Stakeholder's practices for the sustainability assessment of professional urban agriculture reveal numerous original criteria and indicators

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Abstract

With the rapid growth of professional intra-urban agriculture (PIUA) projects in the Global North, sponsors, projects leaders and experts developing these projects are seeking to evaluate their sustainability. In the absence of an assessment tool directly applicable to PIUA projects, they establish their own assessment practices. Our study examines these practices to identify their original features, criteria and indicators used. To this end, we analysed 19 case studies of different PIUA projects. We identified four dimensions underpinning sustainability assessment, namely internal sustainability, external sustainability, the project leader's credibility, and the innovative nature of the project – the latter two dimensions being particularly original compared to the sustainability dimensions usually found in the literature, such as environmental, social and economic dimensions. We also shed light on the wide diversity of the 67 assessment criteria identified, as well as the qualitative nature of 78% of indicators used. Our study also highlights that assessment practices evolve over time as the project progresses from ideation to implementation, according to the variety of assessment situations. Our study is the first to provide an in-depth exploration of PIUA actors' sustainability assessment practices and to shed light on their original features. Our results afford a better understanding of the way the sustainability of PIUA projects is assessed, and contribute to reflection on the design of a flexible assessment tool, considering the diverse criteria and practices used by stakeholders to assess the sustainability of PIUA.

Keywords: evaluation, urban farming, innovation, internal sustainability, external sustainability, qualitative indicators, credibility

1. Introduction

Urban agriculture has been growing rapidly in countries of the Global North in recent years, a trend illustrated by the emergence of different types of projects with diverse purposes pertaining to the sustainability of cities. A recent study counted 417 projects in countries of the Global North (North America, Japan, Australia and Europe), with 24 of those being in France (Orsini et al., 2020). Among

them, professional intra-urban agriculture (PIUA) projects, which include multi-activity micro-farms, greenhouses and indoor systems in urban areas, encompass a range of initiatives. It involves soil-based agriculture, hydroponics, raised beds farming, and rooftop farming, with both outdoor and indoor farming activity. These projects can pursue productive, environmental, social or educational objectives, and sometimes combine several growing techniques and several objectives (Clerino and Fargue-Lelièvre, 2020). Thus, some projects focus on a productive objective while others combine productive and educational, or cultural and social objectives, as illustrated in Figure 1.

Photos P.Clerino

Figure 1: The diversity of professional intra-urban agriculture projects in France: (a) Production-oriented rooftop farm in Paris, using aeroponic systems; (b) Soil-based farm with a cultural and social focus in Saint-Denis; (c) Raised beds farming with a productive and educational focus on a rooftop in Saint-Denis.

A range of sponsors support the development of these projects by providing land or funding to project leaders, to develop their PIUA project, while experts advise sponsors and project leaders on projects' development or selection. These actors vary as they might be public, private, or civil society organizations. Sponsors include local authorities, social landlords, urban planners, banks, and foundations. The project leaders may be urban farmers, civil-society organizations, specialized consulting firms, real estate developers, local authorities, or architects. The experts include research organizations, consulting firms, and public institutions such as the Chambers of Agriculture. Some sponsors can also be project leaders, and project leaders may in some cases be called upon as experts. Project leaders, sponsors and experts are concerned with assessing ex-ante the sustainability of the PIUA projects, to guide projects' elaboration, identify their strengths and weaknesses or to compare project proposals and select the winner of a call for proposals.

Several assessment tools or frameworks have been developed to assess projects' sustainability. Some assessment methods are designed to measure impacts in an ex-post situation, once the project has already been implemented or even completed. This is the case of the OECD method (OECD, 2019), which proposes assessment criteria such as effectiveness and efficiency, estimated based on the achievement of objectives. Such criteria cannot be used ex-ante, at the proposal stage of a project, as they rely on field measurements and observations unavailable before project implementation. Also, the

ability to reach objectives set upstream depends not only on the resources allocated to the project which are known at the proposal stage, but also on external factors that are difficult to predict (Samset and Christensen, 2017), such as involvement of inhabitants in the case of PIUA. The assessment methods proposed for agricultural development projects (Delarue and Cochet, 2013; World Bank, 2006) are also only suitable for ex-post use: these methods compare the impacts of projects to the scenario that would have prevailed without them, and are difficult to apply ex-ante as they rely on indicators measured when the project is implemented.

Other assessment tools are designed to evaluate ex-ante project proposals. However, many of them are specifically designed for industries and investment in new technologies (Bhatnagar and Jancy, 2003; Poteralska, 2017), which do not concern the majority of PIUA projects. They tend to focus on economic criteria, with little consideration for the social and educational dimensions which are important for many PIUA projects. Some decision-making methods can be used in agriculture, but are applied at the plot scale rather than farm level, such as the MASC method (Sadok et al., 2009).

Some multi-criteria assessment methods are designed to assess the sustainability of farms, but the literature has pointed out that these tools are unsuitable for multifunctional farms, as they focus on agricultural activities and production, and fail to take into account non-agricultural activities (Barbier and Lopez-Ridaura, 2010), whereas PIUA projects include educational and social activities that are not strictly productive (Orsini et al., 2020). Also, they include criteria that are not applicable ex-ante such as soil cover index (Migliorini et al., 2018), pesticide use (Meul et al., 2008), or phosphorus and potassium use (Roesch et al., 2017).

Some assessment methods have been designed specifically for urban agriculture, but mainly focus on evaluating the environmental impacts of urban agriculture or the ecosystem services provided (Dorr et al., 2021; Langemeyer et al., 2015; Lin et al., 2015; Petit-Boix and Apul, 2018; Wang and Pryor, 2019), without considering social and economic aspects. Studies on the assessment of all dimensions of sustainability focus on evaluating benefits (Altman et al., 2014; Mackenzie and Davies, 2019; Teitel-Payne et al., 2016) and on a farm's contribution to urban sustainability (Tapia et al., 2021), but not the sustainability of the farm itself, when the internal sustainability of PIUA projects is an important assessment topic for sponsors and project leaders (Clerino and Fargue-Lelièvre, 2020).

Since the overall sustainability of PIUA projects cannot be assessed using established tools or methods, the actors implement their own practices to do so. Several studies have shown that grassroots actors are a source of innovation by building new knowledge and practices (Dolinska and d'Aquino, 2016; Leitgeb et al., 2011; Tambo and Wuenscher, 2017), that can be disseminated and benefit to other stakeholders (Gupta et al., 2019; Salembier et al., 2021; Wu and Zhang, 2013). We thus posit that PIUA stakeholders have developed innovative practices to assess the sustainability of their projects. Sanyé-Mengual et al. (2018), studying the conceptualization of sustainability from the

stakeholders' perspective, identified sustainability elements belonging to the three classic sustainability dimensions (environmental, social and economic). Nevertheless, they did not explore the details of the assessment practices, criteria or indicators used. Our study aims to investigate the stakeholders' assessment practices, to identify their original features concerning sustainability assessment of PIUA. We first focus on the sustainability dimensions considered, with a special interest for those that differ from the classic triptych "environmental, social and economic dimensions". Then we study the nature of criteria and indicators used, and the way stakeholders use them.

