



Selection of Food Systems in Bolivia and Kenya and Methods of Analysis



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1 Background

This document is based on a communication received with the approval letter for this project, in which the review panel stated that, to enable monitoring and evaluation of the project, the selection of cases and methods to be used for analysis must be finalized and justified within the first six months of the project.

This document also addresses questions that the project team discussed with Professors Eve Fouilleux and Hans Peter Binswanger – the two experts of the review panel entrusted with the task of following up on our project – and Ian Johnson, who also joined the meeting at the R4D Forum on 19 March 2015.

During the first six months of the project, the project team has organized inception workshops with a number of key stakeholders in Bolivia and Kenya, including government officers, non-governmental organizations, local community representatives, and local academics. These workshops aimed at further advancing the conceptualization and selection of food systems to be investigated, and at defining the methods to be used for analysing them.

The main criteria for the selection of concrete food systems to be investigated in this project are summarized in Section 2 of this document. Section 3 describes the concept of food systems adopted in the project, as well as the analytical approach taken to select the methods to be used in each step of collecting and interpreting data and information. Section 4 presents and justifies the methods to be used for assessing the functioning and performance (or outcomes) of the food systems studied with regard to the five principles of food sustainability. The last subchapter (4.3) summarizes the methods to be applied for valuing the outcomes of food systems in an inter- and transdisciplinary process whose results will guide the identification of policy options for making food systems more sustainable.

This document only reports on research methods that will be applied during the first phase of project. A more detailed assessment of the indicators and methods used for developing the Food Sustainability Assessment Framework (FoodSAF) will be presented in a second document, to be submitted by the end of 2015.

The document is co-authored by the PI, co-PI's, the coordinator of the project, and Northern and Southern post-doc researchers, and takes account of valuable feedback from three members of the scientific advisory board.

2 Selection of food system case studies

The project's case study regions are the Santa Cruz Department in Bolivia and the north-western Mount Kenya region in Kenya. These regions were selected in a transdisciplinary process after approval of the pre-proposal, based on the following criteria: 1) their importance for regional and national food security; 2) presence of the five ideal-typical food systems that Colonna et al. (2013) consider to be the most relevant from a global perspective (i.e. agro-industrial, regional, local, domestic, and differentiated-quality food systems); 3) the possibility of studying conflicts, competition, and synergies in the context of currently coexisting food systems; 4) presence of rapid agrarian change leading to upheaval in local agricultural systems and activities, impacting the livelihoods of local rural people, and affecting urbanization processes; 5) the possibility of drawing upon previous research of Southern partners.

Selection of the food systems to be investigated in each study region was guided by the following criteria: 1) their spatial, economic, social, and cultural relevance within the study region; 2) representation of all five ideal-typical food systems defined by Colonna et al. (2013) in the overall sample; and 3) coexistence of several food systems in the study regions, enabling investigation of the effects of their interactions. The number of food systems was limited to three in each country, in accordance with the project's human and financial resources.

These criteria led to the following selection of food systems:

The agro-industrial food system is important in both study regions and was therefore selected as a case study in Kenya as well as in Bolivia. In Kenya it involves the production and commercialization of vegetables and fruits, and links the study region with consumers residing mainly in Europe. In Bolivia, the selected agro-industrial food system provides a broad range of foodstuffs that circulate along numerous food value chains originating in the region of San Pedro. Since it would have been impossible to investigate all value chains belonging to this food system, the project team decided to focus on one of the most important ones in terms of resource use, investment, and political attention. This value chain provides the bulk of wheat and edible oils (soy, sunflower) for human

consumption throughout Bolivia, and large quantities of feed (soy, sunflower, sorghum) for dairy and meat production in the study region, throughout Bolivia, and abroad.

One regional food system was selected in Kenya. It encompasses maize and beef value chains and involves mainly small- and medium-scale landholders. They are part of a larger network of actors living in rural food-producing areas in the counties of Meru and Laikipia and actors living in peri-urban and urban sites involved in processing, trading, retailing, and consuming food in the county capitals of Meru and Nanyuki, the municipality of Nyeri, and Kenya's capital Nairobi.

One domestic food system was selected in Bolivia. It consists of the subsistence- and market-oriented food system of the Guaraní indigenous people living in the municipality of Cabezas in the Chaco region of Santa Cruz. This food system involves maize, cassava, peanuts, peppers, beans, fruits, and vegetables. A large share of this food is processed, stored, and consumed within the producing households, and surplus is traded in local to regional markets.

One local food system was selected in Kenya. It involves a short food value chain of producers, artisanal processors, traders, and consumers of maize, potatoes, fruits, and vegetables in the town of Timau, in

Meru County. It makes up a significant portion of the local informal trade sector, which connects small-holder households and local markets.

One differentiated-quality food system was selected in Bolivia. It is one among a number of rapidly growing initiatives that offer “healthy and affordable” food to middle- and low-income consumers in the urban and peri-urban areas in and around the city of Santa Cruz. This food system is characterized by the interaction of a network of agroecological food producers and likeminded processors, traders, retailers, municipal officials, NGOs, and consumers’ organizations.

3 Definition of food systems

Following Rastoin and Gherzi (2010:19), this project defines food systems as “interdependent networks of stakeholders (companies, financial institutions, public and private organizations) in a geographical area (region, state, multinational region) that participate directly or indirectly in the creation of flows of goods and services geared towards satisfying the food needs of one or more groups of consumers in the same geographical area or elsewhere” (own translation).

