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A Conceptual Framework of Living Labs for People for Sustainable Food Systems

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ABSTRACT

Innovation spaces are often dominated by linear, top-down approaches, with the transfer of technology being seen as the solution to many problems rather than trying to understand which innovation processes people are engaging with themselves. In other words, barriers to progress are typically viewed as issues of technology adoption, not as part of the innovation process itself. This study contributes to changing the paradigm by proposing a living lab approach, which considers innovation as an adaptive process where stakeholders co-produce knowledge and collaborate based on inclusivity and empowerment. Our specific concept for this approach is called a Living Lab for People (LL4P). This conceptual paper outlines a framework to guide the development of a LL4P that remains flexible to be adapted for specific sites. While we seek to identify common denominators, we recognize the necessity for such a framework to remain open enough to be adaptable for varied contexts. Consequently, the framework draws on the living lab literature but tailors existing approaches for sustainable food system transformation and puts people (men, women, and marginalized groups among key food system actors) at the center of innovation processes with a clear intention to address power and social inequity. We draw on specific cases in China, Colombia, Kenya and Vietnam as learning grounds for formulating LL4Ps through locally led innovation processes. Based on our learnings and consultations, we define a LL4P as an inclusive and diverse space for people to advance their socio-technical innovation processes and associated modes of governance within a facilitated organizational structure. The principles of LL4Ps include co-production, gender equality and social inclusion, governance and institutional sustainability to advance existing and novel innovation processes. The practical experiences from applying this framework in the four case studies indicate alternative pathways for transforming the food system toward a sustainable and socially equitable trajectory through the establishment of a LL4P.

Keywords: Living lab, Innovation process, sustainable food system, co-production, gender and social inclusion, Governance, Institutional Sustainability, China, Colombia, Kenya, Vietnam

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1. Introduction

Innovation over time has become a term with many meanings, but despite much more differentiated work being done around innovation theories, the more generic, common understanding remains that innovation must have - or be - something new and emanate from somewhere else. This suggests that innovation is “a thing”, and that there is a differentiation between the people who can come up with innovations – the innovators – and the ones who are supposed to adopt these innovations on the receiving end – the “beneficiaries”. The latter is a term used with the implication that there is somehow a presumed benefactor supporting the people subsumed under this term “beneficiary”, who are people in need of support, and in somewhat dire circumstances, often accompanied by images of poverty (Bhati, 2023). These images originate at a time where colonial structures and thinking were still prevalent and often not openly challenged. More recently, however the need for decoloniality of international research, NGOs and development studies has been discussed intensively, though the focus of the discussion remains in Northern higher education institutions (Biekart et al., 2024; Melber et al., 2024). Decoloniality however becomes a must for all involved, if we want to pursue a path that overcomes the consequences of imposed structural adjustments to poorer economies, and other negative consequences of an expanding unilateral world order and certain concepts of worldviews, economic and political thinking as well as societal norms and framings that are imposed or infused into comparatively less powerful parts of the World (Melber et al., 2024).

An institutional shift within the CGIAR to ‘decolonize’ agricultural research is under debate (Gewin 2022). Concretely, for an organization like the CGIAR, this would mean that the structures, the people in charge, the strategies, and the goals and modalities of their work need to be determined by the societies they operate in, and not entities like donors, international organizations and governments rooted in another, more powerful part of the world. It means not only giving more visibility to national researchers, in decolonizing through authorship and representation, but also giving space for alternative ways of knowing and thinking (Gewin, 2022; Habermann, 2014). In reality though, many international organizations still perpetuate a more traditional approach with a linear, and top-down oriented thinking of how development and innovation work – but more recently, there are attempts both from the outside and from within to question this framing and to introduce alternative views (Crane, 2014; Glover, Sumberg, Ton, Andersson, & Badstue, 2019; Habermann et al., 2022; Habermann, Vogl, Mekonnen, Bekele, & Felt, 2021; Woltering & Boa-Alvarado, 2021; Woltering et al., 2022). More generally, there are many calls to heed a more intersectional approach to research and research methodologies: an approach that considers the interplay of race, gender, nation or class in granting or not granting legitimacy to different ways of knowing in order to “*avoid reproducing asymmetries of power that are too often left unquestioned even by progressive ideologies*.” (Malllard, Eggel, & Galvin, 2021, p. 1).

The current global food system has manifold social, economic, and environmental shortcomings. Corporate control, excessive Greenhouse Gas (GHG) emissions, inequality, price

instability, poor diet, and food insecurity are just a select few problems that define the current food system (Béné, 2022; McMichael, 2009, 2013; Webb et al., 2020). Innovation is often considered as a driver of food system transformation. Innovation on its own however will not deliver a sustainable, low-emission food system (Béné, 2022). A much more radical re-thinking of how we can achieve a food systems transformation is needed (Béné, 2022) .

> *[…] while innovation is often presented as a 'game-changer', we show how the current profit-driven nature of its evolutionary selection creates a random, adirectional, process incapable of steering food systems towards sustainability. We argue that unless those different issues are tackled all together in a resolutely normative, global, and prescriptive manner in which science would have a new role to play, there are serious risks that the Great Transformation will not happen.* (Béné, 2022:7)

When dealing with complex challenges, decision-making on food systems transformation requires an approach based on co-production: Co-production is not merely a process of joint data collection, it is a multi-stakeholder process that requires documentation and analysis of social processes, which then helps to foster collective socio-technical change, and a shared understanding of what prevents this kind of change to happen (Akpo et al., 2014). Such processes integrate diverse participants, the best available knowledge, and reconcile their values and preferences, as well as creating ownership – nevertheless they can be time-consuming, costly and opposed by some who believe this to be at the expense of scientific rigor (Neef, 2008; Neef & Neubert, 2010; Norström et al., 2020). Part of this paradigm means going beyond the dominant technology transfer where the innovator hands over a developed technology to a recipient for adoption (Glover, Sumberg, & Andersson, 2016). We challenge this dominant paradigm that pits the binary of users and technologies in separate domains as the process of innovation by engaging with stakeholders who value transformative change. We propose a future where we address wicked problems with complex, flexible and responsive approaches that provide spaces for citizens to be visionaries for their own future food systems. Wicked problems can be problems associated with climate change; they are called wicked problems due to their complex and uncertain nature, and the interdependencies that characterize them (Davies et al., 2015).

A framework for innovation that has gotten increasing attention over the last decade is the concept of Living Labs (LLs). LLs are part of a broader method of participatory action research and experimentation. LLs facilitate collaborative research environments with numerous participants that center their experience and knowledge in the innovation process. The concept has developed from different co-participatory research process developments that have increased the level of engagement of actors in research through time. Under the approach stakeholders change from being adopters of technologies from the 'outside' to co-developers and decision-makers of the actions developed because of this research. LLs are open environments or spaces where innovation takes place in real-world settings. The approach is to take experimentation and innovation out of the formal, controlled 'laboratory' environment and

into the real world[1]. Most innovation and scaling happen in projects that create controlled and enabling contexts in which it is hard for innovations to fail until they face real life conditions: these pilot environments do not reflect the real-world conditions (Woltering et al., 2019). The knowledge gap is then how to support so-called real conditions in real life so that it addresses not only the challenges innovation will face, but also responds to the needs and interests of the relevant stakeholders that will be part of the development and scaling of this innovations in the long-term.

The concept and development of LLs has grown markedly over the past decade or so. Literature on LLs typically credits William J. Mitchell, a Professor of Architecture and Media Arts and Sciences at the Massachusetts Institute of Technology (MIT) as the first one to use the term in the 1990s, although some trace the concept back to 1749 (see Leminen & Westerlund, 2019). At the most basic level, LLs are spaces where open innovation and co-creation occur by centering "users" (and their experiences) within everyday environments, commonly referred to as "real world settings"(Steen & van Bueren, 2017). Understanding who the "user" is and which role "users" are playing in a LL is an often neglected issue: our understanding follows critical Science and Technology Studies (STS) where technologies are recognized to respond to the fluidity of the social context they are embedded in (Akrich, 1992, 1993; Glover et al., 2016). This leads us to look at a whole set of framings, narratives and powerful agendas not openly discussed with people as potential "users" or "clients" of technologies, but also innovation systems or innovation processes (Cornwall & Gaventa, 2001; Glover et al., 2016; Oudshoorn & Pinch, 2003). This neglects the frequent observation that "*the practice of new methods, use of new tools and learning of new techniques is a multidimensional process that involves learning through observation, reflection, selection, experimentation, and adaptation. It involves much more than simply unpacking a technology package and 'plugging it in' or 'switching it on'*." (Glover & Sumberg, 2016).

