Guidelines to assess and design interventions for food system resilience – working draft 01.11.2016

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This working draft is part of a flagship research project of the ETH World Food System Center, led by the ETH Zurich chairs of Sustainable Agroecosystems and Climate Policy and the TdLab. It is subject to modifications.

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Contents

Introduction and goal

Food system resilience is "the capacity over time of a food system and its units at multiple levels, to provide sufficient, appropriate and accessible food to all, in the face of various and even unforeseen disturbances" (Tendall et al., 2015, p. 19). Building resilience in food systems is thus highly relevant when dealing with the many unpredictable shocks that threaten food systems (e.g. price spikes, natural hazards, weather extremes, epidemics, economic and political crises, etc.), and contributes to improving global food security. It entails developing in-built capacities which are continuously improved, rather than a static action plan (as in the case of risk management).

Based on a transdisciplinary and problem-oriented approach, our guidelines support practitioners and facilitators assess and build resilience to shocks in food systems. They outline concrete steps and provide methodological options for assessing food system resilience and designing interventions aimed at improving it. These guidelines are applicable in all contexts regardless of the geographic location and commodities selected. Emphasis is, however, given to contexts where data availability is limited and data collection requires qualitative and participatory approaches.

The current version is more appropriate for research settings, and will be iteratively adapted to on-field settings based on further applied cases.

Supporting references

These guidelines build upon research conducted at the Swiss Federal Institute of Technology ETH Zurich, accessible in more detail in the following publications:

- Tendall, D., Joerin, J., Kopainsky, B., Edward, P., Shreck, A., Le, Q.B., Kruetli, P., Grant, M. and Six, J. (2016) Building Resilient Food Systems: a Strategic Framework for Intervention Design and Assessment. In preparation.
- Joerin, J, Hauenstein, S., Kopainsky, B., Tendall, D. and Six, J. (2016) Resilience in Food Systems. Sight and Life 30(1): 22-27.
- Monastrynaya, E., Joerin, J., Dawoe, E., Six, J. (2016) Assessing the resilience of the cocoa value chain in Ghana, Swiss Federal Institute of Technology ETH Zurich, Zurich, Switzerland.
- Tendall, D., Joerin, J., Kopainsky, B., Edward, P., Shreck, A., Le, Q.B., Kruetli, P., Grant, M. and Six, J. (2015) Food system resilience: defining the concept. Global Food Security, 6: 17-23.
- Hauenstein, S. (2015) Assessing the resilience of the tef value chain in Ethiopia, Swiss Federal Institute of Technology ETH Zurich, Zurich, Switzerland.
- Zweifel, A. (2014) Towards a resilience indicator framework for agri-food systems: a pilot study in Switzerland. Master thesis, Swiss Federal Institute of Technology ETH Zurich, Zurich, Switzerland.

Overview

These guidelines are structured into 4 stages and 10 steps, as shown in Figure 1. These stages consist of: 1) problem identification and framing; 2) definition of the system; 3) resilience assessment; 4) interventions for building resilience.

Each chapter describes the objective of each step, the procedure in practice, possible data sources, supporting methods and literature, and illustrations from contrasting case study examples (the sugar

value chain in Switzerland, the maize value chain in Malawi, the tef value chain in Ethiopia and the cocoa value chain in Ghana).