2. Material and method

To explore stakeholders' practices regarding the sustainability assessment of PIUA projects, we performed a "diagnosis of uses" (Cerf et al., 2012). A diagnosis of uses is an approach designed by ergonomists and agronomists, aiming at identifying issues faced by stakeholders when they implement a specific activity and the way they use diverse tools to cope with these issues. It is then a preliminary stage of the design of a new and more efficient tool. The diagnosis of uses relies on data collection from various potential users of the new tool. In our case, the diagnosis of uses applies to the sustainability assessment of PIUA projects: it aims at highlighting the diversity of criteria and indicators used by different stakeholders, in order to enrich the design of an assessment tool adapted to the diversity of stakeholders' working situations. This diagnosis covered 19 case studies in which PIUA projects were evaluated. Some case studies (12 among 19) deal with a single project which has been evaluated by sponsors when they decided to finance it, or when project leaders were elaborating the project proposal. In other case studies (7 among 19), sponsors and experts assess sustainability of several projects, when calls for proposals cover different projects' sites. Among the 19 case studies, three cover the whole French territory, thirteen the Ile-de-France region, where most of the French PIUA projects are implemented, one the Pays de la Loire region, one the Haut-de-France region and one the Centre-Val de Loire region. Case studies were analysed based on semi-structured interviews, desktop review of official documents relating to selection processes and internal analysis framework of projects. The details of the 19 case studies are presented in Table 1.

Table 1 : Description of the 19 case studies, according to whether it concerns one or several projects, the location of the crops, the cultivation techniques, the projects' selection process and the source of data

ID	Single or multiple projects	Crops location	Cultivation techniques	Projects selection process	Source of data	
					Interviews	Documents analysis
CS1	Single	Rooftop and ground -based	Raised beds	Calls for applications	Interview 1: sponsor (urban planning company)	Official document 1
CS2	Multiple	Multiple	Multiple	Call for expression of interest	Interview 2: sponsor (urban planning public agency) Interview 3: expert (consulting firm)	Official document 2

CS3	Single	Ground-based	Soil-based	Call for proposals	Interview 4: expert (urban agriculture company)	Official document 3 Internal assessment framework 1
CS4	Multiple	Multiple	Multiple	Call for proposals	Interview 5: sponsor (public company)	Official document 4
CS5	Single	Rooftop	Multiple	Call for proposals	Interview 6: sponsor (local authority)	Official document 5
CS6	Single	Indoor	Raised beds	Closed competition	Interview 7: sponsor (local authority) Interview 8: project leader (architectural firm)	Official document 6 Internal assessment framework 2
CS7	Single	Rooftop	Raised beds	Mutual agreement	Interview 9: project leader (civil society organization)	/
CS8	Multiple	Multiple	Multiple	Funding request	Interview 10: sponsor (public bank)	Official document 7
CS9	Multiple	Multiple	Multiple	Funding request	Interview 11: sponsor (private foundation)	/
CS10	Single	Ground-based	Soil-based	Calls for applications	Interview 12: sponsor (local authority)	Official document 8
CS11	Single	Indoor	Hydroponics	Mutual agreement	Interview 13: sponsor (food retailer private company)	/
CS12	Single	Rooftop and ground -based	Soil-based and raised beds	Call for proposals	Interview 14: expert (urban agriculture company) Interview 15: project leader (architectural firm)	Official document 9
CS13	Single	Rooftop and ground -based	Hydroponics and raised beds	Calls for applications	Interview 14: expert (urban agriculture company) Interview 16: sponsor (local authority) Interview 17: sponsor (social housing services)	/
CS14	Single	Indoor	Raised beds	Call for proposals	Interview 6: sponsor (local authority) Interview 18: sponsor (social housing services) Interview 19: expert (public institution)	Official document 10
CS15	Multiple	Multiple	Multiple	Call for proposals	Interview 6: sponsor (local authority) Interview 19: expert (public institution)	Official document 10
CS16	Multiple	Multiple	Multiple	Call for expression of interest	Interview 20: sponsor (local authority)	Official document 11
CS17	Single	Ground-based	Soil-based and raised beds	Call for proposals	Interview 21: project leader (urban agriculture company)	/
CS18	Single	Ground-based	Raised beds	Call for expression of interest	Interview 2: sponsor (urban planning public agency) Interview 3: expert (consulting firm) Interview 22: project leader (property developer)	Official document 2
CS19	Multiple	Multiple	Multiple	Call for proposals	/	Official document 9

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In order to capture the diversity of assessment practices, the sample of case studies was selected to represent:

- The **range of actors** involved in PIUA projects. The sponsors providing land and funding for these projects may be public or private. We interviewed local authorities, a public company, a public bank, urban planners, a private foundation, a food retailer, and social housing services. The project leaders also vary. We interviewed a property developer, a civil society organization, an urban agriculture company, and architectural firms. Finally, we met different experts mobilized by the sponsors for their expertise: consulting firms, companies specialized in urban agriculture, and a public regional authority for food and agriculture.
- The **diversity of PIUA projects**. PIUA projects vary depending on their location and their cropping system. Of the 19 cases studied, the location of the crops was known at the time of the assessment in 12 cases: two of the cases provided for rooftop cultivation, four for ground-based crops, three for both rooftop and ground based crops, and three for indoor farming. The cropping systems were unknown at the time of the project assessment in 8 cases, soil-based in two cases, raised beds in five cases, hydroponics in one case, and combined different cultivation supports in three cases.
- The **diversity of project selection processes**: sponsors can adopt a variety of processes to select a PIUA project. Of the 19 cases we studied, three used calls for expression of interest, three used calls for applications, eight used calls for proposals, two used mutual agreement processes, and two used requests for funding. Finally, one of the processes involved a closed competition. The different processes entail different levels of expectation from sponsors regarding the project proposals submitted by project leaders. With calls for expression of interest, applicants are free to propose a wide range of PIUA projects; the project proposal does not necessarily have to be a final version. Calls for applications are geared towards selecting a project to develop a particular space; here again, a wide range of PIUA projects are possible. Calls for projects generally target more precise needs than calls for expression of interest and calls for applications: the project proposal must fit a specified framework. Closed competition allows public actors to select PIUA projects based on expectations that are very well defined upstream. All these processes involve competitive project proposal bidding. Two processes allow for selection without competition: mutual agreement processes, where the sponsor and the project leader agree on the PIUA project together, and requests for funding, where the project leader submits a project to a sponsor, who decides to support it or not, without comparing it to other project proposals.

We studied the 19 cases by analysing three types of data:

- **Semi-structured interviews** with a range of sponsors, experts and PIUA project leaders. A total of 22 interviews were conducted. Some interviews covered different case studies, when a sponsor, expert or project leader was involved in different case studies. For 18 of the 19 cases studies, at least one interview was held: one interview for 11 of the cases, two interviews for four of the cases, and three interviews in three cases, when a diversity of stakeholders was involved. Interviews were held during a live meeting or through telephone for two of them. During the interviews, questions were asked about the history of the PIUA projects, their objectives and characteristics, the stakeholders involved in the selection processes, how the project proposals were evaluated, by who and based on which criteria or indicators. All interviews were recorded and summarized.
- **Official documents relating to selection processes**: these are specifications and regulations for selection procedures that are published and publicly available. We studied a total of 11 official documents, which provided data for 14 of the 19 case studies. Some documents gave information for two case studies related to the same call for proposals. We extracted from these documents information about the project's objectives, some of their characteristics, but also about the selection processes, how they were put in place, the stakeholders involved and some of the criteria and indicators used to assess project proposals and select awardees.
- **Project proposal analysis frameworks** supporting the selection of winning proposals as part of calls for projects, when they could be retrieved. We were able to access two analytical frameworks, which provided information on two of the 19 cases studies. These frameworks, which do not always exist, are confidential and difficult to access. They reflect the internal discussions of a selection committee and are generally not shared outside this committee. We extracted, from these documents, criteria and indicators used to compare project proposals during selection processes.

