

Strengthening the food systems governance evidence base: Supporting commensurability of research through a systematic review of methods

Working Paper No. 167

CGIAR Research Program on Climate Change, Agriculture and
Food Security (CCAFS)

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RESEARCH PROGRAM ON
Climate Change,
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Abstract

Governance of food systems is a poorly understood determinant of food security. Much scholarship on food systems governance is non-empirical, while existing research is often case study-based and theoretically and methodologically incommensurable. This frustrates aggregation of evidence and generalisation. We undertook a systematic review of methods used in food systems governance research with a view to identifying a core set of indicators for future research. We gathered literature through a structured consultation and sampling from recent reviews. Indicators were identified and classified according to the levels and sectors they investigate. We found a concentration of indicators in food production at local to national levels and a sparseness in distribution and consumption. Unsurprisingly, many indicators of institutional structure were found, while agency-related indicators are moderately represented. We call for piloting and validation of these indicators and for methodological development to fill gaps identified. These efforts are expected to support a more consolidated future evidence base and eventual meta-analysis.

Keywords

Food systems; Governance; Food security; Research Methods; Evidence; Evaluation.

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1 Introduction

A central CCAFS goal is to improve food security. However, despite huge technological advances and the “modernisation” of much of the world’s agricultural production, hunger and malnutrition remain a reality, underlining that food security cannot be achieved through increasing “food availability” alone (Ericksen *et al.* 2009). In shifting attention to the three additional dimensions of food security, namely access and utilisation of food, and stability thereof (FAO 1996), both practitioners and researchers have begun to adopt a systems approach to food. This aims to understand what the productivist paradigm fails to, such as drops in purchasing power of consumers despite higher yields (Ericksen *et al.* 2009, Ingram 2011, Vermeulen *et al.* 2012). It is also increasingly recognised that governance forms an integral part in the functioning of food systems, particularly with the rise of modern value chains that connect producers and consumers across jurisdictions and that are subject to interconnected social, economic, and environmental interactions across scales (Ericksen *et al.* 2009, Termeer *et al.* 2010, Vermeulen *et al.* 2012, Candel 2014). Thus, any serious attempt to address world hunger will need, at minimum, to take account of the influence that governance has on food systems, and preferably design interventions built on an evidence base evaluating the role that different governance arrangements and regimes has on food systems and food security outcomes.

Research on food systems and food security governance has been conducted for quite some time (Makhura 1998, MacRae 1999), but it is only since the food price crisis in 2008 that research on these topics really began to increase in frequency and to adopt explicit conceptualisations of governance, food systems, and food security (Candel 2014). However, the field has yet to arrive at a coherent consensus or synthesis of scholarly output, with reviews producing thematic overviews of the state of the field rather than aggregation of evidence (Bizikova, Echeverría, *et al.* 2014, Candel 2014, Purdon 2014, Hospes and Brons 2016). As such, we have a limited understanding of what governance arrangements are suited to what social and ecological conditions in producing what food system outcomes. Moreover, the tendency in recent decades towards multi-scale and networked forms of governance raises its own set of knowledge gaps in relation to how best to govern food systems to achieve food security and sustainability outcomes. This set of problems is both aided and frustrated by the fact that food systems governance is a topic of interest in

multiple disciplines. As such, the literature benefits from disciplinary insights including agricultural science, anthropology, economics, environmental science, food nutrition, geography, and political science. Unfortunately, however, research and theories are not always communicated and engaged with across disciplines, leading to a range of disjointed concepts and methods being offered to study the topic.

Indeed, eight years after the food price crisis, which stimulated the increase in frequency of scholarship, the time would arguably be ripe for a synthesis of empirical findings to date in order to reach beyond single case studies and aggregate towards more generalizable conclusions and recommendations for governance reforms. Unfortunately, however, the state of existing scholarship does not support this laudable aim. This is due to a number of factors, including the tendency for scholarship to be concentrated on theoretical development rather than on empirical research, and that existing research utilises heterogeneous theories and indicators (Bizikova, Echeverría, *et al.* 2014, Candel 2014, Purdon 2014, Hospes and Brons 2016), which effectively prevents epistemologically realist synthesis and generalisation (Mallett *et al.* 2012, Dupuis and Biesbroek 2013, Langer and Stewart 2014, Purdon 2014, Steinberg 2015). As a result, we cannot prescribe governance arrangements that address food insecurity effectively. Indeed, to understand what is *effective* governance, research is required that can be aggregated in a meta-analysis to derive generalizable conclusions on causality.

With a view to addressing pertinent knowledge gaps in the domain of food security, the CCAFS “Effective Indicators” Working Group (EIWG) was formed at a workshop in Brussels in 2014 sponsored by the CCAFS flagship program on Policies and Institutions for Climate-Resilient Food Systems. Following on from initial preparatory research (Bizikova, Echeverría, *et al.* 2014, Purdon 2014), the Working Group then scoped possibilities for conducting a large-scale meta-analysis of the empirical literature. However, it was realised that this ambition is currently unreachable, for reasons outlined above. Consequently, the goals of the project were reformulated to address a more modest, but nonetheless essential, objective: to lay the foundations for a more consolidated second generation of commensurable research on food systems governance that will support subsequent comparison and aggregation of results. It does this through proposing core indicators to be used in future research, which we assemble from a review of literature, structured around the research question:

How can food systems governance be researched?

To operationalize this research question, the following two sub-questions are formulated:

- What indicators are used in current research to operationalize (aspects of) food systems governance?
- What aspects of food systems governance are not currently operationalized?

In the following section, we elaborate on knowledge gaps and develop a theoretical framework of food systems governance. Section 3 describes the methodology used in this review, with results reported in Section 4. These results are then interpreted and discussed in Section 5 before drawing conclusions in Section 6.

2 Background to the project and theoretical framework

State of the field

Scholarly interest in food security rose rapidly following the world food price crises of 2007–2008 (Candel 2014). While this interest has taken many forms, reflecting the range of disciplines involved, two developments in particular are of relevance. First, attempts to look beyond food shortages in productivist terms led to efforts to develop a systemic view of food to understand the multiple social, economic, and environmental factors impacting upon (and impacted by) food (Ericksen 2008, Ericksen *et al.* 2009, Ingram 2011, Vermeulen *et al.* 2012). Secondly, another stream sought to get beyond purely technical perspectives and to understand how food systems consciously respond to such external factors. The contribution of this stream was to integrate a governance framework by drawing on theories developed in political science and public administration (Termeer *et al.* 2013). As a result of both developments, there has been an increase in scholarly output on governance of food systems, although, as argued by Candel (2014), what this increase primarily represents is the adoption of formalised food systems and governance *concepts*, as research on food has arguably always taken account of governance or systemic factors, even if implicitly.

Recent overviews of the field have highlighted some issues with this body of work. In particular, much scholarship is non-empirical (Candel 2014) and, where research is conducted, it is often single-case studies that do not facilitate broader conclusions (Purdon 2014). Further, much research is not interdisciplinary (Candel 2014), and there is a high level of theoretical and methodological diversity (Candel 2014).

Taken together, these add up to an area that essentially does not have an accessible evidence base beyond site-specific research projects. The dearth and incommensurability of evidence weakens possibilities for aggregation and generation of global conclusions (Dupuis and Biesbroek 2013, Purdon 2014, Steinberg 2015). Unless this problem is addressed, resources will continue to be spent on programmes and research without learning lessons or generating significant knowledge of how governance practices affect food security.

This Working Paper seeks to address this problem. Given the extent of theoretical development (which is detailed below), we consider a more appropriate level at which to make a valuable contribution to be at the methodological. The identification of a core set of indicators with which food systems governance can be researched in the future could lead to the generation of an evidence base that would allow future reviews to draw generalizable causal conclusions as to the effectiveness of food systems governance.

Governance of food systems: theoretical framework

While the goal of this project is methodological rather than theoretical, the task at hand nonetheless requires a thorough foundation in theories of food systems governance (FSG). A theory of FSG is essentially a merger of theories of governance with theories of food systems. Although governance theory has a long history in multiple disciplines, it is the development of a systems theory for food that marks a breakthrough on which current theoretical knowledge is built, and is therefore an appropriate place to begin discussion.

The *food system* framework emerged as a response to a number of factors, namely the spatio-temporal “modernisation” of food production, the persistence of food insecurity despite total increases in food yields, and the recognition of how food influences and is influenced by social, economic, and environmental change (Ericksen 2008, Ericksen *et al.* 2009, Ingram 2011, Vermeulen *et al.* 2012). Drawing key literature together, Ericksen defined a food system as:

- 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). (2008: 234–235)

If the concept of food systems reflects the recognition of the factors that intervene between increasing total food production and eventual nutritional outcomes, the adoption of governance frameworks reflects the realisation that such activities are not random but organised. This organisation is itself a factor that also requires exploration. Governance becomes particularly important in the context of environmental change or other stressors in terms of capabilities for system resilience, adaptation, or transformation (Ericksen *et al.* 2009, von Braun 2009, FAO 2012, Wahlqvist *et al.* 2012).

