Food systems

From concept to practice and vice versa

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Contents

1 Background to the assignment

MoFA/LNV have expressed an interest to put into use the food systems approach (based on Van Berkum et al. 2018) for its Food & Nutrition Security (FNS) programming. The expectation is that this will improve the relevance and effectiveness of RNE policies and projects within low- and middle income countries (LMICs). The Embassy Support Facility has commissioned a small study on the use of the concept of food systems and its implications for FNS programmes at country level. This should result in a practical application based on prior theoretical work done by van Berkum et al. (2018).

Questions to address in the study are:

1. Does the concept of food systems lead to new insights?
2. To what extent are these insights actionable (in terms of interventions)?
3. What are the required changes in current development cooperation practice?

FNS is a multi-sector, multi-level and multi-actor issue. MoFA/LNV uses the following definition for food systems:

> *"A food system is a system that embraces all elements (environment, people, inputs, processes, infrastructure, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food and the outputs of these activities, including socioeconomic and environmental outcomes"*

This internal working paper summarizes some of the academic literature on food systems and systems thinking, in order to inform a system approach to the development of FNS programming. This working paper does not aim or pretend to be comprehensive or all-encompassing. Rather, it aims to give the reader a glance of the key studies that are relevant to understand system thinking in food systems.

2 The use of food system approaches

Food systems have usually been conceptualized as a set of activities ranging from production through to consumption, often represented as a value chain. However, the increasing attention to food security has also expanded the understanding of food systems. Food security[1] is a complex issue, encompassing components of availability, access and utilization, with multiple environmental, social, political and economic determinants. The global commitment to the 2030 Agenda for Sustainable Development and UN Sustainable Development Goals has further emphasised the interlinkages between eradication of hunger and poverty, sustainable use of natural resources, promoting healthy and prosperous lives and social justice (UNEP, 2016; Caron et al. 2018). Sustainable food systems are thus key to deliver on the SDGs (UNEP, 2016). Food system approaches (see Box 1) increasingly consider a more holistic system beyond the value chain to include more (global) environmental and socio-economic drivers and food security outcomes (Ericksen 2008).

Box 1. Food system approach

Ericksen (2008) provides a broad definition of food systems, including:

- the interactions between and within biogeophysical and human environments, which determine a set of activities;
- the activities themselves (from production through to consumption);
- outcomes of the activities (contributions to food security, environmental security and social welfare) and
- other determinants of food security (stemming in part from the interactions in bullet one).

Both food systems and food security in the 21st century are fundamentally characterized by social and economic change. Developing policy to ensure food security is a tremendous challenge that requires a comprehensive and integrated analytical approach.

The Global Panel on Agriculture and Food Systems for Nutrition (2016) recommended that policy makers need to ensure that all part of food systems work together to deliver food security in the form of high-quality diets. This means including all processes and activities in food production (e.g. processing, transportation, retailing, etc.) in addition to agriculture. Global trade has extended these food chains, and shifted power and value to the middle part of the chain (i.e. agri-businesses, manufacturers and retailers). But the Global Panel states that the food systems have been failing consumers, providing unhealthy and unsustainable food, and unable to cope with (future) external stresses (e.g. population growth, climate change, globalization, urbanization). It is therefore recommended that policy makers reshape food systems by extending policy action beyond agriculture to the entire food system.

The Global Panel distinguished six steps to action:

1. *Set a clear diet quality objective* – what diet gaps need to be addressed?
2. *Engage with communities to explore perceptions of causes of the diet gap* – what causes the diet gap (availability, affordability, appeal, external factors)?
3. *Review the role of food systems* – what elements of the food systems are responsible for the diet gaps?
4. *Identify actions for food systems solutions* – what are available options for addressing the diet gaps?
5. *Align actions to create coherence* – what further actions are needed to align these options?
6. *Leverage actions for sustainability* – how can these actions be leveraged?

[1] Food security is defined as when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (World Food Summit, 1996)

Box 2. Action priorities for food security

The Global Panel on Agriculture and Food Systems for Nutrition (2016) identified the following priority areas for policy makers:

- Focus food and agriculture policies on securing diet quality for infants and young children.
- Improve adolescent girls and adult women's diet quality as a priority in all policy making that shapes food systems.
- Ensure that food-based dietary guidelines (FBDGs) guide policy decisions to reshape food systems.
- Animal source foods (ASF) provide important nutrients. Policy support for these foods should be pragmatically evidence-based rather than driven by ideology.
- Make fruits, vegetables, pulses, nuts and seeds much more available, more affordable and safe for all consumers.
- Make policies which regulate product formulation, labelling, advertising, promotion and taxes a high priority.
- Improve accountability at all levels.
- Break down barriers associated with the longstanding division of jurisdictional responsibilities within many governments – between agriculture, health, social protection and commerce.
- Institutionalize high-quality diets through public sector (e.g. schools, hospitals) purchasing power.
- Refocus agriculture research investments globally to support healthy diets and good nutrition.

Van Berkum et al. (2018) define a food system approach (FSA) as "an interdisciplinary framework for research and policy aimed at sustainable solutions for the sufficient supply of healthy food. An FSA analyses the relationships between the different parts of the food system and the outcomes of activities within the system in socio-economic and environmental terms."

