Developing a tool to evaluate the sustainability of intra-urban farms

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Abstract: *An increasing urbanisation is now followed by a developing growth of urban agriculture supported by political frameworks in France. Urban agriculture projects have an exponential development with very diversified technical and business models from low to high tech, purely productive to multifunctional. This type of agriculture aims at sensitizing citizens to agriculture, link city-dwellers to the countryside and claims to participate to the sustainable development of cities. However, the current models established to evaluate farm sustainability are not adapted to the intra-urban context. Our goal is to build a tool to evaluate the sustainability of intra-urban farms, with two purposes: 1/ to provide a tool for project leaders allowing them to assess the strengths and weaknesses of their project; 2/ to produce a tool destined to enable surface providers to compare answers to their call for projects. A participatory approach was chosen to build this tool. A first panel meeting determined the objectives of this tool and a list of criteria for the agro-environmental, socio-territorial and economic dimensions. These objectives and criteria were then submitted to the approval of urban farmers and surface provider via an online survey. In parallel, an adaptation of existing environmental indicators is under way as well as a search for adapted sociological and economic indicators. Some indicators have been identified in the literature and shall be submitted to a large panel of urban farmers and surface provider to evaluate their pertinence and feasibility.*

Keywords: *Urban agriculture, sustainability, evaluation, tool design, participatory research.*

Introduction

Today, the urbanisation is still growing and the FAO forecasts that 70% of the world population will live in cities by 2050 (FAO, 2009). This urbanisation is done on a growing surface, mainly on fertile agricultural lands since cities developed near them. The best lands are also mainly those disappearing. Today, for example, only cereals and horticulture can be found around Paris (Agreste, 2016). In other cities, grapevines can also be found since its added value is high enough to ensure its survival (Agreste, 2017). This entails supply problems. For example, the mean food supply distance of Paris is 660 km and its autonomy for fruits and vegetables is only 60% (Mairie de Paris, 2016).

At the same time, a locavore movement is developing, especially in the northern countries. Consumers also look for a „naturalness“ of produces and a limited number of intermediaries. These movements support the (re)development of urban agriculture as defined by (Mougeot, 2000): An industry located within (intra-urban) or on the fringe (peri-urban) of a town, a city or a metropolis, which grows and raises, processes and distributes a diversity of food and non-food products, (re-) using largely human and material resources, products and services found in and around that urban area, and in turn supplying human and material resources, products and services largely to that urban area.

To this social framework, a favourable political framework is added that aims to support urban agriculture in several French cities. For instance Lyon has an urban agriculture house (www.mau-lyon.fr). In Bordeaux, local representatives have declared to be ready to support urban agriculture (Fronzes, 2017). In Albi, it is a willingness to be a self-sufficiency city in 2020 (Herbillon, 2015), and in Paris the city council roadmap of September 2014 (Mairie de Paris, 2014) promised to have 33 ha of productive agriculture on the walls and roofs by the 2020 deadline. The support of all these stakeholders has led to an exponential development

of intra-urban agriculture in France, with diversified technical and business models from low to high-tech projects, from associations to entrepreneurship and from purely productive to pluri-objectives (Daniel, 2013).

There are several benefits that political stakeholders expect from the development of urban agriculture. Those benefits include the services urban agriculture can provide to the city, such as biodiversity (Madre *et al.*, 2014), food and social links (Pourias, 2014), waste recycling (Grard, 2013), climate change mitigation (Lin *et al.*, 2015). Other arguments have also been put forward, such as employment, circular economy and education (Ville de Romainville, 2017).

Project leaders on the other hand, claim that urban agriculture projects are sustainable, with an emphasis on one or several of the three sustainability pillars (environmental, social, and economic). To support this assertion, urban farmers need tools to evaluate this aspect of their projects.

Tools evaluating sustainability already exist for farms and agricultural production systems at different scales but none exists for urban farming at the farm scale.

A study by Daniel and collaborators tried to apply existing tools or at least part of them to urban farms in the Paris region, (Daniel, 2017). In a previous study (Fargue-Lelièvre and Daniel, 2015), we extracted indicators to evaluate sustainability of farming systems at the farm scale from existing grids. The tools used were IDEA (Zahm et al., 2007), FADEAR (2013), IBEA (2013) and Masc 2.0 (Craheix et al., 2012). Some indicators were identified as being potentially useful for urban agriculture and were used in a yearlong survey of 6 urban farms (Daniel, 2017). However, others were not applicable to urban farms and some dimensions needed to be expanded, especially in the economic and social dimensions for specific constraints and opportunities in urban context. We established a first tool with 15 criteria, each linked to an indicator, which could be measured in an urban farm. However this tool was mainly useful to study the functioning of the farm and not its sustainability as such.