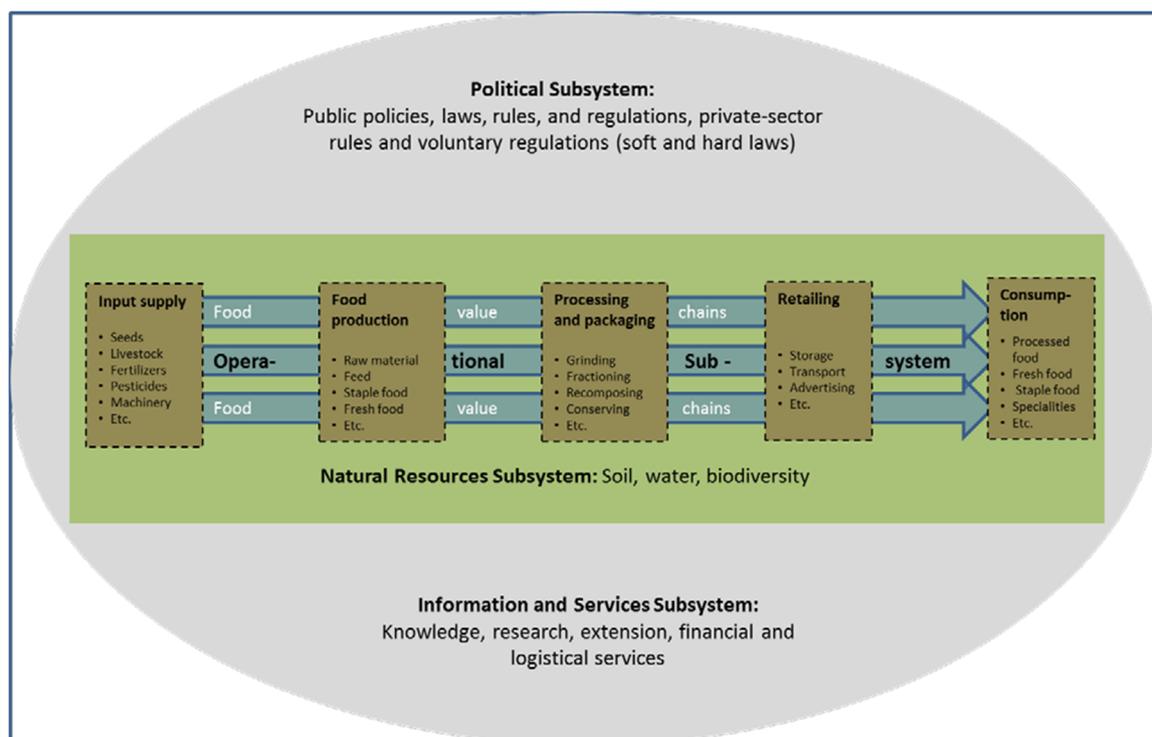


Figure 1: Operationalization of food systems (modified from Rastoin and Gherzi, 2010; Colonna et al. 2013)

In our project, this definition will be operationalized by further dividing food systems into four subsystems: 1) an operational subsystem, which comprises the actors and their activities as well as the institutions directly involved in creating food flows that link input supply, production, processing, and retailing to consumption – that is, essentially, the system’s food value chains; 2) a political subsystem comprising the public and private institutions that guide the decisions of actors in the operational subsystem (i.e. in the food value chains) (Colonna et al. 2013); 3) an information and services subsystem that involves actors who provide specialized information and services, for example related to markets, regulations, inputs, technologies, logistics, or financing, that flow into and within a food system (Rastoin and Gherzi 2010:23ff.); 4) a natural resources subsystem, which comprises the local natural resource basis (Figure 1). This fourth subsystem was added because our project attaches considerable importance to the interaction of food system activities with their environmental basis. In doing so, we follow Ericksen (2008), who likewise includes food systems’ environmental basis in their conceptualization.

Conceiving of a food system as composed by these four subsystems also aids the task of analysing interactions between different food systems, as it enables tracing how key aspects of one (or several) subsystems of one specific food system affects one (or several) subsystems of another food system. This will make it possible to identify patterns of interaction ranging from convergence and complementarity to conflict and mutual exclusion.

4 Analytical approach and selection of methods for food system research

This section complements Section 3.2 (“Research Plan and Methods”) of the full project proposal. It rearranges and describes more extensively the research methods that will be used during the different steps of the analytical approach underlying this project. It is a result of the discussions held during the inception workshops in Bolivia, Kenya, and Switzerland. In essence, our analysis of the selected food systems’ sustainability will follow three analytical steps:

1. Understand how individual food systems function and interact with other food systems (see also Section 1.2. and Figure 1 in full proposal).
2. Determine the outcomes (or performance) of individual and interacting food systems with regard to the five principles of food sustainability: food security, the right to food, reduction of poverty and inequality, reduction of adverse environmental impacts, and social-ecological resilience.
3. Conduct expert and stakeholder-based assessments of the outcomes (or performance) of individual and interacting food systems with regard to the five principles defining food sustainability.

Each step requires identification of the relevant key features of a food system, as well as selection of the methods to be used for collecting the corresponding information. The following subsections present the main methods to be used during each analytical step, along with a summary justification of their selection.