The FSA framework depicts the interactions within the food system as well as with its socio-economic and biophysical environment, and the FNS outcomes (Figure 1). The food system activities are categorized into five components: the value chain, the enabling environment, business services, the food environment and consumer characteristics. Three types of outcomes are considered: socio-economic outcomes (e.g. livelihoods, employment), FNS outcomes and environmental outcomes (impacts on natural resources and climate). The environmental drivers mainly interact with agricultural production activities. The socio-economic drivers affect all food system activities and can give rise to multiplier effects or feedback mechanisms. The authors acknowledge that there are important interactions, tradeoffs and synergies between these different activities, drivers and outcomes that influence the cause-effect relationships. By providing a broad view of the impact of different intervention strategies (whether in the system context or in the value chain itself) it can inform (longer-term) policy choices.

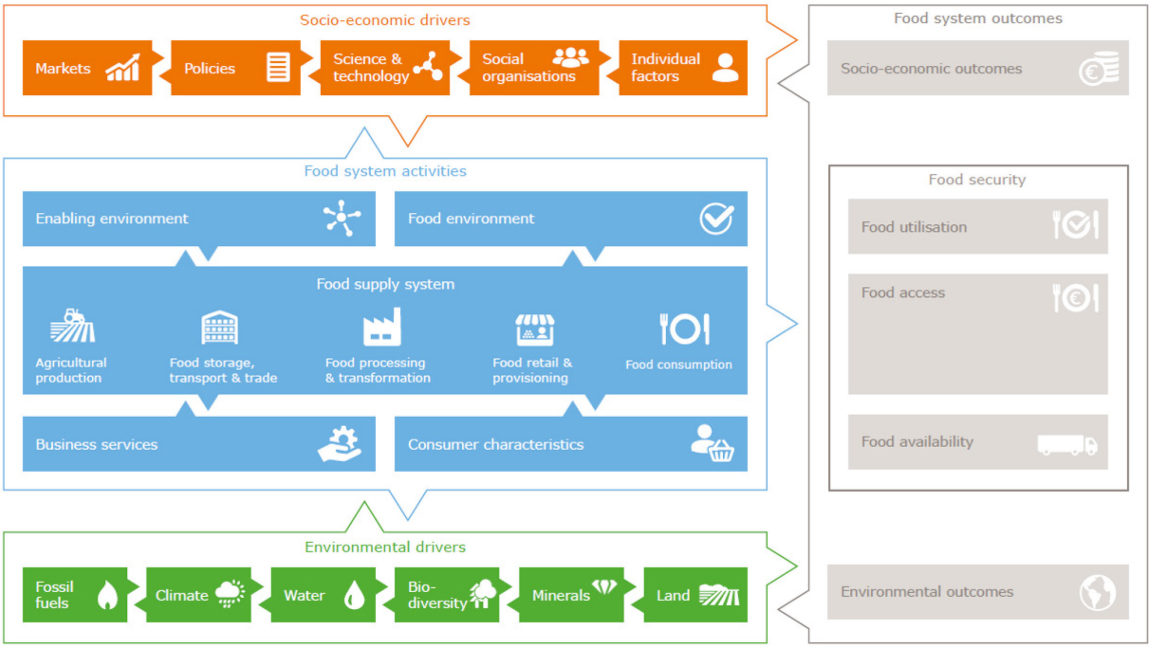

Figure 1 *Food system map (Van Berkum et al. 2018)*

The current global FNS challenges are to (Van Berkum et al. 2018):

- Increase food availability (supply) to feed a growing population, predominantly by reducing waste and building circular food chains. A reduction in meat production is also recommended;
- Improve food utilisation (safe, healthy food) by ensuring varied diets to address malnutrition due to a shortage of micronutrients;
- Improve sustainability (reducing environmental impacts) by producing food within the environmental limits;
- Improve food accessibility (inclusive food systems) by improving living conditions of farmers and workers, and alleviate poverty.

In a business-as-usual scenario, most interventions focus on increasing the agricultural productivity to improve FNS. However, Van Berkum et al. argue that interventions should target other parts of the food system to address the challenges mentioned above.

3 System thinking

Meadows (2001) defined a system as an interconnected set of elements that is coherently interconnected and organized in a way which produces a pattern of behaviours over time – whether a single cell, the universe, an ecosystem or a financial system. The main purpose or function of the system defines the otherwise arbitrary boundary of a system. However, the main function (e.g. food for consumers) of the system is not its only outcome; there are additional negative and positive system outcomes that are determined by the system structure (Kennedy et al. 2018).

Ison et al. (1997) noticed a nuanced yet important difference in systems literature. Academics would either use the word 'systems' as a noun or an adjective. They roughly divided systems literature into two streams:

1. System as noun: a system exists 'out there' in the world (e.g. farming system, value chain, ecosystem). The literature is based on hard systems thinking and seeks to understand and solve a system-determined problem through a holistic description and modelling of system components. This approach is based on reductionist thinking. Examples of literature strands are:
    a. Agroecology and farming systems
    b. Social-ecological systems
2. System as an adjective: a way of thinking about the world (e.g. system thinking, social learning). The literature is based on soft systems thinking and argues that a problem-determined system (e.g. multi-stakeholder learning, innovation platforms) is required to identify sustainable solution. Examples of literature strands are:
    a. Agricultural innovation systems
    b. Political economy

Using the terminology of the Cynefin Framework (Figure 2; Snowden & Boone, 2007), the first strand sees food systems as *complicated* – where cause-effect relationships can be understood through a holistic analysis of the system. The second strand sees food systems as *complex* – arguing that cause-effect relationships only become apparent while taking action through action research and multi-stakeholder learning as not everything can be empirically observed prior to an intervention.