In a systematic review, Candel observed a plurality of overlapping definitions of food security governance, and proposed the following definition:

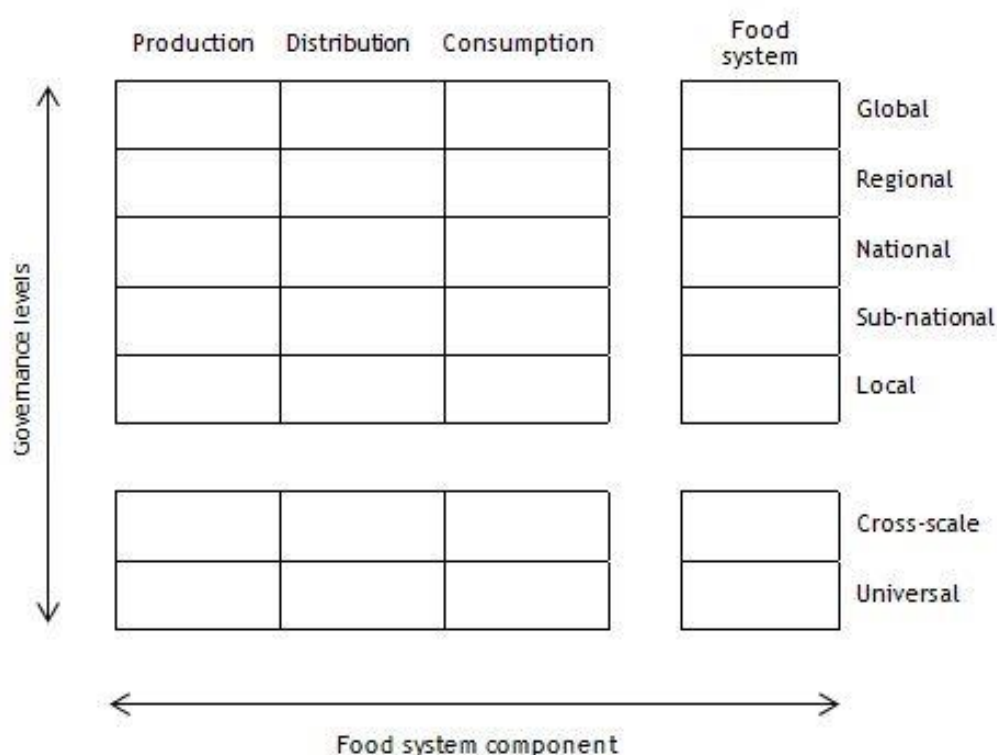
The formal and informal interactions across scales between public and/or private entities ultimately aiming at the realization of food availability, food access, and food utilization, and their stability over time. (Candel 2014: 598)

One element of note in this definition is the concept of governance scale. Drawing again on developments in political science and public administration (e.g. Hooge and Marks 2003), arguments for a “scale-sensitive” (Termeer *et al.* 2010) approach to governance have been made in response to both practical concerns with targeting interventions (Kay 2009, Altieri and Toledo 2011, De Schutter 2014) and also for empirical reasons (Eakin *et al.* 2009, Termeer *et al.* 2010, Juhola and Westerhoff 2011, Purdon 2015). More specifically, the complexity of food systems arising from multiple social, economic, environmental and technical interactions across various scales is considered to require multi-scale governance arrangements (Candel 2014). Consequently, this scale dimension of governance requires conceptualisation. Essentially, scale refers to “spatial, temporal, quantitative, or analytical dimensions used to measure and study any phenomenon,” while level refers to “units of analysis that are located at the same position on a scale” (Gibson *et al.* 2000, p. 218). These concepts are recognised as important because environmental problems, including but

not limited to food security, cut across remits of traditional organisations and governance institutions and manifest differently at different geographic levels (Adger 2001, Eakin *et al.* 2009, Termeer *et al.* 2010, Biermann *et al.* 2012).

Although these theories of scaled governance and food systems are complex and highly developed, we adopt a simplified representation. This is simply because as the scholarly response to the Global Food Crisis since 2008 has been heavily theoretical rather than empirical or methodological, we do not expect that existing methodological indicators can be mapped to theoretical frameworks at the level of detail of current cutting-edge theory. Instead, we adopt a two-dimensional matrix composed of five levels of governance (local through global) and three components of food systems (production, distribution, and consumption). We also add a governance category to take account of explicitly cross-scale interactions or arrangements, while both dimensions also contain “universal” categories for indicators that apply to governance outside of discrete levels, and for a food system in its entirety, respectively. This framework is illustrated in Figure 1.

Figure 1 Theoretical framework: food systems governance indicator matrix



By *operationalization* of this framework, we mean “the act of generating data to empirically represent or measure a construct, including both the intermediate steps of conceptual decomposition and the final act of measurement” (Delaney *et al.* 2016,

p. 7). Our central unit of analysis when looking at operationalizations is the *indicator*. There is no consensus about what constitutes an indicator as distinct, for example, from questions on a data collection instrument or sub-constructs in a conceptual framework, nor are there stable reference points from which to create a definition, with different research designs conceptualising, instrumentising and reporting at different levels of abstraction. Therefore, we label as an “indicator” a construct or instrument in an operationalization, at a harmonised level of abstraction that was agreed upon among the EIWG during a workshop in Wageningen (see Section 3).

We would like to emphasise that in using this simplified FSG framework, we are not ignoring the theoretical developments described earlier. Rather, we seek to report on the methodological state of the field at a level of detail so as to be consistent with all current developments. Therefore, we work within a framework that recognises the minimum contributions that are common across most frameworks.

3 Methods

Collection of literature

We gathered literature through a structured consultation and through drawing from the bibliographies of three recent systematic reviews on similar topics. Although database search is a frequently replicated method of literature gathering in systematic reviews, we chose a Delphi approach to identify relevant publications based on the multi-disciplinary expert knowledge of the field by the participants. Another reason for choosing Delphi relates to the research objectives of the review. We are interested in qualitative contrasts and, as such, we require a purposive sampling rationale that is thematically- or theory-driven rather than seeking statistical representation of a homogeneous population body of literature.

Delphi is a method of structured communication that facilitates knowledge elicitation among a group of experts (Linstone and Turoff 1975). It is characterised by participation of experts and the elicitation of “tacit knowledge,” anonymity of respondents, sharing of responses among the group of participants by a facilitator, and the possibility for adjustment of responses across multiple rounds as participants are shown arguments made by others. Overall, these elements are designed to optimise the tacit knowledge of collectively held expertise. A panel of experts was composed of the 13-member EIWG. This initial group was asked to nominate

additional experts who might be contacted, in order to mitigate against the possibility of artificial consensus among an established group of academics. Two additional experts were nominated and participated on this basis, bringing the total expert group size to 15. Over the course of three rounds, 136 references were compiled.¹

An additional set of reports was drawn from the bibliographies of three recent systematic reviews (Bizikova, Echeverría, *et al.* 2014, Candel 2014, Hospes and Brons 2016). The abstracts of articles in the bibliographies of these reviews were appraised to screen out non-empirical records. A full list of all empirical articles (numbering 54) was then sent around to the EIWG who were asked to select articles that they considered to be particularly relevant, innovative, or path-breaking in terms of methods used. They were also given the opportunity to submit new references, particularly those published since 2013 (i.e. published after the searches and that would therefore not have been found by the systematic reviews). Sixteen references were nominated out of the set of 54 along with four new references. Thus, 156 references were brought forward for screening.

Two criteria were applied for full inclusion in the review: articles must be (a) accessible; and (b) empirical. One hundred and thirty-three references were accessed either through our academic library, open access, or shared upon request, 65 of which were then excluded as non-empirical. Two additional articles were coded as non-empirical but subsequently re-included in the review as they constituted reviews of methods and contained descriptions of indicators of relevance. This left 68 records included in the full review (66 empirical plus 2 methods reviews). Details of these included records are listed in Appendix 1 to this report. The entire search and screening process is recounted in the technical report, in particular in Appendix D.

¹ Participants were asked to nominate keywords to denote topical areas of relevance to the review, to nominate bibliographic references to literature suitable for the review, and to answer questions used for subjective quality appraisals and topical relevance of literature. Much of these steps became redundant when the objectives of the review were revised and the entire body of collected references were to be included. A full description of the process is reported in the technical report.

Data extraction

In what follows, research question (RQ)-level *governance constructs* were taken as the bases for operationalizations and identification of indicators. Tracing conceptual deconstruction of RQ-level constructs down to items on data collection instruments enables a transparent description and analysis of its operationalization (Delaney *et al.* 2014, 2016). Indicators were then identified from these descriptions of operationalizations.

Reports were coded by a team of seven reviewers according to a structured coding framework (the full protocol can be seen in the technical report for this review). Abstracts were first screened to determine whether or not the paper reported on empirical research. Next, an RQ was identified, and in that RQ, any key constructs potentially equivalent to, or as a special case of, “governance” were identified. Note that we did not specify a definition for *governance* because there are many different conceptualisations used for governance in the food systems literature (Candel 2014) and choosing one or more definitions would likely exclude papers using other definitions, or those that come from fields where explicit governance concepts have not yet been adopted. When coding for governance constructs, a list of governance definitions² were used as a broad but not exclusive guide. Non-empirical articles, articles without RQs, and those that did not contain a governance-equivalent construct were excluded.

For each governance construct, conceptual deconstruction was then coded, where possible, from RQ-level constructs to items on data collection instruments. Where reported, data collection methods, data analysis methods, a theoretically based justification of inference from results to conclusions, and discussion of limitations were also identified. This information was then compiled into a “structured summary” for each governance construct. In cases where we retrieved information from reports for a minimum but not all cells in the structured summary, we also took the step of following cited works and of contacting authors. Completed structured summaries for all operationalizations can be found in Appendix G of the accompanying technical report.

² These definitions were taken from Lemos and Agrawal (2006), Hufty (2011), Larson and Petkova (2011). For the definitions themselves, see the technical report section on *coding*.

Analysis

The structured summaries were loaded into Atlas.ti, a qualitative analysis software package, for analytical coding. As a first step, we assessed whether indicators at the agreed-upon harmonised level of conceptual abstraction (see Figure 2) could be identified in either cells on items on data collection instruments or on conceptual deconstruction, and summaries not containing this conceptual level were removed from further analysis. Indicators were then identified from text or graphic at the harmonised conceptual level. In some papers, this conceptual level corresponded to RQ-level constructs, while in other papers to the lowest levels of conceptual deconstruction reported. Indicators were then classified according to three dimensions. Eight codes were used to classify governance level (local; sub-national; national; regional; global; cross scale; universal; “NotGov” – to denote constructs that were not indicators of governance). Food system components were classified using five codes (production; distribution; consumption; miscellaneous – to denote indicators that did not easily fit into any of the three discrete components; “NotFS” – to denote constructs that were not used to study governance of food systems). Finally, the indicators were then coded according to the phenomena being empirically studied (e.g. to distinguish indicators of participation from indicators of deliberation). Coding for phenomena was open, but a startlist of codes was used as a guide. This initial set of codes was developed at the EIWG workshop for the purposes of arriving at a common harmonised conceptual level of “indicators” and is displayed in Figure 2.