Based on the interviews and documents desk review, we systematically recorded in an Excel database every item that allowed the assessment of PIUA projects for each case study. We classified these items as themes, sub-themes, criteria or indicators underpinning the assessment of PIUA projects:

- **Themes and sub-themes** encompass several criteria**,** such as *Contribution to global sustainability* and *Contribution to access to quality local food*;
- **Criteria** are variables that make up sustainability and serve as a basis for formulating assessments (Lairez et al., 2015), such as *Local consumption of products*, and can comprise several indicators;
- **Indicators** are quantitative or qualitative variables used to estimate criteria (Lairez et al., 2015), such as *Share of the production sold locally* or *Local sale of the production*

Then we organized the theme, criteria and indicators recorded. Among the themes and criteria, some were identical or close. For instance, we recorded from two different documents the following draft criteria: *Significant skills of the project leader* and *Project matching with the skills of the candidate*. In this case, we considered that the two draft criteria were similar and merged them under the final criterion *Relevant skills of the project leader*. Where criteria did not fit any of the recorded themes, an overarching theme was formulated. For instance, for the criteria *Preservation of old buildings*, *Use of age-old agricultural know-how* and *Perpetuation of the agricultural use of the land,* a theme *Contribution to heritage preservation* was formulated. Likewise, where indicators recorded could not be grouped under a recorded criterion, an umbrella criterion was formulated. After the classification of the items recorded, we obtained 10 different themes, 67 final criteria and 138 indicators.

We analysed the diversity of the different themes, criteria and indicators used; but also, their frequency of use (occurrences) among the 19 case studies, knowing that different case studies may use the same criteria or indicators.

A statistical analysis based on a Hierarchical Clustering (HC) was also carried out to categorize the case studies according to the number of themes, criteria and indicators they applied. The HC was performed using XLSTAT software.

3. Results and discussion

3.1. Diversity of assessment structure among case studies

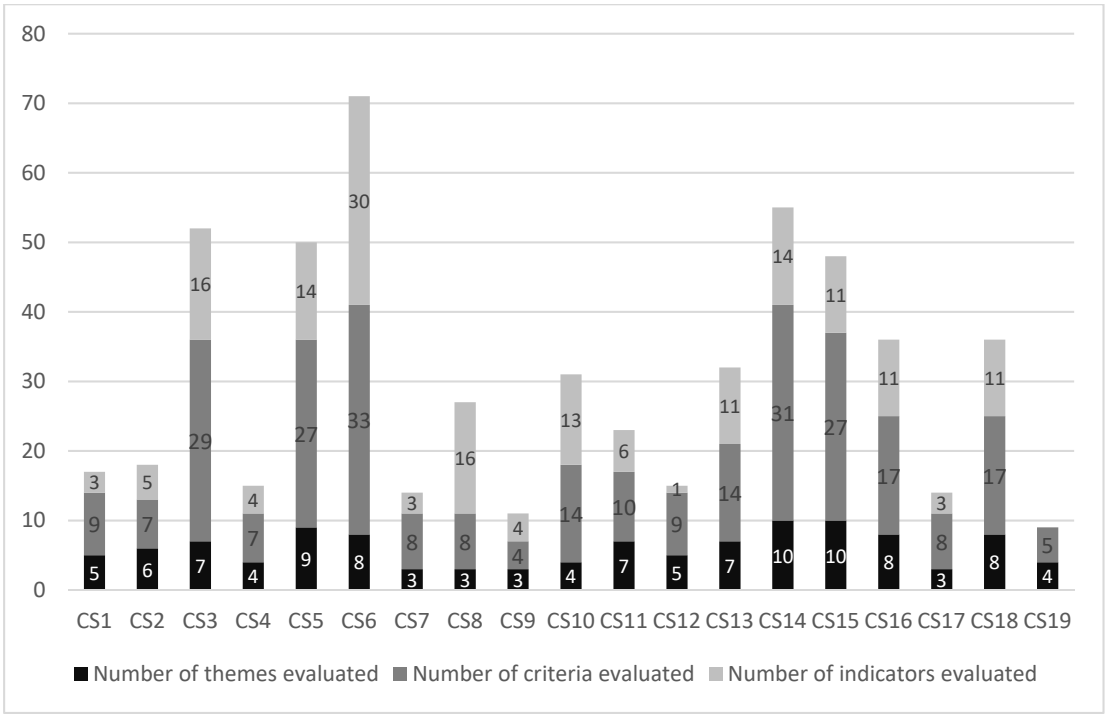

Figure 2 : Number of different themes, criteria and indicators used by each case study (CS)

We observed a wide disparity in the number of themes, criteria and indicators used per case study as presented in Figure 2. Some case studies assess a small amount of sustainability themes (with a minimum of three themes assessed for CS7, CS8, CS9 and CS17), whereas CS14 and CS15 consider up to 10 sustainability themes. An average of 15 criteria were used per case, with a minimum of 4 criteria for CS9 and a maximum of 33 for CS6. While some projects were evaluated based on a very small number of themes and criteria, others were analysed in great depth, suggesting that the evaluators' expectations can vary widely. At last, for some case studies, we identified a large number of indicators (with a maximum of 30 for CS6) whereas no indicators were identified for CS19, suggesting that indicators may be implicit or confidential.

For instance for CS7 corresponding to a farm implemented by a local association in a school, sustainability assessment was based on 1) the theme *Coherence and technical robustness* assessed by criteria *Respect and personal fulfilment of employees* and *Sustainability of contracts for the staff;* 2) the theme *Contribution to local sustainability* assessed by criteria *Fostering of neighbourhood life*, *Suitable activities proposed on the farm for vulnerable populations* and *Job creation;* and 3) the theme *Contribution to global sustainability* assessed by criteria *Preservation of biodiversity, Hosting of school groups* and *Organization of workshops*. Three indicators were identified for CS7: *Creation of jobs with permanent contracts* (used to estimate two different criteria: *Sustainability of contracts for the staff* and *Job creation), Hosting of pupils during school time, after school and during vacations* (used to assess the criteria *Hosting of school groups)* and *Conducting workshops on nature with a science teacher* (used to assess the criteria *Organization of workshops).*

3.2. Original features of the sustainability dimensions and themes for PIUA projects

We identified 10 different themes of sustainability, and gathered those under four dimensions of sustainability (Figure 3).