4.1 Methods for understanding the functioning of food systems

The selection of methods for understanding the functioning of our case study food systems was guided above all by the research questions formulated in the full project proposal, which the project will address in its different work packages. Accordingly, Section 3.2 of the full proposal outlines the selected methods for each research question. Following approval of the project, the project team was asked to further specify the methods to be used for analysing the different key features of a food system, and to justify these choices in greater detail.

Both requests can be met by describing in detail the systematic procedure that the project team followed to select the methods. First, we subdivided food systems into the subsystems presented above: the operational, political, information and services, and natural resources subsystems. Next, we identified key aspects to be studied in each subsystem. On this basis, finally, we determined the most appropriate methods for gathering information and data on each key aspect.

The result of this selection procedure is summarized in Table 1. The table shows the combinations of methods to be used for analysing the previously defined key aspects of the different subsystems and how they interact within the entire food system.

Table 1: Key aspects of food systems and methods to be used for analysing the functioning of food systems

Key aspects of food systems	Methods for data collection	Work packages
Operational subsystem (food value chains)		
Food value chain actors and their economic relationships (including existence of and access to financial infrastructure and support)	Value and commodity chain mapping (WFP 2010, Gereffi & Fernandez-Stark 2011, Ribot 1998) using semi-structured interviews and focus group discussions	WP3
Institutional configurations of value chains (formal and informal institutions guiding interactions within and between different actors along food value chains, including property rights in land and natural resources and power relations)	Institutional analysis (Matsaert, 2002), transaction analysis (Gereffi et al. 2005), and access mapping (Ribot 1998) using focus group discussions, open and semi-structured interviews, participant observation, and oral history of institution building	WPs 2, 3
Livelihood assets and strategies, and related household incomes of key actors in the food system	Livelihood analysis using semi-structured interviews, household surveys, and focus group discussions	WP3
Technical forms of producing, transforming, retailing, and consuming food	Participant observation, participatory mapping, transect walks, reviews of statistics and maps, focus group discussions, semi-structured interviews	WPs 2, 3
Political subsystem		
Policy context (policies; laws; public and private labour, safety, quality and environmental standards; trade and investment regulations; etc.), with a particular focus on multi-layered governance	Review of literature, case law, treaties, statistics, and maps	WP1
Policy spaces at the national level (existence of public and private spaces for participation in the definition and monitoring of policies, standards, and labels concerning food systems, and related power relations)	Review of literature in which food policies are defined, policy coherence analysis (OECD, 2013)	WP1
Actor- and policy-specific food-related values and preferences	Participant observation, focus group discussions, semi-structured interviews, household surveys	WPs 2, 3
Actor- and policy-specific perceptions of risks, vulnerability, food insecurity, sustainability, and development	Participant observation, focus group discussions, semi-structured interviews, oral history	WP2
Information and services subsystem		
Providers of specialized information and services related to markets, regulations, inputs, technologies, logistics, or financing	Review of literature, statistics, and maps; surveys; semi-structured interviews	WPs 1, 2, 3
Availability of and access to knowledge and services related to markets, credits, technologies, private and public regulations, and incentives	Review of literature, statistics, and maps; surveys; semi-structured interviews	WPs 1, 2, 3
Natural resources subsystem		
Types and quality of soil, vegetation, biodiversity, water, and climate	Review of literature and statistics, expert interviews	WP4
Land use and land cover change dynamics	GIS and satellite image interpretation, transect walks, expert interviews	WP4
Types and techniques of resource use (deforestation, crop types and rotations, raw materials for processing, retailing, and transporting food, etc.)	GIS and satellite image interpretation, transect walks, expert interviews, semi-structured interviews with different actors, field visits including transect walks	WP4
Interactions between coexisting food systems and broader socio-economic drivers		
Global drivers (trade and investment flows, national budgets related to import and export of food and inputs, lifestyle and consumption patterns), with a particular focus on multi-layered governance	Review of literature, case law, statistics, and maps	WPs 1, 3
Types and evolution of conflicts, synergies and competition between coexisting food systems	Semi-structured interviews, focus group discussions, participatory timeline development, participatory georeferencing	WP5

4.2 Methods for determining the outcomes of food systems

The second analytical step requires a set of methods that enables adequate identification of the most relevant *outcomes of food systems* with regard to the five principles of food sustainability – food security, the right to food, reduction of poverty and inequality, reduction of adverse environmental impacts, and social-ecological resilience.

Annex 1 provides a detailed overview of the key indicators and methods to be used for determining the outcomes of the case study food systems regarding each of the five principles of food sustainability. It indicates the significance of each indicator, the set of methods for assessing that indicator, and the work packages in charge of applying the different methods.

Some of the information required for determining food sustainability outcomes will be contained in the results of the first analytical step of research summarized in Section 4.1. However, in order to provide a comprehensive overview of all types of information required for determining the food sustainability outcomes, Annexes 1.1 to 1.5 list all indicators, specifying their significance and the methods used to quantify or qualify them. The research process will show what share of that information will result from research steps one and two, respectively.

The outcomes for each individual principle of food sustainability will be characterized by a set of about five to seven key indicators that best represent the specific features of each one of the five principles of food sustainability. This can only be defined after conclusion of the previous research steps. Accordingly, these indicators and methods are not yet outlined in this document. However, they will most probably be selected out of the list of indicators and methods provided in Annex 1.1 to Annex 1.5.