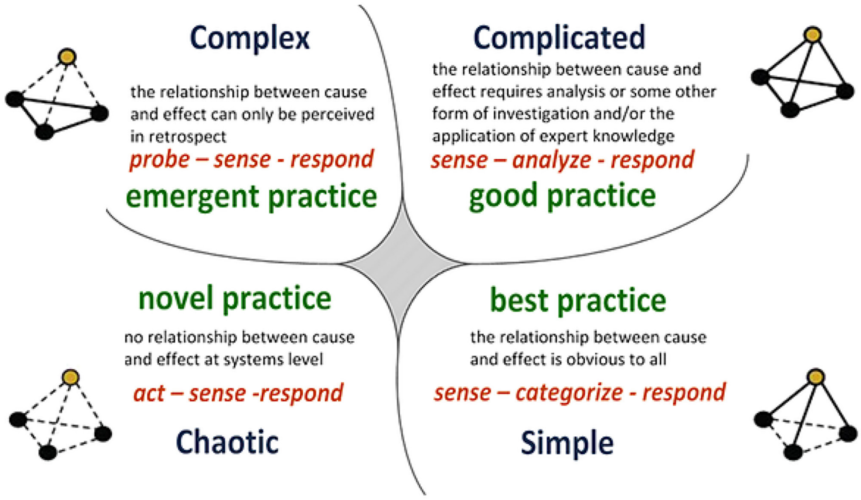

Figure 2 *The Cynefin Framework (Snowden & Boone, 2007)*

A systems approach involves exploring the complexity of interactions within the 'hard' system (i.e. the bio-physical components that can be modelled), and within the 'soft' system (the interactions between the biophysical components, technology and people) (Bosch et al. 2007).

3.1 'Hard' systems thinking

Ericksen (2008) developed a conceptual framework on food systems as a system-determined problem, which has been used and adjusted subsequently by other hard-systems researchers (e.g. Allen & Prosperi, 2016; Ericksen et al., 2010; Ingram, 2011). It includes the major activities and actors involved in the food system as well as the critical processes and factors influencing the social and environmental outcomes that are also part of the food system. The assumption is that it is possible to identify key processes and determinants within complex systems that influence outcomes. Ingram (2011) reviews the application of this framework in several case studies. The framework helped to map where each research effort contributes to the overall system goal of food security. Ingram concludes that: 1) the framework provides a checklist to ensure the necessary issues and actors are included; 2) it helps to assess the impacts of global environmental change on food systems by focussing on vulnerabilities and stresses; 3) it helps in determining the most limiting factors resulting in food insecurity.