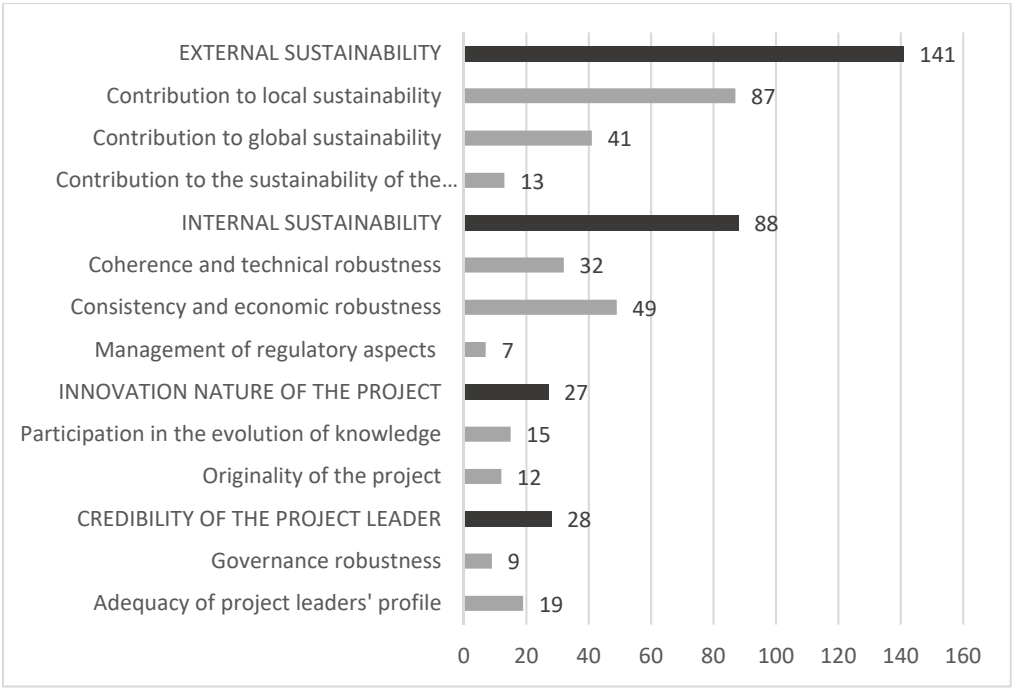

Figure 3: Occurrences of criteria used by the 19 case studies according to their related sustainability dimension (in black) and sustainability theme (in grey). The number of occurrences for each dimension equals the sum of occurrences of the themes below.

3.2.1. Nature of the sustainability dimensions and themes assessed by stakeholders

The first dimension encompasses themes pertaining to the external sustainability of a project. This concept of external sustainability applied to urban agriculture was defined by Aubry et al. (2012), based upon the territorial sustainability of agriculture, that refers to the contribution of agriculture to the sustainable development of its territory. In an urban context, external sustainability is linked to the multifunctionality of PIUA and gathers the services provided by PIUA projects to the city. In our study, external sustainability relies on themes such as (i) project's contribution to sustainability at a local level (city, neighbourhood), (ii) at a global scale (issues relevant at the country or world scale, such as biodiversity or heritage preservation), and (ii) project's contribution to the sponsor's sustainability (positive contribution to its image or to its economic added value for instance).

The second dimension comprises themes and criteria relating to the internal sustainability of a project. In agriculture, internal sustainability can be defined as the internal goals that a farmer wants to achieve (Zahm et al., 2018). In an urban context, internal sustainability relies on different themes such as the project's technical coherence, its economic robustness, and the management of regulatory aspects (respecting the regulations in force, knowledge of the necessary authorizations).

The third dimension of sustainability relates to themes and criteria used for assessing the innovative nature of a project. New issues are emerging around urban agriculture, such as limited and non-traditional access to land (i.e. rooftop or underground farms, precarious lease), use of urban soils and

alternative growing media (i.e. soil pollution management, use of coffee ground as substrate), the specific legal and political environment, the functions which are not strictly productive or the involvement of non-traditional farmers (Pfeiffer et al., 2015). All these distinct features encourage the development of innovative practices, particularly important to adapt to specific urban challenges (Schans et al., 2014). Innovative projects are thus ones that offer levers to overcome these challenges and ensure their sustainability, but novelties applied in urban agriculture also enhance the social, ecological and economic impacts of practicing agriculture within urban areas, holding the potential to contribute to sustainability (Opitz et al., 2016b). To evaluate the innovative nature of a project, our results suggested to rely on two elements: 1) project's originality, whether the project involves an innovation, by introducing new concepts (such as new technology or new form of organization); or by representing a novelty when a similar project has not been seen before ; 2) project's participation in the evolution of knowledge, by generating new knowledge through experimentation, or by disseminating new knowledge through workshops, trainings. This configuration echoes the CK design theory (Hatchuel and Weil, 2009) that consider innovative design as an expansion of both concepts and knowledge.

The fourth and final dimension of sustainability encompasses themes and criteria for assessing the credibility of a project leader, i.e. evaluating the robustness of the project's governance and the adequacy of the project leader and partners' profiles (references, training and motivations). These criteria serve to ascertain whether the project leader is able to ensure the implementation of the project and the achievement of its objectives (set in the project proposal). Such criteria are considered as particularly relevant by stakeholders interviewed, as many project leaders do not come from the farming world, and a lack of training in agriculture is perceived as a risk for the sustainability of projects, as described by Sanyé-Mengual et al., 2018.

3.2.2. Frequency of assessment of the sustainability dimensions

Figure 3 highlights that most criteria used by the 19 case studies refer to external and internal sustainability (229 occurrences of criteria assessing external and internal sustainability). Case studies use more criteria associated with external sustainability than with internal sustainability (141 occurrences for criteria assessing external sustainability versus 88 occurrences for criteria assessing internal sustainability), pointing that in PIUA projects considerable attention is paid to the project's contribution to sustainability at broader levels, and especially at local level, on the scale of the neighbourhood, city or region in which the farm is based.

The criteria pertaining to the credibility of the project leader or the innovative nature of the project are less used than the ones related to internal and external sustainability (28 occurrences for criteria related to the credibility of the project leader and 27 occurrences for criteria related to the innovative nature of the project) but are far from anecdotal in the assessment of PIUA project sustainability. Few previous

297 studies attest to interest in integrating innovation : one study highlights that innovation is an important
298 dimension for defining sustainable urban agriculture (Sanyé-Mengual et al., 2019), and the IDEA tool
299 displays a sustainability objective based on the production and sharing of knowledge to assess
300 sustainability of rural farms (Zahm et al., 2018). However none of them include the credibility of the
301 project leader, whereas Chopin et al., (2021) stressed that governance aspects and the characteristics of
302 the project leader ought to be included in the sustainability analysis of farming projects.

303 ### *3.3. Diversity of criteria for evaluating the sustainability of PIUA projects*

304 The four dimensions of sustainability are organized into themes covering 67 different criteria. Some
305 themes are divided in sub-themes to ease the reading, within the external and internal sustainability
306 dimensions. As presented in Table 2, we analysed the nature of the 67 different criteria and observed
307 the occurrence of each criterion among the 19 case studies to highlight which criteria are mostly used
308 by PIUA stakeholders.

