Embracing uncertainty: foundations of a learning system for food systems transformation

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Abstract

We propose a transformative learning system based on a review of uncertainty emerging from system complexity. The framework is built on locally led action and embedded in a learning system that aiming at transforming the food systems. It is widely agreed that food systems need transformative change to meet societal goals. However, despite this agreement, the implementation of a systems transformation agenda appears to have stalled. We argue that the reason for this failure can be attributed to the complexity of the task and the inherent uncertainty. Based on a review of uncertainty and complexity in change processes, we outline a transformative learning system that has the capacity to achieve the intended transformation. This system requires shifts in roles and modes of operation to facilitate change and to learn about system responses to localized disruptive change. Focusing on the core functions of the new system, we discuss who and how this change can be triggered and how this, in turn, will change the operational modalities of people, the process of change, and the structures and institutions involved in the process. We argue that the foundations of uncertainty and the focus on learning inherent in the new system will facilitate a more agile process. This will allow actors to learn from decentrally pursued food systems reforms and thereby the organic emergence of heterogeneous pathways.

Keywords: Complex systems; Sustainability; Equity; Localization; Tropentag 2023

1. Introduction

The need for transformations in our food systems is widely acknowledged, highlighting a pressing global issue (Fanzo et al., 2020; IPES-Food & ETC Group, 2021). Currently, these systems are failing to achieve desired societal outcomes (Ruggeri Laderchi et al., 2024; Rockström et al., 2023) and are causing significant negative impacts on people, climate, and the environment (Béné, 2022; Fanzo et al., 2021; Thornton, 2023). The lack of institutional capacity to respond effectively to uncertainties such as disruptions and external challenges exacerbates these effects. While the food systems related problems manifest in different ways around the globe, they are present everywhere and the urgency to tackle them is growing. Despite the global consensus on the need for change, recent years have seen insufficient progress in reforming food systems, resulting in a regression in achieving food and nutrition security goals. This situation prompts a critical question: why, despite widespread agreement on the need for systemic transformation, has there been so little advancement in effecting this change?

We argue that the theories of systems transformation provide insufficient guidance on how to put food systems transformation into practice and lack agreement on the types of pathways to catalyze such transformation (Hubeau et al., 2017; Leach et al., 2020; Feola, 2015; Scoones et al., 2020). Furthermore, the connections and feedback loops between local action to national, regional, and global connections are often overlooked (Douthwaite and Hoffecker, 2017; Mayne et al., 2017). This detaches local action from the global transformation agenda that they could valuably contribute to. However, a major challenge is the overwhelming scale of the task implied by transformation (Stirling, 2014), which can make practical action to support it seem daunting at the local level. As a result, local initiatives may focus on smaller, more manageable, and isolatable problems within their sphere of control, which may appear insignificant in the context of the larger food system.

In this paper, we argue that to effect real change in our food systems, we must adopt a new approach that embraces uncertainty in how change is governed and planned. We therefore propose a new transformative learning system to effect the food systems change that is needed. Food systems policies and interventions have mistakenly focused on seeking the transformation ingredients in project-scale designs, planning methods, and impact assessment techniques that are informed by a simple, linear impact logic. However, these ingredients insufficiently manage uncertainties. Consequently, our proposed approach is based on the idea that change is unpredictable and requires flexible thinking and methods from systems science. This also requires awareness of complex food systems interactions across scales that enable or inhibit change. Thus, we suggest that what is required to progress food systems transformation is to advance capacities for localized but systems focused learning and adaptation during change processes with inherently uncertain outcomes. To accomplish this, we propose the idea of a transformative learning system as a way of thinking about how different capacities to learn and adapt can be utilized and be developed in an integrated way. This idea builds on the existing concepts and tools from systems sciences, change management, and complexity-aware approaches.

We will outline how the roles of everyone involved in food systems reforms will have to change. The focus will be on locally framed and implemented initiatives as the source of disruption and inspiration within a cross-scale learning framework. This framework connects

experimentation and ensures systemic learning across scales. The proposed framework responds to the deep uncertainty associated with challenges such as food systems transformation. It is more practical to navigate the situation, i.e. *muddling through*[1], rather than believing that we can engineer pathways to a better future.

To provide the conceptual logic of this transformative learning system, we review foundational concepts addressing uncertainty and complexity. We begin by defining uncertainty as a property of complex systems and explain why learning is critical to managing it. Global development debates and practices are increasingly beginning to grapple with uncertainty in complex systems as a key characteristic of pressing challenges such as sustainability, food and nutrition security, and socially inclusive growth. After introducing the theory and growing practice of dealing with uncertainty, we use this as a way to explain how the food systems transformation agenda is one that needs to be approached with uncertainty in mind. This foundation for the transformative learning system framework introduced above is then further described in section 3. The implications for food systems transformation are then discussed in section 4. Here we argue how a transformative learning system shift might be initiated and what changes are needed in mindsets and practices, institutions and systems, and financing mechanisms. We point to tools and approaches already in use that can be adapted to the functions of the transformative learning system. We conclude with a reflection on the larger changes and different ways of approaching global change.

