Agrilink

AGRICULTURAL KNOWLEDGE: LINKING FARMERS, ADVISORS AND RESEARCHERS TO BOOST INNOVATION

AGRILINK'S MULTI-LEVEL CONCEPTUAL FRAMEWORK

THEORY PRIMER: **26) SYSTEMS AND COMPLEXITY**

Coordinated by **The James Hutton Institute**
Author: **Andy Lane**

EUROPEAN UNION

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 727577.

AgriLink

Agricultural Knowledge: Linking farmers, advisors and researchers to boost innovation.

AgriLink's multi-level conceptual framework

Theory primer: 26) Systems and complexity

The elaboration of this Conceptual Framework has been coordinated by **The James Hutton Institute**, leader of AgriLink's WP2.

List of contributors:

- **Lee-Ann Sutherland** (WP lead), **Pierre Labarthe, Boelie Elzen, Anda Adamsone-Fiskovica**,
- with the support and contributions of Chris Blackmore, Marianne Cerf, Danielle Galliano, Alberto Lafarga, Andy Lane, Catherine Laurent, Livia Madureira, Carla Marques, Cristina Micheloni, Geneviève Nguyen, Katrin Prager, Jaroslav Prazan, Herman Schoorlemmer, Egil Straete, Sandra Sumane, Talis Tisenkopfs, Freddy van Hulst

This document presents the multi-level conceptual framework of the research and innovation project AgriLink. It is a living document.

- A first version was submitted as deliverable D1.1 of AgriLink, Month 6 of the project (November 2017).
- **This updated version has been issued on 01/05/2018.**

It has gone through a transdisciplinary process, with implication of both practitioners and researchers in writing, editing or reviewing the manuscript. This participation has been organised within AgriLink's consortium and beyond, with the involvement of members of the International Advisory Board of the project, including members of the Working Group on Agricultural Knowledge and Innovation System of the Standing Committee on Agricultural Research of the European Commission.

Theory Primers

The purpose of the primers is to provide AgriLink consortium members with an introduction to each topic, which outlines the key points and identifies options for further reading. The primers have also served to demonstrate the wide range of expertise in the consortium, and to highlight the specific research interests of consortium members. Primers are intended to act as a **foundation for academic journal articles, and an early opportunity for collaboration between consortium members**.

26) Systems and complexity

Author: Andy Lane

1.0 General Overview of the Theory or Approach

1.1 Summary of the Theory, Approach or Topic

Both ‘systems’ and ‘complexity’ are terms used in everyday discourse but have more specific connotations within and across academic disciplines.

Systems thinking (or systems practice or systems thinking in practice) is an approach to thinking about and acting in the world that recognises interconnections and contexts by creating systemic (holistic) representations of what ‘we’ perceive about situations. It is a particular way of approaching the understanding of messy or complex situations for some purpose, usually to effect some changes. It is very suited to participatory, action-oriented research; is complementary to more systematic, reductionist methods embodied in the scientific approach; and is informed by many different disciplines and fields of inquiry. In essence systems thinking in practice deals with: understanding inter-relationships, engaging with multiple perspectives and reflecting on boundary judgements.

Complexity is both a theory and a topic in that complexity sciences uses mainly quantitative methods and models to represent large, complex, rational, non-linear, dynamical ‘systems’ that exhibit unpredictable, stochastic or chaotic behaviours while systems thinking in practice largely views complexity as being a property perceived by the observer (a mix of rational and emotional responses to messy or complex situations) rather than as a defined property of the situation itself.

A key feature of systems thinking in practice is to use diagrams to represent ‘systems of interest’ and/or collate multiple perspectives on such ‘systems of interest’. The apostrophes indicate that epistemologically different disciplines can take more positivist (this **is** a system for...) or more constructivist (I see this **as** a system for…) approaches in their thinking and actions.