Research on food system outcomes will focus on the present situation. Nonetheless, we will also determine, to the extent possible, how key features of the food subsystems change over time. This concerns features such as land use and land cover change, policy coherence, and perceptions of poverty, inequality, and food security.

4.2.1 Methods for assessing impacts on food security

The methods selected for this part of research aim at identifying food systems' effects on access to food, as well as its availability, utilization, and stability – which together constitute food security – among different actors related to these food systems. To address this key question, we draw on the entitlement approach proposed by Sen (1981). This means evaluating how direct entitlements (e.g. families partly producing their own food), indirect entitlements

(e.g. families using their income to purchase food), and transfer entitlements (e.g. families benefitting from food donations) are influenced by participation in, or exposure to, a certain food system (Hanazaki et al. 2013). Accordingly, the methods used must provide information about the food security of a wide range of actors and groups, from households to communities and on to the wider context of the food systems being studied. This information will be gathered by means of semi-structured interviews and structured surveys. Data collection will focus on information about households' livelihood assets and strategies, as well as related food security indicators, such as the frequency of food shortages, hunger, and famine (Bickel et al. 2000; Hanazaki et al. 2013). Both actors involved in a single food system activity (production, processing, trading/retailing) and actors involved in several activities will be consid-

ered. This household-level information will be complemented with methods from community food security assessments (participatory land use and access mapping; see Cohen 2002). This means that we also investigate how food security is influenced by institutional arrangements, including property and access rights, forms of farming, power relations, and local perceptions of risk and vulnerability.

To analyse how food systems affect food security at specific stages of their value chains (beyond production and consumption of food) we will use existing statistics and reports; if there is a need for a quality control of such data, we will carry out exploratory household food security surveys among selected key actors related to the processing, packaging, transport, trade, and retail of food (see Annex 1.1).

Food security in the context of a given food system is also influenced by the consumption, processing, and retailing of food originating from other food systems. When determining food security implications of a given food system, we must therefore take into account input and output flows among different food systems. In this regard, this project will complement local information with existing statistical data on incoming and outgoing flows of food, goods, and services within a regional context (Suresh et al. 2014).

4.2.2 Methods for assessing impacts on the right to food

The project's assessment of the right to food will differ considerably from, and add to, its assessment of food security. It will explore the role of the state – by analysing whether and to what extent it fulfils its international obligations – in securing the full realization of the right to food. The main methods are review of laws, policies, land registries, and literature, as well as surveys and expert interviews. Emphasis will be on the assessment of existing instruments and policies and their effectiveness. Likewise, the project will examine how laws and policies relevant to food systems interact; it will analyse their coherence (following the OECD framework of policy coherence for development; OECD 2013) and assess their contribution to advancing the five principles of food sustainability. This analysis harnesses indicators of the right to food (see Annex 1.2) that have been developed by the United Nations Office of the High Commissioner for Human Rights (OHCHR 2012) and are used by United Nations agencies in collaboration with various governments, including the Government of Bolivia.

As a guiding criterion for indicator selection, the project team followed the United Nations Food and Agriculture Organization's methods to monitor the right to food (FAO 2008), so as to guarantee that developed indicators incorporate human rights principles, norms, and standards, while at the same time taking into account certain statistical considerations, such as the need to keep measurement techniques simple, avoid different interpretations, and reduce measurement errors. The analysis follows the United Nations Food and Agriculture Organization's PANTHER framework (FAO 2006) that relates to decision-making processes in addressing the right to food (from policy formulation to law-making down to administrative acts). It concentrates on seven principles: participation, accountability, non-discrimination, transparency, human dignity, empowerment, and rule of law. Authoritative international instruments and documents, such as the *Voluntary Guidelines to Support the Progressive Realization of the Right to Adequate Food in the Context of National Food Security* (FAO, 2005), the *Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests* (FAO 2012), the *Principles for Responsible Investment in Agriculture and Food Systems* of the Committee on World Food Security (CFS 2014), and the former United Nations Special Rapporteur De Schutter's principles on large-scale land acquisitions and leases (De Schutter 2009) were also used as resources for the development and shaping of indicators, particularly with regard to the alignment of food security policies and land governance with the right to food (more details see Annex 1.2).

4.2.3 Methods for assessing impacts on poverty and inequality

Its participation in one or more food systems is one of several factors impacting upon a household's poverty status. Furthermore, poverty has several dimensions: income from employment and other sources, consumption expenditure on food, housing, and other items (as well as non-market output of subsistence producers), access to public goods and services such as education, health-care, infrastructure (energy, water, transport, communication), access to the financial system, and political and social participation ("voice"). We need to assess how the food systems, their evolution, and their interactions have impacted upon these different poverty dimensions both for households involved in food system production and distribution activities and for households whose link with food systems is limited to consumption.

We will collect cross-sectional data from households within the selected food systems using a small survey. We will use a small number of in-depth interviews for elaborating life histories to supplement the survey data with information on how livelihoods changed over time (Camfield and Roelen 2013). This work will follow social anthropological entry studies (exploratory, biographic interviews) focusing on local "framing" of food systems, which will inform the contents of the survey questionnaire and in-depth interviews. Although the sample will be limited in accordance with project resources, we intend to include smallholder farmers, as well as waged workers in the various segments of the relevant food systems and households whose income is derived outside the food systems.