2. Uncertainty, complexity and transformative change – a brief review

The topic of uncertainty is receiving renewed attention in research tackling, among other problems, global food systems challenges (e.g. Scoones and Stirling, 2020; DeMartino et al., 2024). Unlike risk where different known outcomes have known probabilities of materializing, uncertainty lacks calculable probabilities of certain outcomes (Scoones and Stirling, 2020). Since the 1960s, development economists have advocated for embracing uncertainty and more broadly system complexity (Hirschman and Lindblom, 1971; DeMartino et al., 2024). However, DeMartino et al. (2024) argue that ideas around uncertainty have been marginalized in development economics and therefore call for a revitalization of heterodox approaches that explicitly account for uncertainty. This paper builds from DeMartino et al. (2024) to argue that, like many societal challenges, the transformation of food systems needs to be understood as a complex systems problem and embrace uncertainty.

Uncertainty in food systems means that the future evolution, including the nature of shocks, drivers, and outcomes, is unknown or unknowable. Although there is a growing consensus that future food systems should be sustainable, inclusive, and just, it is uncertain which pathways, processes, and mechanisms are necessary to achieve this. The rising occurrences of climate-related disasters, pandemics, conflicts, and political and economic turmoil intensify uncertainties in food systems (Moore et al., 2023).

The implications for transformations, such as development practice, are that the approaches to and destinations of change pathways "remain deeply uncertain" (Scoones and Stirling, 2020). However, current economic approaches are still dominated by attempts to control

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[1] The term 'muddling through' draws from Lindblom (1959) and Hirschman and Lindblom (1971), who understand muddling through as incremental learning from changes in uncertain environments. Here, we think about muddling through as responding to and adapting to uncertainties in the implementation of interventions.

127 uncertainties (DeMartino et al., 2024). The expansion of indicators aims to transform
128 uncertainties into quantifiable risks, disregarding the actual experiences of uncertainty and
129 the current mechanisms that deal with its consequences (Scoones, 1994; DeMartino et al.,
130 2024). For instance, early warning systems for famines in the drylands of Eastern Africa are
131 intrinsically fraught with uncertainties related to weather forecasting and conflicts, which
132 increases the likelihood of underestimating the impacts on food insecurity (Krishnamurthy et
133 al., 2020). Simultaneously, many people in the global south, particularly those in fragile
134 environments, frequently confront uncertainties as a fundamental aspect of their daily lives
135 (see e.g. Scoones 1994). For example, pastoralists in Kenya adopt diverse practices in response
136 to droughts, including sharing livestock, dividing herds, and negotiating land access
137 (Mohamed and Scoones, 2023).

138 Complex systems theory provides a useful framework for understanding uncertainties
139 inherent in food systems transformations. According to this theory, emergent properties and
140 uncertain behaviors and consequences arise as change unfolds. Uncertainty is deeply
141 intertwined with the characteristics of complex systems which imply uncertain outcomes. It is
142 widely recognized that food systems must be understood and engaged with through the
143 framing of complex systems (Hall and Clark, 2010; Kampelmann et al., 2018).[2] This enables an
144 understanding of the complex and interconnected web of actors, drivers, and interactions at
145 different physical and temporal scales in the production, processing, distribution,
146 consumption, and disposal of foods, generating non-linear and uncertain (and hence
147 unpredictable) pathways of food systems transformations (IPES-Food, 2015).

148 Understanding food systems as complex systems requires an awareness that solving complex
149 systems problems, such as food insecurity, cannot be achieved by simply analyzing the
150 component parts of the system (Hambloch et al., 2023). Nonlinear cause-effects are inherent
151 properties of the system itself (Conti et al., 2023; Hambloch et al., 2023). When attempting to
152 improve food systems outcomes, the complexity and uncertainty of food systems can
153 manifest in various and often contradictory ways. Clear interactions exist between different
154 global targets, such as the SDGs, including synergies, trade-offs, and feedback loops. (Herrero
155 et al., 2021). For example, achieving success in one area, such as increasing food availability
156 through improved farm productivity, may unintentionally result in the exclusion of
157 smallholder producers due to falling food prices, incomes, and profitability (Mausch et al.,
158 2020). Similarly, relying solely on smallholder farmers to address food production and income
159 shortfalls is unlikely to be effective unless more fundamental systemic issues are also
160 addressed. This is because returns to farming are marginal on small land parcels (Gassner et
161 al., 2019). Therefore, it is essential to address the material consequences that arise as
162 uncertainty unfolds, such as food price increases and food supply disruptions.