1.2 Major authors and their disciplines

As noted above both ‘topics’ are employed across a wide range of disciplines over many decades, with a number of key writers supported by many followers and other researchers and practitioners. For systems thinking in practice I make no apologies for listing 3 key books here written by colleagues of mine at The Open University, books which are central to our Masters programme in Systems Thinking in Practice, but also two more accessible books or sources by Armson and Meadows respectively. They between them provide guides to a wealth of authors. If these are longer and more detailed than expected then there are any number of both popular and academic books on complexity, complexity theory and complexity science but I do not list any as I instead focus this primer on the ‘systems thinking in practice’ views of complexity rather than these more ‘scientific’ views of complexity.

1.3 Key references (3 to 5 maximum, ideally overview papers if these exist)

Armson, R. (2011) Growing Wings on the Way: Systems thinking for messy situations. Triarchy Press.

Ison, R. (2010) Systems Practice: How to act in a Climate Change World, London: Springer

Meadows, D. Thinking in Systems - see Donella Meadows project, http://donellameadows.org/

Ramage, M. and Shipp, K. (2009) Systems Thinkers, London: Springer

Reynolds, M. and Holwell, S. (Eds) (2010) Systems Approaches to Managing Change: a practical guide, London: Springer

1.4 Brief history of how the theory has developed and been applied

Evolution of systems thinking in practice

This can be quickly summarised in the following diagram from Ison (2010) which outlines the 'Influences that have shaped contemporary systems approaches and the lineages from which they have emerged' and some key writers in each of the lineages:

Ison's viewpoint is explicitly 'partial' in the dual sense of the term: firstly, he does not claim to be exhaustive of all systems thinking ideas; and secondly, he is openly biased towards his own privileging of particular trajectories and the importance of particular named systems practitioners. Its heuristic value as a diagram here is in depicting not only some key historic lineages but also some distinctions on the way in which the systems idea can be used for understanding and managing complex issues, most notably in the axis/continuum on the right side of the diagram which highlights whether those people and associated approaches think of systems as epistemological devices for providing perspectives on the world we experience or whether they seem them as ontological realities, out there in the world (see more on this in the next section).

How systems thinking in practice (for managing complexity) has been applied

Systems thinking practitioners use a number of tools, techniques and skills borrowed from other disciplines, developed within systems thinking itself or derived from practical experiences to represent, understand and design interventions within systems of interest. These tools, techniques and skills are also components of a number of methods (codified use of tools as 'techniques'), approaches (a set of theories/assumptions that have informed the development of methods) and methodologies (the conscious braiding of theory and practice in a given context). A key feature is that one part of the praxis around systems thinking is finding ways of representing a chosen 'system of interest' as a mental construct rather than existing out there in the world, and that is often best done through diagrams, maps or other visual techniques.

Whether systems thinking in practice (for managing complexity) has been utilised to consider AKIS and/or agricultural innovation[1]

The simple answer is yes and has been done so by many of the folk involved in AgriLink or their close associates. The list of publications below is a very small sample from a 5 minute search on Google Scholar for articles on 'systems thinking and AKIS', with notable groups of scholars in Europe, Australasia, North America and Southern Africa. Of course the systems tools and techniques, methods and methodologies that each set of researchers has applied in their studies and to what extent will differ in some way.

Klerkx L., van Mierlo B., Leeuwis C. (2012) Evolution of systems approaches to agricultural innovation: concepts, analysis and interventions. In: Darnhofer I., Gibbon D., Dedieu B. (eds) Farming Systems Research into the 21st Century: The New Dynamic. Springer, Dordrecht

Schut, M., Rodenburg, J., Klerkx, L., van Ast, A., & Bastiaans, L. (2014). Systems approaches to innovation in crop protection. A systematic literature review. Crop Protection, 56, 98-108.

Toillier, A., Triomphe, B., Dabire, D., Mathe, S., Ruf, F., Mahamoudou, K., & Temple, L. (2015). Innovation, knowledge management and researchers' postures: exploring their linkages for improving the performance of innovation platforms.

Poppe, K. (2016). Anticipating the Future: Scenarios for Resilient Institutions in Agricultural Research and Innovation. Proceedings in Food System Dynamics, 1-5.

Drangert, J. O., Kiełbasa, B., Ulen, B., Tonderski, K. S., & Tonderski, A. (2017). Generating applicable environmental knowledge among farmers: experiences from two regions in Poland. Agroecology and Sustainable Food Systems, 1-20.