309 *Table 2: Criteria organized per dimensions and themes, and their occurrence among the 19 case*
310 *studies (a) criteria related to external sustainability, (b) criteria related to internal sustainability, (c)*
311 *criteria related to the innovative nature of the project, (d) criteria related to the credibility of the*
312 *project leader*

EXTERNAL SUSTAINABILITY OF THE PROJECT			
Themes	**Sub-themes**	**Criteria**	**Occurrences of each criterion among case studies (/19)**
Total = 3	Total = 11	Total = 35	Total = 138
Contribution to local sustainability	Ability to integrate into the neighbourhood	Limitation of disturbances for neighbours	3
		Aesthetic quality of the farm	7
		Accessibility of the farm	5
		Take-up of the project by locals	6
	Contribution to local development	Connection with local actors	8
		Job creation	6
		Contribution to the attractiveness of the neighbourhood	6
		Improvement of locals' living environment	7
	Contribution to the inclusion of vulnerable populations	Creation of vocational rehabilitation jobs	3
		Accessibility for people with reduced mobility	1
		Suitable activities proposed on the farm	2
	Contribution to access to quality local food	Diversified food production	5
		Freshness and nutritional quality of produce	5
		Sanitary quality of the produce	4
		Complementarity with the rural farms of the area	4
		Local consumption of products	7
	Fostering of social ties	Fostering of neighbourhood life	2
		Promotion of social diversity	1
		Contribution to stormwater abatement	4

	Ability to provide ecosystem services	Contribution to the reduction of the urban heat island effect	1
Contribution to global sustainability	Contribution to heritage preservation	Preservation of old buildings	1
		Use of age-old agricultural know-how	1
		Perpetuation of the agricultural use of the land	1
	Protection of the environment	Limiting soil and water pollution (reduced use of pesticides or nitrogenous fertilization)	5
		Preservation of biodiversity	6
	Practices linked to the circular economy	Monitoring and limiting of resource consumption	8
		Recycling and waste recovery	6
	Participation in environmental and food education	Hosting of school groups	3
		Organization of workshops	5
	Bringing consumers and producers closer together	Visible production process	1
		Ability to raise awareness of market gardeners' work	1
		Contact between growers and consumers	3
Contribution to the sustainability of the sponsor		Economic added value for the sponsor	2
		Image impact for the sponsor	2
		Integration of the project into the sponsor's strategy	9

313 (a)

INTERNAL SUSTAINABILITY			
Themes	**Sub-themes**	**Criteria**	**Occurrences of the criterion among case studies (/19)**
Total = 3	Total = 6	Total = 22	Total = 88
Coherence and technical robustness	Realistic nature of technical proposals	Realistic cropping systems and yields	7
		Compliance with architectural requirements	3
		Adequate means to expected results	3
		Synergies of the different activities developed on the farm	1
		Reference to the principles of permaculture	1
	Ethical staff management	Sustainability of contracts for the staff (permanent contracts rather than internships or short term contracts)	2
		Respect and personal fulfilment of employees	3
		Limitation of arduous work	2
	Land risk management	Capacity to move to another location, mobile facilities	1
		Land tenure compatible with urban agriculture	2
	Adaptation to the characteristics of the site	Essential premises planned (storage area, public hosting area, sanitations, etc.)	4
		Adaptation of the project to a rooftop location	1
		Taking into account necessary works	2
Consistency and economic robustness	Robustness of the financing plan	Amount of investments compared to financing capacity	12
		Amount and distribution of capital	2
		Aid and subsidies obtained or expected	4
	Economic viability	Turnover and expected results	7

		Cost control (operating costs, staff wages)	7
		Diversification of income sources multifunctionality	6
		Robustness of the marketing plan (identified customers, selling prices, labels)	11
Management of regulatory aspects		Compliance with urban agriculture regulations	4
		Management of the appraisal processes and authorizations	3

(b)

INNOVATIVE NATURE OF THE PROJECT		
Themes	**Criteria**	**Occurrences of the criterion among case studies (/19)**
Total = 2	Total = 5	Total = 27
Participation in the evolution of knowledge	Ability to generate new knowledge – implementation of an experimental device	4
	Ability to disseminate new knowledge	6
	Replicability of the project	5
Originality of the project	Project involving an innovation	11
	Novelty of the project	1

(c)

CREDIBILITY OF THE PROJECT LEADER		
Themes	**Criteria**	**Occurrences of the criterion among case studies (/19)**
Total = 2	Total = 5	Total = 28
Robustness of the project's governance	Composition of the project leader's team and partners	4
	Role and responsibilities of the team and partners	5
Adequacy of the project leader's profile	Quality and consistency of references of the project leader's team and partners	11
	Relevant skills of the project leader	6
	Project leaders' motivation	2

(d)

3.3.1. Nature of the sustainability criteria used by stakeholders

The external sustainability dimension is the richest, with 3 themes and 11 sub-themes covering 35 different criteria. The internal sustainability dimension comprises 3 themes, 6 sub-themes and 22 different criteria, the innovative dimension 2 themes and 5 different criteria, and the dimension of the project leader's credibility also counts 2 themes and 5 different criteria (Table 2).

First, we observed that some criteria are similar to the criteria found in existing assessment tools. For instance, the criteria *Monitoring and limiting of resources consumption* and *Preservation of biodiversity* are similar to the criteria *Use of inputs* and *Biodiversity* found in MOTIF tool (Meul et al., 2008). The criterion *Limiting soil and water pollution* and the theme *Contribution to heritage*

326 *preservation* are similar to the indicators *Reduce impact on human health and ecosystems* and
327 *Preservation of local heritage* found in IDEA tool (Zahm et al., 2018). Then, criteria related to the
328 consistency and economic robustness such as *Aid and Subsidies obtained or expected* or *Turnover and*
329 *expected results* are also similar to criteria found in IDEA tool.

330 We also note original criteria compared to those generally found in methods for evaluating the
331 sustainability of rural farms (Grenz et al., 2009; Schader et al., 2016; López-Ridaura et al., 2002; Meul
332 et al., 2008; Scialabba et al., 2014).

333 Some criteria assess the risk, for the farm, of being refused by the neighbourhood: *Limitation of*
334 *disturbances for neighbours*, *Aesthetic quality of the farm* and *Take-up of the project by locals*. Indeed,
335 bad smells or noise due to agricultural activities can increase the risk that neighbours reject the project;
336 conversely, involving inhabitants in the farm's activities can decrease this risk. Previous studies
337 identified the risk of the farm being refused by the neighbourhood (Desrousseaux and Stahl, 2014;
338 Specht et al., 2016), but no corresponding criteria was included in existing assessment methods.

339 We identified other criteria specific to the risks linked to an urban location such as *Capacity to move*
340 *to another location*, *Land tenure compatible with urban agriculture* and *Adaptation of the project to a*
341 *rooftop location*. For instance, in CS18, land is provided under a short-time lease before the start of a
342 construction project, so the ability of the farm to move to another location is an important criterion. In
343 the case of a rooftop location like in CS5, specific attention is made to the safety measures put in place
344 or the bearing capacity of the roof. These criteria allow to assess how the project will mitigate the risks
345 related to precarious or unsuitable nature of the land available to set up agricultural activities that were
346 pointed out by Sanyé-Mengual et al., 2018.

347 Conversely, other criteria highlight benefits specific to intra-urban settings, such as a *Contribution to*
348 *the attractiveness of the neighbourhood*, *Improvement of locals' living environment*, or *Fostering of*
349 *neighbourhood life* and the capacity to provide ecosystem services, such as *Contribution to*
350 *stormwater abatement* or *Contribution to the reduction of the urban heat island effect*. Moreover, by
351 avoiding long transportation time and by selling perishable products shortly after harvest, intra-urban
352 agriculture makes fresh fruits and vegetables available to city dwellers, like in CS11 were the
353 production is located within a supermarket. We identified the criterion *Freshness and nutritional*
354 *quality of produce* to assess the benefits of growing food as close to the consumer as possible, benefits
355 that were pointed out in the literature (Opitz et al., 2016a).

356 The integration of the theme *Contribution to the inclusion of vulnerable populations* and the related
357 criteria confirms that intra-urban agriculture is a real support to develop activities with social benefits,
358 that might be integrated to the primary goals of the farm, and not only considered as co-benefits of the
359 production activity. This is the case for instance in CS1 where the farm is co-designed with a local
360 association which provides shelter to homeless people in order to include them in the farm activities.