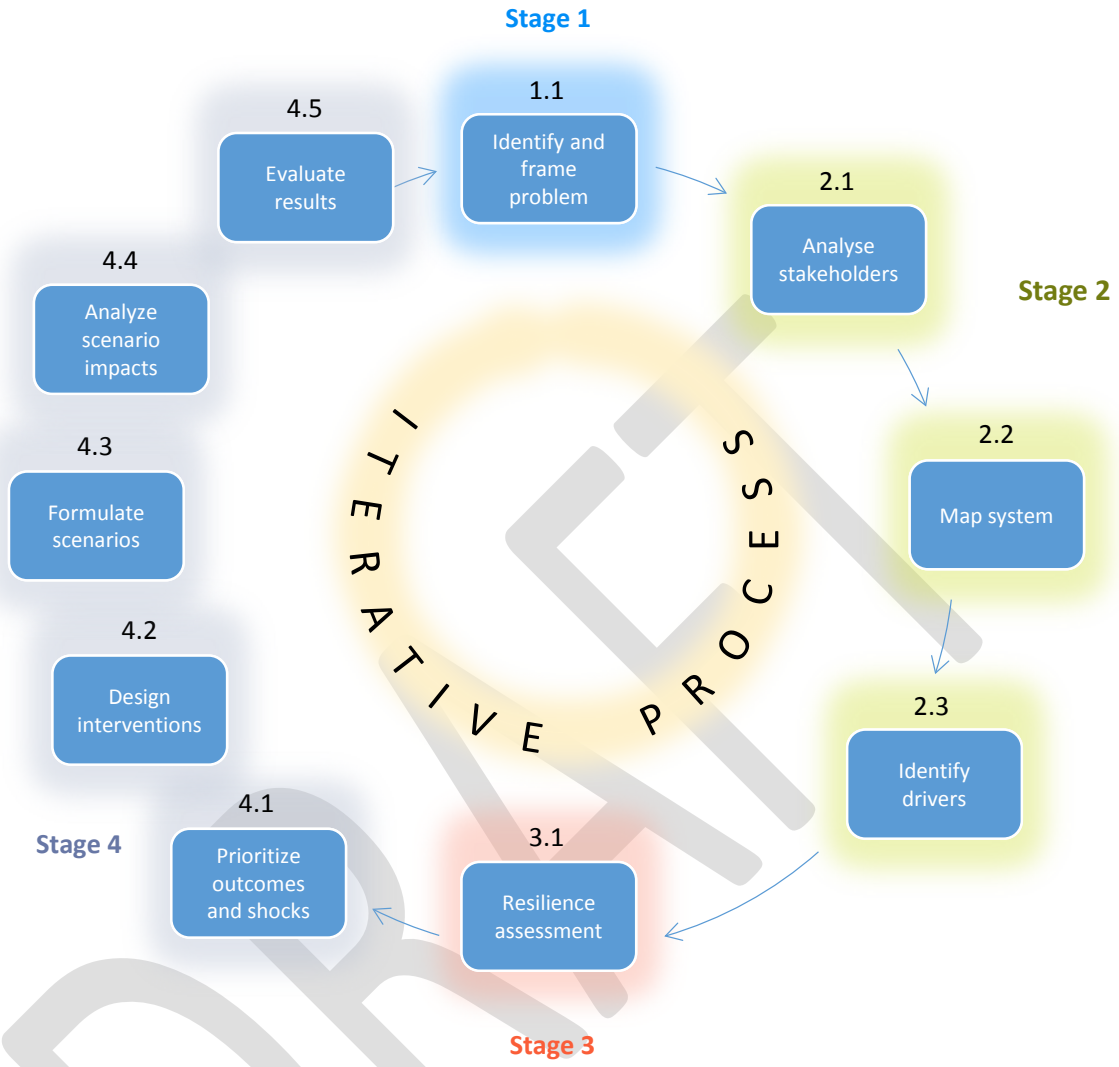


Figure 1: Stages and steps in the guidelines for building food system resilience

Key definitions

Activities: processes in input supply, production, processing, retailing and consumption.
Driver of change: internal and external; include pressures, trends, shocks and interventions.
Facilitator: a person who oversees the progress of conducting the various steps in the guidelines. He/she is responsible for the successful execution of these guidelines.
Food security: "exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life" (FAO, 2003, p. 29).
Food system: "the interactions between and within biogeophysical and human environments, which determine a set of activities" (Ericksen, 2008, p. 234). Activities consist of elements and flows involved in food production, processing, packaging, distribution, retail, and consumption, as well as the corresponding stakeholders. They can consist of single or multiple value chains.

Intervention: an action to improve or change a given state.
Initiator: a person who initiates the execution of these guidelines.
Outcome: the result of previously conducted actions, processes or changes.
Resilience in food systems: the capacity over time of a food system and its units at multiple levels, to provide sufficient, appropriate and accessible food to all, in the face of various and even unforeseen disturbances" (Tendall et al., 2015, p. 19).
Stakeholder: a person, group or organisation who have a say or are important in a particular decision-making process.
Value chain: (which can range from local to global extent) comprises the activities and actors that take a food from its production on the farm, including the inputs into that production, to the consumer and to its disposal as waste. A value chain also describes what and where value is added by these activities and actors:

Further information

- Conceptualisation of linkages of food security: FAO (2003). Trade reforms and food security. Concepualizing the linkages. FAO, pp. 296.
- Conceptualisation of food systems: Ericksen, P.J. (2008). Conceptualizing food systems for global environmental change research. Global Environmental Change, 18, pp. 234-245.

Stage 1 – Problem Identification and Framing

Step 1.1 - Identify and frame problem and entry level

Objective

- The Initiator(s) identify the problem context: system of interest and boundaries, level of analysis, goal, motivation, resources, leadership and facilitation of the process.
- The identified process leader plans the process (implementation plan for the remaining steps of the guidelines).

Procedure

The initiator(s) must explicitly identify which Food system they want to address, and what their goal and motivation is (e.g. the process can aim to build general resilience (no focus on a single specific driver) or resilience to a specific driver of change). Depending on what kind of food system is identified, the guidelines need to be tailored accordingly. For example, looking at a cash crop (e.g. cocoa, coffee, palm oil, etc.) generates different outcomes than assessing the resilience of food security crop (e.g. tef, wheat, etc.). This must later be communicated to and validated by the relevant Stakeholder identified in step 2.1. In order to ensure transparency and trust building a process leader must be designated. This can be the Initiator (although this may raise concerns about objectivity), or a mandated project manager or Facilitator. Academic partners may be well suited to this task, as they can fulfil the role of "honest broker" and provide a neutral platform for Stakeholder to convene. The resources available to conduct the process should be clarified, in order to adjust expectations and planning. Finally, the process leader should plan the implementation of the guideline steps (e.g. time plan, resources allocation, feedback processes).

Three levels of analysis can be used to design Intervention for Resilience in food systems, according to the problem of interest and to who initiates the process:

- National or regional food system: of interest to national policy-makers and governments concerned about the food security of their citizens.
- A food product or commodity Value chain: of interest to individual value chain actors such as industries and retailers, or value chain developers.
- Specific Outcome of local interest, for example smallholder livelihoods, household food security, consumers' health: of interest to specific interest groups, NGOs, and local communities.

The process generally starts at and focuses on one of these levels, which must be identified. The guidelines automatically include additional analysis at the two other levels.

Data sources

Interests and concerns of the process initiators.

Expected outcome

The initiators have identified which food system they will look at and who is the Facilitator to execute the guidelines.

Stage 2 – Definition of the System

Step 2.1 - Analyse stakeholders

Objective

The Facilitator has identified the system's:

- Stakeholders, their influence, power and interest
- Governance structure

The Facilitator has contacted important stakeholders, planned their involvement in the next steps, and informed them about the scope of assessment identified in step 1.1.

Procedure

The process leader identifies and characterizes the stakeholders involved in the activities of the food system at the focus level, as well as relevant stakeholders at other levels. Political and market power, interest (or "stake"), and resources of the stakeholders are important elements to collect. This can be done using a power-interest diagram (figure 2), a stakeholder network diagram which reveals dependencies and influence between stakeholders (see Bryson 2004), or more simply a stakeholder matrix (see Annex 1). The process leader analyses the governance structure (figure 3) by adding an identification of the rules (formal and informal), regulations, standards, laws and other institutions which constrain and define how the system and its actors function. This facilitates the identification of the important stakeholders (in terms of power, resources, and interest) who should be involved in the next steps. Important stakeholders thus include minorities with low power, but who are highly affected by the food system outcomes.