We will interview local government officials to obtain data on household access to public goods and services, and managers of private enterprises in the food systems to obtain data on employees' wage incomes. We will collect data on food prices via direct observation in local informal markets, as well as formal distribution channels such as supermarkets. Data on benchmark poverty lines and inequality measures (such as regional/national poverty rates and Gini coefficients) will be drawn from official and non-official reports and studies.

Semi-structured interviews of management of medium- and large-scale firms active in the food systems will also be used to obtain data for examining the distribution of value added among firms and smallholder farmers active within different value chain segments, and between profits and wages within firms.

The interviews with public- and private-sector managers will further contribute to an understanding of the broader economic, political, and social trajectory of the study areas, which is essential context for understanding the evolution of poverty and inequality, given the latter's multi-dimensional nature and causes (more details see Annex 1.3).

4.2.4 Methods for assessing environmental impacts

Which are the most relevant environmental impacts of the food systems under study, and how can they be identified? This is the key question guiding the selection of methods for this part of research. According to Aubin et al. (2013), available methods for analysing the environmental impacts of food systems concentrate on the effects of food value chains on soil and water quality, as well as their impacts on climate change (via their carbon footprint). These methods are generally based on life cycle assessment (LCA) approaches. However, methods for assessing how food value chains and the wider food systems to which they belong affect biodiversity are still at an early stage of development.

We therefore followed the methodological strategy of Bolwig et al. (2010: 209ff), who propose integrating environmental concerns into an environmental analysis of entire value chains. They opt for a simplified LCA scheme that focuses on a qualitative inventory of resource use at different nodes of the value chain. This serves as a basis for identifying potentially most relevant environmental impacts to be further investigated. This qualitative screening is based on expert knowledge, while also taking into consideration local actors' perceptions of the given food system's environmental impacts (via social anthropology assessments).

A preliminary screening by the research team, along with a review of existing literature, led to the selection of several critical key variables. The first one is resource use intensity – a proxy for assessing environmental impacts of food production related to the use of water, land, and energy. It is based on calculation of the total land, energy, and water requirement per kilogramme of available food in a production system (Gerbens-Leenes et al. 2003). In order to assess the resource use intensity of entire food value chains from production to consumption, we will extend the method to the other value chain stages, including processing, retailing, and consumption. Information on these aspects will be produced by applying methods from process-based LCA approaches (Aubin et al. 2013, Flynn and Baily 2014, Bolwig et al. 2010) mainly to existing statistics and LCA databases. Lacking information will be complemented by own quantifications based on surveys and expert interviews.

We additionally decided to assess the effects of food systems on the diversity of landscapes, crops, seeds, and breeds; soil erosion and soil organic matter content; as well as risks and impacts of food system activities on human health. The resulting biodiversity and soil assessments are intended to enable determination of the spatial units affected by the various stages of food value chains typical of the food systems under study (Bolwig et al. 2010). The spatial boundaries of the land required for production, processing, retail, and waste disposal within a food system will be georeferenced and then characterized in terms of land use and land cover change. This will be achieved by means of existing and new maps developed on the basis of satellite imagery and remote sensing. The resulting sets of GIS-based maps will provide the basis for determining the causal links between food systems and the diversity of landscapes, crops, seeds, and breeds.

The maps will also provide the basis for assessing food systems' impacts on soil erosion and changes in soil organic matter content. The latter will be assessed visually by determining the total land area where a substantial or total loss of productive biological capacity has occurred due to activities related to the food system under study (FAO 2008). Scarce quantitative data will be complemented by information obtained from experts and via participatory mapping and freelisting. Risks and impacts of food system activities on human health will be assessed through interviews with different actors in the different food systems, complemented by expert interviews and review of statistics. A more detailed list of key indicators and methods to be used is given in Annex 1.4.

4.2.5 Methods for assessing impacts on resilience

Walker et al. (2004) defined resilience as “the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks”. The methods for determining social-ecological resilience draw on the Resilience Alliance Manual (2007). This includes the identification of food system components and properties that build resilience, as well as factors that create stress, by developing mental maps with different stakeholders in focus group discussions (see Annex 1.5). The indicators of food system resilience selected for our analysis are based on literature (Carpenter 2001, Cabell and Oelofse 2013) as well as our previous work on the

resilience of livelihoods and agroecosystems (e.g. Ifejika Speranza et al. 2014). The concept of social-ecological resilience is operationalized by means of seven indicators of food systems' social-ecological buffer capacities, five indicators related of self-organization, and five indicators of the learning capacity of the food systems' actors (see Annex 1.5). These literature-based indicators will be discussed and complemented by additional indicators that also reflect actor-specific perceptions of risks, vulnerability, and possible strategies to deal therewith; this will require the use of focus group discussions and participant observation. Some of the information on these indicators (and the methods used for obtaining it) will be provided by assessments made in other work packages dealing with social or ecological issues. For example, the diversity of landscapes, crops, seeds, and breeds will serve as indicators of buffer capacity; information about different forms of organization of food producers, processors, retailers, and consumers will serve to determine their degree of self-organization; and the levels of participation in the definition of food policies or the establishment of private or public labels and standards will serve as indicators for the learning capacity of the actors related to the different food systems, among others (Annex 1.5).

