DEVELOPING LEARNING SYSTEMS FOR ADDRESSING UNCERTAINTY IN FARMING, FOOD AND ENVIRONMENT: WHAT HAS CHANGED IN RECENT TIMES?

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ABSTRACT

Systemic approaches to managing change and dealing with uncertainty in relation to farming, food and environment have evolved over many decades. These approaches take many forms and have been initiated by researchers, advisers, governments, NGOs, farmers, businesses and others. They include learning systems approaches that go beyond emphasising innovation and life-long learning, in appreciating a range of individual and collective perspectives. The importance of learning, and drawing on the multiple perspectives of stakeholders to co-produce knowledge, has become well recognised in contexts ranging from organic farming to managing water catchments to robotic agriculture. Some of the workshops and one-off events held in these contexts have built on relationships among stakeholders to evolve into longer-term inquiries and communities of practice that have adopted learning approaches and Living Labs where multiple stakeholders experiment and co-create innovations. In this paper we, the authors, who have worked on developing learning systems in a range of agricultural and environmental contexts since the 1980s, take a long-term look at what has changed over the years and what may need to change in future. We consider how theories and practices have changed and their influences on each other. Through reflecting on our experiences of learning systems (including those of running PhD courses for researchers alongside the International Farming Systems Association (IFSA) symposia) we review needs for systems thinking in practice (STiP) and some of the responses to these needs. We conclude with some insights into how to design learning systems that take account of the dynamics of learning in times of uncertainty.

Keywords: Learning systems, design, systemic inquiry, change, uncertainty, IFSA.

INTRODUCTION

As we approach the end of our second decade of the 21st century, interconnections among farming, food and environment have become very apparent. Tackling climate change and preserving the environment is seen by many who are associated with farming as the top priority in the context of deliberations about the future of food and farming and future proofing Europe's Common Agricultural Policy (EC, 2017). The EU's 2020 package has set targets by 2020 for 20% reduction of greenhouse gas emissions (from 1990 levels) and 20% increases in energy from renewables and energy efficiency (EC, 2018a). Forests and agricultural lands hold large stocks of carbon and while their change of use

can lead to emissions, our wise use of soils, trees and other plants (e.g. afforestation or changing arable land into grassland) can also help to protect or increase carbon storage, taking CO_2 out of the atmosphere (EC 2018b). Water forms a crucial link between society and the environment, making it central to adaptation to climate change. Water's critical role in food production and food security, is affected as much by how it is used as by its availability, with negative effects coming from poor water quality, infrastructure and poor sanitation (United Nations, 2018). Food waste has become a huge issue with between a third and a half of world food produced not being consumed and many resultant environmental, economic and social impacts at levels ranging from local to global (Fusions, 2016). Major current challenges for agriculture in Europe range from loss of agricultural land, to the need to reduce

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agriculture's environmental footprint, to realising the potential of smarter agriculture - using technologies (such as robots and precision farming) and digitisation to help. These challenges also include understanding and responding appropriately to the interplay between farming and biophysical factors (e.g. in dealing with 'weeds' and 'pests' and avoiding compaction of the soil and in taking whole catchment approaches in order to minimise floods) and developing sustainable employment in the overall sector (CPRE, 2017; Darnhofer *et al.,* 2012). Many of these challenges are characterised by change and uncertainty, not just in relation to say extreme weather, outbreaks of disease and market fluctuations but uncertainty arising from unintended consequences of individuals and groups making changes and responding to events in order to try and improve situations e.g. in relation to land use, technologies and policy. Examples range from pollution or erosion arising from an individual ploughing up a meadow to how farmers use increased data available through precision farming (e.g. to increase production, reduce inputs or both) to seasonal labour shortages resulting from the UK planning to leave the EU.

There is therefore a need at this time in history, in the farming sector and beyond, to be able to learn how to make improvements and to manage under conditions of uncertainty in ways that take account of interconnections and potential unintended consequences. In this paper we review the contribution that the concept and practice of learning systems has made to dealing with uncertainty in systemic ways in relation to farming, food and environment, drawing on examples from our research and scholarship. Our results section includes review of literature and research traditions. We also make a case that learning systems approaches will become increasingly important in future and that it is essential that skills in working with the concept and associated praxis are developed within communities such as the International Farming Systems Association (IFSA). We will also comment on how we have been working towards that end.