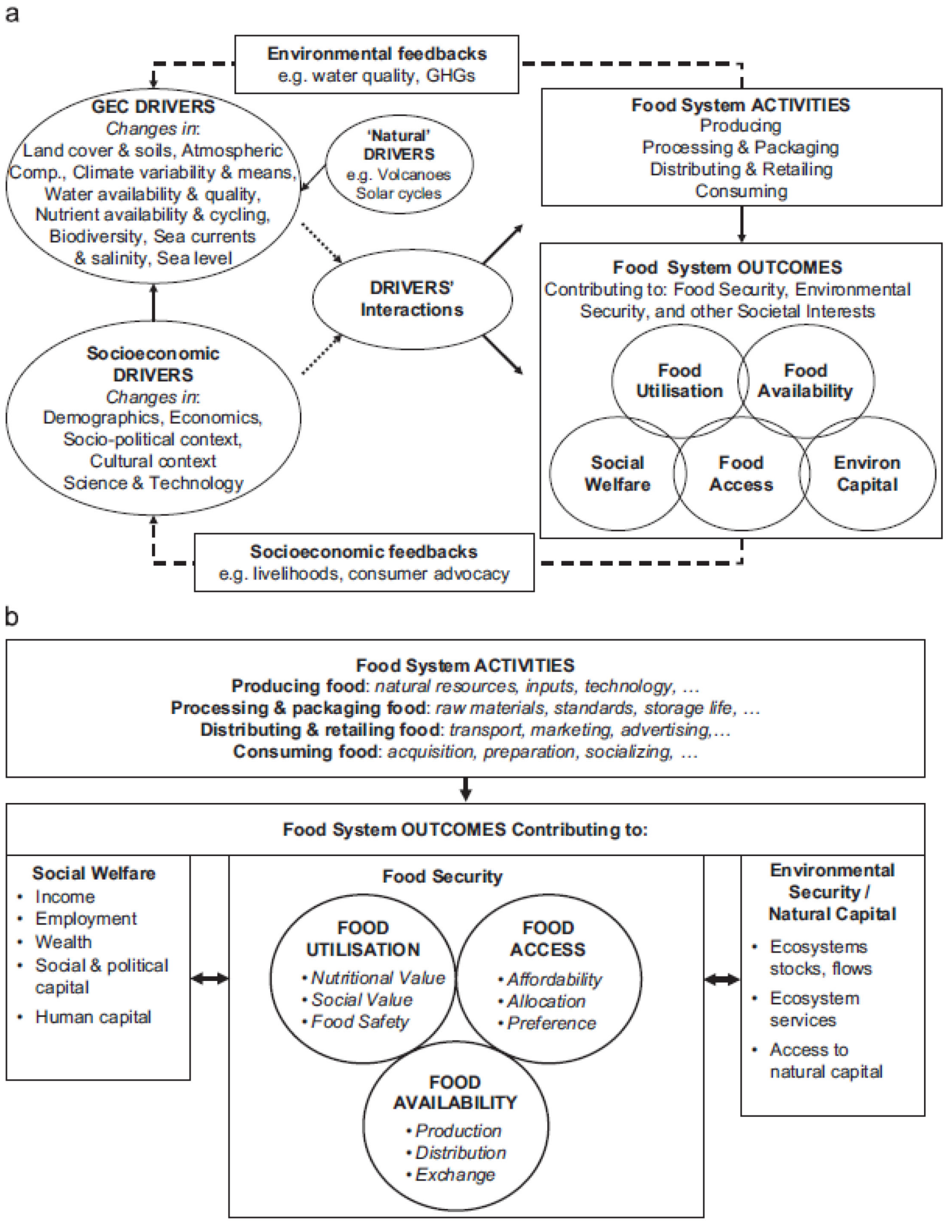

Figure 3 *(a) Food systems and their drivers. (b) Components of food systems. (Ericksen, 2008)*

Building on hard systems thinking, research organisations such as IFPRI and WUR are proposing food system metrics and indices as monitoring tools to describe the state of food systems at regular intervals (also called 'dashboard approach'; Melesse & Van Den Berg, 2017). By applying such tools, one can track system performance along different dimensions and compare food system performance in different countries. For example, IFPRI (2016) proposes a Global Food System Index covering six dimensions: nutritious and healthy consumption, market dynamics, enabling environment, productivity and resource efficiency, environmental sustainability and climate resilience, and social sustainability (Table 1). Each dimension is represented by an index that is composed of multiple metrics.

Table 1 *Proposed Global Food Systems Index (IFPRI 2016)*

Dimension	Sub-component	Indicators	Data source
Nutritious and healthy consumption	Nutrition	Dietary diversity score	FAO
		Average food supply	FAO
		Nutrition plan or strategy	HANCI
	Health	Food safety	IFPRI
		Agency to ensure the safety and health of food	HANCI
Market dynamics	Open trade	Agricultural import tariffs	WTO
	Price volatility	FAO Price Indices	FAO
	Market inclusion smallholders	Rural access to credit	World Bank
Enabling environment	Business environment	Presence of formal grocery sector	EIU
	Research investments	Public expenditure on agricultural R&D	Occasional
	Policy and coordination	Government investment, coordination mechanisms and policy	WB CSA
Productivity and resource efficiency	Staple crop productivity	Average yields cereals and pulses	FAO
	Potential for productivity	Yield gaps	IFPRI
	Resource use efficiency in agriculture	Water productivity	
		Energy use efficiency	
	Food losses and waste	Food loss	FAO
		Food waste	FAO
Environmental sustainability	Climate-smart agriculture	Policies and institutions	World Bank
		Technologies	World Bank
		Results of CSA adoption	World Bank
	Agro-ecological resilience	Land degradation / NDVI	GLADIS
Social sustainability	Women's empowerment	Women's empowerment in 5 domains	WEIA
		Intra-household gender parity	WEIA
	Access to food for vulnerable groups	Share of expenses for food / quality of social safety nets	

Such food system monitoring tools are comprehensive, but also data intensive. Berkhout et al. (2018) note that the analysis of complex and dynamic food systems leads to rapidly expanding data requirements. Despite its huge data demand, these indices tend to show static descriptions of food systems (IFPRI, 2016). Berkhout et al. (2018) suggest several focus point in system analysis to understand the increasing complexity of food systems: trade-offs, tipping points and feedback mechanisms, *but it is not clear how*.

3.2 'Soft' systems thinking

The soft-systems approaches are characterized by multi-stakeholder learning approaches, in particular within the Agricultural Innovation Systems (AIS) literature. Food systems are conceptualized as human activity systems, where actors' relationships and activities are goal-oriented (that is, driven by purpose) but restrained by context (Tröger et al., 2018).

AIS can be regarded as Complex Adaptive Systems: self-organizing systems whose properties cannot be analysed by studying its components separately. A key concept is *agency*: the ability to take action and make a difference over a course of events. Innovation agency is determined by the resources and competences (e.g. knowledge, skills, materials, finance) that an actor or organization has at its disposal for innovation. However, though system actors may try to purposefully influence their environment, unanticipated effects of their actions and random external events beyond the actors' control may either reinforce or counteract their actions (Klerkx et al., 2010).

System approaches are considered necessary to deal with problems that are complex, uncertain and/or wicked, requiring different forms of knowledge to identify solutions that can trigger systemic change. Joint learning and reflection among divers actors, using participatory processes, are considered necessary to generate transformative agency of the system actors. Important features in these learning processes are visualization and communication in group-based analysis to reveal participants' assumptions and to trigger mutual understanding, and to integrate knowledge (Tröger et al. 2018). These system-learning approaches try to avoid problem formulation according to one single perspective to the exclusion of others. They acknowledge the validity and relevance of diverse knowledge types and perspectives, encouraging local participation and capacity building (Ison et al., 1997).