163 The implications of uncertainty are part of daily lives especially for smallholder farmers,
164 operating farms with marginal returns, the implications of uncertain outcomes are core part
165 of decision-making process (Bacon et al., 2017; Molla et al., 2020). Furthermore, the
166 complexity and uncertainty of food systems are often exacerbated by power dynamics and
167 the political influence of dominant actors (Clapp, 2021). This can lead to unintended

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[2] This broad field of theory-informed practice (praxis) draws on a number of earlier ideas and fields of practice, including soft systems thinking which involves an action-oriented process to analyze and address perceived problematic social issues (Checkland and Poulter, 2010).

consequences, such as perpetuating poverty and malnutrition, despite well-intentioned development efforts (Leach et al., 2020). For instance, efforts to enhance diets and address nutritional security may face obstacles due to the interests and incentives of influential actors in food value chains who are seeking new sources of revenue (Hambloch et al., 2023; for a case study, see Ansari et al., 2018). In addition, it is important to note that powerful actors and their interests can greatly influence the way problems and solutions are presented. In situations where the outcomes and pathways for transforming food systems are highly uncertain, power and politics may restrict the range of possible pathways (Stirling, 2008; Scoones and Stirling, 2020).

Research on food systems and complex systems theory highlights the significance of managing uncertainty in practical-oriented transformation research (Thompson et al., 2007; De Martino et al., 2024). Programs and projects operating in complex systems will inevitably have unpredictable outcomes, making them highly uncertain. To address uncertainties, it is critical to adapt to emerging dynamics and processes through iterative, experimental cycles of testing, learning, and readjustment. This helps change the course of system adaptation (Thompson et al., 2007; Foran et al., 2014). To transform food systems successfully, it is essential to acknowledge that the process is complex and uncertain. This requires a fundamentally different approach to intervention and transformation.

3. A coordinated autonomous learning system for transformation

3.1. Learning needs to be centered on locally led action.

Based on our review, transforming food systems requires adapting to complex system dynamics and uncertain future outcomes. However, it is unclear how actors should embrace this complexity and uncertainty. When outcomes and impacts are inherently unknowable, actions and interventions should follow principles[3] to ensure that common visions of inclusive, just, and sustainable food systems are achieved.

A transformation paradigm framed by uncertainty, it is argued, must be characterized by experimentation, learning and adaptation in a particular setting to create a new capacity to act (Bossyns and Verle, 2016). An increasing uncertainty-orientation underlines that food systems transformation is necessarily a locally rooted process as emerging uncertainties are highly context specific (Sayer et al., 2008). Consequently, this requires acquiring tacit knowledge which in itself is a type of knowledge that is not gained in a plannable approach but reveals itself through practice and the acquisition is therefore deeply uncertain in nature. Coupled with the insight that, at the local level, people have long been dealing with uncertainties and have deep insights how they unfold, fundamentally reframes the role of interventions to one of supporting autonomous experimentation.

To ensure people-focused, local innovation and leadership during food systems transformations, new approaches and lines of support should align with the diverse visions and needs of the people projects engage with (Mausch et al., 2021). It is important to consider how current and future technologies could support diverse and multiple pathways defined