METHODS AND MATERIALS

Our insights in this paper are drawn from using the methodology and methods of systemic inquiry and co-inquiry and action research over several decades in contexts ranging from managing water resources to agriculture to university education (Ison, 2017, Foster *et al.,* 2016, Bawden *et al.,* 1985, Blackmore *et al.,* 2015;

Collins *et al.,* 2007, Colvin *et al.,* 2014, Ison *et al.,* 2008, Sriskandarajah *et al.,* 2010). Our research tradition includes a high degree of reflexivity in comparison with many other systems traditions. We bound many of our claims in our experience and aim to take our own perspectives as practitioners into account (Bawden, 2000, Ison, 2017, Ison & Blackmore, 2014). Our 'materials' have largely been people with their multiple perspectives on systems of interest, concepts relevant to systems thinking in practice, particularly learning systems and the ideas that have been generated from our processes of inquiry.

Wenger's concept of 'trajectory', drawn from the tradition of learning systems, will be used to structure this paper. The idea of a trajectory as a past, present and future pathway was developed and used by Wenger (1998) to help people understand their identities in relation to 'communities of practice':

> *[Trajectories] …provide a context in which to determine what, among all the things that are potentially significant, actually becomes significant learning. A sense of trajectory gives us ways of sorting out what matters and what does not, what contributes to our identity and what remains marginal* (Wenger, 1998, p. 155).

We are using a trajectory here more to review the past, ongoing and potential contributions of learning systems in understanding farming, food and environment than in a more personal way. However, communities of practice certainly feature in all these domains and, as action researchers and educators who aim to design, facilitate and enact learning systems, we take the position that we are not just observers looking on but have been and will be a part of the learning systems ideas and practices we now review. We aim here to consider the history, current state of the art and potential future challenges of learning systems approaches in the context of farming, food and environment. We will start with history and move on to current and future times but it is important to remember that as with many other traditions that have several stages or generations, elements of earlier ideas and practices prevail over time alongside and as a part of later traditions. By tradition here we mean "*a network of prejudices (literally understood as a pre-understanding) that provide possible answers and strategies for action.*" (Ison & Russell, 2000b, p3) For example, there are many ontological and epistemological issues that confront anyone wanting to use the learning

system concept and /or engage with the literature. (The distinction between ontological and epistemological can perhaps most easily be summarised in claiming that a situation 'is a learning system' giving ontological status or can be seen 'as a learning system' drawing on a constructivist perspective and different theories of knowledge.) These issues have been present since the start of learning systems traditions and are still present (Bawden, 2000; Ison *et al.,* 2007; Blackmore & Ison, 2012; Ison, 2017). The concept of a learning system has a range of different meanings, many are linked to education or computer software. Here, however, we will not be taking just 'provider led' perspectives but will instead link learning systems to a range of systems theoretical and practice traditions where a system of interest with the purpose of learning can be formulated in a situation of concern (Blackmore, 2009).

RESULTS AND DISCUSSION

The results of our research and inquiries are presented here as two parts of our trajectory – a look back, providing a critical review of the ideas and tools of learning systems and an account of what we see as the current state of the art, including two vignettes from our own experience that exemplify contemporary learning systems practice. We include discussion of what we see as significant in events and ideas of the past and the present. We go on to discuss and evaluate the potential future contributions of learning systems to farming, food and environment.