Soft systems thinking increasingly uses the Multi-Level Perspective (MLP) framework initially developed by Geels (2005). This multi-level perspective incorporates three levels (Wigboldus et al., 2016): *niche* (sheltered conditions that favour emergence of novelties or innovations), *regime* (constellation or system of interacting practices and structures that are relatively stable and status quo, e.g. production systems or markets), and *landscape* (the wider context – worldviews, paradigms, culture, politics, etc. – that is least dynamic). Transitions to more sustainable food systems require the formation of innovation niches that facilitate the collective action of diverse actors for developing new modes of production, new institutional arrangements and new organizational systems. Food systems are transformed when the scaling of innovations established at the innovation niche level interact with current regimes (Klerkx et al., 2010).

Bui et al. (2016) use the MLP framework to review the trajectories of four French initiatives of alternative farming practices as bottom-up solutions to high-input farming systems, in order to identify mechanisms of niche-regime interactions through which 'niches' can contribute to regime reconfigurations. The authors consider the niches to be initiatives in which new rules and practices are developed by a network of diverse actors of the food system. Niche-regime interactions are key processes that integrate the new rules and practices within the regime. Niche-regime linking can happen through technological, network and institutional anchoring. Alternative visions of agriculture were gradually built and the networks of relevant actors expanded to govern the issue. When niche actors start influencing local policies through their interactions with local authorities, they start to impact the regime.

Soft systems thinking acknowledges that system actors are part of complex adaptive systems and have to react constantly to their changing environment, requiring adaptive innovation management. This implies that food system interventions should not try to fully plan, control and manage the food system, but to operate on the probability of events and reduce the chances of undesired results instead (Klerkx et al., 2016).

4 Enabling systemic change

4.1 System dynamics

Systems theory poses that system outcomes and behavioural patterns are caused by system structures, which are in turn influenced by mental models or paradigms (Kennedy et al. 2018). In other words, system outcomes are the result of the behaviour of many actors, who interact with different parts of the system structure (Gladek et al., 2016).

Systems-thinking literature often refers to the thinking model of Maani and Cavana (2007). This model distinguishes four levels of thinking (Figure 3): events or symptoms, patterns of behaviours, systemic structures and mental models. Most decisions and interventions are based on the visible 'events and symptoms' (also called end-of-pipe solutions), even though these are just the tip of the iceberg in reality. Patterns are linked sets of events (i.e. trends) that create a history, and interventions at this level try to anticipate and adjust future trends. Systemic structures reveal how patterns and system components relate to and affect each other. Interventions at this level aim to (re)design the system structure. Mental models reflect beliefs, values and assumptions that we personally hold and feed our reasons for doing things the way we do – yet these mental models rarely come to the surface (e.g. Kennedy et al. 2018; Nguyen & Bosch, 2013). Systems thinking helps to understand deeper system structures that are at the root of the problem (Kennedy et al. 2018), and identifying leverage points (see Box 3) for systemic change.

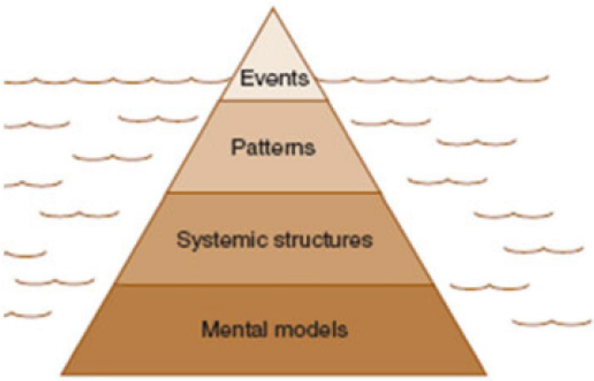

Figure 4 *Four levels of thinking model (Maani & Cavana, 2007)*

Box 3. Leverage points

Nguyen & Bosch (2013; p110): Leverage points are places within a complex system 'where a small shift in one thing can produce big changes in everything – leverage points are points of power' (Meadows 1999, p1). They are 'the right places in a system where small, well-focused actions can sometimes produce significant, enduring improvements' (Senge 2006, p64)." Leverage points exist in all systems but are not necessarily intuitive.

System dynamics focuses on the patterns and systemic structures, mapping the mechanisms of system behaviour as Causal Loop Diagrams (CLD). CLD is a systems modelling technique utilized to qualitatively explore variables and interrelationships of a system of interest. It elicits variables and relations (i.e. the system structure) that describe the behaviour of the system, represented in a conceptual model. The variables are connected by arrows, and type of influence (positive or negative) to indicate the direction of change. If there is a feedback loop, it can reinforce or oppose the original change; in case of the former it is a reinforcing loop, in case of the latter it is a balancing loop (Figure 4). Reinforcing feedback loops generate (exponential) growth or decline. Balancing feedback loops seek balance and equilibrium and help to bring the state of the system in line with a goal (Laurenti et al. 2015). CLD models can be created by researchers, but they can also be developed in a multi-stakeholder process[2]. This process of group thinking facilitates consensus building, alignments of thoughts and actions, and ownership of the model as well as future interventions (Nguyen et al. 2011).