4.3 Assessment of the sustainability of food systems

Research step two will provide findings about what the various food systems' food sustainability outcomes are. However, sustainability science cannot offer any "objective" or commonly accepted frame of reference for judging how a certain empirical outcome relates to food sustainability. For example, if research shows that 15 per cent of smallholders in a food system are food-insecure, it is not automatically clear how sustainable or unsustainable this situation is. To answer this question, we need to establish benchmarks against which empirical outcomes can be assessed in terms of their contribution towards fulfilling the five principles of food sustainability. This requires a third analytical step, which itself is based on a two-step procedure of inter- and transdisciplinary assessment (Schneider et al. 2014). This procedure is organized as follows:

First, the interdisciplinary teams of researchers compare the outcomes with existing local, regional, national, and global norms codified as hard or soft laws and state-of-the-art knowledge in sciences. This produces an expert-based assessment of the sustainability of food systems. This step includes the assessment of possible trade-offs and feedback loops between interacting food systems, emphasizing aspects relating to the five food sustainability principles.

Second, the results of the expert-based assessment are then discussed with the key stakeholder groups interested in making food systems more sustainable. This enables the prioritization of norms and the definition of other norms in addition to those that were determined on the basis of the interdisciplinary assessment by scientists. This inter- and transdisciplinary assessment concerns not only the indicators relating to each individual principle of food sustainability, but also actor-specific valuations (including scientists') as acceptable or unacceptable of trade-offs between changes in the cumulative assessment of indicators used for determining the five food sustainability principles. How do the various actors value, for example, an improvement of food security or an increase in income at the price of growing adverse environmental impacts and decreasing social-ecological resilience?

As agreement and consensus might be impossible to achieve, the assessment of food sustainability will be presented as a set of converging, diverging, and conflicting valuations made by different actor categories. If possible, each of the five principles of food sustainability will be visualized on an ordinal scale based on the integration of research results by experts and stakeholders.

The same procedure will be applied to determine innovative policy options. After being identified by an interdisciplinary team of researchers, they will be fed into a process of discussion leading to converging, diverging, or conflicting policy recommendations. This part of research falls into the responsibility of WP5.

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6 Annex

ANNEX 1.1 Food security				
Key question: What is the current food security situation of actors directly and indirectly related to the food system?				
Activities observed	Key indicators	Significance	Methods	Work packages
Production	Contribution of food system to access to, as well as the availability, utilization, and stability of food within the food system and beyond	Dependence of overall food security in study region on food provided by case study food system	Review of statistics, surveys, expert interviews	WPs 1, 3
	Share of food and feed used for processing food within beyond food system	Dependence of overall food security in study region on processed food provided by case study food system	Review of statistics, surveys, expert interviews	WP1
	Food-producing actors' perceptions of risks, food insecurity, and poverty	Expression of emic notions of risk, insecurity, and poverty in the way food production is organized	Participant observation, focus group discussions, semi-structured interviews	WP2
	Type and distribution of, and access to, land and natural resources (property right institutions)	Link between food security and access to natural resources among food-producing actors	Participant observation, participatory land use and access mapping, focus group discussions, semi-structured interviews	WPs 1, 2
Processing and storage	Contribution of food system to access to, as well as the availability, utilization, and stability of food within the food system and beyond	Importance of processed food in study region and beyond	Review of statistics, surveys, expert interviews	WP3
	Share of food and feed that can be stored for more than one year	Capacity for buffering food or feed shortages or price hikes in international markets	Review of statistics, surveys, expert interviews	WP3
Retail and trade	Prices of fresh and processed food for different socio-economic classes	Affordability of food types for different socio-economic consumer categories	Review of statistics, surveys, expert interviews	WPs 3, 2
Consumption	Access to food, and its availability, use, and origins among actors belonging to the food system	Influences on household food security of actors in the food system	Household food security surveys, complemented with certain methods of community food security assessment	WPs 3, 2
	Access to food, and its availability, use, and origins among actors outside the food system	Influences on household food security of actors outside the food system	Review of statistics, surveys, expert interviews	WP3
	Access to food, and its availability, use, and origins (produced vs. purchased)	Actor-specific food security situation and vulnerability to food insecurity (within vs. outside the food system)	Participatory mapping and observation, focus group discussions, semi-structured interviews, value and commodity chain mapping	WP3
	Perceptions of a "good diet"	Actor-specific notions of food quality (influencing food preferences)	Participant observation, focus group discussions, semi-structured interviews	WP2
	Share of income spent for food	Dependence of food security on monetary income	Review of statistics, surveys, expert interviews	WPs 3, 2
All activities within food system	Power relations, type and frequency of reciprocal interactions in production, processing, distribution and consumption of food	Role of power relations and non-market mechanisms (crop sharing, barter, dependencies, etc.) in achieving food security	Participant observation, focus group discussions, semi-structured interviews	WPs 2, 3