Two well-known writers in this area are Richard Bawden and Niels Röling:

Bawden, R. (2012). How should we farm? The ethical dimension of farming systems. In Farming Systems Research into the 21st century: The new dynamic (pp. 119-139). Springer Netherlands.

Röling, N. (2009). Pathways for impact: scientists' different perspectives on agricultural innovation. International journal of agricultural sustainability, 7(2), 83-94.

To these I can add the theses of two doctoral students I helped supervise, one of which has been published, the other accepted subject to revisions that will be completed shortly:

Seale, C.M. (2017) Learning How to Inform Extension Practices Related to Mandatory Agri-environmental Policy, available at http://oro.open.ac.uk/49284/

O'Flynn, P. (2017) From Knowledge to Invention: Exploring User Innovation in Irish Agriculture

1.5 Basic concepts

Complexity and uncertainty can be features of any human activity system but this is more so when considering many larger scale agriculture situations (Ison, 2010). The number of facts and factors involved, the number of people with different perspectives and disciplinary expertise, all grow larger and seemingly more intractable. To be able to represent a complex messy situation by showing most of the components and how they are thought to fit and work together is therefore very helpful when understanding, researching, designing and implementing systemic changes that draw upon and integrates the thinking from many disciplines.

Drawing on some basic features of systems thinking, there are three generic elements underpinning systems thinking in practice:

- understanding inter-relationships ('thinking' about the bigger picture)
- engaging with multiple perspectives (the 'practice' of joined-up thinking)
- reflecting on boundary judgements (the praxis of thinking in practice).

Something which connects these three elements is finding ways of representing a chosen 'system of interest', and that is often best done through diagrams, maps or other visual techniques. At the Open University we believe that representing 'systems of interest' using visual techniques is therefore an essential part of any participatory and action-oriented researcher's personal toolkit (Armson, 2011).

In identifying 'systems if interest' in any particular situation it is helpful to appreciate three broad areas in which 'systems' are generally understood and used by people, practitioners and academics alike:

- Natural systems ─ individual living organisms or wider biophysical entities like ecosystems, the planet Earth or the solar system.
- Engineered (purposive) systems ─ mechanical equipment, vehicles, computers, heating or irrigation systems etc., and
- Human (purposeful) systems ─ organizations (agricultural advisory agencies, NGOs, government departments, community services etc.), the food economy, agricultural education, agricultural policies, programmes, projects, etc.

Across these three broad areas the first two are usually approached using more systematic and scientific methods and methodologies as the systems are more often seen as ontological realities (see diagram above) while the third area is more often treated through a systemic lens where the representation of the system of interest is used as an epistemological device and the systemic inquiry framed as supporting a learning system (Checkland, 1999; Blackmore, 2010). Of course any such typology is subject to challenge and in recent years there has been much interest in social-ecological and socio-ecological systems which tend to merge the first and third types mentioned here and which also bring the fore the tensions between those disciplines focusing on ecosystems and earth systems as real entities with those disciplines focussing on human activities who take a more fluid focus on 'systems of interest'.

The core systems concept is that of an adaptive whole (a 'system of interest') with irreducible properties that is able to create and maintain itself in response to its changing environment (Checkland, 1999). Such wholes can be regarded as complex adaptive systems or more simply defined as a collection of entities that are seen by someone as interacting together to do something (Morris, 2009). The underlying philosophy of purposeful systems thinking is to be holistic, to look for wholes at the highest appropriate level, rather than to reduce things to ever smaller components. This concept is both simple to state and yet complex to enact because of differing philosophical and practical approaches to the concept of a system.

Given this simple definition of a system and noting the three elements of systems thinking in practice noted above it is not surprising that graphical/diagrammatic/visual representations of systems of interest are a common and widely used tool or technique for representing a chosen 'system of interest' by visually showing relationships and boundaries in ways that can stimulate and support the sharing of multiple perspectives and to work towards more informed actions. Many believe that representing 'systems of interest' using visual techniques is therefore an essential part of any participatory and action-oriented researcher's personal toolkit particularly as diagrams can include both rational thoughts and emotional feelings and where the participants are seen as co-researchers who have some stake in the conception, design, implementation and/or reporting of the research and some stake in implementing any outcomes or recommendations that arise from that research (Oreszczyn and Lane, 2017 – shameless plug!).