The ecosystem of actors specific to PIUA also justified the addition of original criteria. *Integration of the project into the sponsor's strategy* underlines that PIUA projects are also guided by objectives specific to the actors supporting their development. Contributing to the sponsors' strategy can justify why a sponsor allocates resources to the project (subsidies or land), and is also relevant when evaluators need to justify project selection to their hierarchy. *Compliance with urban agriculture regulations* is also a criterion linked to the specific nature of PIUA stakeholders. These regulations are most often derived from classical agricultural regulations, with which sponsors and project leaders with few ties to the farming world are sometimes unfamiliar.

Our study suggests to consider innovation as a sustainability dimension relying on five criteria related to the evolution of knowledge (*Ability to generate new knowledge*, *Ability to disseminate new knowledge*, and *Replicability of the project*), and the originality of the project (*Project involving an innovation* and *Novelty of the project*). These criteria are consistent with some criteria proposed by Le Masson et al., (2010) to assess an innovative design process: by evaluating the *Ability to generate new knowledge* and the *Ability to disseminate new knowledge*, we assess the Value of knowledge generated by the projects, and by evaluating the *Replicability of the project,* we assess the Robustness of the concepts and knowledge generated. These criteria are particularly important in PIUA as the sector is fairly young. Indeed, PIUA often requires the implementation of new technologies about which very little is known (Orsini et al., 2020; Specht et al., 2013). Consequently, existing projects are actively involved in creating and capitalizing on knowledge on various issues linked to urban agriculture. Some existing tools include a sustainability criterion related to the ability of the farm to adopt a new technology (López-Ridaura et al., 2002), which does not consider social innovation or capacity to create and share knowledge, or a criterion related to the participation in innovation networks (Zahm et al., 2018), which does not consider the originality of a project or its ability to replicate.

Finally, we identified the criterion *Complementarity with the rural farms of the area*, which reflects the sponsors' desire to develop spatial and functional complementarities between rural and urban agricultures, such as selling rural farm's products on an urban farm to offer a more diverse range of products to the consumer. This criteria is relevant as there is a need to consider the complementarity of urban and rural agriculture in land-use planning as pointed out by Valente et al., (2014).

3.3.2. Frequency of use of the sustainability criteria by stakeholders

Looking at the occurrences of criteria in Table 2, we can see that the themes mostly assessed among those related to local sustainability are *Connection with local actors* (8 case studies on 19), *Improvement of locals' living environment* (used by 7 case studies on 19), *Aesthetic quality of the farm* (7 case studies on 19), and *Local consumption of products* (7 case studies on 19). The regular use of these criteria emphasizes the links between a farm and its surroundings, highlighting that PIUA takes place on an ultra-local level, on the scale of a city or even a neighbourhood. Regarding the

contribution to global sustainability, the most used criteria are *Monitoring and limiting of resource consumption* (used by 8 case studies on 19), *Preservation of biodiversity* (6 case studies on 19) and *Recycling and waste recovery* (6 case studies on 19), highlighting that a PIUA project must consider, for numerous stakeholders, environmental issues. The last criterion of the external sustainability dimension which is mostly used is *Integration of the project in the sponsor's strategy*, used by 9 case studies on 19, which confirms that PIUA projects are part of overall strategies, territorial or even national, when they are for instance supported by local authorities or national public stakeholders.

For internal sustainability, the most used criteria are *Amount of investments compared to financing capacity* (used by 12 case studies on 19) and *Robustness of the marketing plan* (11 case studies on 19). The use of these economic criteria by most of the case studies confirms the importance of economic viability and robustness of the financing plan for PIUA projects, no matter what the crops location or cultivation techniques are as the criterion *Amount of investments and financing capacity* is used among others by CS3 (crops ground-based and cultivation soil-based), CS13 (crops located on rooftop and ground-based, cultivation with hydroponics and raised-beds), and CS14 (crops located indoor, cultivating in raised-beds). The realistic nature of the technical proposals, evaluated by 7 case studies on 19 with the criterion *Realistic cropping systems and yields*, confirms that evaluators wish to anticipate the risks that high investments represent, especially as urban farmers are often not coming from the agricultural sector and might lack agricultural skills.

Within the dimension related to the innovative nature of the project, the criterion *Project involving an innovation* is used by 11 case studies on 19, confirming the important link between PIUA and innovation, again no matter what the crops location or cultivation techniques are, as the criterion is used when crops are located on rooftops (CS5), indoor (CS6, CS14), or ground-based (CS18) ; and when the cultivation techniques are hydroponics (CS11), soil-based (CS12) or raised beds (CS6, CSS14, CS18) .

Within the dimension related to the credibility of the project leader, the most used criterion is *Quality and consistency of references of the project leader's team and partners*, used by 11 case studies, which can balance the risk induced by innovation. The project might implement a new cultivation technique or involve a social innovation which represent a risk if few feedbacks of similar projects are available; however relevant and consistent references of the project leader might mitigate this risk.

3.4. The qualitative nature of the sustainability indicators identified

Our analysis identified 138 different indicators used by at least one of the 19 case studies. Some indicators are used by different case studies (such as *Farm site open to the public*, or *Response to a political will*) even most of them are unique and use by only one case study. Some indicators are used by a case study to assess different criteria (such as the indicator *Creation of jobs with permanent contracts* used by CS7 to assess both criteria *Sustainability of contracts for the staff* and *Job creation).*

Table 3 presents several indicators, their related criteria and their source, selected to exemplify the diversity of indicators encountered.

Table 3: Overview of the diversity of sustainability indicators identified

Indicators	**Sustainability criteria estimated by the indicators**	**Source**
Produce 4-5 tons a year of leafy greens	Realistic crop plan and yields	Interview, CS11: "*We have to produce 4-5 tons a year, you can't make a loss, we have to at least ensure the profitability of the products we replace and if possible make a little extra margin*."
Have natural lighting	Limitation of arduous work	Document, CS6: "*Visual comfort: the spaces occupied have natural lighting*"
Implement workshops to test farm's activities	Take-up of the project by locals	Interview, CS18: "*We preferred to test things through workshops [...] with the city's non-profit organizations [...] to see whether there were any advantages for the inhabitants*."
Production and consumption within a 20km radius	Local consumption of produce	Document, CS6: "*Fruit and vegetables produced and consumed within a 20km radius*"
Project leader justifying training in the agricultural field and market gardening in particular	Relevant skills of the project leader	Document, CS3: "*Training in the agricultural field and market gardening in particular*"
Project leader from the private sector	Project involving an innovation	Interview, CS6: "*The private sector is more dynamic, it's the one that creates jobs [...] it would be innovative because there would be the whole aspect of supporting people reintegrating society. Today, most of the time this is handled by non-profits or organizations that are trained to do that*"

We identified indicators of different nature, quantitative indicators and qualitative indicators: of the 138 indicators, only 31 are quantitative indicators whereas 107 are qualitative. Quantitative indicators thus account for just 22% of the indicators recorded.

Table 4 analyses how qualitative and quantitative indicators are spread between the different sustainability dimensions and themes, to estimate which kind of indicators are the most used to assess which theme of sustainability. Note that some indicators are used by different case studies or used by a same case study to assess different themes or criteria: therefore, the number of occurrences – 184 - is higher than the number of indicators – 138.