Figure 2 Conceptual level of “indicators” as agreed during workshop. List also functioned as an initial coding framework

Participation; information use; information accessibility; salience; political settlements; agency; long-term policy; political representation; authority; learning; state capacity; accountability; political leadership; dialogue; multi-value; networks; coordination; centralization; facilitation; transparency; uncertainty management; social inclusion; flexibility; resilience/robustness; diversity; polycentricity; trust; commitment; fairness; legitimacy

In the case of governance level and FS component, classification was made according to where the indicator was operationalized and data collected from in the report from which it was extracted. For example, indicators from a study that collects data from members of a provincial agricultural cooperative would be

classified as “sub-national” and “production.” Classification of phenomena was done based on examining what data was collected and/or how indicators were conceptually defined, where this was possible. It must be noted that reporting did not always allow a clear and even picture to be assembled of operationalizations, and the phenomena being studied by an indicator had to be inferred in some cases. Instances of uncertainty are recorded in the technical report.

Once all indicators had been identified from the structured summaries and classified, they were assembled into the food systems governance matrix to generate results of the first iteration of analysis. Following this, the list of indicator-codes was examined for possible mergers in order to consolidate the results. Indicators were recoded, and the matrix updated. In total, three such iterations were performed. As a final step, indicators that had been coded as “Miscellaneous” or “NotFS” were re-examined to see if they might potentially have application elsewhere in the framework, allowing for only minor alterations to the study designs from which they were drawn.

4 Results

Of the 68 reports brought forward for coding, 52 contained a governance construct in its RQ, with two papers containing two governance constructs. These articles were therefore coded to generate 54 structured summaries of operationalizations. In bringing forward these 54 for analysis, 35 contained the minimum information required to identify indicators that could be classified according to our framework. In total, 80 unique indicators were extracted from the literature in this way. After synthesising equivalent indicators, their number totalled 42. These are presented in Table 1, grouped for readability purposes into loose categories.³ A more detailed list, including governance levels and food system components, and original names can be seen in the accompanying technical report in Appendix H.

³ These categories represent emergent second-order themes. However, they were developed during discussion of results, without a protocol, and should not be considered a formal part of our results. They are used here for their digestibility rather than analytical value.

Table 1 Synthesised indicators

Category	Indicator name	Source
Agency	Adaptive capacity	(Leith <i>et al.</i> 2012, Jacobi, Schneider, Mariscal, <i>et al.</i> 2015)
	Leadership	(Gupta 2007, Cooper and Wheeler 2015)
	Learning	(Lebel <i>et al.</i> 2006, Gupta 2007, Wilder <i>et al.</i> 2010, Eakin <i>et al.</i> 2011, Jacobi, Schneider, Bottazzi, <i>et al.</i> 2015)
	Non-state self-organising	(Cooper and Wheeler 2015, Jacobi, Schneider, Bottazzi, <i>et al.</i> 2015, Jacobi, Schneider, Mariscal, <i>et al.</i> 2015)
	Reflexivity	(Termeer <i>et al.</i> 2013, Candel <i>et al.</i> 2015)
	Resilience/robustness	(Lebel <i>et al.</i> 2006, Termeer <i>et al.</i> 2013, Candel <i>et al.</i> 2015)
	Responsiveness	(Termeer <i>et al.</i> 2013, Candel <i>et al.</i> 2015)
	Revitalization	(Termeer <i>et al.</i> 2013, Candel <i>et al.</i> 2015)
Contextual factors	Rule of law	(Mandemaker <i>et al.</i> 2011, Jawtusch <i>et al.</i> 2013)
	Country size	(Lesnikowski <i>et al.</i> 2013)
	Implementation-supporting conditions	(Brownhill and Hickey 2012)
	Political stability	(Mandemaker <i>et al.</i> 2011)
	Public social commitments	(Mandemaker <i>et al.</i> 2011, Lesnikowski <i>et al.</i> 2013)
	Resources	(Gupta <i>et al.</i> 2010, Eakin <i>et al.</i> 2011, Lesnikowski <i>et al.</i> 2013)
Democracy	Accountability	(Lebel <i>et al.</i> 2006, Jawtusch <i>et al.</i> 2013)
	Corruption	(Mandemaker <i>et al.</i> 2011, Lesnikowski <i>et al.</i> 2013)
	Deliberation	(Lebel <i>et al.</i> 2006, Schouten <i>et al.</i> 2012)
	Discursive framing	(Boons and Mendoza 2010, Pesqueira and Glasbergen 2013)
	Electorally democratic	(Lebel <i>et al.</i> 2006, Acemoglu <i>et al.</i> 2009, Mandemaker <i>et al.</i> 2011)
	Empowerment	(Lebel <i>et al.</i> 2006)
	Fairness	(Lebel <i>et al.</i> 2006, Gupta <i>et al.</i> 2010, Jawtusch <i>et al.</i> 2013, Wambugu <i>et al.</i> 2015)
	Gender-sensitivity	(Galiè 2013, Wambugu <i>et al.</i> 2015)
	Legitimacy	(von Geibler 2013)
Participation and multi-stakeholder engagement	(Lebel <i>et al.</i> 2006, Donovan <i>et al.</i> 2010, Eakin <i>et al.</i> 2011, Jawtusch <i>et al.</i> 2013, Pesqueira and Glasbergen 2013, Korhonen-Kurki <i>et al.</i> 2014, Cooper and Wheeler 2015, Wambugu <i>et al.</i> 2015)	
Institutional structure	Centralisation	(Gereffi <i>et al.</i> 2005)
	Common Pool Resource management design	(Poteete and Ostrom 2004, Huntjens <i>et al.</i> 2012)
	Cross-scale interaction	(Donovan <i>et al.</i> 2010, Juhola and Westerhoff 2011, Galiè 2013, Lesnikowski <i>et al.</i> 2013, Cooper and Wheeler 2015)
	Governance	(Donovan <i>et al.</i> 2010, Juhola and Westerhoff 2011, Galiè

	frameworks	2013)
	Holistic	(Jawtusich <i>et al.</i> 2013)
	Implementation-supporting conditions	(Lesnikowski <i>et al.</i> 2013, Bizikova, Nijnik, <i>et al.</i> 2014)
	Informal governance	(Spielman <i>et al.</i> 2008, Osbahr <i>et al.</i> 2010, Juhola and Westerhoff 2011, Galiè 2013)
	Institutional mainstreaming	(Sietz <i>et al.</i> 2011, Bizikova, Nijnik, <i>et al.</i> 2014, Wambugu <i>et al.</i> 2015)
	Legal framework	(Kabubo-Mariara 2007, Korhonen-Kurki <i>et al.</i> 2014, Wambugu <i>et al.</i> 2015)
	Networks	(Juhola and Westerhoff 2011, Pesqueira and Glasbergen 2013, Cooper and Wheeler 2015)
	Policy framework	(Osbaht <i>et al.</i> 2008, Korhonen-Kurki <i>et al.</i> 2014, Wambugu <i>et al.</i> 2015)
	Polycentricity	(Lebel <i>et al.</i> 2006, Cooper and Wheeler 2015)
	Scale-specific responsibilities and competences	(Lebel <i>et al.</i> 2006, Gupta <i>et al.</i> 2010, Quinn <i>et al.</i> 2011, Galiè 2013, Bizikova, Nijnik, <i>et al.</i> 2014, Korhonen-Kurki <i>et al.</i> 2014, Candel <i>et al.</i> 2015)
	State capacity	(Mandemaker <i>et al.</i> 2011, Lesnikowski <i>et al.</i> 2013)
Implementation	Effective	(von Geibler 2013)
	Favorable initial policy change	(Donovan <i>et al.</i> 2010, Korhonen-Kurki <i>et al.</i> 2014)
	Outcomes of similar programmes	(Minde <i>et al.</i> 2008, Lesnikowski <i>et al.</i> 2013)
	Use of knowledge and science	(Donovan <i>et al.</i> 2010, Bizikova, Nijnik, <i>et al.</i> 2014, Cooper and Wheeler 2015, Wambugu <i>et al.</i> 2015)

When coded according to governance level and food system component, the indicators were situated in a matrix representing our food systems governance framework. This matrix is displayed in Table 2.

Table 2 Indicators categorised according to Food Systems Governance framework

	Food production	Food distribution	Food consumption	Food system
Global governance	Effective Legitimacy	Centralisation		Deliberation Discursive framing Networks Participation and multi-stakeholder engagement
Regional governance	Implementation-supporting conditions Institutional mainstreaming Knowledge sharing Reflexivity Resilience/robustness Responsiveness Revitalization Scale-specific responsibilities and competences Use of knowledge and science			
National governance	Corruption Discursive framing Electoral democracy Implementation-supporting conditions Knowledge sharing Legal framework Outcomes of similar programmes Policy framework Political stability Public social commitment Rule of law Scale-specific responsibilities and competences State capacity Use of knowledge and science	Discursive framing		
Sub-national governance	Accountability Deliberation Electoral democracy Empowerment Fairness Holistic Implementation-supporting conditions Knowledge sharing Learning			

	<ul style="list-style-type: none"> Non-state self-organising Participation and multi-stakeholder engagement Polycentricity Resilience/robustness Rule of law Scale-specific responsibilities and competences Use of knowledge and science 			
Local governance	<ul style="list-style-type: none"> Accountability Fairness Gender-sensitivity Holistic Informal governance Leadership Learning Networks Non-state self-organising Participation and multi-stakeholder engagement Rule of law Scale-specific responsibilities and competences Use of knowledge and science 			
Cross-scale	<ul style="list-style-type: none"> Adaptive capacity Cross-scale interaction Governance frameworks Non-state self-organising Polycentricity Scale-specific responsibilities and competences 			

During classification of indicators, a number were classified as *miscellaneous*, i.e. not fitting any of the three discrete food system components, but yet not corresponding to a food system as a whole. Others were classified as *NotFS*, i.e. not relating to food systems, having come from articles that are topically proximate to food (e.g. climate adaptation in rural areas; landscape management; forestry), but that had no relation to food at lower conceptual and methodological levels. In both cases, while they don't fit the matrix as they are operationalized in the articles from which they were taken, some might be applicable to other segments of the framework through as little as altering sampling strategies, and others would require only minimal adaptation to fit elsewhere. These *miscellaneous* and non-food system indicators are presented in Tables 3 and 4.