2.0 Application to the analysing the role of farm advisory services in innovation

2.1 Relevance to AgriLink Objectives

[tick relevant]	AgriLink Objectives
X	Develop a theoretical framework utilising a multi-level perspective to integrate sociological and economic theories with inputs from psychology and learning studies; and assess the functions played by advisory organisations in innovation dynamics at multiple levels (micro-, meso-, macro-levels) **[WP1]**;
X	Assess the diversity of farmers' use of knowledge and services from both formal and informal sources (micro-AKIS), and how they translate this into changes on their own farms **[WP2]**;
	Develop and utilise cutting edge research methods to assess new advisory service models and their innovation potential **[WP2]**;
	Identify thoroughly the roles of the R-FAS (regional FAS) in innovation development, evaluation, adoption and dissemination in various EU rural and agricultural contexts **[WP2]**;
	Test how various forms of (national and regional) governance and funding schemes of farm advice i) support (or not) farmers' micro-AKIS, ii) sustain the relation between research, advice, farmers and facilitate knowledge assemblage iii) enable evaluation of the (positive and negative) effects of innovation for sustainable development of agriculture **[WP4]**;
	Assess the effectiveness of formal support to agricultural advisory organisations forming the R-FAS by combining quantitative and qualitative methods, with a focus on the EU-FAS policy instrument (the first and second version of the regulation) and by relating them to other findings of AgriLink. **[WP4]**.
	At the applied level, the objectives of AgriLink are to:
X	Develop recommendations to enhance farm advisory systems from a multi-level perspective, from the viewpoint of farmers' access to knowledge and services (micro-AKIS) up to the question of governance, also recommending supports to encourage advisors to utilise specific tools, methods to better link science and practice, encourage life-long learning and interactivity between advisors **[WP5]**;
X	Build socio-technical transition scenarios for improving the performance of advisory systems and achieving more sustainable systems - through interactive sessions with policy makers and advisory organisations; explore the practical relevance of AgriLink's recommendations in this process **[WP5]**;
X	Test and validate innovative advisory tools and services to better connect research and practice **[WP3]**;
X	Develop new learning and interaction methods for fruitful exchanges between farmers, researchers and advisors, with a focus on advisors' needs for new skills and new roles **[WP3]**;
	Guarantee the quality of practitioners' involvement throughout the project to support the identification of best fit practices for various types of farm advisory

services (use of new technologies, methods, tools) in different European contexts, and for the governance of their public supports **[WP6]**.

2.2 How this can be applied/developed in AgriLink

From this account of 'systems' and 'complexity' arising from my professional history I can see both a strategic and a tactical level application of systems and complexity within AgriLink.

The strategic level application would be around using the concepts and terminology briefly set out here as one of the overarching frames for the project. At the moment the Multi-Level Perspective is proposed as an overarching framework and I am not suggesting dropping that. Rather I am proposing that the MLP can be more explicitly stated as fitting within a systems thinking in practice frame and that it is being used to deal with the perceived complexity of this messy and complex situation across Europe. This could include developing/adapting/evolving the diagrammatic as well as textual representation of the MLP; critiquing other such diagrams in the literature as to whether and how they portray systems of interest, such as the general view of AKIS (Figure 1) or more contextualised representations of AKIS (Figure 2); and/or developing new diagrams to represent key features of our research. But equally there are other potential uses of systems theories and concepts that could be used if thought appropriate to AgriLink.

The tactical level application would be to collectively decide whether and how we use diagrams as specific tools for capturing our own thinking and experiences during the projects and for eliciting evidence from formal participant and others e.g. in the Living Labs (the request to provide spray diagrams or rich pictures for each LL at the kick-off meeting is an example of capturing and sharing perspectives/information/evidence which can also be record of changes if repeated periodically during the project lifespan). If nothing else we need to be very critical and self-reflective on how we use diagrammatic representations, which is something that could also feature within monitoring and evaluation activities.