Data sources

Expert interviews and literature review.

Expected outcome

A clear understanding about who are part of the selected Food system, including power relationships.

Further support

- A list of potential stakeholders and characterization criteria (Annex 1)
- Identification and procedure to involve stakeholders: Bryson, J. (2004). What to do when Stakeholders matter. Public Management Review 6, pp. 21-53.

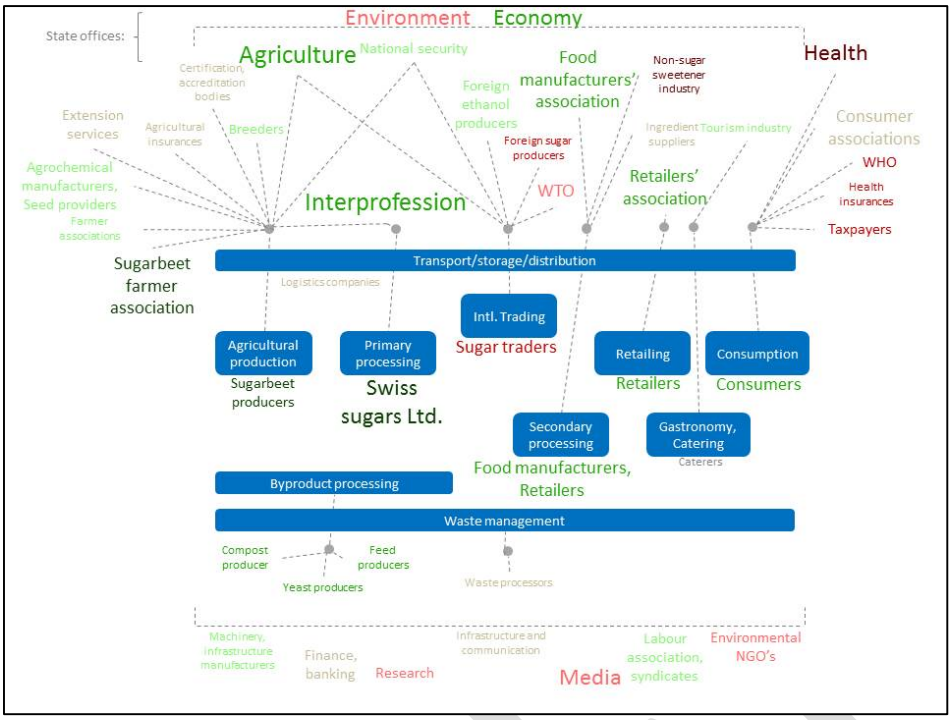


Figure 2: Stakeholder network of sugar value chain, Switzerland. Green = supportive of sugar value chain; red = adverse to sugar value chain; colour intensity = strength of interest; font size = strength of power.

→ **Key interpretation points (**Error! Reference source not found.**):**

- Major stakeholders in terms of power are the federal office for agriculture, the sugar interprofession, and the primary processor.
- Major stakeholders in terms of interest (positive and negative) are the sugarbeet producers, the primary processor, the government office for health, and the non-sugar sweetener industry.
- Stakeholders with negative interests in the Swiss sugar value chain tend to have less power.

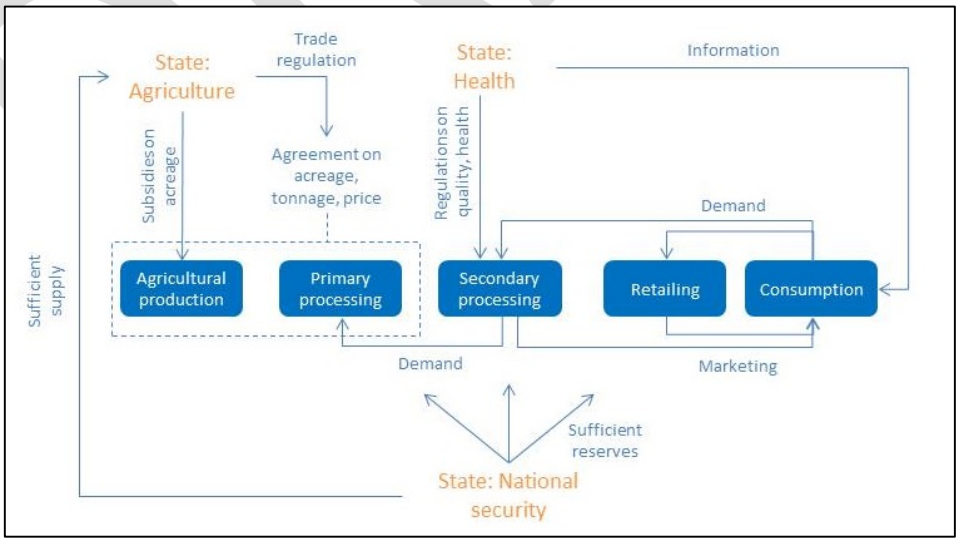


Figure 3: Governance structure of Swiss sugar main channel.

→ **Key interpretation points (**Error! Reference source not found. **3):**

- The Swiss sugar value chain is largely controlled by the state (subsidies and trade regulation).
- Further control occurs through an internal price regulation mechanism set by the sugar interprofession (producers and primary processor).

Step 2.2 - Map system

Objective

Facilitators gain understanding of the food system of interest, including:

- Activities of relevance in the system
- Material flows (including inputs, stocks, and wastes)
- Financial flows (including price development, distribution of (environmental) costs and benefits)
- Information flows (including knowledge transfer and sources)
- Spatial level at which food system activities occur, and which spatial level they affect
- Boundaries of the system

Procedure

Supported by the facilitator, the implementers of the guidelines map the system (using appropriate software e.g. stan2web) with a representation of activities, flows and links between them, and their spatial relevance. This reveals a good deal of the physical structure of the system, and makes transparent which activities are considered and which are beyond the boundaries of the process. Information for mapping is taken from background data (literature review) and stakeholder input (e.g. expert interviews). All stakeholders of importance identified in step 2.1 should later validate the map and have the opportunity to improve it. Materials supporting this mapping are listed below ("Further support")

The mapping can be done for the entire selected system (see figure 4) or be limited to a sub-system (e.g. most critical value chains in a national food system, or dominant process (see figure 5) in a value chain). Selection criteria of the most relevant sub-systems include volume of material flows, monetary flows, information flows or importance for food security.