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[3] While there is a multitude of elaborations of principles in existence, we do not see fundamental disagreements among them, so we do not dive into a review but broadly refer to them as principles of inclusivity, justice and sustainability.
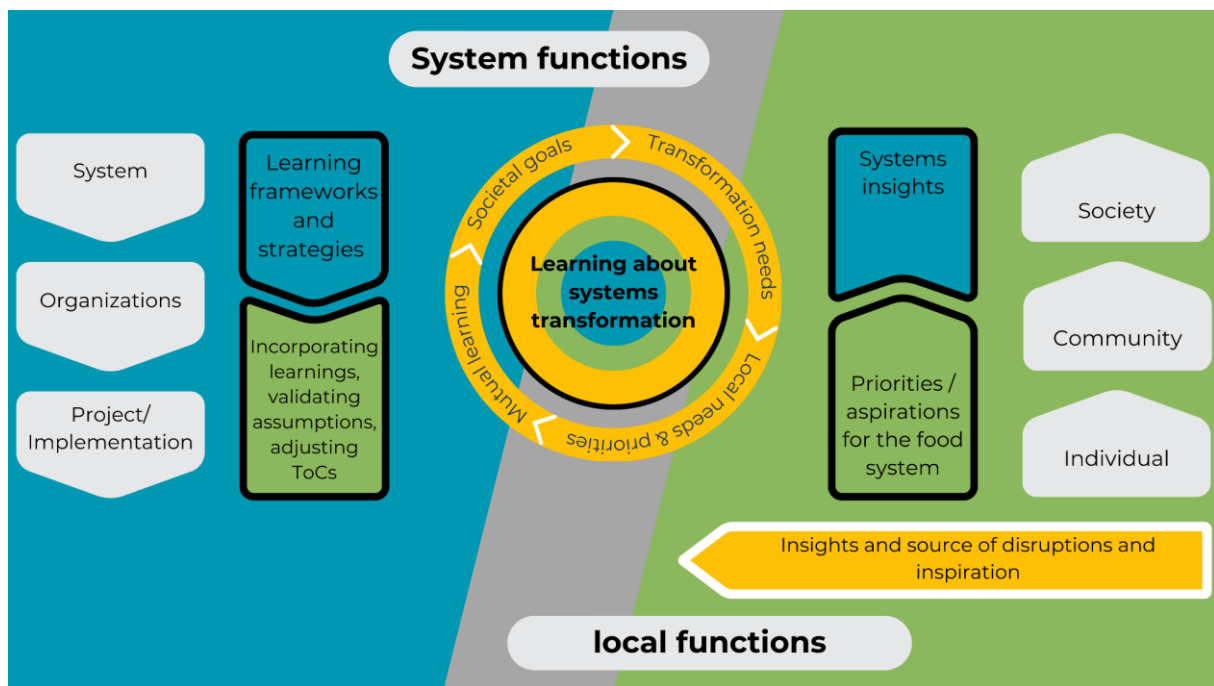
207 and led by the people (Mausch et al., 2021a). This shift in focus raises different questions that
208 are at the heart of learning needs. The process would provide insights and directions on
209 current pathways and their inherent diversity, with the participants' vision at the core. This
210 would allow for a transformative reshaping of operational modalities and focus of support
211 mechanisms, democratizing the innovation process.

212 When local conditions are diverse and individual visions for the future are heterogeneous, a
213 localized[4] and decolonized[5] approach to interventions becomes critically important. Both can
214 also be understood as ways to embrace uncertainty more directly, even if they are not
215 explicitly stated as such. This challenges top-down defined solutions and pathways and
216 emphasizes the agency of the people in the process. To promote diversity and alternative
217 pathways, it is necessary to prioritize inclusivity, cultural sensitivity, capability enhancement,
218 adaptivity, and evidence-based approaches. This requires a significant shift in finance
219 mechanisms, with more financial resources allocated to local actors who are involved in the
220 local context and may be part of social movements that oppose unjust practices.

221 We argue that uncertainty and the resulting need to connect locally led processes of
222 experimentation with a broader food systems transformation agenda requires a fundamental
223 shift in roles across people and structures within the system. Actions and ideas will be shaped
224 locally by those people and communities that are affected. Simultaneously, organizations
225 overseeing projects and broader structures and institutional arrangements must directly
226 support these local processes, as well as connect localized actions towards learning across
227 time and scale at the meta-level. Figure 1 summarizes the changes in roles within an
228 integrated learning system and the resulting benefits.

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[4] Localization of development has recently regained significant traction and appears to be mainstream now among development agencies (Bilsky et al., 2021; North and Longhurst, 2013; Reddy, 2016). Localization of development refers to the shift towards increased access for local actors to funding streams, decision-making spaces, capacity development, local leadership, and policy influence (Robillard et al. 2021). Fundamentally, it recognizes that local actors are often better positioned to contextualize uncertainty and respond to it. Localization became formally part of mainstream humanitarian development after the 2016 World Humanitarian Summit. For the currently wide endorsement, see for example the widely signed and endorsed (Charter for Change, 2024)

[5] "Decolonizing development means disrupting the deeply-rooted hierarchies, asymmetric power structures, the universalization of Western knowledge, the privileging of whiteness, and the taken-for-granted Othering of the majority world." (Sultana 2019, p. 34). This involves addressing power inequalities in development finance and implementation, respecting, and including diverse forms of knowledge, and promoting a diversity of transformation pathways in food systems (Nelson and Edwards, 2020). Despite also being a political project, decolonizing development implies the redefinition of goals where personal life goals become the focus and multiple pathways are therefore supported independently from outside agendas or priorities (Domptail et al., 2023; Herring et al., 2020).

Figure 1: Shifting roles for connecting localized experimentation and action to system scale learning and transformational change.

Rather than attempting to control unknowable processes and outcomes, we argue that the emerging learning focused approach must recognize and embrace uncertainties. The emphasis should be on providing a framework to guide investments and actions that will facilitate local actions learning and connect these across scales within the system during the transformation process. The intersection of this learning system and shift in focus to localized leadership and action is critically important. This intersection is where new insights, forms of knowledge, and insights about system dynamics will emerge.

3.2. The mechanics of the learning system

The combination of a locally centered approach of experimentation enabling transformative change and the embeddedness into a system of learning to leverage broader systemic insights and facilitate adaptations calls for three critical capacities to embrace uncertainty needed at multiple scales for food systems transformation.