2.3 Research questions relevant to AgriLink

I do not see how the main concepts of systems and complexity can be used to directly inform the research questions. There are a number of research questions that flow from my own (and colleagues) use of systems concepts in practice around 'AKIS' which I will feed in separately.

2.4 Methodological implications

<u>Types of methods typically associated with the theory or approach</u>

As I have already noted these are numerous but the use of visual representations is one that needs discussing further

<u>Implications for specific workpackages (e.g. sampling, data collection, research questions)</u>

Again, as already noted, some data collection could be facilitated through the use of diagrams but equally diagrams could also play a part in monitoring and evaluation activities.

2.5 Strengths and weaknesses/Sensitivities regarding use

None beyond those mentioned elsewhere.

2.6 Potential operational problems

The use of visual representations/diagrams does not suit all researchers or all participants which can influence what they do (or not do) with them. So there use in practice requires careful handling and in some cases (such as large workshops) professional facilitation to attend to the running of the event leaving researchers with a more directed role in the evidence gathering/data elicitation as co-participant or participant observer. Suitable guidance/training in chosen techniques would be essential.

Optional Section 3: Practical example

Oreszczyn and Lane (2017) includes lots of examples of using diagrams in participatory research but in the meantime two of the cases discussed there can also be read about in Oreszczyn and Lane (2010 or 2012).

Optional Section 4: Recommended further reading

If systems and complexity are very new topics to you the, apart from the many publications already mentioned, you could look at this free course on systems thinking and practice (http://www.open.edu/openlearn/science-maths-technology/computing-and-ict/systems-computer/systems-thinking-and-practice/content-section-0) or another one on Mastering systems thinking in practice which will hopefully be live by the time you read this and I can add or circulate the weblink.

References (to documents referenced in this template only)

Armson, R. (2011) Growing Wings on the Way: Systems Thinking for Messy Situations, Axminster: Triarchy Press

Blackmore, C. (Ed) (2010) Social Learning Systems and Communities of Practice, London: Springer

Checkland, P. (1999) Systems Thinking, Systems Practice (2nd Edn.), London: Wiley.

EU SCAR (2012) Agricultural Knowledge and Innovation Systems in Transition – a reflection paper. Brussels.

Ison, R. (2010) Systems Practice: How to act in a Climate Change World, London: Springer

Morris, R. M. (2009) 'Thinking about systems for sustainable lifestyles', Environmental Scientist, 18(1): 15-18

Oreszczyn, S., Lane, A. and Carr S (2010) The role of networks of practice and webs of influencers on farmers' engagement with and learning about agricultural innovations, Journal of Rural Studies, 26 (4), pp 404-417

Oreszczyn, S. and Lane, A. (2012) Mapping knowledge exchange in the UK Hedgerow management system: A report on a workshop held at the first International Hedgelink Conference, Staffordshire University, Stoke on Trent, UK. 3-5 September, 2012, 14pp, available at http://oro.open.ac.uk/35938/

Oreszczyn, S. and Lane, A. (2017, forthcoming) Mapping environmental sustainability: Reflecting on systemic practices for participatory research, Policy Press, https://policypress.co.uk/mapping-environmental-sustainability [Hardcover Publication date - 6th Sep 2017]

Prager K and Thomson K. (2014) AKIS and advisory services in the Republic of Ireland Report for the AKIS inventory (WP3) of the PRO AKIS project, http://www.proakis.eu/sites/www.proakis.eu/files/Final%20Draft-%20Country%20Report%20Ireland(4).pdf

Ramage, M. and Shipp, K. (2009) Systems Thinkers, London: Springer

Reynolds, M. and Holwell, S. (Eds) (2010) Systems Approaches to Managing Change: a practical guide, London: Springer

---

[1] And related topics such as ‘Environmental tipping points and food system dynamics’ as seen from the global food security programme which does focus a lot on agricultural innovation. E.g. see https://www.foodsecurity.ac.uk/publications/