Thus, if we talk about "users" in the context of a living lab they are acting on behalf of their interest, who can also "re-inscribe" their own visions into the living lab (Akrich, 1992): the design laid out (by the designers, often scientists or technology developers) "inscribes" a certain vision into a technology, or a social process. This vision is then often "described" by the users. The original idea of the designers becomes displaced by a new script developed by the users – a technology designed for one purpose may then be used for another purpose the designers had never thought of themselves (Akrich, 1992). The same can apply to social processes, institutions and even organizations: users can change, and they can instigate change. Users are not only people waiting to be given, to be taught, they have their own agency and drive to transform how they are being governed, what technologies they are offered to use, or told to use, how to self-organize. Users are not just receivers, they have their own visions of how to live in a food

[1] What we mean by the "real world" refers to settings where most, if not all, factors are not directly controlled for the purposes of scientific experimentation. These settings stand in contrast to laboratory settings where instruments and techniques are used to control for factors that could change results for scientific experimentation.

system, how to govern a food system. Therefore, we seek to shift the focus of living labs to the user as the central agent of change in transformative innovation processes.

To better understand how others integrate and position users in their living labs, we conducted a critical review[2] (Grant & Booth, 2009) of the academic and grey literature on living labs. The review helped us to identify the state of knowledge on the concept and gaps in theory and practice. We drew four conclusions from living lab literature which are highly relevant for the design of LL4Ps: 1) living labs have only recently been applied to sustainable food system transformation 2) a vast majority of living labs are in the European or North American context; 3) living labs often lack an explicitly focus on delivering benefits for participants; 4) living labs implementation pays insufficient attention to addressing issues of power and equity in multi-actor spaces. To respond to all these shortcomings, we have developed a novel approach we call a Living Lab for People (LL4P). For our own work, we understand innovation as an open concept for a process where innovation can be as much a social process and a way of working together as it can be a change in production or a mere product – it is about a space, virtual or physical, where people themselves develop new ways of thinking and doing. Our understanding is based on elevating the voices of and empowering historically marginalized populations, such as women, youth and underrepresented groups, in the process of food system transformation. These are the groups who are disproportionately affected by the current food system and, as such, their perspectives should be valued and reflected in a co-productive approach to innovation.

The LL4P approach is inspired by locally led innovation, in a bottom-up, process and action-oriented manner. Through such a people-oriented approach, food system transformations will not only embody a new mindset with a new set of norms, but also facilitate a change in governance to strengthen local actors and institutions and address power imbalance. Hence the focus is not on products and technical innovations, it is much more on how local actors and institutions can work together in the way *they* want, and for a future *they* want.

While our thinking aligns with the understanding of other related concepts such as agricultural innovation systems (AIS) as a network of different kinds of actors from individual to organizations, and even companies, there are still noticeable differences. The type of network AIS is addressing comprises institutions and policies in various sectors that facilitate the social and economic use of new products, services, processes, and organizational structures. In this understanding, the focus is more on the enabling environment and the actors enabling innovation to happen. And this is also where its challenge lies: for AIS to work, it needs to address sector specific issues around policies and systemic barriers, that have to be solved more on a top-down than grassroots level – while the demand can be expressed from there, the

[2] According to Grant & Booth (2009) a critical review "aims to demonstrate [that the] writing has extensively researched literature and critically evaluated its quality. [it] goes beyond mere description to include degree of analysis and conceptual Innovation…" (p. 94)

solutions are often deeply structural and cannot be solved by locally-led initiatives. (Gutiérrez Cano et al., 2023; IFPRI, 2023)

This is where our suggestion for a LL4P can help fill a critical gap in the innovation process: our focus is on locally led innovation processes operating, at least initially, within the framework of existing policy agenda (i.e., national priorities) that later may evolve to influencing policy and systemic issues on a political level. While these locally led innovation processes can embed specific products or production modalities into their agenda, they can also be innovative modes of governance, of working together in groups or networks, and simply in a new approach for people to collaborate and come up with better ideas and solutions for their own futures.

This difference also applies to AIS related innovation oriented concepts such as innovation platforms (Schut, L., Kamanda, Sartas, & Leeuwis, 2019). While they aim to create more coherence among different stakeholder groups, their focus is mostly on identifying problems and solutions with an innovation objective but often on a higher level than what a LL4P would be addressing, because as to their nature they are embedded in existing governance systems that are then also expected to play a part in implementing the solutions – this has in the past often created high expectations at the outset, but then innovation platforms rarely survived the project periods of their initial development (Kaleb & Habermann, 2015).

We draw on the "niche innovation concept" (Geels, 2002), where users have special demands and are willing to support emerging innovations in their different natures. Geels (2002) proposes that transformative change can be pushed through the development of "niche innovations" that propose alternatives to the different regimes of the system. Moreover, not every niche innovation is transformative. There are three transformative ways to innovate according to Ghosh et al. (2021): building and nurturing niches, expanding and mainstreaming niches, and opening up and unlocking regimes.

At the same time, the LL4P concept understands that different stakeholders come together with their own mental models, interests, knowledge, assets, and power. Therefore, we consider the LL4P as an inclusive and diverse space for people to co-produce, test, demonstrate and advance their socio-technical innovation processes and associated modes of governance within a facilitated organizational structure toward a common goal. While technology has been the focus of innovation investment by many development organizations, significantly less attention has been paid to social and organizational innovation processes to ensure the inclusiveness and equitability of innovation agenda setting and consequently the impact and sustainability of such innovation processes. In the next section we explain the methods applied to define this conceptual framework. We then provide a review of relevant LL literature to outline the gaps identified above. We then turn to some of the key principles that define the LL4P concept and approach. Lastly, we detail the four unique and diverse contexts where LL4Ps are being developed.

2. Methods

The development of the LL4P conceptual framework went through several stages. Based on a critical review of the LL literature and consultations with national stakeholders, the need to

adapt the conventional LL concept became immediately clear. We realized there were some shortcomings in a more conventional LL approach for the objectives of our work. A more people-oriented approach with a bottom-up perspective was needed to guide the participatory action research in four Global South target countries, China, Colombia, Kenya and Vietnam. This approach is part of the CGIAR Research Initiative on Low-Emissions Food Systems also known as Mitigate+.

Based on exchanges with representatives of an existing living lab implemented by a Kenyan and a Dutch university, we decided to develop a more people-oriented approach with a bottom-up perspective. We set up an expert panel that was tasked with the development of a conceptual framework for the LL4P concept. We then conducted a critical review of the LL literature with a specific focus on LLs in the context of food systems/agriculture and developing countries. The papers were identified using Google Scholar and the Web of Science through individual and combinations of keywords, including “living labs”, “agriculture”, “food systems” and “sustainability”. Additional literature was added to the review through snowballing the bibliographies of existing academic articles and grey literature. We then analyzed the collection of literature by looking for how they considered issues of development, inclusiveness, power, food systems change and delivering benefits to living lab participants.

Additionally, internal reflections were carried out among scientists involved in the project, using semi-structured questionnaire informed by the four dimensions of key characteristics of LLs (Steen & van Bueren, 2017): aim, activities, participants, and context. Such deliberate, structured reflection exercise provided important insights on the alternative framings in response to the contextual differences of the sites that influence how each LL should shape up.

Based on these insights, we then proposed a definition for LL4P and collated a set of normative principles, noting how they interrelatedly contribute to the overall design and implementation of the concept for innovations for sustainable food system transformation. The next section provides an overview of the findings from this process.

3. Literature Review

In the literature reviewed, we found that there are several key features that distinguish LLs from other research and innovation discourses. It is important to note that many initiatives are called LLs, but in this paper we consider living labs to be iterative collaborative platforms involving co-creation and experimentation by various actors from research, government and business, and citizens, working together in a real life context (Bouwma et al., 2022).

First, in literature LLs are characterized by a strong focus on “user” involvement and co-production. Users are perceived not as passive subjects of research, but as being actively engaged in the design, development, and evaluation of new ideas and/or technologies. Secondly, LLs are typically characterized by an open and collaborative approach to innovation. Rather than innovation being the sole responsibility of experts, LL’s encourage open

collaboration between diverse groups of people who may or may not be dividing into different groups according to their needs or stake in the process. Thirdly, LLs are designed to be conducted in so-called “real-world” settings, which allows participants to test and validate new ideas in an ostensibly more realistic socially, ecologically, and economically valid context. This enables in situ innovation to be driven by LL participants, which helps to co-develop better suited solutions and to identify any unintended consequences or other effects. We define stakeholders as the actors and institutions with an interest in the LL or affected by its purposes and activities, while participants are the actors and institutions actively involved and contributing to it.

There is tremendous diversity amongst the literature and the practice of LLs. One of the most cited articles on LLs (Leminen & Westerlund, 2012) proposes four broad types of LLs:

1) utilizer-driven, or the organization or company employing a LL for the purposes of product innovation;

2) enabler-driven, which is typically a LL being used for the purposes of local governments for (improvement of) public service delivery;

3) provider-driven, or universities/research institutions with a specific innovation goal and;

4) user-driven, or a collective interest in innovation around a theme or common purpose.

There can certainly be overlap in these four typologies as LLs can be part of a dynamic process that changes over time depending on the place, participants or problem. Steen and van Bueren (2017) reviewed literature on LLs to analyze the “defining characteristics of urban living labs” which included nine characteristics grouped in four dimensions: 1) aim; 2) activities; 3) participants, and 4) context (see table 1).