Data sources

FAO country profiles, FAOstat, national statistics and reports (offices for agriculture, environment, statistics, food, health), World Bank, World Food Programme, scientific literature, NGO reports, industry reports and statistics, stakeholder knowledge (via interviews).

Expected outcome

A detailed understanding about which activities of the selected system are relevant. Learn about the various flows of the system and which flows are most critical and where potential risk of system failure could be found. This step enhances the understanding of the system characteristics.

Further support

- A template for food system mapping (Annex 2)
- Participatory mapping of value chains: LINK methodology: A participatory guide to business models that link smallholders to markets. Lundy, M. et al. CIAT publication N° 380, Cali, Colombia, 2012.
- Material flow analysis: Brunner, P.H; Rechberger, H. Practical Handbook of Material Flow Analysis. Lewis Publishers, Boca Raton, U.S.A., 2004.
- Material flow analysis applied to food systems: Risku-Norja, H; Mäenpää, I. MFA model to assess economic and environmental consequences of food production and consumption. Ecological Economics 60, 2007, pp. 700-711.
- Material Flow Assessments: tool to draw material flow assessments, freely available on http://www.stan2web.net/.

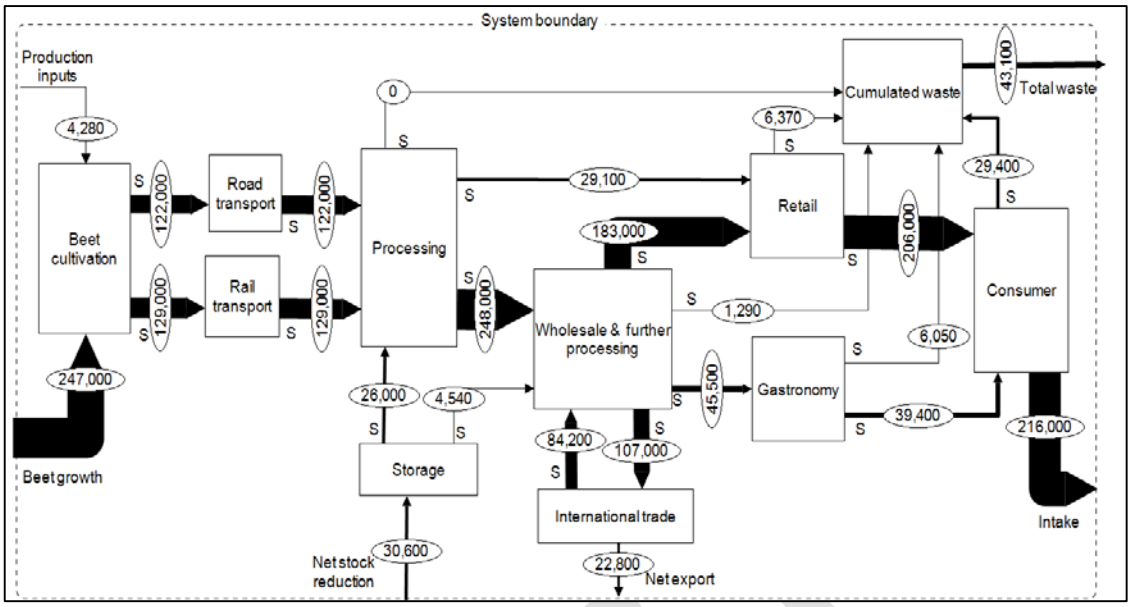


Figure 4: material flow diagram of sugar in Switzerland, year 2012 (in t/y sugar equivalents) (adapted from Zweifel, A. 2014).

→ Key interpretation points (Figure 4):

- Major channel is domestic production to domestic consumption through secondary processing of sugar in processed food manufacturing.
- International trade is significant, and wastes are not negligible.