Capacity for *local action within systems*. When new roles are introduced in a learning system, it is necessary to develop additional capacities and skills. It is important to strengthen the capabilities and skills of individuals, projects, and organizations involved in the transformation process. This will enable them to make sense of unfolding system-level events and outcomes through learning, evaluation, planning, and replanning processes (Cronkleton et al. 2022). There is ample evidence of the way many communities living under conditions of uncertainty have developed a repertoire of coping strategies to handle unpredictable events such as droughts or commodity price crashes (Scoones, 1994; Mohamed and Scoones, 2023). The food systems transformation agenda suggests that communities across the world will need to deal with a more profound degree of uncertainty that will require a series of adaptations at local, national, and global scales. People, communities, organizations that have been dealing with the uncertainties that affect them are arguably in the best position to also drive change within

256   the transformation process and test new ideas and responses. What needs support is the
257   strategic learning on their way through the uncertainty of unfolding events will thus be more
258   important than ever.

259   Capacity for *coordinated action and collaborative sensemaking across actions*. With a focus on
260   system transformation that is emerging from local disruption and inspiration, a need for a
261   much greater degree of coordination across local initiatives emerges. This involves synergizing
262   efforts, avoiding duplication, and building coalitions of interest. It also entails supporting
263   broader learning efforts to strengthen the collective muddling through process that
264   uncertainty demands. Another part of this form of collaboration across local efforts is to gain
265   sight of negative consequences and trade-offs that may be affecting people in other
266   geographies. Again, strengthening the learning and evaluation capability of people and
267   organizations will contribute to better coordination across geographies. However, this process
268   also requires a broader range of methods to consider other forms of knowledge and insights,
269   allowing tacit knowledge to emerge.

270   Capacity for *distributed governance and trust*. New governance arrangements are necessary
271   for integrating local knowledge and learnings across scales towards larger system
272   transformation. These governance arrangements need to be based on full local leadership and
273   agency to engage in transformation within the lived realities of people. Specifically,
274   governance arrangements that form the basis for legitimacy and resulting forms of leadership
275   are required to set a broader and more democratic global agenda. Put more simply, local
276   ownership of transformation involves not only ownership of local agendas, actions, and
277   outcomes, but also ensures a role in influencing national and global agendas that inevitably
278   set the framework conditions for local action through regulation, incentives, and market
279   mechanisms. The necessary glue in such arrangements are forms of trust that build on the
280   transparency of arrangements to collect information on transformation outcomes and lessons
281   rooted in the values of people and organizations.

282   To transform the food system, it is necessary to embed capacities to embrace uncertainty in
283   a system of learning functions. This will allow individuals within the system and the system
284   itself to learn during the change process (see the inner circle of Figure 1). The combination of
285   these capacities and functions, embedded within new roles, will form the framework of our
286   proposed integrated transformative learning system (see Figure 2).
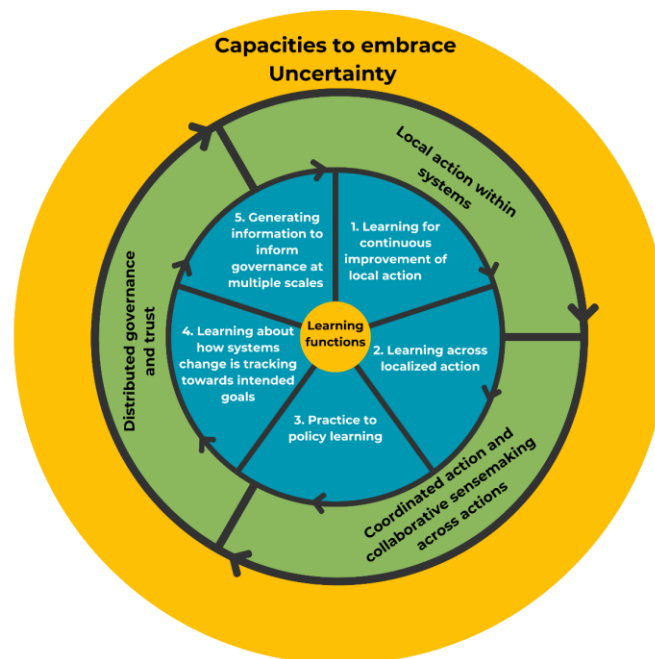
Figure 2: Capacities and functions within a transformative learning system under uncertainty.