Table 1. Overview of the defining characteristics of living labs

Aspects	Characteristics
Aims	Aimed at **innovation**
	Aimed at **formal learning** for replication
	For urban living labs: Aimed at increasing **urban sustainability**
Activities	**Development** (all phases of the product development process)
	Co-creation
	Iteration (feedback, evaluation, and improvement)
Participants	**Public actors, private actors, users** and **knowledge institutes** participate in the living lab activities
	All actors involved have **decision-making power**
Context	The living lab activities take place in the **real-life use context** of the innovation. In many urban living labs, this is a territory or a space-bound place.

Source: Steen and van Bueren (2017)

Ballon and Schuurman (2015) identified some of the key "cornerstones" that have been influential in the conceptual development of the LL over time. The first is "user-driven innovation" and the second is the theory on the domestication of information and communication technology. Neither of those are particularly novel or important for LLs in the case of agriculture and food systems. The narrow focus on "users" assumes that all participants are currently or will be using technologies developed or improved by a LL. LLs that focus on information and communication technology are also less relevant for agriculture and food systems because of the focus on improving existing technological systems, such as mobile networks, applications and infrastructure. Ballon and Schuurman's (2015) third cornerstone is the concept of "stigmergy" which is "addressing complex problems by collective, yet uncoordinated, actions and interactions of communities of individuals." The last cornerstone draws from literature on open and business model innovation that argues for collaboration between private sector actors and other stakeholders to find an open and appropriate "business architecture".

Dutilleul, Birrer, and Mensink (2010) point to five different broad spheres within which a variety of LLs can be situated: 1) an innovation system; 2) a real-life social setting; 3) an approach for user involvement in innovation; 4) an organization facilitating LL approaches and 5) the European LL 'movement' (epitomized by the European Network of Living Labs). These categories can be understood as being amongst the highest level or broadest way to distinguish

between the operationalization of LLs. Schuurman, De Marez, and Ballon (2015) reviewed 45 peer-reviewed articles that explicitly focus on LLs. In terms of the frameworks adopted between those articles, they distinguish between “open innovation” (11), “user innovation” (17), “user centered design/participatory design” (19) and “none” (18). The most common characteristics they identified for “open innovation” included: 1) exploration, or activities oriented towards capturing or benefitting from “external sources of knowledge”; 2) exploitation: going beyond the organization or host to leverage existing knowledge/technology; 3) retention: containing or circulating knowledge over time beyond the organization or host. “User innovation” is distinguished between two types: 1) innovation for users and 2) innovation with users. The former is characterized by passive user feedback incorporated by the designers to center their feedback in design creation and subsequent revision. Innovation with users, on the other hand, refers to a co-creation process where designers/manufacturers actively collaborate with users in an iterative manner.

Participatory design and the remaining studies categorized as “none” are not elaborated and therefore could be quite vague. However, the literature does point broadly to a preference of open innovation which, according to Schuurman et al. (2015) makes the concept resemble an something like an empty container where one can add whatever one feels fit. Viewed broadly, the concept of LL does seem to lack directional principles to deal with important components of a generative research process such as inclusion or power. Even without any such guidelines, LL literature also fails to engage significantly with how such issues of inclusion, power, or other intersectoral concepts might be constraints or opportunities for innovation with few exceptions (Bulkeley et al., 2016; Dutilleul et al., 2010; Menny, Palgan, & McCormick, 2018; Nguyen, Marques, & Benneworth, 2022).

In terms of the role of the participants (or users), LL literature makes important distinctions on the appropriateness of design. For example, Schliwa and McCormick (2018) distinguish between “user-centric” and “citizen-centric” LLs. The former tends to be at a smaller scale (e.g., home, office of neighborhood) with a shorter-term project cycle and focuses on the development of a specific product or “service system” through experimentation. “Citizen-centric” LLs, on the other hand, tend to be at a larger scale (e.g., campus, city or region) with a longer-term horizon that intends to more systematically integrate participants at all stages of the project. Therefore, the goal of a “citizen-centric” LL also tends to work on collectively identifying and innovating solutions to be more transformative within the project’s bounded area (i.e., working on sustainability).

Overall, the literature on LLs suggests that this research and innovation methodology has the potential to generate significant value for both researchers (Almirall, Lee, & Wareham, 2012; Dell’Era & Landoni, 2014; Leminen & Westerlund, 2012) and users (Bridi et al., 2022; Habibipour, 2022; Soliman-Junior, Awwal, Ayo-Adejuyigbe, Tzortzopoulos, & Kagioglou, 2022). By involving stakeholders and prospective users in the co-production and evaluation of new ideas, LLs can help researchers to better understand and address the needs and preferences of

their target audience, and to develop solutions that are more relevant, feasible, and desirable. However, there are several challenges and limitations to the LL approach, including the need to manage and coordinate the participation of multiple stakeholders (Leminen, Nyström, & Westerlund, 2015; Leminen & Westerlund, 2012), the difficulty of scaling up successful innovations (Guzmán et al., 2013; Pfotenhauer et al., 2022; Plassnig et al., 2022), and the potential for bias and subjectivity in the evaluation process (Kareborn & Stahlbrost, 2009; Nyström, Leminen, Westerlund, & Kortelainen, 2014).

Existing reviews of LL literature point to the creation of the European Network of Living Labs (ENoLL) in 2006 as the first institutional commitment to design and implement LLs at a significant scale (Hossain, Leminen, & Westerlund, 2018; McLoughlin et al., 2018; Westerlund, Leminen, & Rajahonka, 2018). (Gamache et al., 2020) reviewed 763 articles that mention the term “Living-lab” and found significant Eurocentrism both in the origins and application of the concept. Of the articles they analyzed, 600 (or 78.6%) represented LLs in Europe, 50 (or 7.0%) from the United States and 118 (or 12.0%) from “other countries.” The journal representation is heavily skewed towards the disciplines of computer science, information science and communication technology, with only 15.9% relating to “green, sustainable science technology” in the most prolific years of publishing on LLs analyzed (2017-2018). Furthermore, LLs in practice and in literature tend to have an urban bias.

LLs in non-EU geographical contexts and those with differentiated objectives are now starting to fill gaps in the literature for how LLs are deployed outside of the “European movement”, and what are the different characteristics these LLs require which is where the concept really gained momentum. This is precisely the aim of Galway et al. (2022) who argue that if LL are going to be leveraged for social and ecological justice then the concept needs to advance in four directions: 1) expand across a greater diversity of settings; 2) critically analyze and contribute to improving governance and power dynamics; 3) explore learning over time under co-creation and; 4) examine the role of academic institutions to impede or support the previous three directions. Indeed, these directions identified by Galway et al. (2022) are some of the cutting-edge topics currently being discussed in the LL literature that has advanced significantly beyond the ”European movement”. These are precisely the gaps our concept of Living Lab for People (LL4P) intends to fill, both conceptually and in practice.

4. The Living Lab for People Principles

The LL4P approach avoids the imposition of ideas by supporting and sharing existing locally led innovation processes. LL4P marshal financial, human and institutional resources to serve as a knowledge brokers in the four target countries and, eventually, beyond. A fundamental challenge for the LL4P is to avoid the all-too-common legacy of development projects where donor-led efforts bring resources and impose ideas only to leave remnants and responsibilities for local partners in a somewhat colonial manner.

Decolonizing research is an often contradictory endeavor (Biekart et al., 2024). Research partnerships are wrought with multiple identities and hierarchies of power where privilege and exploitation can occur (Habermann, 2006; Habermann & Langthaler, 2010; Maselli, Lys, & Schmid, 2006). These are partnerships between different scientific institutions – however once the research moves to a more action-oriented objective it becomes more challenging to remain focused on an equitable and sustainable collaboration (Bekele & Ango, 2015; Habermann et al., 2021; Smith et al., 2010). This is however not a new challenge, even 30 years ago there was already a need to discuss if, "for some professional scientists, 'participatory research' implies that 'we' allow 'them' (rural people) to participate in 'our' research. For community organizers or rural communities, it may mean that 'they' allow outsiders (us) to take part in local land use experiments and their interpretation" (Rocheleau, 1994: 5). These problems persist, even if sometimes disguised under headings of seemingly new concepts that are simply changing the wording, but remain top-down and extractive in nature, nevertheless.

Following the explorative phase and the LL literature review, we agree to initially focus on three basic principles that will be applicable to all four LL4P sites:

1. Co-production
2. Gender and social inclusion
3. Governance and institutional sustainability

The need for a **co-production approach** has been explained in the introduction; a shift on what knowledge counts, where it comes from and who decides what matters and what innovation processes mean implies a shift in power, where the user acquires a much more prominent place than the designers of innovation, and where the users become designers themselves, be it on social processes, governance modalities or actual products.

Secondly, **gender and social inclusion**, social equity and justice are fundamental for the LL4P. If supported by relevant stakeholders and opportunities, a LL4P can adopt a gender-transformative approach. This approach aims to remove normative and structural barriers to gender equality, allowing the emergence of more equal power relationships.

The third key principle of the LL4P approach is **governance and institutional sustainability** for the LL4P – this can be facilitated by embedding the LL4P in a local organization. Depending on the case, this organization is typically involved from the inception of the LL4P and could be a local governmental agency, a Non-Governmental Organization (NGO), workers' cooperative or a locally led movement. Joint learning is part of the conceptual design of the LL4P.