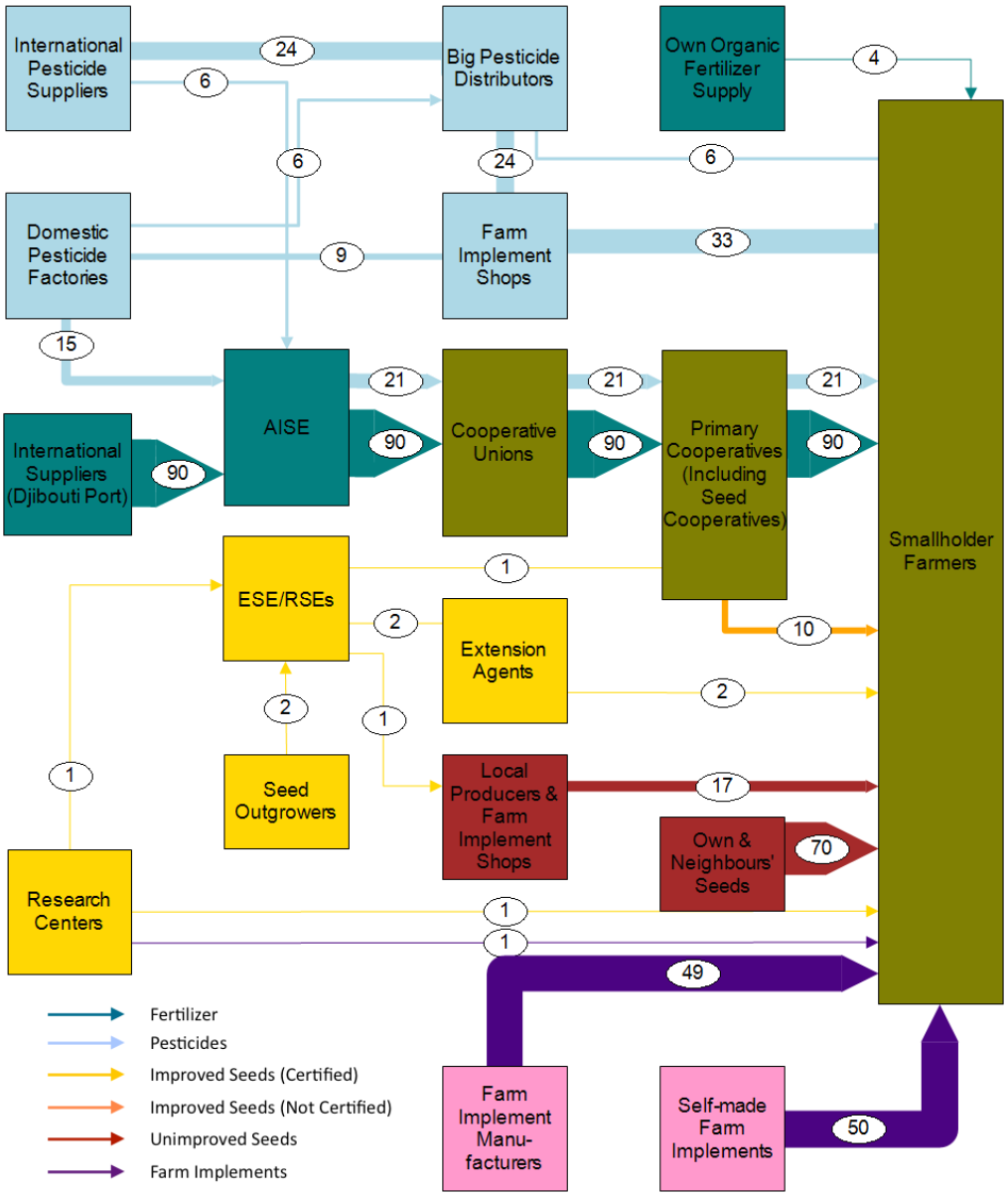


Figure 5: material flow diagram of input supply process of tef in Ethiopia, year 2015 (in % of total input use by tef farmers) (adapted from Hauenstein, S. 2015).

→ **Key interpretation points (**Error! Reference source not found.**5):**

- 87% of used seeds are unimproved. Large potential for developing and distributing improved seed varieties
- The majority of applied fertilizers and pesticides originates from abroad
- Half of the used farm implements by smallholder farmers are self-made

Step 2.3 - Identify drivers of change

Objective

Potential drivers of changes, including various types of shocks, may threaten the chosen food system

- Either, facilitators identify the major drivers of change, or;
- Key stakeholders of the selected food system identify them (this is possible when the number of stakeholders is small and readily available for consultation)

Procedure

Either through literature review (e.g. analysis of similar systems, historical records), or in a participatory workshop, stakeholders brainstorm which drivers of change affect or could potentially affect the system identified in step 1.1 and 2.2. Further drivers of change can be identified based on the list of possible drivers of change provided in Annex 3. Drivers which originate from other levels (e.g. local drought occurrences at the specific outcome level, national policies at the national food system level, etc.) should also be included. The exposure of individual food system activities to each driver of change should be quantified (e.g. scale from 0 = negligible effect, to 2 = strong effect) (see figure 6). The rate at which the driver affects the system (e.g. in days, years, centuries) should be identified. The links between drivers and system activities can be added to the outcomes established in step 2.4 through causal mapping.

If the goal of the process (step 1.1) is to study a particular driver of interest (e.g. climate change), the current step can be reduced to that driver of interest. Nevertheless, it is of interest to identify further potential drivers of change which may interact with it.

Data sources

Stakeholder knowledge, industry and NGO reports and archives, scientific literature.

Expected outcome

This step generates a clear understanding about what kind of disturbances (drivers of change) or shocks threaten (or are likely to do so in the future) the identified food system. This step is of key relevance to steps 3.1 (resilience assessment) and 4.1 (formulation of scenarios).

Further support

- List of potential drivers of change (Annex 3)

Value chain activity	Driver of change	Land use change	Soil degradation	Climate change	Changes in water resources	Changes in nutrient availability	**Changes in fuel availability**	Demographics	Gobalization	Economic crises	Political interventionms	Lifestyle changes	Innovations in science/technology
	Spatial level	G	G	G	R	G	G	C	G	G	N	R	C
	Temporal level	D	C	D	D	C	D	D	D	**M**	**M**	**Y**	**Y**
Inputs (seed, pest control, machinery, fertilizers)		0	0	1	1	2	2	0	1	1	1	1	2
Agricultural production (CH)		2	2	2	2	2	2	1	1	1	0	1	2
Primary processing		1	0	0	1	0	2	1	2	1	0	2	1
Secondary processing (including other ingredients)		1	1	1	1	1	2	1	2	2	1	2	2
Imports		2	2	2	2	2	2	2	2	2	2	0	0
Retailing		1	0	0	1	0	2	2	2	2	0	2	1
Consumption		0	0	0	1	0	2	2	1	2	0	1	2
Transport/storage		1	0	1	1	0	2	1	2	1	1	1	1
Waste management		1	1	0	1	0	1	2	1	0	0	2	1

Figure 6: Analysis of a selection of drivers of the Swiss sugar value chain, the strength of their effect on the value chain activities, and the spatial and temporal levels at which these effects occur. Spatial level: G = global, C = continental, N = national, R = regional, L = local. Temporal level: C = centuries, D = decades, Y = years, M = months, W = weeks. Rating of strength of effect of driver on activity: 0 = no or negligible effect; 1 = some effect; 2 = strong effect. Bold/red = most affected activities, respectively drivers with the shortest time level.