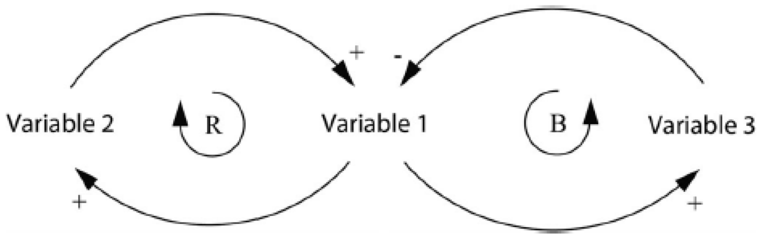

Figure 5 *Examples of causal links and feedback loops (Laurenti et al. 2015)*

Common systemic patterns of behaviour are called *archetypes*. Some archetypes are well understood, yet the same mistakes in decision making continue to occur (Kennedy et al. 2018). This is because systemic structures are often invisible until someone points them out. System structures are rarely consciously built; often they emerge from the choices people make over time (Senge, 2014).

Some examples of archetypes[3] are described by Nguyen and Bosch (2013):

- *Limits to growth*: The system consists of a reinforcing and a balancing loop. People react to growth by putting pressure on the reinforcing loop, trying to slow it down when the limits of growth become more apparent. But the leverage lies in reinforcing the forces of the balancing loop to avoid that growth exceeds the limits of the system.
- *Fixes that fail*: the system is composed of a balancing loop and reinforcing loop, where unintended and often harmful consequences follow well-intended actions (Fig 5). Quick fix solutions may ease the problem in the short term, but create unintended consequences in the long term. The leverage point is at maintaining a long-term focus in developing remedies.
- *Tragedy of the common*: the system has two reinforcing and two balancing loops (Fig 6). Common sense behaviour results in destructive consequences over time as individuals use a commonly available but limited resources solely on the basis of individual need resulting in diminishing returns and depletion of the resource. The leverage point lies in the development of an integrated master plan to manage the commons through self-regulation or official regulating mechanisms.

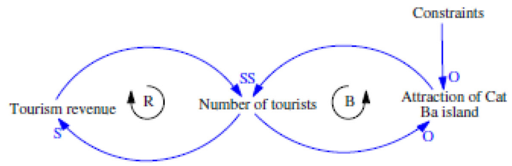

Figure 4 Tourism development as a 'limits to growth' systems archetype. Legend: S (same direction), O (opposite direction), R (reinforcing), B (balancing)

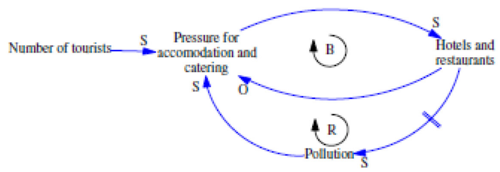

Figure 5 Tourism development as a 'fixes that fail' systems archetype. Legend: S (same direction), O (opposite direction), R (reinforcing), B (balancing), // (delay)

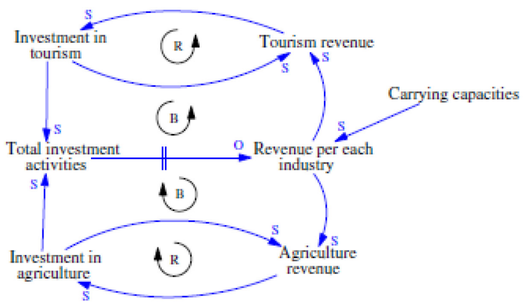

Figure 6 Carrying capacities as a 'tragedy of the commons' systems archetype. Legend: S (same direction), O (opposite direction), R (reinforcing), B (balancing), // (delay)

2 See the Facilitator Manual on 'System tools for complex health systems: a guide to creating Causal Loop Diagrams' developed by Columbia University and Mailman School of Public Health. 2015.

3 See Senge (2014) for a more complete overview of common archetypes.

- *Shifting the burden*: the system consists of two balancing loops, both trying to correct the same problem (Fig 7). The quick fix (top) solves the problem rapidly but temporarily. The more fundamental response (bottom) has a delay; the effects are less evident but eventually more effective. This archetype represents a human tendency to deal with the easy, the obvious and the urgent before one is forced to deal with the difficult, the ambiguous and the important. The leverage point lies in strengthening the fundamental response and weakening the symptomatic response. Symptomatic solutions should be used only if imperative, while working on long-term solutions.

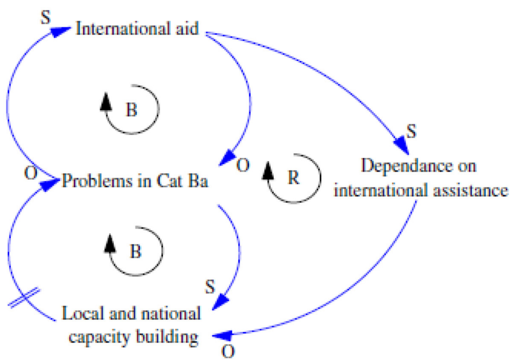

Figure 7 International aid as a 'shifting the burden' systems archetype. Legend: S (same direction), O (opposite direction), R (reinforcing), B (balancing), // (delay)

Gladek et al. (2016) identified several common structural failures in current food systems:
- the poverty trap – poverty is a self-reinforcing cycle of restrictions in opportunities, vulnerability to shocks and social exclusion;
- power-wealth entrenchment – a few actors have disproportionate influence due to dominant power structures that are tightly coupled with the interests of wealthy actors;
- institutional lock-ins in trade – unfair global competition as a result of institutionalized liberalization of international trade;
- tragedy of the commons – individual decisions result in the abuse or depletion of common natural resources and ecosystem services);
- technical and infrastructural lock-ins – prevalence of conventional intensive agricultural production systems.