The LL4P takes a governance approach that situates the innovation process within the socio-environmental context of an area and the lived experiences of citizens (Fèche, Noûs, & Barataud, 2021). Because it centers on the participatory engagement of citizens and science, the consideration of the social, environmental, and economic context within which the LL4P is embedded is key. In our understanding, a sustainable and citizen focused LL4P concept ideally is based on strengthening local solutions, emerging from an inclusive and gender-sensitive consultation process with multiple stakeholders. However, what this looks like both in terms of

process and the nature of stakeholder engagement is highly context-specific and will vary at different sites. In some cases, the LL4P may be embedded in a wider governance structure, such as a national governmental initiative. In other cases, it can be managed by a host organization with the mandate to promote local innovation processes, such as an incubator or research agency, that is however capable of looking beyond mere identification of new technologies but has an understanding for innovation as an open concept for a process, where innovation can be as much a social process and a way of working together, as explained in the introduction.

Our approach for the LL4P understands that locally led innovation processes should originate with people who have a stake in a given food system, rather than importing or imposing solutions from elsewhere. By embracing the broad lessons of LLs, it facilitates the active engagement of stakeholders within an open innovation space in a real-world context. By doing so, the LL4P integrates knowledge and governance generated from inside and outside of a given food system for the common goals of the participants involved. The next section provides a rich description of the LL4P concept as the basis for a novel approach to participatory innovation processes, and LLs more generally.

Co-production

Co-production has emerged as a key concept for a plethora of fields of study (Akpo et al., 2014; Carter, Steynor, Vincent, Visman, & Waagsaether, 2019; Chiputwa et al., 2020; Cook et al., 2021; Durose, Perry, & Richardson, 2022; Miller & Wyborn, 2020; Norström et al., 2020; Slater & Robinson, 2020; Sultana, 2021; Vincent et al., 2021). Lately, it has become something of a buzzword: co-production seems to be all over the place, as a bit of a hollow concept (Durose et al., 2022). Part of being everywhere has depoliticized co-production because "*much of the literature on co-production is aspiration*" (Turnhout etal., 2020: 1); it is too often used as a placeholder to signify something being done relationally without much consideration for broader societal issues and power relations. That does not mean the term co-production is not useful. For our research on the LL4P we understand co-production as the process of recognizing privilege and marginalization in the process of collaborative innovation processes. This means that we understand participants in the LL4P have assumptions about what the objectives or outcomes of the innovation process should be based on their own experiences and interests. We aim to be reflexive about our role and how we can attend to power imbalances when involving participants.

To do justice to the food system focus of our work in the LL4P, our approach to co-production is informed by political ecology (Forsyth, 2003; Nyantakyi-Frimpong, 2021; Robbins, 2004), which is an interdisciplinary field of study that addresses conditions and changes in socio-ecological systems with an explicit consideration of power relations (Robbins, 2019). When political ecology is applied to food systems it helps to better understand how history and society influences how people talk about food systems, and whom they see as winners and losers (Jacobi, Villavicencio Valdez, & Benabderrazik, 2021). Such an approach is crucial when looking at co-production of knowledge that aims to change food systems. We argue that the political ecology of co-production in the LL4P helps us avoid 'depolitizing' the innovation process, or treating the LL4P as a space devoid of power and merely an object of development (Ferguson, 1994; Jacobs, 2010; Moncrieffe & Eyben, 2007; Njuki et al., 2022). Rather, we understand that

some participating groups are structurally marginalized by their relationship to the food system, access to productive resources and political power. Therefore, the co-production of knowledge in the LL4P is inherently linked to our principle on gender equality and social inclusion as explained below.

Principles of Co-production: We are committed to endogenous and iterative innovation processes in the LL4P. Nevertheless, we follow Norström et al. (2020) by adopting four principles of co-production: 1) context-based; 2) pluralistic [knowledge]; 3) goal-oriented and; 4) interactive. Our approach considers the multiple and interrelated forms of marginalization inherent to knowledge systems and strives to overcome marginalization through an inclusive approach to stakeholder engagement and by considering diverse knowledge systems. As part of this approach, we support the collective agency of marginalized groups.

Gender and Social Inclusion

A starting point for gender transformative change is building critical awareness among women and men (Rietveld et al., 2022). Both gender-responsive and gender-transformative approaches are informed by an intersectional gender analysis of the local food system, which considers social factors such as ethnicity, age-group, wealth, class and migration status in conjunction with gender.

Elite capture is the tendency of powerful (elite) stakeholders to dominate stakeholder processes, such as stakeholder identification and mobilization (gatekeeping who gets in), influencing the discourse to focus on 'elite' problems and challenges (gatekeeping what is discussed / brought to the table) and manipulating resources/solutions to be directed to benefit the elite. We identify that elite capture is a real threat for the LL4P approach. To avoid or mitigate elite capture we propose understanding and shifting power dynamics across different levels and along different axis. In doing so, the governance structure needs to include a mechanism to understand and anticipate what social identities tend to wield power and which tend to be disempowered. We must be prepared to be confronted with politics and potential contentious situations when the interests of different social groups (or stakeholders) clash. We build support to act in the interest of marginalized groups and observe how this will or will not benefit the community at large.

Gender Transformative approaches can often be perceived by powerful groups as not being in the interest of men, especially when only women's empowerment is emphasized. However, it is not only about gender, but how other vulnerabilities must be recognized with a social inclusion approach. Building support around creating better conditions for non-excluded groups such as men makes inclusion for all – for example, emphasizing positive masculinities.

The LL4P supports an integral approach for addressing gender and social equality by centering those issues when appropriate in every stakeholder discussion/meeting. This helps to ensure an inclusive co-design of innovations and the co-production of knowledge when including reflective questions in the design process. It is important to keep in mind that co-production, in a socially inclusive fashion, often disrupts the status quo. If there is (some) support in the LL4P for striving more actively towards gender equality, specific gender transformative approaches may be organized.

Gender equality and social inclusion: the LL4P strives for a gender/intersectional transformative approach, which aims to dismantle normative and structural barriers to gender equality and other marginalized groups. A minimum standard for considering gender in the LL4P is to raise awareness among women and men about current dominant gender norms and women's and men's gendered roles in the household and community, what this means in terms of equality and how this affects the well-being and opportunities for livelihood improvement of women and men and of households and the communities at large with other vulnerabilities (Oxfam, 2013; UNFPA, 2019). In its stakeholder engagement processes the LL4P will need to ensure meaningful inclusion and participation of both the more dominant and the more marginal social groups in the LL4P area. A first step will be to conduct an intersectional gender and power analysis which can then inform the design and implementation of stakeholder engagement strategies.

Governance and Institutional Sustainability

Stakeholders brought together in the LL4P have diverse (and even disparate) interests, epistemologies, and livelihoods. Governance in a LL4P is embedded in the social processes organizing the contributions to the innovation processes. Emerging from these processes are frameworks or "rules" guiding how decisions will be made. Key for governance is determining how shared objectives will be agreed upon, and how inclusivity and gender responsiveness can be considered in the socio-ecological-technical system context of the LL4P. In other words, these processes are part of addressing the "institutional fit" (Cox, 2012). Institutional fit is important for the LL4P to function as it guarantees that rules have a real purpose, are accepted, and effectively followed.

Our approach treats knowledge and power as relational concepts. Power is not something one person or stakeholder necessarily holds, but it is wielded in different ways over time depending on the context and the involved stakeholders (Muhl etal., 2022). How the LL4P engages different stakeholders can vary from a very bottom-up approach towards institutional development to very loose locally led governance structures. The LL4P concept provides a general framework for institutional hosting, where applicable – in some cases this may involve a physical institution, in other cases the LL4P may be embedded in a wider structure of governance in a food system that has to be defined on a site-specific level. An example for the first was established in the Kenyan and Vietnamese LL4P, and the latter one is found in Colombia and China, as described below.

We developed strategies to promote institutional sustainability for the LL4P. Because there is a tendency of project induced, institution-based development of activities like a LL4P with often little sustainability, this is an important point to consider. Due to the specific aims of the LL4P for food systems transformation there is a need to relate to and contribute towards changing the food system within which it is embedded. However, this only makes sense if this is already an important issue at the site where the LL4P is established – if this is not seen as an important issue on a local level at the outset, then the LL4P loses its meaning and purpose.

As such, the LL4P needs to fit specific socio-ecological contexts, market and non-market relations and cultural norms. Drawing inspiration from a territorial approach, our approach also "aims to reinforce the capacity of agri-food systems to valorize specific territorial resources and social relations of proximity" (Lamine et al., 2012:231). Rather than imposing a new model on the existing political economy of food systems, territorialized governance understands that alternative or 'niche' innovations/practices are already present. Those niches then need to be supported through the partnership to affect broader systematic change.