ANNEX 1.2 Right to food – Key question: What is the current status of the realization of the right to food of actors directly and indirectly related to the food system?				
Activit.	Key indicators	Significance	Methods	WPs
Production	Time frame and coverage of national policies on agricultural production, food availability, and management of droughts, crop failures and disasters	Synergies and clashes between agricultural policies and the right to food; implementation of the right to food in time of crises and disasters	Review of policies and literature	WP1
	Distribution of land according to type of beneficiary	Equality, non-discrimination, empowerment of vulnerable groups	Land registry, participant observation, participatory land use and access mapping, focus group discussions, semi-structured interviews	WP 2
	Proportion of land titles granted to women	Equality, non-discrimination	Land registry, focus group discussions, semi-structured interviews	WP2
	Percentage of irrigated land compared to total cultivated land	Strengthening of local food production	Review of statistics, surveys, expert interviews	WP4
	Percentage of public investment in agro-pastoral activities compared to general expenses	Strengthening of local food production	Review of statistics, surveys, expert interviews	WP1
	Number of municipalities with services to support agricultural production	Strengthening of local food production	Review of statistics, surveys, expert interviews	WP2
	Number of certified eco-friendly agricultural producers	The ecological dimension of the right to food	Review of statistics, surveys, expert interviews	WP2
Processing and storage	Proportion of food-producing establishments inspected for food quality standards, and frequency of inspections	State's obligation to ensure adequate and safe food	Review of statistics, surveys, expert interviews	WP2
Retail and trade	Proportion of food-distributing establishments inspected for food quality standards, and frequency of inspections	State's obligation to ensure adequate and safe food	Review of statistics, surveys, expert interviews	WP2
Consumption	Time frame and coverage of national policy on food safety and consumer protection, nutrition and nutrition adequacy norms	State's obligation to ensure adequate and safe food	Review of policies and literature	WP1
	Proportion of cases adjudicated under food safety and consumer protection law	State's obligation to ensure adequate and safe food	Review of case law and literature	WP1
	Share of public social sector budget spent on food safety and consumer protection advocacy, education, research, and enforcement (via laws and regulations)	State's obligation to ensure adequate and safe food	Review of statistics, surveys, expert interviews	WPs 1, 2, 3
	Disposal rate or average time to adjudicate a case registered in a consumer court	State's obligation to ensure adequate and safe food	Review of statistics, surveys, expert interviews	WP1
	Number of educational campaigns on food and nutrition	State's obligation to ensure adequate, safe, and nutritious food	Review of statistics, surveys, expert interviews	WP1
	Number of programmes that promote cultural aspects of food and their nutritional value, and balanced diets	Cultural adequacy of food and its nutritional value	Review of statistics, surveys, expert interviews	WPs 1, 2
All activities within food system	Existence of ratified international human rights treaties relevant to the right to food	Recognition and implementation of the right to food	Review of treaties and literature	WP1
	Recognition of the right to food in the constitution or other forms of superior law	Recognition and implementation of the right to food	Review of laws and literature	WP1
	Existence of laws at national, provincial, and local level for the implementation of the right to food	Implementation of the right to food at legal level	Review of laws and literature	WP1
	Existence of policies, plans, and strategies for food security	Implementation of the right to food at policy level	Review of policies and literature	WP1
	Proportion of received complaints on the right to food investigated and adjudicated by judges, national human rights institutions, human rights ombudspersons, or other mechanisms, and proportion of these effectively responded to by the government	Implementation of the right to food at judicial level	Review of cases, statistics, surveys, expert interviews	WP1
	Unemployment rate and social protection schemes or average wage rate of segments of labour force involved in the food system	State's obligation to safeguard financial means to procure food	Review of statistics, laws, and policies, access mapping based on participatory observation, focus group discussions, semi-structured interviews, surveys, expert interviews	WPs 2, 3
	Net official development assistance for food security received or provided as a proportion of public expenditure on food security or gross national income	State's obligation to cooperate internationally by investing in food security	Review of statistics, surveys, expert interviews	WPs 1, 3
	Number of registered and/or active NGOs (per 100,000 persons) involved in the promotion and protection of food security and/or the right to food	Degree of involvement of civil society in implementation of the right to food	Participant observation, semi-structured interviews	WP2

ANNEX 1.3 Poverty and inequality				
Key question: What is the current income distribution position of actors directly and indirectly related to the food system?				
Activities observed	Key indicators	Significance	Methods	Work packages
Production	Farmers' income and non-market production	Poverty status and inequality assessment (income and income equivalents relative to poverty line and relative to other groups of actors in the food system)	Small household survey, individual life histories	WPs 3, 2
	Wages of large farm employees	Poverty status and inequality assessment (relative to poverty line and relative to other groups of actors in the food system)	Small survey, interviews with workers, trade unions, and managers	WP3
	Incomes of large, medium, and small farms and firms	Inequality assessment to enabling estimation of profitability of farms or firms and distribution of values (rents) within value chains	Semi-structured interviews with firms to obtain information on production costs and product selling prices at different stages of value chain	WP3
Processing storage, and transport	Wages of employees, profits of firms	Poverty status and inequality assessment (relative to poverty line and relative to other groups of actors in the food system)	Semi-structured interviews with managers, workers, and trade unions	WP3
Retail and trade	Wages of employees, profits of firms	Poverty status and inequality assessment, relative to poverty line and relative to other groups of actors in the food system	Semi-structured interviews with managers, workers, and trade unions	WP3
Consumption	Prices of goods in different distribution channels (formal and informal), price inflation	Poverty status and inequality assessment (purchasing power of income and changes in purchasing power)	Direct observation of various channels (supermarkets, small stores, rural and urban formal and informal markets)	WPs 3, 2
	Food expenditure and consumption baskets (including non-marketized production)	Poverty status and food security assessment (purchasing power of income and changes in purchasing power)	Small survey, individual life histories	WP3
All activities within food system	Expenditures on other consumption goods, access to public and private goods and services (social, health, educational, infrastructural, financial services), national and subnational poverty lines and poverty/inequality indicators (nutrition, health, education, participation, etc.), livelihood assets	Poverty status and inequality assessment, looking at overall consumption (including of non-food items and services), non-economic dimensions of poverty (participation), and livelihoods	Semi-structured interviews with local government officials, small survey, individual life histories, livelihood analysis based on semi-structured interviews	WPs 3, 2