A look back: Looking back it is possible to see where the ideas and tools of learning systems have come from, who has been using them in the context of farming, food and environment and to what effect. Some of these ideas and tools come from using systems ideas in the context of agriculture and others from a focus on learning in a range of different domains. Systems agriculture was the early 1980s response to the looming agricultural crisis in Australia with its essential thrust of keeping together Kurt Lewin's triangle of learning-research-action (Bawden *et al.,* 1985). Globally, of course, Farming Systems Research and Development had been formulated as a systemic way forward to research and extension in donor-led programs in developing countries beginning in the late 1970s (Shaner *et al.,* 1981). Wilson (1988), Conway (1990) Open University (1981, 1987), Bawden *et al.* (1984, 1994) and Röling (1990, 1992) were among those focusing on systems thinking and practice in agriculture and rural development at this time, all drawing on other and often earlier work on systems thinking and practice, including learning systems and agricultural systems. A common influence was Colin Spedding's work on agricultural systems (1976, 1979).

Much of the early work in the farming systems tradition saw people as elements in a basically biophysical system (Bawden *et al.,* 1985). Other framings came later, partly inspired by, for example Peter Checkland and his colleagues' work on soft systems methodology (Checkland & Scholes, 1990) and Geoffrey Vickers' work on systems thinking and human activity systems (Vickers, 1970, 1972, 1978, 1983). All explored the interconnections of bio-physical and human activity systems and were concerned with both understanding and changing agriculture and food production and consumption practices in order to address a wide range of issues ranging from efficiency and ethicality to pollution, erosion and energy resources. Agricultural research was not their only focus. The Open University course Food Production Systems, led by Dick Morris (Open University, 1981, 1987), ran from 1981 until 1994 and is one example where the strands of systems theoretical work derived from systems practice in multiple domains were applied in an agricultural context.

The 'Hawkesbury tradition', also with a strong educational focus and led by Richard Bawden (Bawden *et al.,* 1984; Bawden, 1995; Bawden & Packham, 1993, 2007), is another such example. Röling and his colleagues focused explicitly on knowledge systems in research and practice in the context of sustainability (Roling, 1990, 1992, Woodhill & Roling, 1998). In the International Farming Systems Association (IFSA) community, learning began to be recognised in the 1990s after the first international IFSA conference in Edinburgh in 1993. It became a very popular workshop theme (Collinson, 2000). Another influential tradition that surfaced during these times, that had a broader environmental focus, was ecological systems. The Odum brothers – Harold and Eugene – are well known for introducing systems ideas into ecology (Odum, 1971; Odum, 1983). Many others also developed these ideas, drawing from general systems theory and cybernetics, e.g. Boulding (1978), Holling (1973).

The tradition of agroecology and agroecosystems recognised interconnections between agriculture and ecology (Cox & Atkins, 1979; Conway, 1990). Starting

with ideas on 'learning as systems' rather than with the systems traditions associated with agriculture, food or environment, the work of Vickers (1965, 1987), Schön (1973), Argyris & Schön (1978), Senge (1990), Wenger (2000), and others, have all drawn on classic systemic works on learning (e.g. John Dewey (1933), Kurt Lewin (1946) and Gregory Bateson (1972)) who in turn built on the ideas of many others.

The boundaries between different agricultural, rural development, ecological and learning systems of interest are not clear cut. Many of those working on agricultural, rural development and ecological systems worked in groups that had broader systemic traditions and so had multiple starting points in which learning was also a primary focus.

Data mentioned in the Table 1 shows that some of the features of these learning systems traditions and is intended to give a 'flavour' of these traditions and a starting point. It is in no way a comprehensive synthesis. The traditions also have many interconnections.

Table 1. Examples of learning systems traditions.