The researchers plea for better decision-making tools and channels for ex-ante assessments of policies. Past policies have had disastrous results due to a lack of knowledge of how systems behave resulting in undesirable outcomes (e.g. expansion of palm oil resulting in large-scale deforestation of rainforests). The challenge is to find synergies in solutions that result in adaptive and resilient food systems that provide nutritious food for all, within the planetary boundaries, supporting livelihoods and wellbeing of the people working within the food system.

4.2 Prioritising leverage points

Meadows (1999) proposed a hierarchy of intervention points to trigger transformative change in a complex system. She argues that changing parameters of cause-effect relationships is most often applied in interventions, yet least effective as it does not alter the system goals and/or structure. For example, imposing prices, quotas or taxes within a food value chain may allow national authorities to control the 'flow rate', but it will not bring about transformative change. According to Meadows, the best places to intervene in a system (in decreasing order of effectiveness) are:
1. Change the mindset or paradigm out of which the system (goals, power structure, rules, culture) arises – *mental models*
2. Change the goals of the system – *systemic structure*
3. Allow diversity for self-organization (address the distribution of power over the rules of the system) – *systemic structure*
4. Change the rules of the system (incentives, punishments, constraints) – *systemic structure*
5. Improve the information flows – *systemic structure*
6. Allow thing to grow faster: driving positive feedback loops – *systemic structure*
7. Allow thing to adjust to goals faster: regulating negative feedback loops – *systemic structure*
8. Adjust the lengths of delay relative to the rate of system change – *patterns*
9. Change the way stocks and flows are connected: material flows and nodes of material intersection – *patterns*
10. Change whatever numbers you can measure: constants, parameters, numbers (subsidies, taxes, standards) – *events*

Box 4. Unpacking leverage mechanisms

Kennedy et al. (2018, p18): "In the leverage analogy, the impacts or targeted outcomes are similar to the *weights* you are trying to move. some examples of weights include soil erosion, CO_2 emissions, or food waste. The leverage points, or *fulcrums*, can be described as the contributing elements or processes which need to be shifted in the system to create change. This could include soil management practices, vehicle purchasing, or food storage and cooking. Finally, the *levers* are the mechanisms or strategies for change, which are made up of different interventions that can be implemented, such as education, policy, or subsidies."

Effective leverage (see Box 4) occurs when the mechanism for change is feasible and effective in shifting the system to the desirable direction, away from the state in which negative impacts are occurring (Kennedy et al., 2018).

5 Applications of systems thinking to design interventions

5.1 Multi-stakeholder involvement in systems thinking for natural resource management

Bosch et al. (2007) report on three case studies that applied systems thinking in natural resource management projects, using a similar multi-stakeholder process to analyse systems, explore scenarios and decide on actions to be taken. In order to explore the system of interest, the case studies used a Bayesian belief network (BBN): a cause and effect diagram (flow diagram) in which *nodes* present factors believed (by different stakeholders) to influence particular outcomes. The BBNs were used as a mechanism to facilitate the sharing and integration of the different stakeholder views. This process allows different stakeholders to externalize their knowledge within a group, combine the knowledge (co-creation) and learn from each other (internalizing joint new knowledge). Once the influence diagram is constructed it can identify which parts of the system (existing) hard data and models can be used to quantify relationships, and for which parts experiential knowledge can be used to fill in data gaps. Conditional probability tables were constructed to systematically describe the relationships between nodes for different potential states (possible outcomes) of each node and the probability of it occurring. Such a knowledge base can assist stakeholders in decision making through analysing different scenarios. Though the BNN model is not a perfect representation of the system, embedding the model in an adaptive management cycle allows its improvement through monitoring and joint learning. Such computer-based modelling systems can be useful tools to explore and formulate problems to inform decision making and action, while allowing uncertainty in knowledge to be expressed and facilitate communication between stakeholders.

Systems thinking can be aided by a variety of tools, ranging from informal and non-technical to highly structured and technical in their application and form. At the most basic level, brainstorming sessions with stakeholders can be used to conceptualize problems and projects, with or without formal group techniques such as Delphi or citizen’s jury to access expert opinion. In addition, there are a multitude of computer-based techniques to build Bayesian models. Regardless of the tools used, it is important to embed them within a well-facilitated participatory process and empower a wide range of stakeholder to share their knowledge and be involved in decision making.