ANNEX 1.4 Environmental impacts				
Key Question: What are the environmental impacts of food system activities?				
Activities observed	Key indicators	Significance	Methods	Work packages
All activities within food system from input supply to consumption	Main agroecological effects of food systems	Identify the key natural resources and ecological functions negatively affected by food system activities	Qualitative screening of key environmental impacts	WP 4,2,3,1
	Resource use intensity of one unit of food circulating from production to consumption	Quantify the consumption of land, water and (fossil) energy required for one unit of food	Simplified LCA method based on Gerbens-Leenes et al. (2003) focusing on freshwater consumption, greenhouse gas emissions, agrochemical inputs, and waste disposal	WP 4
	Food system effects on land use and land cover change and related changes regarding the diversity of ecosystems, habitats, ecosystem connectivity, and in-situ agrobiodiversity conservation	Land use and land cover change in food systems provide a basis for assessing the food system effects on the diversity of landscapes, threatened species (red list), and domesticated plants and animals	Land use and land cover change (LULCC) analysis, including documentation of type and number of crops and breeds used; LULCC analysis will be complemented with information from transect walks, participatory mapping of land use, focus group discussions, existing maps, and satellite images	WP4
	Soil quality and soil erosion	Makes it possible to determine the effects of food systems on soil degradation or soil conservation	Visual soil assessment (determination of the total area of land where cultivation has caused a substantial or total loss of productive biological capacity, FAO 2008); remote sensing and soil degradation mapping	WP4
	Effects of food system activities on selected human health aspects	Provides an idea of how food system activities affect human health via side-effects related to food system activities or via reduced food quality	Assessment of the perceptions of different actors in the food system via interviews with selected households in farming communities, agricultural workers, traders, consumers and health experts related to the food system; review of existing reports and literature	WP4

ANNEX 1.5 Social-ecological resilience				
Key Question: How do different actors perceive risk and vulnerability, and what is the state of the food systems' social-ecological resilience?				
Activities observed	Key indicators (based on Cabell and Oelofse 2013)	Significance	Methods	Info by WP
Transversal to all food systems activities	Risks, vulnerabilities and trends influencing the food system	Define "specific resilience": resilience of what to what (Carpenter 2001)?	Focus group discussions with farmers, agricultural workers, traders and typical consumers related to the food system	WPs 2, 3, 4
	<ol style="list-style-type: none"> 1) Diversity of system components (including indicators from environmental sustainability assessment), seeds management/availability Spatial and temporal heterogeneity of land use patterns 2) Natural capital (entitlements in terms of access to assets such as productive resources) 3) Financial capital (incomes and access to finance) 4) Human capital (education, experience, health) 5) Social capital (existence of networks and endowments, i.e. assets ownership) 6) Physical capital (infrastructure, services, access to healthy and affordable food) 	Buffer capacity of food systems in response to stress factors (environmental as well as sociocultural and economic)	Integration of data gathered by other WPs (for indicators 1–7) and focus group discussions for validating insights from integration	WPs 2, 3, 4, 5
	<ol style="list-style-type: none"> 1) Centralization/decentralization (e.g. direct trade relations, or many middlemen?) 2) Social self-organization trust, collaboration, interest groups, transparency, reliance on local vs. external resources 3) Wage levels of food system activities 4) Provision of habitats for biodiversity, ecological compensation, and ecosystem services 5) Connectivity of system components (Interaction of food systems and food system components: many weak connections, or few, highly dependent connections? Competition or cooperation?) 	Self-organization of food system components in response to stress factors (environmental as well as sociocultural and economic)	Integration of data gathered by other WPs (for indicators 1–5) and focus group discussions for validating insights from integration	WPs 2, 3, 4, 5
	<ol style="list-style-type: none"> 1) Knowledge of threats and opportunities 2) Enhancement of human capital (information and knowledge production/sharing/accessibility) 3) Reflective and shared learning (participation in the establishment of food policies or private and public labels and standards) 4) Functioning feedback mechanisms (information sources, frequency of interaction with them, new ideas and practices learned) 5) Knowledge legacy and identity (shared societal/collective vision, existence and use of local knowledge) 	Learning capacity of food systems in response to stress factors (environmental as well as sociocultural and economic)	Integration of data gathered by other WPs (for indicators 1–5) and focus group discussions for validating insights from integration	WPs 1, 2, 3, 4, 5

This working paper describes the concept of food systems used in the r4d project “Towards Food Sustainability”. According to this concept, a food system can be subdivided into a political subsystem, an operational subsystem, a subsystem of information and services, and a subsystem of the natural resource base. We also describe the project’s case studies in Kenya and Bolivia, explaining why and how they were selected. The project comprises six case studies: an agro-industrial food system each in Kenya and Bolivia; a domestic-indigenous and an agroecological food system in Bolivia; and a local and a regional food system in Kenya. Further, this working paper lists specific indicators and methods used to investigate each of the five normative principles of food sustainability.

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