Authors[1]	Name of traditions[2]	Features of tradition
Schön, Argyris & Schön	Learning systems, learning organisations, learning society	Constructs for different purposes, interconnected transformations, design and institutions supporting learning
Vickers	Appreciative systems	Temporal dynamics, questions what we can and cannot perceive at a particular time, appreciative inquiries
Senge	Learning organisations	Systems thinking, personal mastery, mental models, building shared vision, team learning
Bawden, Packham, Macadam, Sriskandarajah, Ison (Hawkesbury)	Critical social learning systems, knowing systems (Hawkesbury tradition)	Being critical of the way we live our lives, learning how to act collectively, approaching issues systemically. Recognising worldviews and their influence, a focus on epistemic development. Experiential learning.
Wenger, Lave	Communities of practice and social learning systems	Domains, communities, practices, boundary interactions, trajectories, a social theory of learning
Röling, Jiggins, Woodhill, van Bommel	Knowledge systems, social learning	Transdisciplinary, social ecological systems, learning as a social process, co-production of knowledge, knowledge systems as soft systems
Hubert, Ison, Röling, 'Cow up a Tree' & LEARN group authors	Learning systems and farming systems research	Multi-stakeholder approaches, learning in networks, fostering emergence of new approaches to knowing and learning
Ison, Blackmore, Collins, Reynolds, Foster	Social learning systems, systemic inquiry and co-inquiry (Open University)	Appreciating multiple perspectives, inquiry-based practice, engaging with uncertainty, facilitating concerted action, reflexive practice
Sriskandarajah, Hansen, Bawden, Tidball, Wals, Blackmore	Resilient learning systems	Action research, experiential learning, soft systems methodology, epistemic development, local democratic community development.
Klerx, van Mierlo, Leeuwis, Roling	Agricultural innovation systems (Wageningen)	Shared learning and change, social networks of innovators, multi-actor processes
Ison, Sriskandarajah, Blackmore	Course and conference-based learning systems for Systems Thinking in Practice in Research	Conference-based systemic inquiries, students' own learning systems, informed by a range of systems theoretical and practice traditions

[1] This list of authors is not comprehensive, many others have contributed and worked with these lead authors, including many involved with IFSA.

[1] Some of the authors have contributed to a wider range of traditions. Affiliations given are just a starting point, many more could be included.

A full analysis of how "learning systems" thinking and practice relating to farming, food and environment have evolved is beyond the scope of this paper. Further details can be found elsewhere. For instance, the LEARN group (2000) argued for more systemic responses to crises in farming, natural resource use, food systems and rural livelihoods, through changing practices associated with knowing and learning; Darnhofer *et al.* (2012) describe how farming systems research has evolved as researchers increasingly recognised the importance of taking environmental and social contexts into account when developing agricultural technologies and as a shift towards interdisciplinary research was taking place around the 1980s. They note that in addition to systems thinking and interdisciplinarity, participatory approaches that lead to reciprocal learning processes among stakeholders have become characteristic of farming systems research. Blackmore (2010) tracks the development of early social learning systems, critical social learning systems and communities of practice approaches, as they have been applied in a wide range of domains of practice, including sustainable development and natural resource management. Ison (2017) and Ramage & Shipp (2009) both considered a wide range of different influences and lineages that shaped contemporary systems approaches. Learning systems are recognised by these authors as a key grouping of ideas (Ramage & Shipp, p5) and as a primary vehicle for designing curricula, research-based inquiry, situation improving action and for the education of the systems practitioner (Ison, 2017, p270).

State of the art: In some respects the nature of the events that led to the emergence of learning systems approaches has changed little. Messy, interconnected issues, complex situations, multiple stakeholders, inequity and uncertainty that gave rise to systems approaches of the twentieth century are all still experienced by many in the context of farming, food and environment. However, as we discuss further in our two vignettes (below), the actual issues and situations have changed significantly, as have the ways in which many of us respond to them, both as researchers and as citizens. Increasing globalisation, technological development, population growth, climate change, the rise of social media and associated cultural changes have fuelled many changes in contexts, changes in the nature of interactions, changes in institutions and governance and changes in our own perspectives. For example, the

past thirty years has seen continuing growth in urbanisation in many parts of the world with increasing food security issues, mainly in low and middle-income countries (Satterthwaite *et al,* 2010). There has been a rapid increase in the use of plastic packaging associated with food and water, (Laville & Taylor, 2017) with issues of pollution arising regarding their disposal. Use of digital technologies has opened up communications worldwide with many benefits but has also generated huge amounts of electronic waste. New livelihoods have of course emerged in re-use and recycling of these different kinds of waste but our institutions (e.g. regulations) often do not as yet support them well. Responses to pests and weeds are also very different to a couple of decades ago with the systemic effects of their use gaining recognition (e.g. through declining bee populations, increase in plant diseases and resistance to herbicides) and increased regulation. Organic farming has increased in parts of Europe and robotic agriculture has begun to provide the means to radically reduce use of herbicides.