We propose 5 key learning functions within this learning focused framework to harness the capacities to embrace uncertainty for transformative change:

1. **Learning for continuous improvement of local action:** Focuses on framing the problem locally and strengthening the learning and evaluation capacity of people and organizations to understand and manage their own transformation journey within the system. Provides the means to experiment with action and impact logics against aspirations to change parts of food systems performance, and to develop lessons about what works and where broader system blockages or lock-ins occur.
2. **Learning across localized action:** Focuses on continuous, incremental, and adaptive peer-to-peer learning. Provides the means to generate lessons from transformation experiences in different contexts of uncertainty and across scales (people, organization, countries, ...).
3. **Practice to policy learning:** Focuses on locally embedded practice-to-policy learning. Provides the means to communicate lessons from local practice to policy and decision makers in governments, development agencies and funders. Provides information and lessons on the need for further policy and institutional reforms to achieve food systems performance goals.
4. **Learning about how systems change is tracking towards intended goals:** Focuses on collaboratively developing the means to track progress and directionality across different contexts and using multiple means to extend performance insights.
5. **Generating information to inform governance at multiple scales:** Focuses on generating information on governance, outcomes and impacts. Provides the means to generate information to transparently inform different stakeholders about the progress of ongoing transformation processes towards food systems performance goals, highlighting trade-offs and perverse consequences, especially for marginalized groups. Provides politically powerful metrics to catalyze continued investment.

315 The role of the framework is twofold. It will help conceptualize the organization of an
316 integrated set of learning processes needed to support engagement with the uncertainties of
317 the food systems transformation agenda. Perhaps more importantly, it will serve as a
318 framework for guiding investment in food systems transformation toward the capabilities and
319 institutional arrangements and sources of change needed to enable these learning functions.
320 We refer to this as a *transformative* learning system because it is transformative in two senses.
321 It is transformative in the sense that it provides a way of supporting local action and learning
322 to disrupt and direct efforts in the wider food systems to experiment through the
323 transformation, while keeping sight on the systemic changes unfolding and reflecting on
324 principles against the emerging outcomes. In this way, the learning dynamic between local
325 and systems scales is enabled through virtuous learning cycles. It is also transformative in the
326 sense that it disrupts and transforms the way societies engage with uncertainty challenges by
327 providing a different way to imagine and organize the learning arrangement required in such
328 circumstances. The transformation of food systems is one example, but there are many
329 equally pressing challenges of this kind.

330 Our purpose here is to highlight the emerging outcomes of a transformative learning system
331 and not to unpack the sorts of tools that could support these learning functions. Supporting
332 people and organizations to muddle through by strengthening learning and evaluation
333 capacity is in itself not a new idea and is core to the established field of complex systems
334 practice. Nor could it be argued that strengthening learning and evaluation capability alone is
335 sufficient to transform food systems. There is an existing suite of tools and approaches to
336 operationalize the kinds of learning that these functions imply. Instead, our goal is to highlight
337 a different way that actors from the local to system scale can engage differently and
338 meaningfully in the food systems transformation agenda.

339 The new actions that emerge from new roles will be different. Changes in funding
340 mechanisms, investments in R&D, infrastructure and mindsets will be required along the way.
341 More importantly, the argument here is that without a more integrated set of learning and
342 evaluation capacities are locally rooted and reach across scales, choices, and priorities in
343 different areas of investment and public debate will be blind to and unprepared for the
344 uncertainty of realities that will characterize food systems transformation.

4. Steps towards putting a transformative learning system into practice - a discussion

4.1. Triggering change

348 The implementation of the proposed transformative learning system needs to be a process of
349 experimentation and testing under uncertainty, accompanied by research. It requires major
350 changes at all levels and among all stakeholders. At times, the magnitude of change required
351 may seem daunting and may lead to a reversion to the old habit of addressing problems in
352 isolation within the process. However, the shift to a learning system for transformative change
353 could begin gradually and in a decentralized manner.

354 In fact, many tools already in use today (e.g. multi-stakeholder platforms, theories of change,
355 MEL systems) will remain relevant for the new learning system (see Table 1). They will need
356 to be deployed in different modes and for a set of adjusted goals. For individuals in the sector,

357 organizations in the sector, and the sector as a whole, this implies short-term adjustments
358 with longer-term changes in sight.

359 Table 1 summarizes the new roles emerging from the previous section and provides some
360 examples of existing tools that can be deployed in different ways to address these new roles.