For the social dimension, which is very important in urban agriculture, a previous study by (Chen and Holden, 2017) has shown that the social life cycle assessment is not adapted to the farm level with only 3 indicators out of 19 directly scaled for the farm level.

Looking at those results, we decided to create a whole new tool, relevant both for urban farmer and surface providers. Constructing a whole new tool would insure internal coherence. This new tool aims to be an auto-evaluation tool for farmers to help them identify their strong points and weaknesses and to make rational strategic choices. For surface providers, this tool would be used as a mean to compare the different projects when they make calls for bids for new surfaces.

The indicators identified in our 2015 study could be integrated in the new tool, provided they are deemed pertinent by stakeholders.

Materials and Methods

The development of a sustainability evaluation tool has been theorized by (Lairez et al., 2015). It is divided in three steps: the specifications definition, the definition of the conceptual frame and methodology and lastly choosing results representation. The definition of the conceptual frame and methodology can be broken down in four steps. The first step is the definition of the objectives of the tool and the vision of sustainability defining the tool. The sustainability criteria are determined by these objectives and explicitly described. The second step is the choice of indicators to measure these criteria. The third phase is defining the parameters of interpretation (reference values and transformation methods) and the aggregation method (ponderation, compensation). The fourth and last step is the test of the method on real cases to evaluate its pertinence, reliability and sensitivity.

We chose to use a participatory approach: the first phase is done with the stakeholders, as well as the validation of the indicators, whereas the third step will need to be done in

collaboration with experts. The last step, consisting of testing the tool prototype, will be done on real urban farms and will rely on a participative, reflexive, evaluation.

The first step was done with a panel of 5 scientific experts, 2 urban farmers and 1 town representative. The result of this work was the identification of the objectives of the tool for stakeholders and a list of criteria to evaluate the sustainability of urban farms.

These 2 lists were submitted to a larger group of stakeholders via an online survey. Invitations to answer this survey were sent via urban agriculture groups including the French Professional Urban Agriculture Association (AFAUP) and through email contacts, using a snowball approach. 28 answers were collected between September and December 2017.

The choice of indicators to measure these criteria is more difficult. A previous work on urban farms (Daniel, 2017) has shown that some measurements may be difficult. For example, most urban farms use compost from city waste and do not know either the composition or sometimes even the quantity used. On the social and economic side, volunteers are also a frequently used workforce, which is quite different from rural and peri-urban farming systems.

To identify pertinent indicators, we decided to use an approach resembling the systematic reviews to search for them in other fields.

A literature review was performed using the following protocol:

- A Google search on sustainability indicators in urban agriculture, complemented by a local search through colleagues, for reports in French or English on urban agriculture sustainability, which identified 15 reports of more than 20 cities in northern and southern countries.
- A search on the Web of Science on the 20th of November 2017 using the combined keywords “sustainability” and “indicators”. Since we were trying to find other sources of indicators not necessarily related to agriculture we chose to do a very broad search and then select within this potential. We limited this search to the years 2013 to 2017 due to the large number of results, and restricted it to articles, proceedings and reviews. This search brought 5238 articles. All titles and keywords for each article were read and only those deemed pertinent were kept. We looked particularly for the following themes: agriculture, urban, social, economic, small scale, methodologies, and participatory approach. 295 articles were selected at the end of this step. All abstracts were read. After this step, 67 articles and 1 book were selected. 55 full papers were available. After reading these articles, a snowball method directed us to other pertinent work (20 new articles at the time).

Survey results and analysis

The panel meeting lead to the definition of seven objectives for urban agriculture and 30 criteria related to 3 dimensions (agro-environmental, socio-territorial and economic). The goal of the survey was to validate the importance of objectives and criteria identified for stakeholders.