There has been learning associated with many of these changes but also apparent evidence of not learning with different elements and processes not joining up. So how does our understanding and use of learning systems differ from twenty years ago? In the 1980s and 90s a learning system usually meant a group of interconnected subsystems, made up of elements and processes that combine for the purpose of learning. The placement of a boundary around this system depended on both perspective and detailed purpose. However, the perspective of the designer of the learning system was often not made apparent. The language of systems followed that of science in rarely using the first person and making claims to be objective.

A learning system was often viewed from a" first order" perspective, drawing on first-order cybernetic traditions usually aligned with a 'hard systems' approach which is more systematic than systemic. This approach sets out aims and objectives, including learning outcomes which encourage goal-seeking behaviour and assume control is possible. Instructional methods are prescribed and the design tends to follow a blueprint (Ison, 2017). In contrast, a learning system that draws on second-order cybernetic traditions takes account of the history of a situation and the traditions of understanding of those involved (Ison & Russell, 2000a,b, Ison *et al.,* 2008, Ison & Blackmore, 2014). No claims are made for objectivity

as the perspective of the observer, or designer, of the learning system is made explicit and taken into account. Supporting the learner in the process of learning rather than just learning outcomes are in focus. The emphasis in a learning system that draws on a second-order perspective is on facilitating learning and constructing or co-constructing knowledge rather than teaching and knowledge transfer. This second-order perspective on learning systems was very rarely found in the 1980s and 1990s and is more common today, though both approaches are still found (Sriskandarajah *et al.,* 2010). Ison & Russell (2000a) suggest that the second-order perspective on learning systems is not necessarily a desirable alternative to the first – both can be important and they can be understood as a duality.

We exemplify this second order design in practice by presenting here two vignettes to illustrate contemporary learning systems practice of relevance to agriculture, food and environment. We subsequently go on to draw out the characteristics and questions from these examples which we discuss in the final section.

Vignette 1. Designing and evaluating a conference-based and course-based critical social learning system to support systems thinking in practice in PhD research: A course-based initiative for PhD students keen to incorporate systems approaches (systems theories and methodologies) into their research practice ran in conjunction with the 2018 IFSA conference in Chania. The course was developed by the authors and some of their peers alongside IFSA's symposia in Arhus in 2012, in Berlin in 2014 and in Shropshire, UK in 2016. It can be considered as a contemporary learning system which draws on both first and second-order principles of design.

In Arhus the main focus was on making connections among issues of farming, food, rural areas and environment and negotiating boundaries for research in these areas, a process becoming more and more complicated. The Berlin course explored working strategically with farming systems research to address global challenges. In Shropshire the overarching course theme was appreciating how purposeful transformations are realized in different parts of the world in areas of farming, food, rural areas and environment. The Chania focus was on uncertainties and opportunities in farming systems. In first-order terms, each presentation of the course could be thought of as a sub-system within an overall learning system related to

farming systems research. But if keeping the overall purpose of the learning system as incorporating systems approaches into PhD research practice then the boundary would include not only the IFSA initiative but others in separate sub-systems. For instance, the authors developed the course further in parallel to the International Society for the Systems Sciences in Berlin in 2015, Boulder, Colorado in 2016 and Vienna in 2017. The model of the course has been developed to use as a 'wrap-around' to any conference where enhancement of systems thinking in practice capabilities may be desired or warranted. Intended learning outcomes are specified, partly to indicate what the course is about and partly because they are a requirement of accreditation by universities. Students' evaluation of the course has demonstrated that their learning often extends beyond the stated learning outcomes.