Table 3 Indicators classified as *miscellaneous* in food system

Indicator name	Source	Governance level	Reason for miscellaneous classification
Common Pool Resource management design	(Huntjens <i>et al.</i> 2012)	Universal	Indicator comes from comparative study of common pool resource regimes, some of which directly relate to food and others not.
Fairness	(Gupta <i>et al.</i> 2010)	Universal	Taken from study on institutional characteristics facilitating adaptive capacity. It is operationalized across a wide range of societal sectors, including agriculture (production). The research framework was intentionally designed to be applicable to any level of governance and can examine any FS component.
Implementation-supporting conditions	(Brownhill and Hickey 2012)	Sub-national	Focus is on food security. Could be applied to FS in general, although operationalized at geographically constrained site.
Leadership	(Gupta <i>et al.</i> 2010)	Universal	See: <i>Fairness</i>
Learning	(Gupta <i>et al.</i> 2010)	Universal	See: <i>Fairness</i>
Reflexivity	(Candel <i>et al.</i> 2015)	Regional	Governance in this paper deals with Food Security in a broad sense. It does not fit into discrete FS components, nor does it correspond to systems thinking.
Resilience/robustness	(Candel <i>et al.</i> 2015)	Regional	See: <i>Reflexivity</i>
Resources	(Gupta <i>et al.</i> 2010)	Universal	See: <i>Fairness</i>
Responsiveness	(Candel <i>et al.</i> 2015)	Regional	See: <i>Reflexivity</i>
Revitalization	(Candel <i>et al.</i> 2015)	Regional	See: <i>Reflexivity</i>
Scale-specific responsibilities and competences	(Candel <i>et al.</i> 2015)	Regional	See: <i>Reflexivity</i>
	(Gupta <i>et al.</i> 2010)	Universal	See: <i>Fairness</i>

Table 4 Non-food system indicators

Indicator name	Source	Indicator name	Source
Adaptive capacity	(Leith <i>et al.</i> 2012)	Learning	(Eakin <i>et al.</i> 2011)
Common Pool Resource management design	(Poteete and Ostrom 2004)		(Wilder <i>et al.</i> 2010)
Corruption	(Lesnikowski <i>et al.</i> 2013)	Legal Framework	(Wambugu <i>et al.</i> 2015)
Country size	(Lesnikowski <i>et al.</i> 2013)		(Korhonen-Kurki <i>et al.</i> 2014)
Cross-scale interaction	(Lesnikowski <i>et al.</i> 2013)	Networks	(Juhola and Westerhoff 2011)
	(Donovan <i>et al.</i> 2010)	Outcomes of similar programmes	(Lesnikowski <i>et al.</i> 2013)
	(Juhola and Westerhoff 2011)	Participation and multi-stakeholder engagement	(Wambugu <i>et al.</i> 2015)
Electorally democratic	(Acemoglu <i>et al.</i> 2009)		(Eakin <i>et al.</i> 2011)
Fairness	(Wambugu <i>et al.</i> 2015)		(Donovan <i>et al.</i> 2010)
Favorable initial policy change	(Donovan <i>et al.</i> 2010)		(Korhonen-Kurki <i>et al.</i> 2014)
	(Korhonen-Kurki <i>et al.</i> 2014)	Policy framework	(Wambugu <i>et al.</i> 2015)
Gender-sensitivity	(Wambugu <i>et al.</i> 2015)		(Korhonen-Kurki <i>et al.</i> 2014)
Governance framework	(Donovan <i>et al.</i> 2010)	Public social commitments	(Lesnikowski <i>et al.</i> 2013)
	(Juhola and Westerhoff 2011)	Resources	(Eakin <i>et al.</i> 2011)
Implementation-supporting conditions	(Lesnikowski <i>et al.</i> 2013)		(Lesnikowski <i>et al.</i> 2013)
Informal governance	(Juhola and Westerhoff 2011)	Scale-specific responsibilities and competences	(Korhonen-Kurki <i>et al.</i> 2014)
	(Osahr <i>et al.</i> 2010)		(Quinn <i>et al.</i> 2011)
Institutional mainstreaming	(Wambugu <i>et al.</i> 2015)	State capacity	(Lesnikowski <i>et al.</i> 2013)
	(Sietz <i>et al.</i> 2011)	Use of knowledge and science	(Wambugu <i>et al.</i> 2015)
			(Donovan <i>et al.</i> 2010)

It must be cautioned that this second set of results is considerably more speculative than those presented in the matrix and should be read with care. In particular, those non-FS indicators are presented only for context and while future work may try to

adapt them for use in FSG research, no attempt is made to do so in this report. The implications of these results are discussed in the next section.

5 Discussion

Levels and components operationalized

Despite the development of both food security and food systems frameworks and the prescriptions to expand the study of food beyond a narrow focus on production and yield increases (FAO 1996, Ingram 2011, Vermeulen *et al.* 2012), the indicators we have identified in this review are heavily concentrated in the *food production* component. Within production, national-level and local-level governance appears well-studied, while there are also numerous indicators at sub-national and regional levels. A tempting conclusion to jump to would be that this reflects traditional conflating of the study of food with that of agriculture and the study of governance with that of (particularly national) government. However, this conclusion cannot be inferred simply based on concentrations of indicators in the matrix.

In contrast to the heavy concentration of indicators in food production, practically all other components are empty. The minor exception to this is the case of indicators focusing on a food system as a whole as opposed to discrete components. However, even this is misleading, as of the four indicators in the cell *Global-Food Systems*, three were taken from one paper (Pesqueira and Glasbergen 2013), while all nine out of eleven indicators that were classified as *miscellaneous* but that have application over FS as a whole are drawn from only two articles (Gupta *et al.* 2010, Candel *et al.* 2015). Relative sparseness might be attributable to our sampling of the literature; however, near total absence seems to suggest that these components of the food system are not being empirically studied from a governance perspective, or that such research is in existence but is not being engaged by the food systems community of scholars.

Indeed, looking at the systematic review by Hospes and Brons (2016), the closest topically to this review, the most strongly represented journals focussed on environmental science or agriculture – areas that are likely to focus on food production. Journal subject foci that would be more likely to address distribution (e.g. planning, management, or business) and consumption (e.g. health and nutrition) appeared far less frequently. Literature in their review was gathered using a database search using terms derived from the two concepts of *food system* and *governance*.

As such, it is likely that the underrepresentation of distribution and consumption-focused research is a symptom of such research not having adopted food systems and governance concepts. Another possible explanation is the theoretical framework we used. This framework tries to both work with systems approaches but at the same time categorise indicators into discrete components. This explanation is substantiated by the significant number of indicators that did not fit the FS framing and were classified as *miscellaneous*.

One observation of note is that a tentative trend can be observed whereby distribution, consumption, and food systems as a whole are covered more at higher levels of governance, particularly if reading also from indicators classified as *miscellaneous*. In certain ways, this observation should not surprise us, because food or distribution systems that cross (sub-national or national) borders are intuitively better governed at higher scales, and presumably research methods are developed accordingly. However, this pattern is very weak and would need only a few papers changing to alter or completely break the pattern. It also doesn't explain the lack of indicators for governance of food consumption: whereas distribution or food systems as a whole are not easily studied at the local level, thus the sparseness of distribution-governance at lower levels might well be expected, the same logic does not apply to the site of consumption.

Such an association based on scale is further problematised by the relatively low number of indicators for cross-scale governance, all of which are found in the food production component. It is precisely with the complexity recognised in systems approaches that the cross-scale governance of food becomes most relevant. However, the results suggest that we lack methods to research cross-scale governance and are therefore ill-equipped as yet to study and understand this phenomenon.

Combined, these patterns suggest that methodological developments in food systems governance works have yet to catch up with theoretical advances. The set of indicators in the matrix offers a wealth of options for fine-grained study of governance of food production, but little assistance for the study of food distribution or consumption governance, particularly at lower scales. This uneven distribution has serious consequences. For example, it is often posited that complex problems need to be governed at higher levels (von Braun 2009, FAO 2012), which provides the rationale for global institutional arrangements. However, using the methods found to study complex food issues at higher levels of governance alone does not

allow this common-sense idea to be empirically tested. And the relative lack of instruments for the study of cross-scale governance, particularly for more complex or systemic aspects of food, would leave this vital relation underexplored. However, by itself, a prevalence-based appraisal is not very enlightening, particularly since we have sampled the literature thematically. We therefore turn now towards the kinds of phenomena examined by this set of indicators.