Under the multi-level perspective, innovative practices are defined as "social niches" that, when supported, can make broader systematic change (Geels, 2011). This approach therefore necessitates an understanding of local power dynamics and productive relations within the LL4P territory. However, whether a LL4P will be sustainable institutionally, depends on several factors, that are to some extent also applicable to the LL4P embedded in a wider governance structure:

1) Does the idea of the LL4P have some resonance in the host organization's mission?
2) Is this expressed in a long term interest of the host organization to maintain the LL4P after the end of the project?
3) Is the host sufficiently equipped in terms of capacities and infrastructure and able to continue the LL4P in the long term?
4) Does the LL4P have political support in the relevant governance structures?
5) Is the host organization financially equipped to maintain the LL4P?
6) Is the LL4P supported by a broad and inclusive range of stakeholders?

Principle of governance and institutional sustainability: an implicit aim of the LL4P is strategic and demand-led support of participating stakeholders. Therefore, both governance structures and principles need to adhere to what is needed for the LL4P to achieve sustainability in its specific socio-ecological context. This can include strategizing and collaborating on long-term financing among different partners, applying analytical tools for participatory innovation processes, science-policy dialogues, and institutional partnerships – ultimately the needs are defined by the actors involved in the LL4P themselves and should serve to consolidate the sustainability of the LL4P on an institutional level. Those governance structures however need to be aligned with principles of social inclusiveness and gender equality, as highlighted above.

5. Applying the LL4P Concept in Different Contexts

The following four case studies describe how the concept of a LL4P is being adapted and implemented in China, Colombia, Kenya and Vietnam at each of the project sites of the CGIAR Research Initiative on Low-Emission Food Systems (Mitigate+). The implementation of the LL4P was at different stages at the time of this publication, with none of them being fully operational. Consequently, some of the processes described below are on-going and cannot yet be fully described. Nonetheless, our intention is to illustrate how the concept can potentially

accommodate specific contexts, and that there is not one singular LL4P model, while still adhering to the foundational principles explained above. The descriptions below serve to illuminate the different context and framings the LL4Ps are embedded and how they managed to apply the LL4P concept at the stage of initial development. The four cases offer windows into the diversity of contexts where the LL4P concept can be adapted by highlighting the strengths of the approach and some of the challenges that remain.

China: Low-emissions Food Systems and Green Growth in a "Future Village"

Background

In China, the LL4P is partnering with universities and the different levels of government in Zhejiang province to support low-emission food system transformation and green growth in Qingshan village. The LL4P is building on the previous success regarding village-scale watershed conservation and eco-tourism through community-level collective action, which has already improved local environmental governance.

One of the key initiatives in China is to explore how low-emission rural development can be enhanced in the Chinese countryside. Qingshan village is in the Southeast of China in Zhejiang Province, just outside of the city of Hangzhou. In 2003, Qingshan was formed when the towns of Lishan, Dongwu, and Tabian were merged in an area of 45.6 square kilometers with 2,662 people. The village aims to promote inclusive sustainable development (including carbon neutrality and low/zero carbon construction) for the sake of common prosperity. For these reasons, Qingshan has been called a "future village" in China. Qingshan is covered by around 80% tree cover (shrub and bamboo forests) and has three medium-sized reservoirs. The village's total income has more than doubled between 2020 and 2022 from 732,000 yuan to 1.5 million yuan, while per capita income has increased from 30,000 yuan to 48,800 yuan in the last 15 years. The main sources of income are land and housing leasing along with tourism and agriculture. 90% of agricultural output stems from bamboo with the other 10% coming from wheat, vegetables, and tea. As tourism has increased, Qingshan has created schools that promote environmental sustainability and built a library on traditional folk design. Partly due to these actions, the village has attracted 80 new residents while 57 have benefited from these industry policies.

Qingshan's "future village" status stems from the national "Ten thousand project" aimed to create beautiful and revitalized rural areas. The aim is to massively improve quality of life for villagers including roads, sanitation, education, low/zero carbon emissions, and income. Between 2020 and 2022, the increases in tourism and government funding improved rural peoples' well-being and increased their collective wealth. Because of the massive amounts of bamboo forest in Zhejiang and Qingshan, efforts are underway to increase coverage both for economic and carbon sequestration benefits. Qingshan is relatively new, having only been created in 2003, and has seen 4 stages of rural development. In the first stage between 2003 and 2014, the main source of income was from cultivating bamboo and rice. However, there are

limited opportunities for growth here and many young people migrated to urban areas, resulting in a generational gap.

Between 2015 and 2016, there was an emphasis on micro-watershed protection through the "Good Water Fund" for the Longwu Reservoir, the main drinking water source for the village. In the bamboo forests around the reservoir the local government reserved land, banned pesticides and compensated farmers at a fair price. In 2016, the results were clear as pollutant levels were dramatically reduced, leading to some of the cleanest water within 50 km. Between 2017 and 2019, the focus was on cross-border cooperation including the Rong Design Library gaining a Qingshan office, the Qingshan Nature School opening, and 20 other similar industries; Qingshan is hence known as an international art and design village. Since 2019, the focus has been on the concept of a "Future Village", or a rural community with a cosmopolitan vision. The village emphasizes people-oriented, local conditions, ecological priority, and cultural leadership for the future. The key stakeholders of the village are the farmers, households, water utility company, governments (local, regional, national, and international), and different investors (Alibaba, Wanxiang Trust, and Nature's Good Neighbor Program) who established the Longwu Water Fund.

Potential low-carbon practices for the village includes: 1) Composting, 2) Overall reduction in the use of chemical fertilizers and emissions from waste burning, 3) Plans to build large scale composting plants and perform a study on health of agricultural areas that use chemical fertilizers vs natural composting, 4) Garden/Courtyard Economy: Aim to make full use of the sloping land to diversify crop yields, 5) Sustainable Rice: 40% of rice paddies in Qingshan are held by 5 large rice growers. Few challenges, however, persist. Residents show signs of basic low-carbon practices but less knowledge of the future village concept. Further development can empower rural revitalization and villager knowledge of these low/zero carbon practices. A limited number of stakeholders have in-depth systematic knowledge and opinions on low-carbon policies and how such policies will affect them.

Specificities of the LL4P

When Qingshan village was incorporated by combining three hamlets in 2003 it has since experienced four stages of rural development. In the first stage between 2003 and 2014, the main income came from cultivating bamboo and rice. Embedded in the fast urbanization and structural transformation of China, many rural dwellers migrated to cities for better job opportunities and left the village decaying. The Longwu Reservoir, which supplies the drinking water for the village, was polluted largely by farming activities. Between 2015 and 2016, the Longwu Water Fund was jointly founded by two local social organizations (the Alibaba Foundation and Wanxiang Trust) and an international NGO (The Nature Conservancy), which embarked on environmental conservation projects in Qingshan. Supported by the village committee, the Water Fund transferred a large proportion of bamboo land in the catchment

area around the reservoir, from farmers and compensated them with a fair price. Pesticides and fertilizers were banned on those lands. The water quality edged up from the third level to the best level by national water standards in 2016. Between 2017 and 2019, Qingshan initiated its path in cross-sector cooperation between residents, NGOs, multi-level government agencies, the private sector, and other local organizations, such as the Qingshan Nature School, the Rong Design Library, and 20 other entrepreneurial initiatives. Since 2019, Qingshan has transformed its focus towards realizing the goal of becoming a Future Village, with particular emphasis on being people-oriented, context-based, prioritizing the eco-environment, and developing cultural influence for the future. A village council was developed by key stakeholders including the traditional rural households, new residents, different levels of government, and NGOs to co-create the future in Qingshan.

Qingshan Village has been designated as one of the Future Village pilots and Low (Zero) Carbon Pilot Villages in Zhejiang Province since 2022. The overall aim of the pilot is to improve villagers' quality of life, including roads, sanitation, education, low/zero carbon emissions, and income. Specifically, piloting Future Villages traces its origin to the Green Rural Revival Program [*qian cun zheng zhi, wan cun shi fan*; also known as *Qian Wan Program*] since 2003, which was implemented to renovate about 10 thousand incorporated villages and leverage a thousand central villages as moderately prosperous models. Villages were encouraged to clean up ditches and to reduce the use of chemicals inputs in agriculture. The leasing of land and houses, tourism, and agriculture have dominated the income sources of Qingshan. For the last 15 years, the per-capita income of the village residents has increased by over 63% from less than 30 thousand yuan. Between 2020 and 2022, the increases in tourism and government funding have supported the people and increased the collective wealth of the village. From 2020 to 2022, the village collective income has more than doubled.

Phases of the LL4P

In keeping with the locally initiated innovations in Qingshan, the LL4P in China is built on the existing nature-positive practices of local stakeholders and therefore envisages four practical phases of progress. The first phase is to identify key stakeholders in the food system of Qingshan, and to understand the interactive relationships and governance model at the village level. China LL4P documented and analyzed the locally initiated bottom-up mechanisms to facilitate village governance, based on extensive literature (policy and empirical evidence) review and field surveys.