The key elements of the learning system design are (i) a conference host and community that values learning; (ii) a sponsoring and/or host University able to offer credits for doctoral or graduate-level training; (iii) a process design based on systemic inquiry; (iv) pre and post-conference time dedicated to the participants framing of the inquiry, valuing of prior experience and group-based learning; (v) dedicated staff immersed in the different cyber-systemic traditions as well as learning system design and facilitation capability and (vi) freedom to use the associated conference itself as a source of input as well as being the subject of critical inquiry (Blackmore *et al,* 2015).

Drawing on second-order principles, a lot of emphasis is put on the history of the situations explored and the traditions of understanding of those involved. Changes in thinking and changes in practice are noted e.g. regarding increased recognition of wider groups of stakeholders and their perspectives and from changes in legislation (e.g. with the EU's water framework directive) and advances in technology (e.g. in agricultural robotics and precision farming). Students take stock of their research trajectories and gain experience in using systems thinking in practice. The authors make explicit their own perspectives, recognising that they make a choice regarding which traditions of understanding to build on and which systems theories to draw to students' attention. A key aim is to support students in making links between their own experiences and traditions and those introduced in the course and the conference. The course recognises a

need to develop particular skills and abilities e.g. in systemic inquiry. Systems diagramming techniques are taught to enable communication about the students' different systems of interest but flexibility is maintained about how students use these techniques. Students work as a critical social learning system (CSLS), using Bawden's concept of a CSLS as "a collection of individuals who agree to act together as a coherent group of people who are prepared to 'collectively learn their way through' an issue that they all agree is problematic in some way or another to them all" (Bawden, 2010, p94). We encourage students to approach the course critically and to take responsibility for their own learning. Situations of concern are broad-ranging, including those associated with many of the challenges mentioned in this paper, the common ground for the course is systems thinking in practice. However, all student participants have in common the doing of their own PhD or Masters research. Overviews are provided in the course, as well as examples of experiences of using particular theories, techniques and methodologies. Those running the course take a lead in providing these overviews but students are also invited to contribute their own experiences. We recognise that students face many challenges in identifying and developing appropriate conceptual frameworks and methodologies for their research and we try to avoid advocacy of one approach over another.

All programmes have been evaluated though full reporting of evaluations await resources for systematic treatment and, desirably, longitudinal survey. On the whole evaluations have been very positive; alumni have also been involved in subsequent presentations. With resources and appropriate institutional arrangements there is considerable potential to build and sustain a flourishing community of practice.

Vignette 2. A systemic co-inquiry for learning for transformation of water managing and governance: For more than two decades a group of researchers (many of whom attend IFSA symposia on a regular basis) has been involved in a systemic co-inquiry concerning water managing and governance (Ison *et al.,* 2004, 2007, 2011; Collins *et al.,* 2007; Steyaert & Jiggins, 2007; Hubert *et al.*, 2012; Colvin *et al.,* 2014; Foster *et al.,* 2016; Blackmore *et al.,* 2016). This co-inquiry (meaning a collaborative inquiry) can also be considered as a learning system that draws on many of the traditions listed in Table 1. Thinking of it as a learning

system can help to draw attention to the interconnections among its many processes and the significance of its history and systemic traditions of understanding. Some key elements of this learning system design were (i) a research community that values learning; (ii) an iterative process-design based on systemic co-inquiry; (iii) groups of stakeholders who recognise needs for transformation of water managing and governance; (iv) the context of "resource dilemmas …brought about by humans having become a major force of nature and by the increasingly contested means of access to, and use of, common pool resources as typified in the hydrological cycle" (Ison *et al.,* 2007 p500). In this long-term co-inquiry those collaborating were stakeholders in water managing and governing from government, academia, NGOs and local communities in parts of the UK, Netherlands, Italy, Sweden, Australia, France and South Africa. A succession of research projects and workshops have enabled this inquiry to continue but the boundary of this learning system includes a lot more besides the actual projects and workshops, as stakeholders who have been involved in the process have drawn on their learning and continued the transformations through their own initiatives.