→ **Key interpretation points (**Error! Reference source not found.**):**

- The most critical driver is increasing fossil fuel scarcity, due to the high dependency of all activities on fossil fuels.
- The most exposed activities to drivers of change in general are agricultural production, imports, and secondary processing.
- The drivers with the shortest time lag for effects to be felt are economic crises and political interventions, lifestyle changes, and innovation in science/technology.

Stage 3 – Resilience Assessment

Step 3.1 - Assess resilience

Objective

The stakeholders:

- Have learnt about the concept and implications of resilience;
- Have estimated semi-quantitatively how resilient the system is;
- Know the system's strengths and weaknesses in terms of resilience.

Procedure

The facilitator should start with an introduction to the concept of food system resilience, and what characterizes a resilient food system. An overall idea of food system resilience can be found in Tendall et al. (2015). Depending on how the problem was identified in step 1.1, the resilience assessment is performed differently. In this procedure, we focus on the most likely case which is an identifiable value chain (e.g. tef value chain) that is exposed to multiple types of shocks (details of this example are available in Annex 4). Secondary data on tef is few and therefore requires field work. In a first step, the general list of resilience questions/indicators (Annex 5) (drawn from literature review and field experiences) is adapted to the identified food system. The facilitator will then transform the general resilience questions/indicators into the specific context of each process of the identified food system (see Annex 6 for 'farmers'). This will result in individual sets of surveys for each process group of the identified food system. These individual surveys should then be tested and validated by local experts and representatives from the particular process groups. Possible changes in the formulation of questions is possible as well as to add or remove questions. Furthermore, the facilitators can provide the option for respondents of the surveys to weigh certain questions more or less in terms of their overall relevance. The finalised surveys should then be answered by each identified stakeholder for his/her own activity.

Further processing of the collected data is done by the facilitator: for qualitative answers they can be numerically graded (for example between 0 = no, 0.5 = somewhat, and 1 = yes): this grading is flexible and can be more or less sensitive (i.e. more or less grades on the scale). The grades can then be aggregated for each food system process, for example by summing the grades achieved and dividing them by the total grade achievable, thus giving a ratio of resilience potential achieved. During the aggregation, indicators can be weighted differently, based on the stakeholders' weighting. These results can further be graphically summarized in the form of wheels for example (see Figure 7 for a representation of the major food system activities of the sugar value chain Switzerland and Figure 8 for individual resilience attributes of the agricultural production of the Swiss sugar value chain and Figure 9 cross-analysis of the tef value chain (activities and resilience attributes)), simplifying the communication and analysis of results, and identification of strengths and weaknesses.

Note that this does not provide a proven, absolute evaluation of the channels' resilience. It provides a relative assessment of where the channel is expected to show more resilience, and where it might have resilience gaps which could be improved. Possible correlations between indicators may also exist, but have not been assessed yet for this list of indicators.

Data sources

Stakeholder knowledge (gained through surveys), archives, past exposure and reactions to disturbances, data collected in the previous steps.

Expected outcome

A clear picture (graphical representation) about which activities of the identified food system (step 1.1) have higher or lower resilience levels. In other words, which activities can better withstand and respond to potential shocks. Depending on the objective of the facilitator(s), resilience levels of identified food systems can also be assessed for specific shocks instead of a general assessment. This step is of key relevance to stage 4.

Further support

- Preliminary list of resilience indicators and questions (Annex 5)
- Theory and practical steps for resilience assessment in general: Resilience Alliance. Assessing resilience in social-ecological systems: workbook for practitioners, version 2.0. 2010, pp. 54. http://www.resalliance.org/3871.php
- Example of resilience indicator questions from a household food security perspective: International Institute for Sustainable Development. Climate resilience and food security – a framework for planning and monitoring. Winnipeg, Canada, 2013, pp. 29.

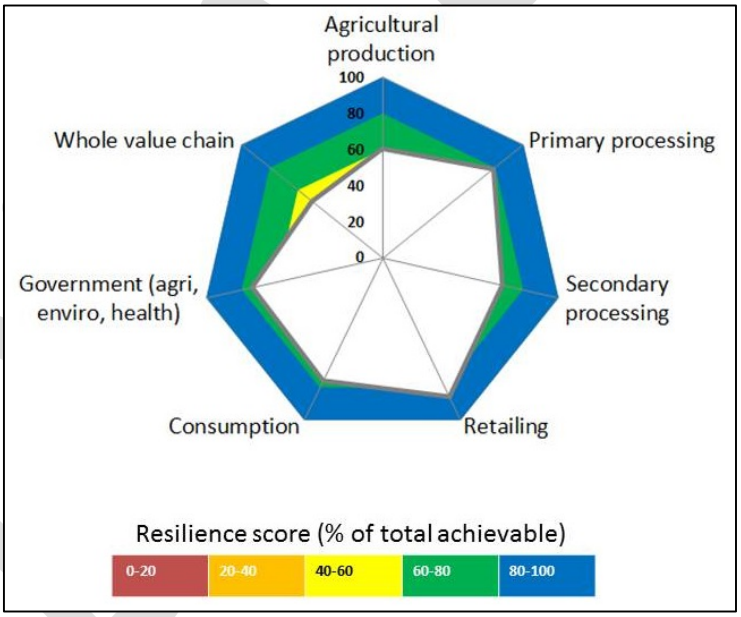


Figure 7: Resilience assessment of the Swiss sugar value chain, broken down by activity. A score of 100% means that all of the indicators of resilience considered are achieved, whereas a score of 0% means that none of the indicators of resilience considered are achieved.