Governance properties operationalised

Perhaps not surprisingly, a large share of indicators examine the structure of governance institutions. These range from straightforward descriptions of legal, policy, and governance frameworks (Kabubo-Mariara 2007, Osbahr *et al.* 2008, Donovan *et al.* 2010, Juhola and Westerhoff 2011, Galiè 2013, Korhonen-Kurki *et al.* 2014, Wambugu *et al.* 2015) to those that examine more relational aspects of governance institutions such as degrees of centralisation (Gereffi *et al.* 2005), network properties (Juhola and Westerhoff 2011, Pesqueira and Glasbergen 2013, Cooper and Wheeler 2015), the extent to which decision-making is characterised by polycentricity (Lebel *et al.* 2006, Cooper and Wheeler 2015), participation and engagement of stakeholders (Lebel *et al.* 2006, Donovan *et al.* 2010, Eakin *et al.* 2011, Jawtusich *et al.* 2013, Pesqueira and Glasbergen 2013, Korhonen-Kurki *et al.* 2014, Cooper and Wheeler 2015, Wambugu *et al.* 2015), competences that are situated within nested hierarchies (Lebel *et al.* 2006, Gupta *et al.* 2010, Quinn *et al.* 2011, Galiè 2013, Bizikova, Nijnik, *et al.* 2014, Korhonen-Kurki *et al.* 2014, Candel *et al.* 2015), or relations that cross scales (Donovan *et al.* 2010, Juhola and Westerhoff 2011, Galiè 2013, Lesnikowski *et al.* 2013, Cooper and Wheeler 2015). A number of studies also contain indicators that look at aspects of informal governance (Spielman *et al.* 2008, Osbahr *et al.* 2010, Juhola and Westerhoff 2011, Galiè 2013). Charges have been levelled that food systems governance research is overly concerned with technical aspects of governance (Candel 2014, Purdon 2014), so it is to be expected that such a large share of indicators are concerned with institutional structure.

A welcome set of results considering this charge are those agency-related indicators. That is, indicators that examine how governance institutions respond to external change and how they self-transform. Notable here are those that focus on learning (Lebel *et al.* 2006, Gupta 2007, Wilder *et al.* 2010, Eakin *et al.* 2011, Jacobi, Schneider, Bottazzi, *et al.* 2015). Perhaps encouragingly, some indicators are used to examine self-organising of non-state actors (Cooper and Wheeler 2015, Jacobi, Schneider, Bottazzi, *et al.* 2015, Jacobi, Schneider, Mariscal, *et al.* 2015), a

phenomenon that will probably be of increasing importance given the shift in both research and practice away from the centrality of the (nation-)state. Worryingly however, four well-conceptualised agency indicators (Reflexivity; Resilience/robustness; Responsiveness; Revitalization) are largely derived from only two articles that share an overlap in authorship (Termeer *et al.* 2013, Candel *et al.* 2015) and are concentrated at regional-level governance, suggesting that the breadth of agency-oriented indicators is less than what appears on first reading.

Of these structural and agency-oriented indicators, some can be observed to have explicit scale dimensions (e.g. Centralisation, Cross-scale interaction, Non-state self-organising). It is important that issues of scale be examined in light of the growing recognition that food security and environmental problems cross borders and are manifest at different scales. However, methodological incorporation of this awareness, while welcome, is not sufficient. Many “scale-aware” indicators are still operationalized at particular levels (to take just two characteristic examples, data for cross-scale interaction indicators operationalized by the constructs “formal dialogue with the EU” and “participation in institutions of global governance” were both collected at the national level [Donovan *et al.* 2010, Lesnikowski *et al.* 2013]), while relatively few take the next step of operationalizing these indicators in a multi-level study, such as those in the “Cross-scale-Production” cell in the matrix. Indicators that do not examine multi-level dynamics with data from *multiple levels* do not allow examination of the vital question of how food systems are impacted by cross-scale linkages.

Another set of indicators relates to democracy. These include long-standing characteristics of liberal democracy, e.g. Electoral democracy (Lebel *et al.* 2006, Acemoglu *et al.* 2009, Mandemaker *et al.* 2011), Accountability (Lebel *et al.* 2006, Jawtusch *et al.* 2013), Corruption (Mandemaker *et al.* 2011, Lesnikowski *et al.* 2013), and Legitimacy (von Geibler 2013). There are also some which reflect a more recent trend of “deepening democracy” (Fung 2004, Cornwall and Coelho 2007), e.g. Deliberation (Lebel *et al.* 2006, Schouten *et al.* 2012), Participation and multi-stakeholder engagement (Lebel *et al.* 2006, Donovan *et al.* 2010, Eakin *et al.* 2011, Jawtusch *et al.* 2013, Pesqueira and Glasbergen 2013, Korhonen-Kurki *et al.* 2014, Cooper and Wheeler 2015, Wambugu *et al.* 2015), Gender-sensitivity (Galiè 2013, Wambugu *et al.* 2015), and Fairness (Lebel *et al.* 2006, Gupta *et al.* 2010, Jawtusch *et al.* 2013, Wambugu *et al.* 2015). This would appear to provide a useful balance for research into democratic qualities of governance. Notably, however, some such as those used by Mandemaker *et al.* (2011) or by Jawtusch *et al.* (2013)

come from methodological toolkits for the study of “good governance.” “Good governance” is often professed to increase food security (FAO 2011) yet the relationship is problematic at best (Grindle 2004, Azmat and Coghill 2005). These indicator sets carry norms that have been criticised as Western-centric (Blunt 1995, Hermes and Lensink 2001) (and indeed others also carry norms, although less explicitly), a point that is returned to below.

A smaller set of indicators could be described as oriented towards assessing the implementation of governance reforms in relation to food systems. These include, for example, examining whether initial policy changes have been made (Donovan *et al.* 2010, Korhonen-Kurki *et al.* 2014), or assessments of similar programmes (Minde *et al.* 2008, Lesnikowski *et al.* 2013). One could also take some democracy indicators and use them as assessment indicators (e.g. Fairness, Empowerment, Gender-sensitivity). Indicators such as these would make an important component of a methodological toolkit as they are necessary for evaluative purposes. Note, however, that proportionally their number is small, and are focussed more on evaluating *implementation* than on *impact* of governance change. Indeed, dependent variables were outside the scope of this review, and a strong impact evaluation design would use dependent variables from outside the domain of governance (e.g. food security levels; environmental impact).

Key insights

With this overview, a number of observations about this set of indicators can be seen in terms of what kind of phenomena they represent and what is not represented. First is the welcome inclusion of agency along with institutional structure indicators. The governance dimension was introduced to food systems approaches in order to understand how food systems adapt or transform in response to environmental or economic stress (Eriksen *et al.* 2009, Ingram 2011). Yet, much governance research has a tendency to reduce governance to a set of technical or institutional properties. This inclusion of agency-oriented indicators does enable us to get beyond a purely technical account. Some weaknesses were observed, notably the clustering around one set of researchers and at higher governance levels. Operationalization only at higher levels will only enable observation of top-down agency. Therefore, addressing issues of agency both at local scales and across scales should be seen as a priority.

Secondly, if used in evaluation studies, most of the indicators found would be best used as independent variables, whereas we only have a small number of indicators

that can be used for process assessment (e.g. initial implementation of policy change [Donovan *et al.* 2010, Korhonen-Kurki *et al.* 2014], or inclusion of stakeholders [Wambugu *et al.* 2015]). This raises a number of issues. While it was argued above that some of the democracy indicators might also be used for assessment purposes, it was also cautioned that these indicators carry implicit and explicit norms that should be examined carefully and critically prior to being prescribed in a core methodological framework. For example, a number of papers examine the self-organising of non-state actors (Cooper and Wheeler 2015, Jacobi, Schneider, Bottazzi, et al. 2015, Jacobi, Schneider, Mariscal, et al. 2015), which should probably be seen as a positive recognition that governments and states are not the only actors affecting food systems. However, when viewed in the context of a generalised retreat of the state in favour of the market, celebrating the autonomous acts of “the community” might instead end up furthering ideological interests.

Furthermore, while impact evaluations, strictly defined, would require variables from the domain of food systems rather than governance (e.g. nutritional outcomes, access to food, environmental impacts, and so on) and hence fall outside the scope of this review, it is striking that implementation-monitoring indicators are so few when it is precisely this area where indicators would need to be most food system-specific. This is probably a symptom of indicators being assimilated from existing governance research, with less methodological development specifically for the governance of food systems. Thus, the development or tailoring of indicators that examine, for example, mainstreaming of food systems approaches across sector-specific institutions, or particular nutritional targets adopted by policy, should be seen as a priority. However, a focus on FS-oriented implementation or output indicators should not distract from the equal need for solid dependent variables to be used in future *impact* evaluation research, something that is outside the scope of this review. Many existing studies do not ask causal questions, or they evaluate governance according to implementation rather than impact variables (Minde *et al.* 2008, von Geibler 2013). Therefore, it needs to be stressed that without dependent variables that are operationalized outside of the domain of governance,⁴ the next generation of research will not produce findings that inform how governance can best address food systems challenges.

⁴ There is a caveat as some conceptualisations of food systems have integral governance components (Quinn *et al.* 2011, Galiè 2013), making such a crisp separation impossible for those frameworks.

Third, our findings confirm observations made by Candel (2014) that much research treats governance in functionalist terms. This is known as managerial bias, where research is done in a way that highlights those features that are recognized as relevant to interveners, using frames that position interveners as relevant and presenting results in a manner functional to intervention by funders (Roberts *et al.* 2005). Such approaches are usually blinkered to issues like conflicts of interests, or insolvable “wicked problems” (Candel 2014, Purdon 2014). Even with the agency-oriented indicators, much of the methods found serve the purpose of monitoring the capacity of governance to deal with problems, which is completely to be expected given that our research goals relate to addressing food security through governance interventions. However, there is a strong tradition of critical research in political science, anthropology, political economy, geography, cultural studies, and other disciplines that, while not contributing to immediate and solutions-oriented results, has nonetheless led over time to some significant paradigmatic changes. This tradition is for the most part absent, with the possible exception of discursive framing (Boons and Mendoza 2010, Pesqueira and Glasbergen 2013). While critical research might seem superfluous, it is important that methods be developed, or borrowed and adapted, to study any such area that is not well-represented by the present indicator set. If issues such as ideology, structural discrimination, orientalism, or governmentality continue to evade empirical observation, they will continue to be poorly understood even though they play significant roles in governance of food systems.