Foster *et al.* (2015 (following Ison, 2002; Ison *et al.,* 2004; Wallis, 2015) describe systemic co-inquiry as:

 "…a mode of investigation that is open to changing situations, pursuing new directions, and engaging with new or different theoretical/ methodological frameworks. In contrast to programmes and projects, which tend to focus on timelines and outputs, systemic co-inquiries proceed by enacting a social learning process with those who have a stake in a situation experienced as problematic or as presenting an opportunity. Thereby, they enable participants to begin their investigations in a different emotional space to that which accompanies the emotion of certainty usually associated with programmes and projects. Systemic inquiries are flexible and do not always have a specific end-point: there is no 'right' way to do a systemic co-inquiry. They can precede, run in parallel with, or incorporate a programme or project, and they can be as short as a few hours or run indefinitely until those engaged agree to stop" (Foster et al., 2015).

There have been many outcomes from this overall inquiry and its constituent parts that are seen by the authors of this paper as significant e.g. improved

understandings and contributions to catchment-based approaches for managing water, appreciation of the changing understandings and changing practices that can lead to concerted action to improve situations; involvement of wider groups of stakeholders in decision making; development of tools and heuristics to enable a systemic approach to managing and governing, and developing new institutions and policies that are conducive to systems thinking in practice and better water governance (Steyaert & Jiggins, 2007; Foster *et al.*, 2016). Colvin *et al.* (2014) detailed a decade of this inquiry, highlighting three of its case studies – in UK, South Africa and Italy. They made a case for investing in local level systemic innovation through social-learning praxis design approaches and in learning processes around these case-studies. This overall inquiry also made a case for investing in social learning as an alternative, but complementary, governance mechanism for systemic innovation for sustainable development.

These two vignettes demonstrate the following characteristics

1. Considering the trajectory of the courses and inquiries with a history, present and future, highlights the interconnections between one-off events in terms of people, ideas and activities. Communities of practice can be identified around each learning system.
2. Key roles and responsibilities for developing learning systems have been identified in each situation, such as those of facilitator, designer, evaluator, communicator, champion, change agent and boundary spanner with other communities of practice.
3. Individual and collective learning was in evidence
4. Attention has been given to the design process in each case drawing on principles of co-design and second order design
5. Over time 'Alumni' of the processes involved have emerged who have been invited to contribute to the various events and activities.
6. A continuing need for systems thinking in practice is evident
7. The processes involved place demands on thinking about and designing institutional and governance arrangements to sustain on-going inquiry.

A look forward: Considering courses, inquiries and other processes as learning systems for purposeful action inevitably keeps a focus on learning and on

systems. Yet both these are contested concepts (Blackmore, 2007) and different ontological and epistemological assumptions in thinking and practice are not always made explicit. It is therefore perhaps not surprising that understandings and practices of learning systems vary. We argue that while learning systems practices serve many purposes and that some variation is therefore to be expected, making explicit the assumptions that underpin these practices is important for critical thinking and acting in terms of learning to become institutionalised and enacted, as if a learning system was functioning.

A quick internet search demonstrates that the linear concept of 'delivery' of learning outcomes appears to have gained ground in recent years with increased use of digital technologies. Fields such as implementation science; integration science; nudge and behavioural economics tend to perpetuate this linear paradigm. We suggest that this trend together with some of the earlier examples included in this paper, such as the large-scale increase in food and plastic waste, amount to a crisis in our society undermined by the persistence of systematic, linear models that especially privilege delivery or implementation of pre-givens rather than the effectiveness of human actions in rapidly changing contexts. In our experience, attempting such delivery of pre-givens is usually an inappropriate course of action when there is uncertainty. For instance, regarding extreme weather events, implementing a learning and action plan to address drought conditions won't necessarily help to address later issues of flooding, unless practitioners develop the ability to step back on a regular basis and take a systemic learning approach that takes account of their contexts. It is also just not possible to 'deliver' learning outcomes in relation to many of the current challenges of food, farming and environment as what is learnt depends to a large degree on how a learner contextualises whatever they engage with. Recognising the courses and inquiries detailed in the two vignettes of the last section as learning systems enabled their facilitators and designers to negotiate and re-negotiate system boundaries in terms of who to involve and how, which ideas and techniques to use and to recognise which people, events and ideas in the environments of these activities were influential and able to be influenced. Feedback from one event to another was done explicitly with all stakeholders drawing on not just their own previous experiences but

those of others who had taken part in previous events. Facilitators and designers made their own perspectives apparent. Systemic co-inquiries, or finding out together in ways that take account of changing contexts, was a response to uncertainty in participants' situations and to not knowing how to go forward.