The second phase is to unpack and strengthen the shared values among different stakeholders through participatory approaches. China LL4P delineated the stakeholders' perceived low-carbon food systems and captured the major influencers of these perceptions. This phase particularly underlined the inclusion of women when applying the participatory methods. The third phase is to collaborate with local institutions to facilitate Qingshan's composting practice

and plan, garden economy, sustainable rice cultivation practices and Qingshan Creek Agricultural (Paddy Field) Pollution Control Pilot Project. The measuring of carbon emissions at the village scale will be explored, with an objective to use bamboo forests as carbon sink. The progressing of context-based collaborative activities, in accordance with the inclusion of residents (including women, indigenous households, and new villagers), NGOs, the private sector, multi-level government apparatus and so forth, will provide opportunities to work on food-water-energy nexus in the village level.

The fourth phase is for the LL4P output to realize sustainability and provide lessons for "replication" elsewhere in rural China. In the case of financing, the payment for ecosystem services by the beneficiaries could be key. The village-scale methodology for gauging carbon sink and carbon emissions paves the way for developing the carbon sink market and leveraging a beneficiary payment scheme.

Colombia: Creation of Spaces for the Discussion of Sociotechnical Innovations

Background

In Colombia, the LL4P is in the town of La Montañita in the department of Caquetá, a transition region between the Andes and the Amazon Basin. This department plays a central role in reducing emissions in Colombia because of four main reasons (Rodríguez et al., 2023): 1) 72% of its area is still covered by forest (FAO & ADR, 2021); 2) it has one of the highest deforestation rates at the national level accounting for about 26.3% of national deforestation (IDEAM, 2019); 3) the change from natural forest to pasture contributes 84% of the department's total emissions (IDEAM, PNUD, MADS, DNP, & Cancillería, 2016); 4) this is a prioritize department for government interventions as it was highly affected by the armed conflict. In the municipality of La Montañita about 70% of the land has been converted into pastures (SINCHI, 2020), but there are still important remnants of natural ecosystems and the deep intention of communities to transition towards more sustainable production systems.

The LL4P is working with both the cattle/dairy sector and cacao value chains. These sectors have been selected based on the following reasons: their contributions to GHG emissions; the potential to reduce these emissions by sociotechnical innovations; and the promotion of government as alternatives to reduce the pressure on forests and peacebuilding, in the case of cacao. In addition to the purpose of reduce emissions from food systems, the LL4P in Colombia is also aiming to support the strengthening of peasant economies and community participation, as well as food security and biodiversity protection within the farms to assist in the construction of social capital for peacebuilding in a region that was highly affected by the long term Colombian internal armed conflict.

Specificities of the LL4P

The LL4P in Colombia is in a region that has been highly affected by the internal armed conflict for about five decades. As a region affected by conflict, and where many governmental and non-

governmental projects and initiatives have been taking place (sometimes damaging more the social tissue), the LL4P in Colombia requires a strong emphasis on building trust with the community, and in building on existing social processes and participatory arenas that aim to promote peace and sustainability. Therefore, the basis of the work is done at the community level and with peasant organizations where the most vulnerable and socially excluded people are located and where the internal armed conflict had the most deleterious effects (Bautista Revelo et al., 2022).

In Colombia, women represent 47.2 % of the population living in rural areas (MOADR, 2020). However, only 26% of the productive lands are managed by women (OXFAM, 2017), and those in charge of women tend to be smaller and with less access to technologies, credit, and technical assistance. For this reason and to overcome these inequalities, the LL4P in Colombia has a strong component on gender and social inclusion. This has been developed through a targeted invitation of women and youth to the spaces of discussion and co-creation as well as through specific research on the barriers for women and youth to participate in food value chains as well as their role in sociotechnical innovations.

The Colombian LL4P has a bottom-up knowledge co-creation design where the voices of most vulnerable people are put in the center. This is a learning perspective in which different perceptions, knowledge, understandings, and worldviews are recognized and legitimized to successfully have co-production of sustainable sociotechnical innovations (Bonatti et al., 2022) for climate change mitigation, while enhancing the social fabric of an area affected by conflict. As our approach is to build on local processes, we identified emerging Multistakeholder Platforms (MSPs) where interactions between producers, cooperatives, local committees, NGOs, government, and consumers have the potential to support sustainable food systems. In that regard, the local host could be a leading organization within the institutional structure that is building an MSP both in cocoa and in livestock.

The motivation of participants to be part of the LL4P is to work in sustainable food systems that will allow the producers to access differentiated markets to have better income. Additionally, in the region there is a rise of environmental awareness, which also plays a role in the motivation to participate in the LL4P.

Phases of the LL4P

In the LL4P in Colombia we envision three phases: setting up, sustainability and scalability (Mulder, Velthausz, & Kriens, 2008):

1. During the setting up process is important to have a diagnosis of the food systems, stakeholder consultations, identifying the systems which have more potential to reduce emissions, to find a local important topic to work along the main objective of the LL4P regarding transition to low-emission food systems, motivate the participation of the stakeholders.

2. Sustainability, to identify a local host that has a strong presence in the territory and that can keep working on the LL4P after the project termination.
3. Scalability, linked to the sustainability, the local host should have a national presence to be able to scale the LL4P framework for low-emission food systems to other regions of Colombia.

Kenya: a LL4P with an Institution-based Territorial Approach based on Action Research

Background

The Kenya LL4P is situated in the Northern Rift Valley in Nandi County. This is a major agricultural production zone for domestic consumption. Nandi County was selected as a LL4P site in the Low-Emission Food System Initiative because it offers a wide range of different commodities and linkages to different actors and societal groups. (Habermann & Zhang, 2022)

In Nandi County, livestock keeping is a major economic activity. More than 80% of the households use livestock sourced products for home consumption, and they have revenue from milk, eggs, or live animals (Jalang'o, Korir, & Habermann, 2022). Livestock, as in ruminants and poultry, provides manure for crop production and biogas generation, draft power and for cultural purposes (Jalang'o et al., 2022). Poultry is mainly kept by women, but overall dairy and beef cattle are by far the most common livestock in Nandi County (Jalang'o et al., 2022). This is dairy of exotic breeds like Friesians and Ayrshire, less important livestock are pigs, fish (aquaculture) and bees (apiculture) (Jalang'o et al., 2022). However, during the establishment of the LL4P some changes were perceived as the changes in climate, prices of commodities and agricultural inputs are forcing farmers to make decisions to adapt to this complex and dynamic environmental and market situation. As of 2022, the largest part of Nandi County was used for food crops, followed by cash crops with tea, coffee and sugarcane holding a large share of that, and then horticultural crops; major food crops are maize, finger millet and sorghum, as well as beans (Jalang'o et al., 2022).

The major commodities also conform with what is prioritized in the national policy frameworks for mitigation and climate-smart agriculture. Livestock is the major source of GHG emissions in the Kenyan agricultural sector. In Nandi County, the semi-intensive dairy production system is dominant: enteric methane emissions and nitrous oxide emissions from manure deposited in pastures are the dominant GHG contributions from the livestock sector (Ndung'u et al., 2022). About 94% are attributable to enteric methane production, and 4% result from emissions from manure (Ndung'u et al., 2022; Weiler et al., 2014)), the remaining are attributable to emissions from feed production, energy use on-farm and farm inputs (Ndung'u, Takahashi et al. 2022). Another important source of GHG emissions is deforestation (Mutune & Thuy, 2023): deforestation from 2001 to 2022 resulted in a loss of 14.3 kha of tree over – this equals 13% in tree cover, and with that 8.83 Mt of CO_2 emissions (GFW, 2023).

As a whole, the Nandi county food system is under pressure: there is a growing demand for food and nutritional requirements of vulnerable populations, and there is growing pressure to

conform to government prescribed conditions on reporting for Nationally Determined Contributions to meet internationally agreed climate targets although there is currently no direct reporting mechanism from county to national level (Jalang'o et al., 2022). Climate change and its impact on production challenges affecting crop yield and livestock productivity has a profound impact on food security and income in the county (Jalang'o et al., 2022). Simultaneously, environmental impacts aggravate the overall situation of the local agrifood system.

Specificities of the LL4P

In Kenya, there was no LL4P present at the beginning of the initiative, although there were some LLs established by other projects. There was nothing similar in Nandi County. It was not clear to CGIAR researchers in the beginning how a LL4P could be implemented if there was no existing concept to build on. However, there was an example of an institution-based LL not far from Nandi County, that inspired the implementation subsequently. To understand how a LL4P could work in Nandi County, stakeholders were consulted in workshops and key informant interviews. After initial stakeholder consultation in Nandi County, it became apparent to the CGIAR Low Emissions Food Systems (Mitigate+) Initiative that finding a host institution for the LL4P was the preferred option for stakeholders.

Some of the questions that were addressed in the initial scoping phase were added benefits, the incentives to participate, and which interests will be considered, as well as careful consideration of power and inclusion. The criteria applied for site selection were documented (Habermann & Zhang, 2022). The Initiative's research team looked for evidence for critical mitigation potential, whether this was in line with country priorities/policies and major emission sources relevant for the country and carbon sequestration opportunities. Other criteria included spatial relevance – would this be specific case or was there any option for a broader learning experience across different geographies. Evaluating existing stakeholder networks helped the team to understand who could be a potential host for the LL4P, also considering how this host was already addressing acute and prolonged climate challenges (Habermann & Zhang, 2022). Hence, to identify the specific site and host organization, the team looked at existing literature and data, held informal consultations with stakeholders and potential partner organizations (Habermann & Zhang, 2022).