And fourth, the indicators reviewed are theory- rather than empirically-driven. That is, indicators used in research are derived from propositions and assumed to be relevant in particular cases, as opposed to having empirically-demonstrated salience. Related is the crucial question of who has a voice in framing the problems considered in food systems research and in defining and giving meaning to the set of indicators? The indicators are gathered from multiple disciplines and would ideally be tested for salience in research designs and teams that are transdisciplinary. Nonetheless, research to date appears discipline-specific and engagement of output across disciplines remains low, particularly for fields where governance or systems concepts are not yet commonly used. Methodically, next-generation research about food systems governance across scales may therefore deliver significant advances by adaptively and reflexively using these indicators in transdisciplinary research designs and teams.

Limitations

The implications of the results discussed above must be looked at in light of the limitations of this review. First, we cannot claim with confidence that the sample of literature we reviewed, and hence the indicators we found, are representative of the field. By collecting literature through consultation, we pursued a strategy aimed at achieving breadth through drawing from different disciplines and perspectives. There was very little overlap among the articles nominated by the 15 people involved in the consultation, and moreover, roughly half of the individually-nominated references were not known about to any significant extent by the rest of the Working Group. All this suggests that the field is characterised by a lack of cross-disciplinary engagement and that there are pockets of scholarship that we have not picked up on. For example, there almost certainly is research being conducted on governance of food consumption by health scientists, but this is not being picked up by the food systems governance community possibly because it falls under the umbrella of food *policy* or *standards*. Similarly, research on distribution might be missed because it is framed as value chain analysis rather than governance, and is mostly concerned with private sector objectives rather than food security or sustainability goals. Additionally, our focus on accessible publications may have systematically excluded important sources, such as books. While the consultation could certainly have benefited from a wider panel of experts (participating experts were drawn almost exclusively from the EIWG), the subject areas from which our literature is drawn is still comparable with reviews that have used traditional database search. This suggests that further sampling is needed of those research areas that have not yet adopted food systems or governance concepts but that are nonetheless relevant. Such sampling could be done through a combination of iterative, purposive database searching and extended consultation with experts in those underrepresented fields.

Secondly, we have taken the methods reported in articles at face value and have not applied any quality screening. Therefore, there is always a risk that some of the indicators we report lack validity or are unworkable, which if used without caution could lead to erroneous conclusions. This underlines the need for piloting and validation of this set of methods. Third and relatedly, research methods derive their validity from the fit between the conceptual and empirical. As such, drawing methods from research designs structured around particular theoretical frameworks and effectively shoehorning discrete indicators into a systems framework bring clear threats to validity. Added to this is the validity and reliability of synthesising research designs built at different conceptual levels into a common harmonised

conceptual level. In some papers, indicators were drawn from research question-level constructs, while in others from the lowest reported conceptual level. Both the harmonisation and distinction between indicators could be called into question. For example, some might consider *leadership* as an indicator of *adaptive capacity* (e.g. Gupta *et al.* 2010), or *adaptive capacity* as an indicator of *resilience* (e.g. Ifejika Speranza *et al.* 2014). Ultimately, an objective synthesis will always be elusive in the absence of a stable external theoretical framework of reference and a stable conceptual hierarchy. Similarly, some unwarranted conflation of distinct indicators is inevitable (e.g. compare definitions of “adaptive capacity” in Brown *et al.* [2012] and Jacobi *et al.* [2015]) in assembling a collection of indicators of this breadth. As such, the synthesis is interpretive and subject to disagreement. As with the previous limitation, validation is required through application.

Fourth, the framework we used is itself a simplified representation of more formal and thorough theories of FSG. It is subject to weaknesses, in particular regarding the three FS components (production, distribution, and consumption). For instance, the spatial and temporal extension of sites of production along the value chain means that production and distribution become less distinct, with practices such as processing or packaging easily fitting into either component. Similarly, the three components assume linearity, which precludes more cyclical approaches to food (e.g. Jurgilevich *et al.* [2016])). Indeed, the large number of indicators that were classified as *miscellaneous* does suggest a problem with the fit of the framework. On the other hand, classification according to governance *levels* might also be constraining. Scales of governance and of FS might not always correspond with one another, while the argument has also been made that scale is as much a methodological construct as an observable phenomenon (Moore 2008).

A fifth limitation is that with the compromise between space and detail, indicators are only partially represented here. In this Working Paper, analysis is confined to a synthesis and classification of indicators based on sites of operationalization and phenomena examined. Other aspects that could be examined include epistemological status of data, temporal dimensions, the types of analysis they support, and disciplinary origins and potential biases. In the technical report for this project, more methodological detail is given. However, even these are only guides, and many are incomplete. Full analysis, adoption, and replication of these methods would probably require contacting and seeking guidance from the authors who used or designed the methods. Unfortunately, sharing and adoption of methods is not helped by the reporting norms of journal articles.

Future steps

Taking the points discussed so far into account, we can begin to outline some future steps beyond this project. A first priority is to pilot and validate the indicators described in this Working Paper. A second priority is for methodological development for sparsely represented areas of the FSG framework, and for phenomena that are underrepresented. These include indicators for governance of distribution and consumption, either through development of new indicators or through more engagement by the FSG community with researchers already working on food consumption or distribution. It also includes scale indicators that are operationalizable *across scales*, agency at more levels than at present, indicators for assessment – in particular, those with specifically food systems dimensions – and methods to give a more critical view of governance. This methodological development would ideally augment this review through sampling literature in areas that we have missed – although a clear understanding of what can be considered food systems governance (e.g. food policy; food safety standards; supply chain management; food sovereignty; etc.) is required for any such wider sampling. Both of these steps should ideally be undertaken in interdisciplinary teams.

This augmented set of validated indicators then needs to be integrated into more formalised FSG theoretical frameworks than the matrix used in this review. This will require dialogue between methodologists and theorists. Following these immediate priorities is expected to result in a consolidated methodological framework for a second generation of research on food systems governance. It is recommended that CCAFS encourage through networks and through funded programmes the uptake of this expected framework. This is an area that the EIWG can help with through promoting such research among our networks.

Finally, in the medium to long term, these steps should lead to a body of research that supports a meta-analysis, the conclusions of which should be used to inform better interventions.

6 Conclusions

Research on governance of food systems has been ad-hoc, disparate, and lacks common methods. Combined, this results in a body of evidence that lacks commensurability, making it difficult to draw conclusions that have relevance beyond the specific sites where research has taken place. This Working Paper has

sought to identify a core set of indicators used to study food systems governance in order to contribute to the foundations for a second generation of research that it is hoped will be comparable and will enable aggregation and secondary analysis of results.

Through reviewing the literature, we have found a concentration of indicators of FSG in the production sector at local to national scales and a sparseness of methods used to study distribution and consumption. We must warn that this claim is tentative and reflects the literature included in our review which, it should be stressed, is not representative. However, rather than attributing this finding solely to poor sampling, it is probably symptomatic of two additional factors. First, although the emerging research community around FSG is interdisciplinary to an extent, cross-disciplinary engagement with fields that study governance of distribution and consumption, e.g. management or health, remain lacking. A second possible explanation is that such fields have not yet adapted explicit *food systems* and *governance* concepts to frame their research. For these two reasons, there are likely research methods that are useful for the study of FSG but are not yet adopted by the community.

Among those indicators we found, there was an expected strong presence of indicators looking at institutional structure. There was also a welcome representation of agency-related indicators, which are important to get beyond purely technical analyses of governance and to understand adaptation and transformation in response to stress. There are, however, reasons for caution, as much of these agency indicators were clustered around one set of authors, and were operationalized only at higher levels of governance. As such, these indicators do not allow an examination of, for example, bottom-up agency. Furthermore, while we did find some indicators that examine cross-scale dynamics (either from a structural or agency perspective), many of these were only operationalized at one particular level. It is increasingly recognised that cross-scale linkages play an important, though as yet poorly understood, role in governance of food systems. However, unless researchers operationalize cross-scale indicators in research designs that specifically collect data from multiple levels of governance, these dynamics will continue to be poorly understood.

With regard to assessing the impact that governance has on food systems, the scope of our review excluded the examination of dependent variables in terms of food systems outcomes. As such, most of the indicators we examined might be used as

independent variables. Nevertheless, a number of indicators we reviewed could be used as dimensions to assess FSG against (e.g. initial policy changes or some democracy indicators such as Gender-sensitivity). The number of such indicators was comparatively small, however. Many appear to be adopted from governance research in other fields. However, it is precisely in the area of *assessment* that specifically *food systems* governance indicators are required. This is a priority for methodological development.

We undertook this review of governance indicators with a view to facilitating research on how governance can improve food systems outcomes. It is therefore not surprising that the indicators we found are predominantly functionalist in how they view governance. This is important for research investigating causality and impact evaluation. Unfortunately, however, critical research into governance is neglected as a consequence. If unaddressed, the absence of a critical perspective will leave many important areas unexamined.

It must be noted that our conclusions are subject to limitations. Our findings are limited by how we sampled literature. This results on the one hand from the collective expertise of the EIWG and the exclusion of books in favour of accessible publications. On the other hand, we risk reproducing a bias among the FSG community in terms of which disciplines are engaged with and which not, while also neglecting research that has not yet adopted food systems and/or governance perspectives but that is nonetheless of relevance. Secondly, we have taken and presented methods at face value, without quality appraisals. Third, we have taken indicators from the conceptual frameworks for which they were designed and placed them in a framework for which they may no longer have validity. And fourth, description of indicators is partial, and adoption and replication of methods will require guidance from authors who designed them.

Acknowledging these limitations, this research calls for four follow-up steps. First, the indicators described in this report (and in more detail in the accompanying technical report) require piloting and validation. This would ideally be done by interdisciplinary research teams. Secondly, methodological development is required for areas and phenomena that are not well-represented by the indicators found in this review. This includes: s

- indicators for governance of distribution and consumption;
- scale indicators operationalized *across scales*;
- agency indicators at lower levels of governance;

- assessment indicators tailored for food systems; and
- methods for critical research on governance.