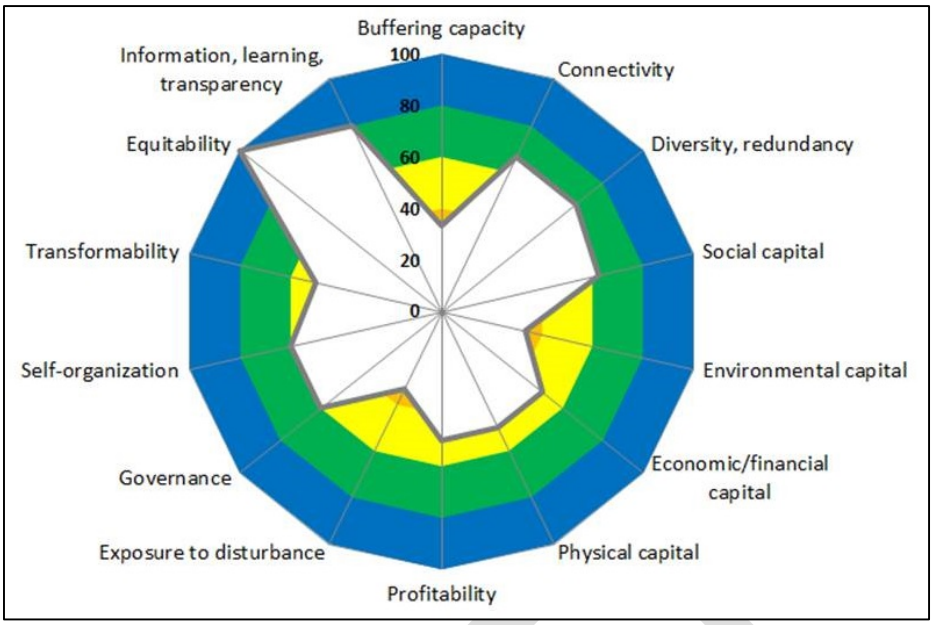


Figure 8: Detailed resilience assessment of the agricultural production activity of the Swiss sugar value chain, broken down by resilience attribute (in no particular order).

→ Key interpretation points (Figure 7, Figure 8):

- The Swiss sugar value chain generally has a high resilience level
- Its weakest points are agricultural production, and whole value chain aspects
- Main weak points in agricultural production are buffering capacity, environmental capital, and exposure to disturbance.

Value chain step / Attribute	Improved inputs	Unimproved inputs	Production	Trade	Processing & Retail	Consumption
Buffering capacity						
Environmental capital						
Connectivity						
Diversity						
Equitability						
Exposure to pressure						
Governance capacity						
Information, learning						
Profitability & fin. cap.						
Self-Organization						
Transformability						

Figure 9: Resilience scores for all tef value chain stages; dark red is very low, orange is low, beige is medium, light green is high, dark green is very high.

→ Key interpretation points (Figure 9):

- The Unimproved inputs show higher resilience than the improved inputs
- Information and learning and transformability are low for most activities

Stage 4 – Interventions for Building Resilience

Step 4.1 - Prioritize outcomes and shocks

Objective

- Stakeholders of the identified food system have defined system outcomes for understanding the implications of shocks (drivers of change).

Procedure

Following the resilience assessment, a workshop with key stakeholders (step 2.1) should be organised by the facilitator(s) to identify the major outcomes of concern. The results from the resilience assessment (step 3.1) should be first presented by the facilitator(s) to the key stakeholders. Following this, stakeholders discuss and prioritise which outcomes should be achieved (Annex 7, Annex 8) and which shocks (drivers of change) should be prioritized (Annex 9) later in designing interventions (step 4.2). The prioritization of outcomes and shocks (drivers of change) can be based on the strength of the contribution of the food system to the outcome, as well as the rate and desirability of the outcome. Alternatively, prioritization can be done by stakeholders using for example multi-criteria analysis techniques (see "Further support" below).The links between outcomes and elements (or activities) of the food system should be captured on a poster, for example by building a causal map (see generic template in Annex 10). This essentially links the activities and outcomes and shocks (drivers of change) of the food system with arrows representing causal effects (what leads to what) rather than material flows. This also helps to reveal combined effects and possible feedback loops from outcomes to activities and shocks (drivers of change) (see Figure 10). Stakeholders should also identify which outcomes are desirable (positive) and which are undesirable (negative) according to their own interests, and the rate at which the outcomes occur (e.g. days, years, centuries).

This step can be more or less quantitative, depending on the level of detail required, and the resources available (data, time, modelling capacity). If high resources are available, outcomes can be assessed using models and/or indicators (see possible methods below under "Further support"). Ideally, this step is fed by data and information provided by the relevant stakeholders in a workshop. However, if stakeholders are not available to meet, the facilitator(s) may also develop causal maps on their own based on the analysis of the resilience assessment and further secondary literature.

Data sources

Stakeholder knowledge, impact assessment literature (such as life-cycle assessments of food products), sustainability reports, industry performance reports, reports by NGOs.

Expected outcome

Stakeholders have identified which outcomes and shocks (drivers of change) should be addressed. Causal relationships have been made between activities, outcomes and shocks to graphically represent which links need to prioritized for enhancing the resilience of the identified food system. This step is of key relevance to step 4.2.

Further support

- List of possible outcomes (Annex 7)
- Prioritization matrix of outcomes (Annex 8)
- Prioritization matrix of drivers of change (Annex 9)
- Template for causal mapping (Annex 10)

