessible data. We relied on respondents self-reporting; any form of consumer diaries would not be possible in such a large sample. The emission reduction potential has very high variance caused by the differences in garden management (Cleveland et al. 2017). Due to the nature of a large quantitative study, it was not possible to gather detailed information on garden management, thus we provide a range of reduction potential, rather than an exact number. Yet, another aspect of FSP suggests that the emission reduction potential is important. We focused only on the food produced and consumed in a household but an additional proportion of food is obtained as a gift or exchanged by all Czech households regardless of whether they produce food by themselves or not. The share of given or exchanged food is 5% of vegetables, 7% of fruits and 6% of potatoes (see Jehlička and Daněk 2017). This food is also home grown and has positive environmental consequences. As we did not include the other types of self-produced food into our analysis (eggs, meat, etc.), these could also slightly increase the emission saving potential though they are produced and consumed less often than vegetables, fruit and potatoes. Therefore, our calculation of the GHG emissions reduction potential of FSP should be viewed as a conservative estimation.

5. Conclusions

This research confirmed that FSP, a social practice until recently neglected in terms of its contribution to sustainability, harbours a significant sustainability potential. Using sociological survey data, our research shows that the population of active gardeners in the Czech Republic, which makes up 38% of the total population, produces significant volumes of certain types of food: 36% of vegetables, 34% of fruits and 28% of potatoes consumed in their households. The informal food system, under which active gardeners produce, consume and share their products, is geographically very localised, creating short circuits of food and energy flows. As a consequence, compared to conventionally produced food, this mode of food provisioning contributes to savings of GHG emissions of between 42 and 92 kg of

CO_2eq/person/year. This amount constitutes 2.5–5.4% of food related GHG emissions, which makes up 0.4–0.8% of the overall country's emission (the range depends on the inclusion of the effect of garden management). What is important is that localized production is not negatively counterweighted by either the excessive use of industrial fertilisers or by the use of cars for transportation to the gardens. In accordance with previous research in the Czech Republic, but in contrast to several qualitative studies, the absolute majority of active gardeners in our sample do not put environmental protection high on their list of motivations. On the contrary, the environmental motivation was the least important for them. Those – very few – gardeners who prioritise the environmental tend to produce less food than the gardeners without this motivation.

We therefore argue that our findings provided support for recent claims about the need to extend the quest for sustainability beyond strategies reliant on post-materialist value change that is, in turn, reflected in pro-environmental consumerist behaviour. "Quiet sustainability", or everyday practices of material and energy flows such as FSP, which in most cases are not motivated environmentally, can be as valuable – and often more so – in terms of their contribution to sustainability, as value-driven, post-materialist environmentally motivated consumerist behaviours.

From the policy perspective, the lack of a connection between FSP and environmental motivation suggests that policy makers do not need to stress the pro-environmental consequences of FSP.I Instead, they should promote opportunities for citizens to participate in FSP. This applies especially to allotment gardens which are often rented rather than owned by the gardeners. The allotments tend to be under a lot of pressure from the developers and city councils who perceive allotment gardening as an old-fashioned custom which does not suit modern cities. However, the opposite is true, gardens and FSP are important parts of the urban food system and active gardeners contribute to its overall sustainability.

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Highlights

- Active gardeners show high combined rate of self-sufficiency: 36% of consumed vegetables, 34% of fruit and 28% of potatoes is produced by themselves.
- The amount of self-provisioned food makes up to 92 kg CO_2eq/person/year, which makes up to 5.4% of household food related greenhouse gas emissions.
- Most often active gardeners use only natural fertilisers and do not need to travel to their gardens by cars.
- Contribution to environmental protection is not at all important as motivation for food self-provisioning. Though, the active gardeners contribute to reduction of greenhouse gas emissions.