The host organization had to fulfill the following criteria:

- Mission of the organization is within the range of food systems and emission studies.
- Organization is active in capacity building and has at least some research activities on-going and/or planned.
- Explicit interest in facilitating innovation processes in food systems and emissions reduction.
- Understanding and endorsement of the idea of bottom-up innovation development and participatory governance.

- Organization has the minimum capacity to develop, host and implement the concept of a LL4P both in terms of infrastructure and resources, and the capacity to seek continuous funding for the LL4P.
- County government endorses the organization to host the LL4P.
- Host is well networked with both government and non-government actors and has the capacity to build networks beyond the county.
- There is a clear endorsement of a dedicated number of staff with decision-making power to host the LL4P. (Habermann & Zhang, 2022)

With that in mind, it became soon clear to us that the Kaimosi Agricultural Training Centre (KATC) was the ideal host institution for the LL4P in Nandi County. In addition to having ideal prerequisites, the timing was ideal because at the time of decision KATC was assigned new leadership and with the dynamic, young but experienced director came a new breeze into the institution. KATC is at 1500 m altitude and comprises 94 ha of land. KATC offers training on diverse crops, dairy and horticulture. The facilities offer opportunities for in-situ research on a variety of crops common in Nandi County.

Phases of the LL4P

The LL4P approach for the Nandi County LL4P is built on three pillars (Habermann & Zhang, 2022:2):

1. Strong civil society/user integration in the innovation process: active part for citizens and involvement in decision-making while being gender-responsive and inclusive.

2. Strong involvement of science and practice: bridging disciplinary boundaries and societal layers in involving different stakeholder groups, considering both producers and consumers, policy makers and researchers, extension and private businesses, cooperatives and individuals.

3. Studying socio-ecological interactions from different stakeholders' points of view and identifying strategies for addressing power imbalances…

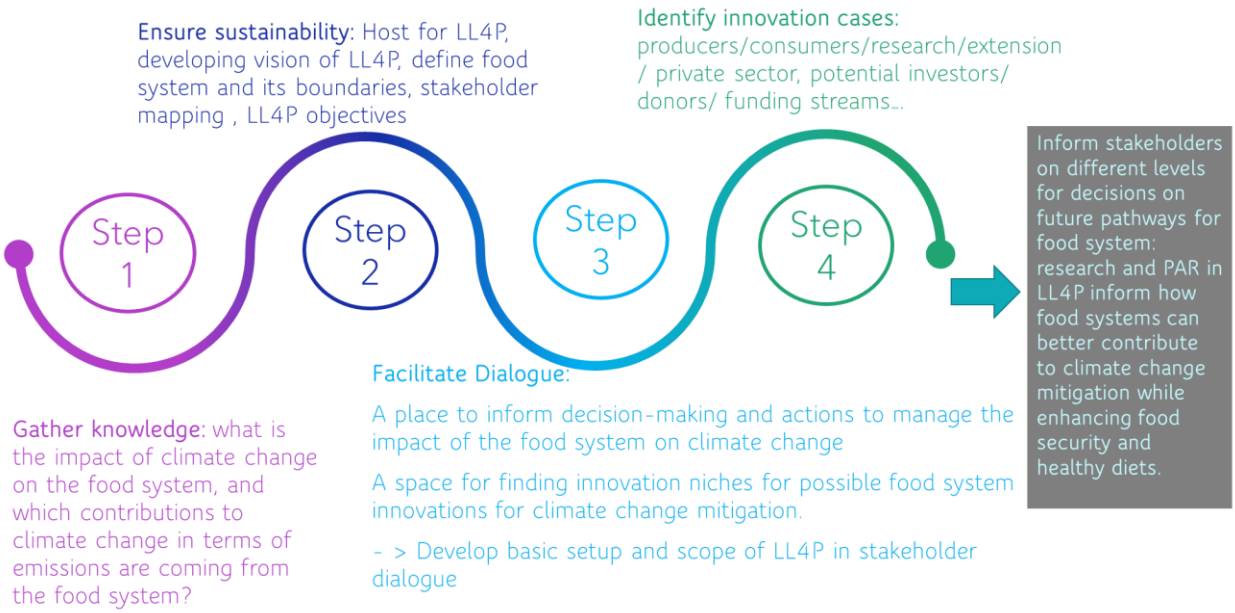

Figure 1: The 4 Steps towards a LL4P in Nandi County (Habermann and Zhang 2022).

To establish the LL4P following the principles and building on the pillars above takes time but it is mandatory to facilitate institutional sustainability. The team followed the four steps from gathering knowledge (1), ensuring sustainability (2), facilitate dialogue (3), to develop innovation cases (4). In step 2, an advisory board will be established that is inclusive, gender responsive and representative of the various aspects of the food system in Nandi County. The board is then responsible for developing an innovation agenda and assessment framework to be able to identify relevant innovation cases later and to assist in securing funding for those cases in the long run.

Vietnam: Developing an Adaptive LL4P in the Mekong Delta

Background

The LL4P in Vietnam is located in the Mekong delta – the most important region for domestic food production in Vietnam. Agriculture, aquaculture, and forestry are currently the three key pillars of the Mekong Delta's GDP (e.g., accounted for 41% of its GDP in 2011) (Smith, 2013). The Delta region supplies more than 50% of the country's rice (Le & Umetsu, 2022; MARD, 2021) and more than 90% of national rice exports (To et al., 2016). It supplies up to 70% of annual seafood export values (Tri et al., 2022). The government of Vietnam plans to restructure and modernize agriculture in Mekong Delta by establishing specialized farming areas for its key agricultural products, reducing emissions in rice, forestry and aquaculture production and ensuring national food security. The Mekong delta includes 13 provinces – each has its own emission reduction and agriculture production strategies, but all aim to achieve Vietnam's Nationally Determined Contribution, National Food Security strategy and National Climate Change Strategy.

However, transforming the food system in Mekong delta is hindered by: (i) the rapid and ongoing effects of climate change, such as sea level rise; (ii) unsustainable value chains; (iii) poverty, inequalities, and food insecurity and (iv) weak institutional settings and governance (Seijger et al., 2019). The region has the highest percentage of people at risk of falling back into poverty due to the combined effects of adverse economic conditions and climate change. Vietnam has developed many Mekong development strategies and plans. However, these policies often overlook ongoing negotiations amongst multiple groups who might have different views and conflicting interests. As a result, strategic plans are not being implemented in the way in which they were intended or are not being implemented at all (Korbee, Nguyen, Hermans, & Pham, 2019).

Specificities of the LL4P

The LL4P in Vietnam was selected based on a review of policies and literature as well as stakeholder consultations (including government agencies, civil society organizations, researchers, private sector and community-based organizations) at the national and sub-national level. These stakeholders selected the Mekong delta as LL4P in Vietnam because:

- As the region is the most important food hub in the country, government agencies and international organizations have developed innovative agriculture production models in the region and therefore can offer lessons learn on how stakeholders can co-produce knowledge and co-develop solutions to address the four key barriers for transformative food system as discussed above. Moreover, while many technical innovations are already piloted in Mekong delta, scaling up these innovations is challenging because there is limited involvement of local people in decision making, a lack of understanding of local views on why they accept or resist to adopt the innovation (Dung et al., 2018), a lack of understanding on who benefits and who is affected by these innovations (Jafino et al., 2021; Käkönen, 2008) as well as addressing the political economy which hinders their large scale adoption.
- The Mekong delta is a good example of how cross-sectoral coordination and multidisciplinary stakeholders are essential for transformative agriculture production. The sustainable food system in Mekong Delta relies on effective, efficient and equitable rice-shrimp and mangrove-shrimp mixed production. It also relies on ensuring the production of a certain commodity product will not negatively impact another ecosystem (e.g., the expansion of aquaculture has led to massive destruction of mangroves).

  The LL4P principle on governance emphasizes the importance of local leadership in hosting and managing the LL4P. In Vietnam, the LL4P is hosted by a regional university which can ensure sustainability of the LL4P.

Phases of the LL4P

The LL4P is established based on a careful review of existing policies and practices to avoid similar mistakes that lead to the failure of previous initiatives. It also reinforces existing inequity

and power dynamics while building on best practices in the context of the Mekong delta. The Vietnamese LL4P is demand driven and aligns with stakeholders' interests and vision (Phase 1). The governance of the LL4P is based on the lessons learnt in the region and stakeholder interests, but it will be continuously adapted to the changing context, regular dialogues and collaboration amongst stakeholders, notably women, men, youth and vulnerable groups who are empowered with new knowledge and skills through capacity building tailored to their needs (Phase 2). While it is expected that the local host will sustain the LL4P with its mandates, committed funding and capacity, it is expected that gradually stakeholders in LL4P will co-shared vision and long-term commitment to develop and adapt innovation and new governance regime established (Phase 3). It is important to note that Phase 1, Phase 2 and Phase 3 are interactive and provide feedback loops for each other. For example, new innovations and new governance established by Phase 3 might requires new capacity building for stakeholders and a new form of stakeholder engagement based on their needs (Phase 2) and monitoring and evaluation to draw lessons learnt for scaling (Phase 1).