361   *Table 1: Practical steps towards the transformative learning system: changing roles and corresponding tools for people and system.*

Function	People		System	
	New role	Tools	New role	Tools
Leading and managing locally	Primary source of knowledge, problem framing, solution identification, project leadership	Design-thinking toolbox, Community engagement workshops, leadership training	Capacity development for systemic thinking, accepting higher risk for innovation	Experimental approaches, grant schemes, challenge programs
Learning across localized action	Facilitate emancipatory learning, challenge status quo	Peer-to-peer support networks, communities of practice	Utilize existing capabilities, learning-oriented approach, sustainable financing	Complex Theories of Change (ToCs), experimental systemic interventions, adaptive project management
Practice to policy interface	Generate and disseminate disruptive lessons and information	Stock-taking exercises	Bridge practical experiences and policy-making	Communities of practice, donor coordination, policy think tanks, research networks
Tracking how systems change/Transform	Provide localized insights, manage trade-offs	Mapping exercises, local case studies	Reflexive approach, focus on process and complexity, develop complex metrics	Analysis and learning facilitation capabilities, new process indicators, data collection protocols for national statistics and citizen science
New knowledge about systems	Integrate diverse knowledge sources	Collaborative research platforms, knowledge sharing forums	Ensure adherence to principles in outcome assessments	Principle-based assessment guidelines, systemic evaluation frameworks

362

363 We are already seeing glimpses of things moving in directions that are consistent with what
364 the transformative learning system would look like - for example, the need for localization is
365 widely recognized. This is the starting point connecting and implementing the learning
366 elements across locations and levels.

4.2. Shifting mindsets and doing things differently

368 The foundation of the new system is a shift in mindsets and ways of thinking. For social
369 conventions, we know that it takes a relatively small minority of about 25% of a group to
370 change in order to reach tipping points (Centola et al., 2018). This can start with thinking about
371 different questions, adding new dimensions to the discussion, and doing things differently.
372 From there, it is a matter of building strategic alliances within and across all levels and building
373 momentum. Similarly, at the organizational level, food systems actors should form strategic
374 alliances with groups that are challenging current system practices, such as social movements,
375 labor unions, and farmers' organizations, to enable transformative change from the grassroots
376 level, rather than trying to engineer it from the top-down (Behar, 2022). This is where mutual
377 learning occurs, and local and global agendas intersect to facilitate transformative change.

378 For individuals, the beginning of the change process is simple, yet challenging. Adopt a
379 learning perspective and reflect on current projects with a systems transformation
380 perspective. This involves adopting an adaptive and reflexive approach that allows for a
381 different set of questions to be asked. It should involve adding new and different types of
382 metrics to monitoring indicators that focus more on the process of change, taking a hard look
383 at the assumptions in theories of change, or having a different conversation with people
384 engaged in or affected by the project. Embracing the uncertainty that is already part of daily
385 operations and using it as an element of reflection could already provide a new perspective
386 on the process and lead to new insights. These are the first steps that can be incorporated into
387 current project mechanisms at little or no additional cost while generating valuable insights
388 for systems transformation processes.

389 However, the project environment itself requires a different setup. Beyond these tweaks in
390 the current project environment, which are helpful to start the process of adding new
391 perspectives, they are not sufficient to transform the sector. For the learning system to start
392 functioning, the focus must be on the new sources of disruption to the current system and
393 new perspectives for generating insights into the system responses. This will need to be
394 accompanied by new types of project governance. Engagement processes will have to take
395 different forms. Most radically, it would take the opposite form of today's standard operations
396 and start from the local population that engages an agency to support their muddling process,
397 rather than agencies implementing solutions in a location.

398 This new arrangement will result in project participants and local organizations playing a very
399 different role in the process. Projects will be led locally and institutions will play a supporting
400 role providing feedback into the process and offering learning frameworks and strategies. The
401 tools currently in use are already able to accommodate these changes and remain relevant,
402 although they will need to be deployed in different ways and forms. One example is Theories
403 of Change (ToCs). On a practical level, this means a slightly more complex set-up where locally
404 led projects and corresponding ToCs need to be embedded in a higher-level learning structure
405 that is able to facilitate learning and progress assessment. For the system-level learnings, ToCs
406 will also need to be broadened to incorporate more elements that reflect the complexity of
407 food systems dynamics that are beyond the control of localized actions, but highly relevant as

408 they influence the local environment. Therefore, clear assumptions of these interactions
409 should be made and then focus on learning about their validity.

410 Projects need to be learning oriented. They need to acknowledge the scarcity of system
411 capacity, be trust-based, build on local innovation and knowledge (Liverpool-Tasie et al.,
412 2020), and embrace adaptive, responsive management approaches and reflexive learning.
413 Over time, this will allow a deeper understanding of system responses to local changes and
414 facilitate the transformation process through adjusted sets of local actions that trigger system
415 changes in the right direction. This broader learning needs to be cascaded, reflecting, and
416 linking local learning. A multi-way coordination and communication process, designed to allow
417 different intersecting learnings, will support these shifts and insights, and trigger a new set of
418 changes within the already changing local parts of the system. Uncertainty at all levels is a key
419 feature of the process, and rather than shying away from or attempting to control these
420 uncertainties, they should be recognized as key aspects that facilitate the learning journey
421 towards understanding system change.