This methodological work would do well to consult with works missed in our review, particularly those researching food distribution and consumption, and those that are not framed by food systems or governance concepts. The set of indicators that results from this extension work will then require integration into theories of food systems governance that are more developed than the matrix used in this review.

Addressing these first steps will contribute to a consolidated methodological framework for future research on food systems governance. We recommend that CCAFS encourage uptake of this expected framework through networks and through funded programmes. Uptake is expected to increase the comparability of the next generation of FSG research. This should result in a body of comparable evidence that supports a meta-analysis from which empirically supported and generalizable conclusions can be drawn about how governance can further food systems goals.

Appendix 1: List of records included in full review

Project ID	Short reference	Full reference
EGRef#002	Adger <i>et al.</i> (2005)	Adger, W.N., Brown, K., and Thompkins, E.L., 2005. The political economy of cross-scale networks in resource co-management. <i>Ecology and Society</i> , 10 (2), 9.
EGRef#005	Auld (2010)	Auld, G., 2010. Assessing certification as governance: effects and broader consequences for coffee. <i>The Journal of Environment & Development</i> , 19 (2), 215-241.
EGRef#010	Biermann <i>et al.</i> (2012)	Biermann, F., Abbott, K., Andresen, S., Bäckstrand, K., Bernstein, S., Betsill, M.M., Bulkeley, H., Cashore, B., Clapp, J., Folke, C., Gupta, A., Gupta, J., Haas, P.M., Jordan, A., Kanie, N., Kluvánková-Oravská, T., Lebel, L., Liverman, D., Meadowcroft, J., Mitchell, R.B., Newell, P., Oberthür, S., Olsson, L., Pattberg, P., Sánchez-Rodríguez, R., Schroeder, H., Underdal, A., Vieira, S.C., Vogel, C., Young, O.R., Brock, A., and Zondervan, R., 2012. Transforming governance and institutions for global sustainability: key insights from the Earth System Governance Project. <i>Current Opinion in Environmental Sustainability</i> , 4 (1), 51-60.
EGRef#014	Boons and Mendoza (2010)	Boons, F. and Mendoza, A., 2010. Constructing sustainable palm oil: how actors define sustainability. <i>Journal of Cleaner Production</i> , 18 (16-17), 1686-1695.
EGRef#017	Candel (2014)	Candel, J.J.L., 2014. Food security governance: a systematic literature review. <i>Food Security</i> , 6 (4), 585-601.
EGRef#018	Chibinga <i>et al.</i> (2010)	Chibinga, O.C., Musimba, N.M., Nyangito, M., and Simbaya, J., 2010. Climate variability: pastoralists' perception, practices and enhancing adaptive pasture use for food security in Choma district, southern Zambia. In: <i>RUFORUM Second Biennial Meeting</i> . Presented at the RUFORUM, Entebbe, Uganda.
EGRef#019	Clapp (2003)	Clapp, J., 2003. Transnational corporate interests and global environmental governance: negotiating rules for agricultural biotechnology and chemicals. <i>Environmental Politics</i> , 12 (4), 1-23.
EGRef#020	Cooper and Wheeler (2015)	Cooper, S.J. and Wheeler, T., 2015. Adaptive governance: livelihood innovation for climate resilience in Uganda. <i>Geoforum</i> , 65, 96-107.
EGRef#021	Douxchamps <i>et al.</i> (2015)	Douxchamps, S., Wijk, M.T.V., Silvestri, S., Moussa, A.S., Quiros, C., Ndour, N.Y.B., Buah, S., Somé, L., Herrero, M., Kristjanson, P., Ouedraogo, M., Thornton, P.K., Asten, P.V., Zougmore, R., and Rufino, M.C., 2015. Linking agricultural adaptation strategies, food security and vulnerability: evidence from West Africa. <i>Regional Environmental Change</i> , 1-13.
EGRef#022	Drimie and Ruysenaar (2010)	Drimie, S. and Ruysenaar, S., 2010. The integrated food security strategy of South Africa: an institutional analysis.
EGRef#023	DuPuis and Gillon (2008)	DuPuis, E.M. and Gillon, S., 2008. Alternative modes of governance: organic as civic engagement. <i>Agriculture and Human Values</i> , 26 (1-2), 43-56.
EGRef#028	Evans (2011)	Evans, A., 2011. Governance for a resilient food system. <i>Oxfam Policy and Practice: Agriculture, Food and Land</i> , 11 (2), 63-92.
EGRef#029	Finan and	Finan, T.J. and Nelson, D.R., 2001. Making rain, making roads, making do: public and private adaptations to drought in Ceará, northeast

	Nelson (2001)	Brazil. <i>Climate Research</i> , 19 (2), 97-108.
EGR#031	Galiè (2013)	Galiè, A., 2013. Governance of seed and food security through participatory plant breeding: empirical evidence and gender analysis from Syria. <i>Natural Resources Forum</i> , 37 (1), 31-42.
EGR#037	Hesselberg and Yaro (2006)	Hesselberg, J. and Yaro, J.A., 2006. An assessment of the extent and causes of food insecurity in northern Ghana using a livelihood vulnerability framework. <i>GeoJournal</i> , 67 (1), 41-55.
EGR#038	Holden and Lunduka (2010)	Holden, S. and Lunduka, R., 2010. <i>Too poor to be efficient? Impacts of the targeted fertilizer subsidy programme in Malawi on farm plot level input use, crop choice and land productivity</i> . Norway: Department of International Environment and Development Studies, Noragric, No. 55.
EGR#040	Huntjens <i>et al.</i> (2012)	Huntjens, P., Lebel, L., Pahl-Wostl, C., Camkin, J., Schulze, R., and Kranz, N., 2012. Institutional design propositions for the governance of adaptation to climate change in the water sector. <i>Global Environmental Change</i> , 22 (1), 67-81.
EGR#042	Jacobi, Schneider, Bottazzi, <i>et al.</i> (2015)	Jacobi, J., Schneider, M., Bottazzi, P., Pillco, M., Calizaya, P., and Rist, S., 2015. Agroecosystem resilience and farmers' perceptions of climate change impacts on cocoa farms in Alto Beni, Bolivia. <i>Renewable Agriculture and Food Systems</i> , 30 (02), 170-183.
EGR#043	Juhola and Westerhoff (2011)	Juhola, S. and Westerhoff, L., 2011. Challenges of adaptation to climate change across multiple scales: a case study of network governance in two European countries. <i>Environmental Science & Policy</i> , 14 (3), 239-247.
EGR#044	Kochar (2005)	Kochar, A., 2005. Can targeted food programs improve nutrition? An empirical analysis of India's public distribution system. <i>Economic Development and Cultural Change</i> , 54 (1), 203-235.
EGR#046	Korhonen-Kurki <i>et al.</i> (2014)	Korhonen-Kurki, K., Seiring, J., Brockhaus, M., and Gregorio, M.D., 2014. Enabling factors for establishing REDD+ in a context of weak governance. <i>Climate Policy</i> , 14 (2), 167-186.
EGR#047	Lebel <i>et al.</i> (2006)	Lebel, L., Anderies, J., Campbell, B., Folke, C., Hatfield-Dodds, S., Hughes, T., and Wilson, J., 2006. Governance and the capacity to manage resilience in regional social-ecological systems. <i>Ecology and Society</i> , 11 (1), 19.
EGR#048	Leith <i>et al.</i> (2012)	Leith, P., Jacobs, B., Brown, P.R., and Nelson, R., 2012. A participatory assessment of NRM capacity to inform policy and practice: cross-scale evaluation of enabling and constraining factors. <i>Society & Natural Resources</i> , 25 (8), 775-793.
EGR#052	Mandemaker <i>et al.</i> (2011)	Mandemaker, M., Bakker, M., and Stoorvogel, J., 2011. The role of governance in agricultural expansion and intensification: a global study of arable agriculture. <i>Ecology and Society</i> , 6 (12), 8.
EGR#053	Masiero (2015)	Masiero, S., 2015. Redesigning the Indian food security system through e-governance: the case of Kerala. <i>World Development</i> , 67, 126-137.
EGR#055	Minde <i>et al.</i> (2008)	Minde, I.J., Jayne, T., Crawford, E., Ariga, J., and Jones, G., 2008. <i>Promoting fertilizer use in Africa: current issues and empirical evidence from Malawi, Zambia, and Kenya</i> . East Lansing: Michigan State University, Department of Agricultural, Food, and Resource Economics, No. 54501.
EGR#057	Nelson and Finan (2009)	Nelson, D.R. and Finan, T.J., 2009. Praying for drought: persistent vulnerability and the politics of patronage in Ceará, northeast Brazil. <i>American Anthropologist</i> , 111 (3), 302-316.
EGR#059	Osborne <i>et al.</i>	Osborne, H., Twyman, C., Adger, W.N., and Thomas, D.S.G., 2010.