Other contemporary processes, such as "Living Labs", have similar aims and processes to systemic inquiries (see http://www.openlivinglabs.eu/node/1429) and also respond to uncertainty. The authors find Papagorgio's (2017) focus on labs for social innovation of particular relevance to our own situations, with many similarities to the systemic inquiries we have described. Seeing these labs as learning systems could help to keep on negotiating and reviewing their boundaries and to recognise what they affect and are affected by. Alternatively what we have done over the last decades in terms of design and conduct of learning systems could be reframed as enacting context sensitive, thus adaptive, 'learning labs'.

Much has been learnt about designing learning systems that take account of the dynamics of learning in the uncertainty of the changing context of the farming-food-environment nexus through the traditions referred to in the paper. We, the authors, are among those who have recognised learning system design as an important part of dealing with these dynamics (Ison *et al.,* 2007; Ison & Russell, 2000a; Sriskandarajah *et al.,* 2010; Ison & Blackmore, 2014; Blackmore *et al.,* 2015, 2017).

Vickers notion of appreciative systems (1970, 1987) and Wenger's work on communities of practice (1998) have provided particular inspiration in this respect. Vickers recognised a flux of events and ideas that appreciative inquiries draw from and inform, and that change does not always manifest itself as action at a particular time, it can come later.

> *"I recall an occasion when an important governing body debated for a year what should be done in a situation which seemed to require some radical solution. They finally decided that there was nothing to be done. No action followed – yet nothing was ever the same again. The mental activity which reached this negative conclusion radically changed their view and valuation of their situation. In particular, it changed their idea of what can be tolerated; a most important threshold in the regulative cycle. Men, institutions and societies learn what to want as well as how to get,*

> *what to be as well as what to do; and the two forms of adaptation are closely connected… (Vickers, 1987)."*

Wenger's social theory of learning includes many insights on how a mix of participation and non-participation helps define our identities, highlighting that we have many choices about how we locate ourselves in a social landscape, what we do and don't care about, what we try to know and understand and what we ignore, the connections we seek and avoid, how we engage and direct our energies and how we attempt to steer our trajectories. (Wenger, 1998, p167). Yet these choices can be as much about how a community of practice does or does not provide a conducive context for participation as about what the individual might choose. Hence in designing learning systems such as those referred to in our vignettes we put a lot of emphasis on the process, the significance of history and in providing an enabling context for participants, including ourselves, to learn and to change. We have much experience to draw on about what can influence learning about systems thinking in practice (STiP) and over time have very much welcomed an emerging STiP learning systems community of practice and support it in many ways. However, we recognise that whatever aspirations and intentions we and the others we work with have in the design and facilitation of our events, we cannot control the learning outcomes. So in common with other traditions we have been a part of (e.g. at Hawkesbury and at the Open University) we try to encourage participants to take responsibility for their own learning and we aim to be reflexive in our own roles as designers and facilitators, welcoming challenges and critical feedback from participants.

CONCLUSION

Many recognise that individuals and groups often do not learn how to change but stay stuck doing 'more of the same' which is not an appropriate response to some of the intractable issues of food, farming and environment. Dan Ariely suggests that if we understood our cognitive limitations in the same way we understand our physical limitations we could design a better world (Ariely, 2010).

Perhaps not taking account of our cognitive limitations is one reason why we do not always recognise change, nor our role in it, let alone work out how to respond systemically and how to anticipate and avoid unintended consequences. Our experience has also been that in

short supply are skills in critical designing and facilitating of learning systems that can lead to development of STiP skills of relevance to the dynamics of the farming-food-environment nexus. We are encouraged that the IFSA community is among those who have begun to address these issues of developing skills for systemic change for the future.

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