443 *Table 4: Occurrences of indicators used by the 19 case studies according to their related*
444 *sustainability dimension and theme*

Dimensions	Themes	Occurrences among all the indicators used	Occurrences among the qualitative indicators used	Occurrences among the quantitative indicators used
External sustainability	Contribution to local sustainability	*27*	25	2
	Contribution to global sustainability	*31*	31	0
	Contribution to the sustainability of the sponsor	*10*	10	0
Internal sustainability	Coherence and technical robustness	*28*	22	6
	Consistency and economic robustness	*52*	27	25
	Management of regulatory aspects	*8*	8	0
Innovative nature of the project	Participation in the evolution of knowledge	*7*	6	1
	Originality of the project	*10*	10	0
Credibility of the project leader	Governance robustness	*4*	4	0
	Adequacy of project leaders' profile	*7*	7	0
Total		***184***	**150**	**34**

445

446 Table 4 shows 25 occurrences of the theme *Consistency and economic robustness* among the 34
447 occurrences of quantitative indicators, underlining that quantitative indicators are mostly used to
448 assess economic criteria. However, 27 occurrences of qualitative indicators are also recorded to assess
449 this theme, confirming that qualitative indicators represent an alternative to assess economic criteria,
450 such as *Diversification of the sources of income* or *Farmer paid as city agent*. In addition, qualitative
451 indicators are used to assess a wide diversity of theme, unlike quantitative ones, such as *Contribution*
452 *to global sustainability* (31 occurrences), *Contribution to local sustainability* (25 occurrences), or
453 *Coherence and technical robustness* (22 occurrences).

454 In practice, PIUA actors thus tend to use more qualitative than quantitative indicators to assess the
455 sustainability of projects. Qualitative indicators, especially those reported as “present” or “absent”,
456 informed by “yes” or “no”, and that do not include thresholds, are easier to establish and to articulate.

It is therefore unsurprising that in the absence of a consensual assessment method proposed by scientists, PIUA actors have developed qualitative indicators themselves.

This trend is not systematically observed in the literature, or at least to a lesser extent. Only 25% of the indicators used in the Five Borough Farm tool are qualitative (Altman et al., 2014), against 55% in the FADEAR tool (FADEAR, 2013) and 62% in the IDEA method (Zahm et al., 2018). However, our results support the conclusions of some studies which stress that qualitative indicators are essential for evaluating sustainability, alongside quantitative indicators, as they allow for better inclusion of stakeholders' values and practices impacting their capability to implement sustainability (Scerri and James, 2010). Likewise, they align with the finding that qualitative methods are in the majority for the assessment of the socio-cultural benefits of urban agriculture (Ilieva et al., 2021).

3.5. Identification of three groups of cases studies according to assessment practices

The last stage of analysis focused on the links between case studies and themes, criteria and indicators used for assessment. In other words, we wanted to know whether certain assessment situations led to the use of specific themes, criteria and indicators.

A Hierarchical Clustering divided the case studies into three groups, each group including case studies with similar trends in the number of themes, criteria and indicators used as presented in Figure 4. Group 1 includes five case studies (CS3, CS5, CS6, CS14 and CS15), Group 2 gathers nine case studies (CS1, CS2, CS4, CS7, CS9, CS11, CS12, CS17 and CS19) and Group 3 includes five case studies (CS8, CS10, CS13, CS16 and CS18).

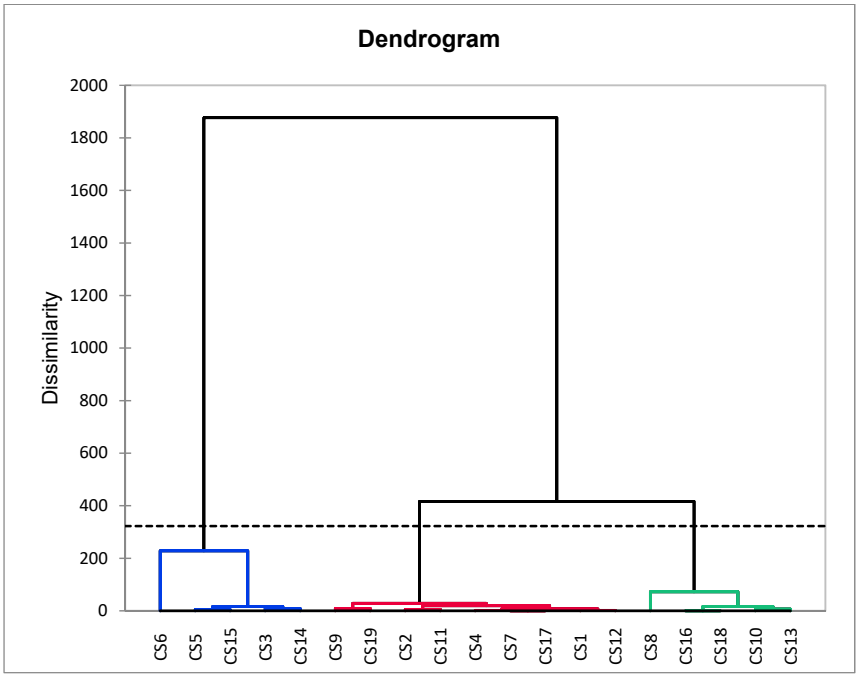

Figure 4: Dendrogram of the Hierarchical Clustering – Group 1 in blue, Group 2 in red, Group 3 in green.

479 The characteristics of the groups are presented in Table 5.

480 *Table 5: Features of the three groups of case studies identified by a Hierarchical Clustering,*
481 *according to (a) the average number of criteria and indicators used, and (b) the average occurrences*
482 *of criteria per case study according to their related sustainability dimensions and theme*

	Group1	Group 2	Group 3
Average number of criteria used	29.4	7.4	14.0
Average number of indicators used	17.0	3.2	12.4

483 (a)

Dimensions	Themes	Average occurrences of criteria per case study		
		Group 1	Group 2	Group 3
External sustainability	Contribution to local sustainability	8.4	2.9	3.8
	Contribution to global sustainability	4.6	1.1	1.6
	Contribution to the sustainability of the sponsor	1.2	0.3	0.8
Internal sustainability	Coherence and technical robustness	5	0.4	0.6
	Consistency and economic robustness	3.8	1.2	3.8
	Management of regulatory aspects	1.4	0	0
Innovative nature of the project	Participation in the evolution of knowledge	1.4	0.2	1.2
	Originality of the project	0.8	0.4	0.8
Credibility of the project leader	Governance robustness	1	0.1	0.6
	Adequacy of project leaders' profile	1.8	0.7	0.8

484 (b)

485 Group 1 includes 5 case studies, using the highest number of themes, criteria and indicators to assess
486 their projects. This group uses in average 29 criteria to assess sustainability, underlining that the
487 evaluators of Group 1 have a precise idea of the kind of project they expect. Indeed, within this group,
488 the selection processes are calls for projects and closed competition, processes used when evaluators
489 already know precisely the PIUA project they want to implement. Group 1 uses the most indicators
490 (17 in average per case study), several criteria related to *Coherence and technical robustness* (5 in
491 average) and is the only group to use criteria related to *Management of regulatory aspects*, suggesting
492 that the evaluators have advanced knowledge about technical and legal related issues. This is
493 confirmed as all the case studies of Group 1 call in external expertise in urban agriculture, either
494 during the selection process, or both before and during the selection process.