	(2010)	Evaluating successful livelihood adaptation to climate variability and change in southern Africa. <i>Ecology and Society</i> , 15 (2), 27.
EGRRef#060	Osbaht <i>et al.</i> (2008)	Osbaht, H., Twyman, C., Neil Adger, W., and Thomas, D.S.G., 2008. Effective livelihood adaptation to climate change disturbance: scale dimensions of practice in Mozambique. <i>Geoforum</i> , 39 (6), 1951-1964.
EGRRef#062	Pedersen and Benjaminsen (2007)	Pedersen, J. and Benjaminsen, T.A., 2007. One leg or two? Food security and pastoralism in the northern Sahel. <i>Human Ecology</i> , 36 (1), 43-57.
EGRRef#065	Pesqueira and Glasbergen (2013)	Pesqueira, L. and Glasbergen, P., 2013. Playing the politics of scale: Oxfam's intervention in the Roundtable on Sustainable Palm Oil. <i>Geoforum</i> , 45, 296-304.
EGRRef#070	Poteete and Ostrom (2004)	Poteete, A.R. and Ostrom, E., 2004. Heterogeneity, group size and collective action: the role of institutions in forest management. <i>Development and Change</i> , 35 (3), 435-461.
EGRRef#071	Quinn <i>et al.</i> (2011)	Quinn, C.H., Ziervogel, G., Taylor, A., Takama, T., and Thomalla, F., 2011. Coping with multiple stresses in rural South Africa. <i>Ecology and Society</i> , 16 (3), 2.
EGRRef#074	Rocha and Lessa (2009)	Rocha, C. and Lessa, I., 2009. Urban governance for food security: the alternative food system in Belo Horizonte, Brazil. <i>International Planning Studies</i> , 14 (4), 389-400.
EGRRef#075	Sahley <i>et al.</i> (2005)	Sahley, C., Groelsema, B., Marchione, T., and Nelson, D., 2005. <i>The governance dimensions of food security in Malawi</i> . USAID.
EGRRef#076	Schader <i>et al.</i> (2014)	Schader, C., Grenz, J., Meier, M., and Stolze, M., 2014. Scope and precision of sustainability assessment approaches to food systems. <i>Ecology and Society</i> , 19 (3), 42.
EGRRef#077	Schouten <i>et al.</i> (2012)	Schouten, G., Leroy, P., and Glasbergen, P., 2012. On the deliberative capacity of private multi-stakeholder governance: the Roundtables on Responsible Soy and Sustainable Palm Oil. <i>Ecological Economics</i> , 83, 42-50.
EGRRef#078	Sonnino <i>et al.</i> (2014)	Sonnino, R., 2013. Local foodscapes: place and power in the agri-food system. <i>Acta Agriculturae Scandinavica, Section B – Soil & Plant Science</i> , 63 (sup1), 2-7.
EGRRef#079	Spielman <i>et al.</i> (2008)	Spielman, D.J., Cohen, M.J., and Mogue, T., 2008. <i>Mobilizing rural institutions for sustainable livelihoods and equitable development: a case study of local governance and smallholder cooperatives in Ethiopia</i> . Washington, DC: International Food Policy Research Institute.
EGRRef#081	Tompkins and Adger (2004)	Tompkins, E.L. and Adger, W.N., 2004. Does adaptive management of natural resources enhance resilience to climate change? <i>Ecology and Society</i> , 9 (2), 10.
EGRRef#083	Umali-Deininger and Deininger (2001)	Umali-Deininger, D.L. and Deininger, K.W., 2001. Towards greater food security for India's poor: balancing government intervention and private competition. <i>Agricultural Economics</i> , 25 (2-3), 321-335.
EGRRef#084	von Geibler (2013)	von Geibler, J., 2013. Market-based governance for sustainability in value chains: conditions for successful standard setting in the palm oil sector. <i>Journal of Cleaner Production</i> , 56, 39-53.
EGRRef#085	Wertz-Kanounnikoff and McNeill (2012)	Wertz-Kanounnikoff, S. and McNeill, D., 2012. Performance indicators and REDD+ implementation. In: A. Angelsen, M. Brockhaus, W.D. Sunderlin, and L. Verchot (eds), <i>Analysing REDD+: Challenges and Choices</i> (pp. 233-246). CIFOR, Bogor, Indonesia.

EGRef#089	Acemoglu <i>et al.</i> (2009)	Acemoglu, D., Johnson, S., Robinson, J.A., and Yared, P., 2009. Reevaluating the modernization hypothesis. <i>Journal of Monetary Economics</i> , 56 (8), 1043-1058.
EGRef#102	Jacobi, Schneider, Mariscal, <i>et al.</i> (2015)	Jacobi, J., Schneider, M., Mariscal, M.P., Huber, S., Weidmann, S., Bottazzi, P., and Rist, S., 2015. Farm resilience in organic and nonorganic cocoa farming systems in Alto Beni, Bolivia. <i>Agroecology and Sustainable Food Systems</i> , 39 (7), 798-823.
EGRef#104	Kay (2002)	Kay, C., 2002. Why East Asia overtook Latin America: agrarian reform, industrialisation and development. <i>Third World Quarterly</i> , 23 (6), 1073-1102.
EGRef#105	Khan (2011)	Khan, M., 2011. <i>Political settlements and the governance of growth-enhancing institutions</i> . London: School of Oriental and Africa Studies.
EGRef#119	Füssel (2010)	Füssel, H.-M., 2010. How inequitable is the global distribution of responsibility, capability, and vulnerability to climate change: a comprehensive indicator-based assessment. <i>Global Environmental Change</i> , 20 (4), 597-611.
EGREF#123	Kabubo-Mariara (2007)	Kabubo-Mariara, J., 2007. Land conservation and tenure security in Kenya: Boserup's hypothesis revisited. <i>Ecological Economics</i> , 64 (1), 25-35.
EGREF#131	Purdon (2013)	Purdon, M., 2013. Land acquisitions in Tanzania: strong sustainability, weak sustainability and the importance of comparative methods. <i>Journal of Agricultural and Environmental Ethics</i> , 26 (6), 1127-1156.
EGREF#135	Wambugu <i>et al.</i> (2015)	Wambugu, S.W., Chomba, S.W., and Atela, J., 2015. Institutional arrangements for climate-smart landscapes. In: P. A. Minang, M. van Noordwijk, O. E. Freeman, C. Mbow, J. de Leeuw, and D. Catacutan, editors. <i>Climate-Smart Landscapes: Multifunctionality in Practice</i> . Nairobi: World Agroforestry Centre (ICRAF).
EGREF#136	Wilbanks and Kates (2010)	Wilbanks, T.J. and Kates, R.W., 2010. Beyond adapting to climate change: embedding adaptation in responses to multiple threats and stresses. <i>Annals of the Association of American Geographers</i> , 100 (4), 719-728.
EGREF#145	Barungi (2013)	Barungi, J., 2013. <i>Agri-food system governance and service delivery in Uganda: a case study of Tororo District</i> . No. 61.
EGREF#152	Bizikova <i>et al.</i> (2014)	Bizikova, L., Nijnik, M., and Nijnik, A., 2014. Exploring institutional changes in agriculture to inform adaptation planning to climate change in transition countries. <i>Mitigation and Adaptation Strategies for Global Change</i> , 20 (8), 1385-1406.
EGREF#159	Brownhill and Hickey (2012)	Brownhill, L. and Hickey, G.M., 2012. Using interview triads to understand the barriers to effective food security policy in Kenya: a case study application. <i>Food Security</i> , 4 (3), 369-380.
EGREF#177	Duncan and Barling (2012)	Duncan, J. and Barling, D., 2012. Renewal through participation in global food security governance: implementing the international food security and nutrition civil society mechanism to the Committee on World Food Security. <i>International Journal of Sociology of Agriculture and Food</i> , 19 (2), 143-161.
EGREF#178	Eakin <i>et al.</i> (2011)	Eakin, H., Eriksen, S., Eikeland, P.-O., and Øyen, C., 2011. Public sector reform and governance for adaptation: implications of new public management for adaptive capacity in Mexico and Norway. <i>Environmental management</i> , 47 (3), 338-351.
EGREF#197	Gereffi <i>et al.</i> (2005)	Gereffi, G., Humphrey, J., and Sturgeon, T., 2005. The governance of global value chains. <i>Review of International Political Economy</i> , 12 (1), 78-104.

EGREF#225	Kirwan and Maye (2013)	Kirwan, J. and Maye, D., 2013. Food security framings within the UK and the integration of local food systems. <i>Journal of Rural Studies</i> , 29, 91-100.
EGREF#232	Lesnikowski et al. (2013)	Lesnikowski, A.C., Ford, J.D., Berrang-Ford, L., Barrera, M., Berry, P., Henderson, J., and Heymann, S.J., 2013. National-level factors affecting planned, public adaptation to health impacts of climate change. <i>Global Environmental Change</i> , 23 (5), 1153-1163.
EGREF#272	Schiff (2008)	Schiff, R., 2008. The role of food policy councils in developing sustainable food systems. <i>Journal of Hunger & Environmental Nutrition</i> , 3 (2-3), 206-228.
EGREF#276	Sietz et al. (2011)	Sietz, D., Boschütz, M., and Klein, R.J., 2011. Mainstreaming climate adaptation into development assistance: rationale, institutional barriers and opportunities in Mozambique. <i>Environmental Science & Policy</i> , 14 (4), 493-502.
EGREF#283	Stringer et al. (2009)	Stringer, L.C., Dyer, J.C., Reed, M.S., Dougill, A.J., Twyman, C., and Mkwambisi, D., 2009. Adaptations to climate change, drought and desertification: local insights to enhance policy in southern Africa. <i>Environmental Science & Policy</i> , 12 (7), 748-765.
EGREF#290	Tirado et al. (2010)	Tirado, M.C., Cohen, M.J., Aberman, N., Meerman, J., and Thompson, B., 2010. Addressing the challenges of climate change and biofuel production for food and nutrition security. <i>Food Research International</i> , 43 (7), 1729-1744.
EGREF#302	Wilder et al. (2010)	Wilder, M., Scott, C.A., Pablos, N.P., Varady, R.G., Garfin, G.M., and McEvoy, J., 2010. Adapting across boundaries: climate change, social learning, and resilience in the US-Mexico border region. <i>Annals of the Association of American Geographers</i> , 100 (4), 917-928.
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EGREF#308	Gupta et al. (2010)	Gupta, J., Termeer, C., Klostermann, J., Meijerink, S., van den Brink, M., Jong, P., Nootboom, S., and Bergsma, E., 2010. The adaptive capacity wheel: a method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. <i>Environmental Science & Policy</i> , 13 (6), 459-471.
EGREF#309	Termeer et al. (2013)	Termeer, C.J.A.M., Dewulf, A., Breeman, G., and Stiller, S.J., 2013. Governance capabilities for dealing wisely with wicked problems. <i>Administration & Society</i> , 47 (6), 680-710.

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