The seven objectives identified by the panel were the following:

1. Minimize impacts/maximize services of the farm to the city (water, soil, biodiversity, air, heat, waste)
2. Valorise the link to city and contribute to urban metabolism (build integrated systems energy, workforce, fertilization, trade)
3. Have economic meaning (adapting to stakeholders, meaningful value redistribution)
4. Contribute to environmental and food education
5. Contribute to consumer/producer connection
6. Maximize socio-territorial service to the city (recovery of space by the inhabitants)

7. Maximize socio-territorial service to the city (landscape)

An in-depth analysis of the survey will be done during spring 2018 but a preliminary analysis of the data shows interesting results.

We obtained 29 answers: 17 from urban farmers, five from city representative, one from a landlord and six from other stakeholders (French environment and energy agency – Ademe-, 3 urban agriculture expertise agencies and one researcher). The relatively small number of answers has to be put in perspective in the French urban agriculture field. Despite an exponential growth, urban agriculture remains a small sector in France and counts 50-60 members only to the French professional urban farmers association (AFAUP). A first sample analysis showed the diversity of the french sector (Tables 1a, b and c).

Table 1. Sample analysis: 1a. Production methods of urban farmers. Some farms are on several sites with different production methods, 1b: Total area cropped in the urban agricultural project, 1c: Size of the cities where the urban agricultural projects are situated.

1a: Production methods

Production methods	Open ground and open air	Containers (ground or roof)	Greenhouses (Open ground or containers)	Hydroponics (ground or roof)	Beds on a roof
Number of projects	9	9	4	4	1

1b: Total area cropped

Areas cropped	<100m²	100-500m²	500-1000m²	>1000m²
Number of projects	1	3	5	9

1c: Size of cities

Number of inhabitants	<25 000	25 000-100 000	>100 000
Number of projects	1	3	9

The surveyed stakeholders were asked whether the objectives defined for the tool seemed important, secondary or useless to them (Table 2). All objectives seemed important to most of them, especially that of minimizing impacts and maximizing service to the city and environmental and food education. These objectives are frequently claimed by urban projects when they answer call for bids. Landscape services seemed to be less important to the surveyed but still necessary to take into account in the tool. At the panel meeting defining objectives, they were suggested by the city representative and since most of the answers in the survey were given by urban farmers this could explain this slight difference.

The answers to the survey led us to conclude that our tool should be based on these objectives, with potential rephrasing.

Three other objectives were suggested by one person (therapeutic, city resilience, bringing urban consumers and rural producers closer) and one was suggested by two persons (food production, which is not always the stated mission of an urban farm).

Table 2. Evaluation of the importance of each objective for the tool (number of answers out of 28 total answers).

Objective	Important	Secondary	Useless
Minimize impacts/maximize service to city	25	3	
Urban metabolism and link to city	16	11	1
Economic meaning	19	7	2
Environmental and food education	26	2	
Consumer/Producer connection	20	7	1
Recovery of space	18	10	
Landscape	11	16	1

The same question was asked about the 30 criteria. Each criterion was to be assessed qualitatively as to its pertinence on a scale from 0 to 5, 0 meaning the criterion was not pertinent and 5 that the criterion was particularly important (Tables 2 to 4). We called positive evaluation the sum of grade three to five and negative evaluation the sum of grades zero to two.

Table 2. Importance of Agro-environmental criteria (number of answers out of 28 total answers per criterion).

Criteria	0	1	2	3	4	5
Environmental footprint	1	0	1	4	7	15
Biodiversity (cropped)	0	1	7	5	8	7
Biodiversity (wild)	1	3	7	8	6	3
Process optimization	1	4	7	5	6	5
Process sobriety	1	1	3	5	10	8
Resources consumption	0	1	2	2	11	12
Resources economy	0	0	1	3	13	11
Resources recycling	0	0	2	3	16	7
Planning and environmental consideration	0	0	3	3	6	16

The criteria were not all deemed pertinent for all surveyed. For the agro-environmental dimension, the environmental footprint, resources consumption/economy/recycling and environmental considerations were the most pertinent criteria 26, 25, 27, 26 and 25 positive evaluations respectively). However biodiversity and process optimization did not seem as pertinent to the surveyed (8, 11 and 12 negative evaluations respectively). This is surprising since biodiversity is a criteria present in all sustainability evaluation tools of farms including an environmental dimension.

Table 3. Importance of socio-territorial criteria (number of answers out of 28 total answers per criterion).