5.2 Achieving regime change through innovation platforms

The Convergence of Sciences - Strengthening Innovation Systems (CoS-SIS) programme set up and researched innovation platforms (IPs) for open-ended experimental action in Benin, Ghana and Mali. The IPs sought to create the right conditions at institutional level to facilitate farmer adoption of promising technologies. They built on Agricultural Innovation Systems theory and the Multi-Level Perspective (developed by Geels 2005) as a concept, distinguishing niche, regime and landscape levels. “In niches, the IPs can experiment and generate change relatively easily but with little guarantee of ‘institutionalisation’, i.e. of effecting more permanent and robust change in regimes that are constituted by the established and embedded rules, norms, laws, routine practices and so on. The landscapes (markets, climate change etc.) create contexts and are sources of exogenous change” (Hounkonnou et al. 2018). The main assumption was that change at system levels higher than crop, field and farm is a crucial necessary condition for smallholder development. Regime change was understood as significant changes in some combination of official and informal rules, norms, sociotechnologies, practices, incentives, relationships and rules for interpreting meaning and knowledge development. Six pathways were identified that catalysed significant institutional innovations:

1. The role of the IP facilitator in creating inter-personal trust.
2. The ways in which IP members used their pre-existing networks of influence to work across levels of governance.
3. Sharing the evidence generated by special studies and action-researching among new, widely built academic, professional and organisation relationships within and beyond the niches in which the experimental actions were tested.
4. Seizing opportunities in response to contextual dynamics enabled IPs to act quickly on the basis of their empirical evidences, strategic analyses and networked relationships.
5. Deliberate efforts to recognise, understand and resolve conflicts and power plays.
6. Favouring experiment over un-evidenced opinion, focused on iterative experiments and analyses of opportunity for opening up spaces for change, and data-based feedback on what working (or not).

5.3 Designing interventions based on system dynamics

Kennedy et al. (2018) apply system dynamics to identify leverage points in food systems. They propose three steps to identify appropriate interventions:

1. Identify system outcomes that needs shifting to a more sustainable state, prioritizing:
   – Long-term irreversible impacts
   – Impacts which undermine the ability of the earth to provide a safe operating space for humans
   – Impact for which outcomes for people and environment have a high degree of uncertainty
2. Sketch a systems map, looking at the processes and system structures which lead to the impacts, prioritizing:
   – Processes which contribute to a large number of impacts across the system
   – Processes which lead to a disproportionately large part of a single impact
   – Processes which contribute to reinforcing feedback loops which will perpetuate the problem unless interrupted.
3. Identify the lever (i.e. intervention) which will shift the impact. Interventions are prioritized based on their (economic, social, political, practical and technical) feasibility and (systemic) effectiveness.

Young (2018) proposes a four-step approach to develop a 'chain of evidence' to facilitate decision making on interventions. The four steps ask what is:

1. Possible – scenario development (e.g. Field Anomaly Relaxation method, identifying 4-6 key variables and 3-5 qualitative states to build narratives with different time scales and possible future outcomes).
2. Probable – modelling & simulation of system behaviour, based on assessment / understanding of the 'system': interaction of components; inter-relationships of the processes within the system and interconnections between systems across time. + stock & flow model to understand sensitivity to change, and possible levers.
3. Actionable – SWOT in reverse (TOWS) to focus on external environment first.
4. Desirable – multi-criteria decision analysis, risk analysis (risk = impact x likelihood), stakeholder analysis

6 Towards a tool for policy development

The aim of the policy development tool is to decide on evidence-based FNS programming that brings about desirable transformative change in food systems in LMICs. We use a blended approach, integrating empirical evidence with experiential knowledge from stakeholders and experts to develop a comprehensive picture of a food system of interest. Developing a joint understanding of system mechanisms and structures will allow the identification of intervention points to inform the FNS programming.

The following considerations are taken into account:

- Resources are limited, which makes data-intensive approaches impractical. Commissioning multi-year studies to fully map a national food systems (e.g. following the Global Food Systems Index approach) to inform RNE programming is unrealistic.
- RNEs typically operate within a political-economic context that influence priorities and thus programming. RNEs seek to represent the interests of the Dutch Government while contributing to the development objectives of the host countries.
- RNEs do not have the mandate nor clout to alter paradigms to drive systemic change, yet they can intervene at some strategic entry points of national food systems subject to the resources and expertise available to the RNEs.
- RNEs have strong local networks with the national public sector, (inter)national private sector and civil society (in particular international NGOs). This creates opportunities for using multi-stakeholder approaches and partnership building as part of the FNS programming.
- Although it is impossible to fully understand and measure complex systems, interventions can be designed based on bounded and temporary rationality. However, intervening in complex systems can change them in unforeseen ways due to delays in cause-effect relationships and unforeseen aggregated effects of multiple causes. A ‘theory of limits’ and strategy for managing the limits of our knowledge of the system of interest are thus needed (Richardson 2007). Any FNS programming should thus include a process for reflection and learning, to adjust and adapt interventions if necessary.

Optional elements of the tool:

- A step-by-step manual for a blended approach (combining existing empirical data and multi-stakeholder processes) to understand the food system dynamics. Includes a facilitation guide for a multi-stakeholder workshop to map a food system and identify intervention points.
- A typology of insights from systems thinking applicable to a food system approach. Each ‘type’ discusses an intervention strategy (e.g. targeting feedback mechanisms, addressing root causes, alleviate symptoms), accompanied with descriptive examples from Ethiopia.
- Overall reflection on the added value of systems thinking for the Dutch FNS programming. Examples of Dutch interventions in Ethiopia are discussed from a system-thinking perspective.

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