495 The second group includes 9 case studies, using the lowest average number of criteria and indicators
496 (7 criteria used in average per case study and 3 indicators). Among the 9 case studies, 7 did not call
497 any external expertise in urban agriculture, which can explain the low number of criteria and
498 indicators used. In this group, 4 case studies ended up in several projects and 5 in a unique project; and
499 the group includes the 2 case studies where projects are implemented through a mutual agreement

between sponsors and project leader. Therefore, the low number of criteria might not only be linked to the lack of expertise in PIUA, but can be a deliberate strategy: some case studies might use few criteria as they concern different sites of implementation, or as they will create the criteria during the process of project elaboration. Case studies of Group 3 uses most of their criteria to assess external sustainability and more precisely *Contribution to local sustainability* (2.9 occurrences representing 39% of the occurrences for this group, Table 5) and *Contribution to global sustainability* (1.1 occurrence representing 15% of the occurrences for this group), underlining that these topics are of primary concern for evaluators even when the project is not defined, and may be their first motivation to implement a PIUA project.

Group 3 includes 5 case studies, using an intermediary number of criteria and indicators compared to Group 1 and Group 2 (average of 14 criteria and 12 indicators used by case studies). Four of the five case studies of Group 3 involved external expertise in PIUA either during or before and during the selection process of projects, explaining why this group uses more criteria and indicators than Group 2. Case studies of Group 3 also implemented selection procedures such as call for expression for interest and calls for applications, which are selection processes that allow a wide variety of project proposals and are generally launched when the project idea is not totally mature. This can explain why the number of criteria and indicators used is lower than in Group 1. The case studies of Group 3 focus on *Consistency and economic robustness* (average of 3.8 criteria representing 27% of the occurrences) suggesting that economic aspects are a major concern for evaluators.

The three groups use different kinds and amounts of criteria and indicators to assess PIUA projects. A first hypothesis to explain it could be the co-evolution of the project and the assessment process: the process of assessing PIUA projects is not fixed in time, but evolves alongside the project. The way in which the sustainability of a PIUA project is assessed changes as the project progresses, adapting to the evolution of the project. The clearer the project idea is, the more accurate and specific the criteria to assess it can be. This is the result of a dialogue between stakeholders involved (sponsors, project leaders and experts), and represents a process of mutual learning between them. Thanks to discussions, they refine the characteristics of the project itself, the way it is perceived as sustainable, and of the criteria to assess it. In our study, Group 2 could represent the first stage of evolution, based on project ideas and few criteria, then Group 3 the second stage of evolution, when the project idea is a bit more mature and criteria more diverse, and Group 1 the third stage where project proposals are defined in details and criteria to assess them precisely designed. The need to adapt the assessment method to the project cycle has already been highlighted in the context of the assessment of the innovation's social impact (Molecke and Pache, 2019). McConville and Mihelcic (2007) have also developed a matrix to assess water and sanitation project sustainability combining sustainability factors and project life-cycle stages. However, no existing method to assess farm sustainability suggests different sets of criteria according to the project development stage (Grenz et al., 2009; Schader et al., 2016; Scialabba et al.,

2014; Zahm et al., 2018), whereas the need to develop a temporal dynamic assessment of farm sustainability has been described (Chopin et al., 2021).

A second hypothesis to explain the disparities between the three groups regarding the number and type of criteria used could be that evaluators adapt the design of criteria to their use. In some situations, a large number of criteria and indicators is needed to explain why a project should be selected, when an evaluator needs to convince a supervisor or a local politician. A diversity of criteria can also be needed when the design of a project is the result of a collective process involving stakeholders who may have different objectives. Both situations are represented in Group 1 where the case studies involve local authorities as sponsors with different partners and external expertise, suggesting that the decisions to design and select PIUA projects involved various actors and needed to be well justified as it involved public investments. In other cases, few criteria and indicators are needed, as the evaluators do not want to design the project in details, but want to allow another stakeholder to do it without too many constraints and to foster innovation to receive original project proposals. A small number of criteria can also be formulated when the decision to select a project does not need to be thoroughly argued or when project criteria will be the result of a collective learning: this is the case when a project is selected by a single actor or based on mutual agreement between different stakeholders. Both situations are present in Group 2 where external expertise rarely called upon and mutual agreement used, highlighting more individual and intuitive decisions than in Group 1, which needs less justification.

Our study is part of a project aiming at designing a specific tool to assess the sustainability of PIUA. As discussed by Cerf et al. (2012), when a new tool is designed, acknowledging diversity among the uses implies to introduce flexibility into the tool. In our case, the three groups of case studies identified confirmed a diversity of assessment practices (using more or less criteria and indicators, focusing on different sustainability themes) and suggests a diversity of uses for the assessment tool to be designed. Flexibility means that the assessment tool will provide information relevant for a diversity of decision contexts (for different stages of project development) and operating methods (whether the assessment is made collectively or not, to support the design of a project, justify its selection, assess its potential impacts etc.). Many studies pointed out the low level of use of decision support tools due to the gap between the way designers elaborated the tool and the way users make decisions (Díez et al., 2009; McCown, 2002; McIntosh et al., 2007), therefore our study enriches the understanding of users' assessment practices, that should be taken into account for the design of a flexible tool to assess sustainability of PIUA projects.

4. Conclusion

The rapid development of PIUA projects is generating the need to assess their sustainability. Stakeholders such as sponsors, project leaders and PIUA experts have developed their own assessment

practices. This study examined these practices with a view to shedding light on the original features of the assessment of PIUA projects' sustainability as implemented by the actors involved. The analysis of 19 case studies allowed us to identify four dimensions of sustainability used to assess PIUA projects: external sustainability, internal sustainability, credibility of the project leader, and innovative nature of the project – the last two of which are original in the context of sustainability assessment in agriculture. We also identified 67 assessment criteria, some of these being particularly original, compared to the classical methods of assessment of agriculture: for instance, a project's contribution to the appeal of its neighbourhood, its complementarity with the rural farms in the area, or the freshness of its produce. Finally, we showed that assessment practices differ among case studies by identifying three groups of case studies, some using a large number of criteria and indicators, other only a few, and focusing on different sustainability themes. This diversity of practices seems to be linked to an evolution of assessment practices over time, and to the variety of assessment situations. The sustainability assessment practices of PIUA stakeholders are proving to be a source of innovation, to feed urban agriculture sustainability assessment; and our conclusions confirm the need for an assessment tool where criteria and indicators used can vary according to the project stage and the assessment situation. We are aware that the set of criteria and indicators identified based on 19 case studies is not comprehensive, however it can be a basis to design a tool for assessing the sustainability of PIUA projects, which will be completed by supplementary criteria identified by local stakeholders as relevant for their specific situation. In this perspective, the assessment tool should be very flexible, both to sort the relevant criteria and to complete the list of criteria, matching with the diversity of stakeholders' practices and expectations.

Declarations

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Conflicts of interest

The authors declare that they have no conflict of interest.

Ethics approval

This study involved interviews with human participants. It didn't include any health-related experiment or private data questions, thus it is not concerned by the Helsinki declaration on medical research ethical questions.

Consent to participate

Informed consent to participate was obtained from all participants included in the study.

Consent for publication

Informed consent for publication of the results was obtained from all participants included in the study. The data published about the case studies were anonymized for their publication.

Availability of data and material

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Code availability

Not applicable.

Authors' contribution

Conceptualization and methodology P.C., A.F.L and J.M.M. Data collection, analysis, writing P.C. Review and supervision A.F.L and J.M.M.

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