Criteria	0	1	2	3	4	5
Local partners	0	4	2	3	12	7
Link to local network	0	3	2	3	8	12
Link to inhabitants	0	1	2	3	10	12
Suppliers policy	4	2	6	9	6	1
Participation to governance	1	4	1	13	6	3
Knowledge sharing and education	0	2	3	7	7	9
Working conditions	0	1	1	9	7	10
Management and internal dialog	2	1	3	8	9	5
Risk management, health and security	2	2	4	8	6	6
Governance transparency	3	3	2	7	9	4
Planning and urban uses	2	1	4	8	7	6
Recovery of space use by inhabitants	2	1	7	8	6	4
Landscape impact	0	5	6	4	7	6

For the socio-territorial dimension, local partners, link to local network and inhabitants, education and working conditions are the most important criteria (22, 23, 25, 23 and 26 positive answers respectively). More criteria however seemed less important than for the agro-environmental dimension. Suppliers' policy, recovery of space use by inhabitants and

landscape impacts did not seem pertinent (12, 10 and 11 negative evaluations respectively). The last criterion is related to the last objective which was also evaluated as less pertinent.

Table 4. Importance of Economic criteria (number of answers out of 28 total answers per criterion).

Criteria	0	1	2	3	4	5
Redistribution to employees	1	3	5	7	8	4
Redistribution to other stakeholders	2	3	5	9	6	3
Quality and labels	1	3	7	8	6	3
Contribution to local development	0	1	1	5	12	9
Produce value	1	2	2	5	11	7
Revenue repartition	1	3	3	6	11	4
Subsidies and funding	4	3	5	4	8	4
Transferability of farm	4	2	1	6	9	6

For the economic dimension, contribution to local development, produce value and transferability of farm had the highest marks (26, 23 and 21 positive answers respectively but with the most answers with a grade five). Redistribution to other stakeholders, quality and labels and subsidies and funding were evaluated as less pertinent (10, 11 and 12 negative answers respectively). The last might be an effect of incomprehension of whether high subsidies and funding would be “good” or “bad”.

In the survey, free expression spaces were left for people to leave their comments or suggestions for other objectives and indicators but also about the criteria description. 6 answers noted difficulties in understanding what was behind some of the criteria. For example, some respondents suggested we add other criteria, which were in fact already included but maybe not highlighted enough (knowledge sharing, farm profitability – twice -, architectural and landscape integration and its link to choosing the farm type). We thus decided to improve the name and description of all criteria for the coming tool, in order for it to be better understood. This is now under work with interviews of farmers and advisors and another survey to come during the summer to evaluate if our new presentation is more intelligible to all.

During both panel and survey, stakeholders remarked on the diversity of projects and the way to make this useful for all of them when not all criteria are expected to be applicable to every project. Our goal is to make a tool composed of several parts. In this way farmers could choose to only use the part that is pertinent to their case. This will have an impact on the aggregation method chosen since the different dimensions cannot be compiled but must each remain visible so that people reading the results will know explicitly which dimension/criteria were used in the analysis.

Review results and analysis

At the time of this paper, two thirds of the articles have been analysed. Some of the articles were not pertinent either because the content did not relate to sustainability as such or because the scale studied did not enable us to derive any indicators useful at the farm level. This is a first result of our review: most of the articles related to urban agriculture sustainability have been studying the city or at most the borough level and most indicators are not relevant for the farm or cannot be downscaled to the farm level.

However, some article and report contain concepts and indicators that could be adapted.

In the Five Borough Farm study (Altman et L, 2014; Barry et al., 2014), the authors mainly identify indicators at the level of the city. However some of them could be adapted to the

farm level like sweat equity defined as (the number of hours worked per week) x (the number of weeks worked) x (the minimal wage) to evaluate the value of volunteer work, which is of particular importance in urban farm projects in France. The same method is used in France by associations to evaluate volunteer implication and the importance of the work done by the association (N. Lahoud, personal communication).

In addition, studies of brownfield remediation and comparison of remediation methods use indicators that could be used for urban agriculture (Cappai et al., 2016; Cappuyns, 2016).

Cappuyns (2016) describes the SuRF framework (Sustainable Remediation Forum UK) with its 5 social criteria: „Protection of human health and the wider environment“, „Safe working practices“, „Consistent, clear and reproducible evidence-based decision making“, „record keeping and transparent reporting“, „good governance and stakeholder involvement“, „sound science“, which are then refined in 14 categories measured by indicators. Some of those categories could be used in urban agriculture like social justice and equality, ethics in business management, functioning of the community, communication, local policy, quality management.