4.3. Implications for systemic change

423 For these localized lessons and insights to be harnessed effectively, evaluation methods that
424 can handle complexity must be deployed. The necessary tools already exist; reframing them
425 will improve the process. Evaluation also needs to be conducted in a more distributed format,
426 ensuring participation at all levels to allow for interpretations from all perspectives. There is
427 likely to be a need to shift the focus to more argumentative and formative types of evaluation,
428 with a stronger orientation towards processes rather than outcomes. Reflexive learning by
429 participants rather than external assessment and control will help to overcome biases and
430 shed light on previously blind spots.

431 As it is recognized that transformative change in food systems takes time (almost certainly
432 longer than standard project timeframes), newly established process indicators as well as
433 impact and outcome indicators, need to be embedded at the institutional level rather than at
434 the project level for more medium- to long-term timeframes. One example of this can be
435 found in UNDP's portfolio approach (UNDP, 2023) which aims to improve understanding of
436 how transformation takes place. UNDP also offers some guidance on tools and their
437 application (Haldrup, 2024), such as ToCs and corresponding MEL systems which need to put
438 more emphasis on explicitly exploring and learning about causal processes and mechanisms
439 rather than narrowly focusing on outcome and impact components.

440 Pathways for change will inevitably be highly diverse. Rethinking scaling from the perspective
441 of a process of change rather than a solution and starting from the people to be supported
442 rather than the technology, would be one of the new types of questions to be asked, leading
443 to new knowledge about systems change. This is not to say that we should look for local
444 initiatives that work and scale them - on the contrary, scaling would look at principles and
445 value-based outcomes and scale approaches, processes and enabling systems rather than
446 approaches or technologies. This diversity of pathways and focus on highly localized or even
447 individual goals and resulting processes will ultimately highlight a new system of changes that
448 lead to overall systems change.

449 Importantly for international development practice, a focus on strengthening a transformative
450 learning system opens up a new avenue for interventions that focus on the institutional
451 developments needed to strengthen the functioning of these systems at all levels and scales.

4.4.   Funding for new roles and functions

While there is scope to start the process within current mechanisms, new financing mechanisms and approaches have the power to accelerate the process and effect deeper changes. In a facilitative role, financing mechanisms and conditions should avoid glossing over inherent uncertainties. The new functions of the transformative learning system will need to accommodate two basic elements: 1. Institutional funding to allow learning functions to perform beyond projects, 2. Funding for autonomous localized action in the absence of predefined outputs and outcomes - this can be done directly or indirectly through other institutional arrangements.

Opening up spaces for experimentation and localized muddling with a larger vision for food systems transformation has the potential to accelerate the changes we desperately need. The Think Tank Initiative, for example, highlighted that core funding, committed for 10 years, enabled organizations to learn and implement strategic shifts (Christoplos et al. 2019). Along with closer vertical and horizontal coordination, and a focus on the comparative advantages of both donor agencies and grantee organizations at all levels, a learning system could quickly gain traction and effect change.

Conclusions

In order to effectively transform food systems, it is essential to navigate ever-increasing uncertainties. Transforming complex food systems must be a process of adapting to these systems and stimulating innovation to achieve new properties such as sustainability, equity, and justice. This approach supports alternative pathways and outcomes that may not yet be known. While the tasks may be urgent and daunting, the knowledge and capabilities of the entire system of actors are broad and powerful.

This shift is redefining our notions of success and failure and broadening the range of actors driving change and the skills they need to effectively navigate uncertainty. There is little disagreement about the norms and principles that should accompany these changes, but there has been little acknowledgement of uncertainty. Using the emerging mechanisms of localization and decolonization as a starting point, we proposed a new learning system that can facilitate a democratic approach to transformation and limit the risks of derailment by vested interests.

We believe that any intervention, regardless of its size, can contribute to learning and system transformation during implementation. Each initiative should serve as systems probe that delivers local progress and, more importantly, improves our understanding of the system itself, its reactions to the probe, and the underlying dynamisms. The focus should not be on the degree to which the system has changed, but rather on how it has changed. Through this process we can learn how the entire system reacts to certain shifts and how these changes translate to different outcomes.

Small tweaks and shifts in focus may be insignificant in isolation, but when embedded in a larger learning system that spans all levels, they can become transformative. The argument presented is that we should not strive for perfection in innovation, but rather for perfection in learning. Food systems actors should embrace muddling as a new and valid approach that serves a learning purpose - purposeful muddling. For those funding the transformation, it will require a shift in approaches and mechanisms that involve a higher degree of uncertainty in outcomes and an increased focus on the process. If food systems actors can achieve this and

496 demonstrate how to manage this complex agenda in practice, it can set a new standard far
497 beyond the food systems arena and have a positive effect on other complex systems facing
498 similar needs for transformative approaches and seemingly intractable challenges.

Statements and Declarations

500 The authors declared that they have no conflict of interest.

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