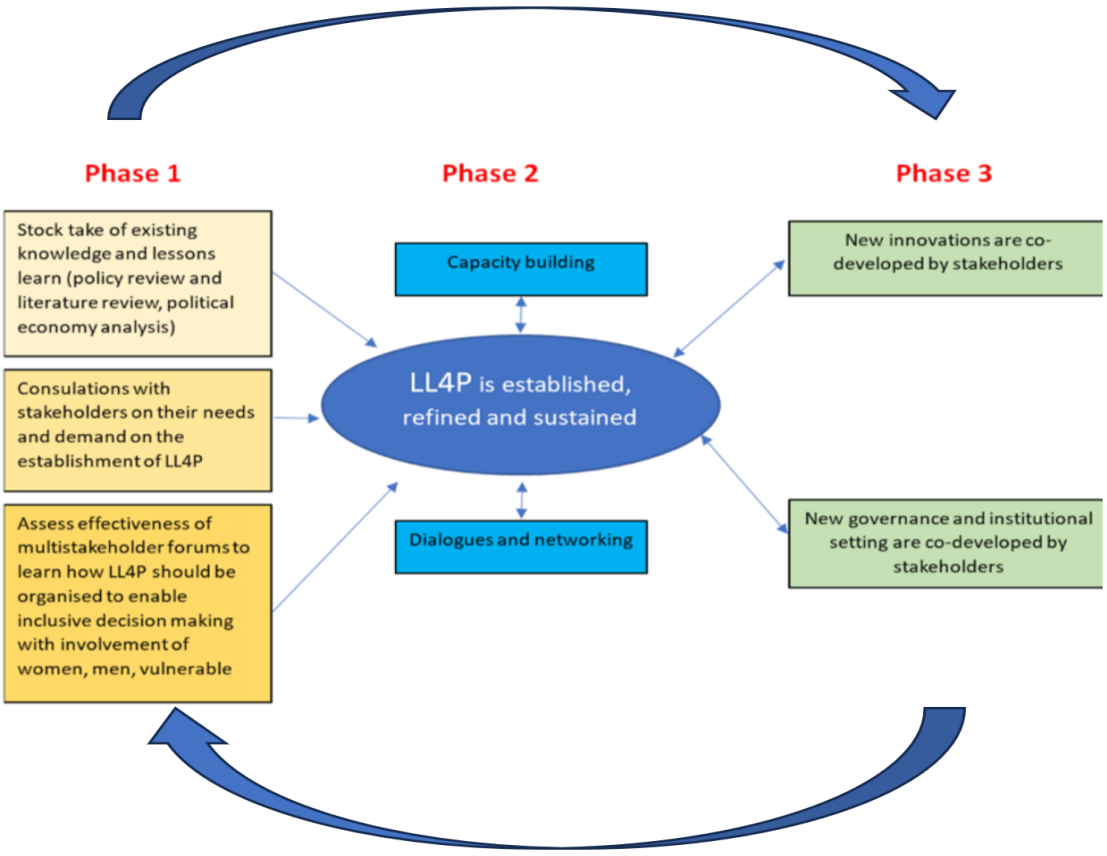

Figure 2: Phases of the LL4P in Vietnam

6. Synthesizing Experience and Learning from four Illustrative Cases

In China, the LL4P has emerged from a village-led coalition between village committees, local government, and private sector, aligning with national policies on socio-ecological harmony and rural revitalization. This process started in a bottom-up approach to identifying environmental problems and solving them locally. Although not being labeled or organized as a LL at the time, the governance and structure bears many key features to facilitate the development of a LL4P. There are a number of activities and projects ongoing that are part of the overall LL4P objectives of low-emission food systems transformation and green growth. The emphasis on the latter, and the fact that the LL4P is not only embedded in a strong political structure, but also building on an established system of community-level collective action and associated local environmental governance makes it unique among the four cases.

In Colombia, the LL4P is working with the dairy sector and the cacao value chains, due to their impact on GHG emissions. However, an important aspect is also the connection between the use of natural resources and peace-building. Through a nexus of food security and conservation for biodiversity, as well as social capital for peace building, community members are buying-in to the LL4P approach. Trust and social processes for participation are crucial in this context. The LL4P is therefore very much rooted in working with peasant organizations, who have a livelihood rooted in the land, to reach the most vulnerable and socially excluded people. The emerging Multistakeholder Platforms are supporting people in identifying access to new markets for improving their income, while increasing environmental awareness for a more sustainable and inclusive food system. This LL4P is grassroots-oriented and focuses on a unique context with a complex history of conflict and destruction of environmental resources in absence of functioning governance structures.

In Kenya the LL4P is based around a specific institution, which is also unique among the four cases. This is the Kaimosi Agricultural Training Centre (KATC), that belongs to the Nandi County government. Here, the LL4P becomes a hub, a meeting place and a platform, to promote what people believe to be important issues for their future in a sustainable, low-emission food system. The LL4P has its own advisory board that consists of a variety of stakeholders representing different agro-ecological zones, different interest groups, men and women. The agenda for this board is developed through consultative meetings and workshops with people from different parts of the county, but was not there at the outset, it is supposed to develop organically in a facilitated process.

For the site in Vietnam, another model of a LL4P was chosen: the landscape-level approach. Here the Mekong delta region was selected as an example for cross-sectoral coordination and interactions of multidisciplinary stakeholders for transforming agricultural production. The host is a local university, which is currently in the process of reaching out to a diversity of stakeholders in the context of cross-sectoral collaboration in the Mekong delta region.

Our conceptualization of a LL4P for sustainable food systems corresponds to the concerns and characteristics of existing LLs in agrarian contexts to some extent (García-Llorente, et al., 2019), and to the agricultural sector in general (Beaudoin et al., 2022; Hvitsand, Raanaas, Gjøtterud, & Nicolaysen, 2022; McPhee et al., 2021; Potters et al., 2022). Moreover, innovation processes for food systems need to be tailored to the specific contexts of the participants under an open space where diverse people collaborate in real life settings.

Additionally, our conceptual framework also attends to the importance of power and equity and recognizes that innovation is a process and not merely a product. We understand that the principles of power and equity are foundational to any innovation process if it is to transition systems towards a more sustainable future. The voices and perspectives of groups of people who are disproportionately affected by a system are key to developing solutions to change it, with support of the respective governance structures in the various cases.

In all cases there was agreement on widespread systematic issues, such as the sustainability and GHG emissions profile of food systems, that created an interest of local stakeholders. In the different LL4Ps, there is scope to find out which locally led innovations exist to provide answers or appropriate technologies. Through the engagement with local stakeholders, answers can be found to these questions that come from inside the food system and become embedded in the system in the long term rather than constantly seeking answers from the "outside world".

In many cases, LLs are driven by 'strong' governments or agencies with resources and mediated by strong civil society stakeholders. How feasible is implementing LLs when there either is no strong government, or there are not resources, or the civil society stakeholders have limited or no power? It is here where issues of power and equity become particularly relevant. In our case studies the variations between the sites regarding this were as diverse as the actual challenges faced issues such as a diverse organizational profile of the host institution, overlapping barriers like green growth, conflict, and the effects of climate change. Additionally, each of the countries represent diverse socio-economic and ecological contexts – from the eastern slope of the Andes in Colombia to the lowlands of the Mekong delta and the Rift Valley in Kenya.

Based on our experiences, we believe that the LL4P is a novel approach for locally led innovation processes. It requires an honest and clear understanding of what is meant by an LL in this specific context, and a straightforward implementation of stakeholder-led decision-making with minimum outsider involvement. The LL4P approach presents a novel addition to the existing literature on LLs by expanding the geographical scope and diversity of its application and by significantly growing the reach of LLs to address issues of power and equity in the innovation process.

7. Conclusion

A LL4P is a concept and method that has the potential to facilitate innovation processes which originate from people regarding their own future. The principles and perspectives described in

this paper detail a new approach that stands in contrast to the traditional top-down approach to innovation. We label the LL4P as both a concept and a method. This paper outlined the theoretical assumptions and foundations behind the concept. The rich description of the four cases details how the concept is also a method by being implemented in four very different contexts.

We conclude that a LL4P is a concept and method that has the potential to facilitate innovation processes which originate from people regarding their own future. There are certain limitations and persisting challenges. For example, the LL4P concept is currently being implemented in four contexts where different iterations are being adapted to these contexts. However, as the four LL4Ps continue to be adapted, and hopefully expanded, new challenges will arise to ensure more sustained and wider impacts on the broader food system. Nevertheless, We believe that the concept of LL4P outlines a new approach for many of the issues that we were addressed in the introduction of this paper: a grass-roots oriented approach to innovation, looking at innovation as a process, not a product, and an approach that opens up spaces of modes governance that can co-exist in this space from a bureaucratic government to local-level collective action-oriented gatherings. A LL4P can only lead to transformational change if it acknowledges that the real innovation that is needed is not on “things” but on ways to engage with stakeholders, addressing root causes that hold the problems in place.

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