Our research also highlighted that most evaluation tools of sustainability on agriculture use qualitative evaluation of how the farmer perceives his workload. For example in the IDEA method, which is widely used in France (Boisset et al. 2008) farmer perception is the measure for farm probable continuity, work intensity, quality of life and isolation. One of the interesting results of brownfield studies is that they also question the perception of the inhabitants. Urban farming has a strong link to the inhabitants and the transparency will also have to be evaluated via the possibility for inhabitants to interact with the farmer. This could be measured in different ways, such as a notebook left by the urban farm for locals to write on or by giving an email address to which inhabitants could send remarks. Communication at the beginning of the project is also a way to measure the link to local network.

Other indicators seemed to us particularly adapted to the urban farming situation for example the average pay of employees, the income difference between genders, life satisfaction of employees and safety (Bela and Rasnaca, 2015). Some seem very interesting but may not be directly applicable due to the size of urban farms such as age and gender structure, multiculturalism and education level of the staff (Galdeano-Gomez et al., 2017).

Other articles have been added to the initial selection, enabling us to assess 17 sustainability tools including IDEAv3 (Boisset al., 2008), Diagnostic Agriculture Paysanne (FADEAR, 1998), RAD (2010), MESMIS (Lopez-Ridaura et al., 2002), MOTIFS (Meul et al., 2008), SAFA (FAO, 2013), SuRF-UK (Cappuyns, 2016), SPEAR (ARUP, 2012) and OVALI (Protino et al., 2014). The characteristics of these tools have been evaluated such as the scale of application, the users targeted, the dimensions involved, the number of criteria and indicators, or involvement of stakeholders in the elaboration of the tool. This highlighted four tools as relevant to the scope of our research work, namely IDEA, RAD, FADEAR and MESMIS as they are all designed for farm level, include the social, environmental and economical dimension, and include several criteria and indicators in each dimension. We are using these 4 tools in combination with the indicators found in the literature review to build a first proposal of indicators.

The next step of our work is to find experts in different fields of sociology, economy and technical sciences to validate the pertinence of our indicators choice. We will also go back to the end users to validate the usability of these indicators by urban farmers, agricultural advisors and cities.

Outlook

Our preliminary work has shown the specificity of intra-urban agriculture and the need for a specific tool for the evaluation of sustainability. Indeed, even if sustainability evaluation tools have been designed for rural farms, the specific intra-urban context requires that urban farm ensures a high density of environmental, social and economical services, which cannot all be assessed by the criteria of existing evaluation tools. During this first phase, all contacted

stakeholders have shown a high interest in its creation and most have agreed to be involved in the next phases. A first analysis of the survey showed that the French stakeholders of urban agriculture find the structure of our tool pertinent to the analysis of urban farms, however it also highlighted that individual interviews are necessary to precise the criteria. These interviews will be done during spring 2018 with urban farms having diversified production systems and business models in order to identify their specificities and reflect these in the ergonomics of the tools. A particular emphasis will be given to designing the breakdown of the tool into independently useful sections to be used at will by urban farmers. The next phase, corresponding to the choice of indicators, is under way, combining both existing reviews and the identification of indicators performed during previous studies (Fargue-Lelièvre and Daniel, 2015). Our first results show that studies done on brownfields could be relevant to urban agriculture for the social dimension in particular.

Once a list of indicators adapted to urban farms is compiled, the choice of the indicators and matching those indicators to the most relevant criteria will be done with an expert panel of researchers of technical sciences, economics and sociology fields. These indicators will then be submitted to the enlarged panel of experts for an evaluation of their pertinence.

The sustainability auto-evaluation tool for urban farms is conceived as an evolving tool to include new indicators if new objectives are identified or if new research allows measurements of other indicators. As such, the results of the Urbaclim project (Climate-KIC project), studying the impact of urban agriculture on reducing food miles and mitigating climate impact, and the results of the SEMOIRS project (ADEME MODEVAL-URBA project), studying the ecosystem services by urban farms and their soils, will also be used for the environmental indicators.

One question raised by the current project is the choice of reference values that will define sustainability for each criterion and objective. An easy answer could be the use of qualitative values in the first prototype but this calls for a wider reflection involving stakeholders and experts at the national and maybe international level. This question is beyond the scope of the current project but will be crucial to the future use of the tool.

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