- Supporting material for conducting participatory workshops:
    - http://www.seedsforchange.org.uk/resources
    - http://www.participatorymethods.org/task/facilitate
- Sustainability outcome indicators (extensive): FAO. Sustainability assessment of food and agriculture systems (SAFA): indicators. Food and Agriculture Organization of the United Nations, Rome, Italy, 2013, p. 281.
- Sustainability outcome indicators (selection for food systems): Heller, M.C; Keoleian, G.A. Assessing the sustainability of the US food system: a life cycle perspective. Agricultural Systems 76, 2003, pp. 1007-1041.
- Environmental outcome indicators in life cycle assessment (selection): Goedkoop M.J; Heijungs R; Huijbregts M; De Schryver A; Struijs J; Van Zelm R. ReCiPe 2008, A life cycle impact assessment method which comprises harmonised category indicators at the midpoint and the endpoint level - First edition Report I: Characterisation. Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, The Netherlands, 2012, pp. 137. http://www.lcia-recipe.net
- Social outcome indicators: Norris, C.B. et al. The methodological sheets for sub-categories in social life cycle assessment (S-LCA). UNEP-SETAC Life Cycle Initiative, 2013, p. 152.
- Development outcome indicators: http://data.worldbank.org/data-catalog/world-development-indicators
- Causal mapping: http://pictureitsolved.com/resources/practices/causal-mapping/
- Causal mapping: Scavarda et al. A methodology for constructing collective causal maps. Decision Sciences 37(2), 2006, 263-283.
- Causal mapping: example for obesity in the UK: www.shiftn.com/obesity/Full-Map.html
- Causal mapping: tool to draw causal maps, freely available for non-commercial and non-governmental use: http://vensim.com/free-download/
- Multi-criteria assessment for prioritization: UK government: Multi-criteria analysis: a manual. London, UK, Department for communities and local government: 168 p., 2009
- Designing interventions in value chains: LINK methodology: A participatory guide to business models that link smallholders to markets. Lundy, M. et al. CIAT publication N° 380, Cali, Colombia, 2012.

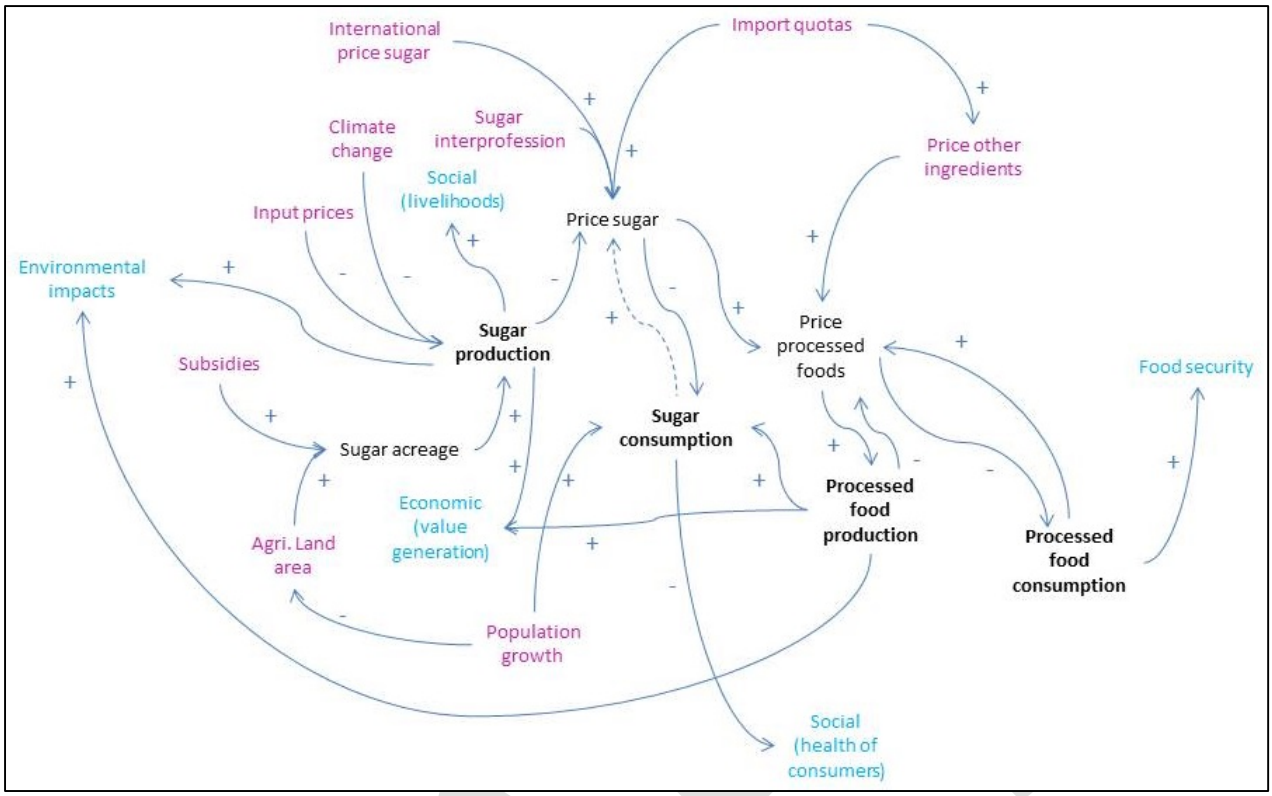


Figure 10: Causal map of Swiss sugar value chain, including the main drivers. Pink = drivers; bold = sugar channel activities; blue = outcomes.

→ Key interpretation points (Figure 10):

- A controlling feedback loop occurs through environmental impacts, which are caused in part by the activities of the food system, and in turn restrict those activities.

Step 4.2 - Design interventions

Objective

- The stakeholders have identified potential interventions to enhance the resilience of the identified food system, in particular resilience to prioritized shocks (drivers of change).

Procedure

Also in a participatory workshop (possibly the same as in step 4.1), the stakeholders define and prioritize what needs to be improved in the identified food system (step 1.1). Based on the findings from the resilience assessment (step 3.1) and the prioritization of outcomes and shocks (drivers of change) (step 4.1), the stakeholders design concrete interventions for building resilience.

This process can be started through a brainstorming session, where a large number of potential interventions are collected ranging from very specific and incremental to broad-targeted and system-changing. These interventions would then not be tied to particular shocks (drivers of change) and aim to increase the overall resilience of the system. For example, each participant can list 3 ideas, which are then collected and grouped by similarity. This list of possible interventions must then be prioritized through criteria of relevance (does it address the prioritized issues?), feasibility (are there sufficient technical and financial resources, is there significant stakeholder support or opposition?), and impact potential (is the intervention expected to make a large difference, how much time will it take?). A restricted set of interventions can thus be selected (see Figure 11); complementary interventions can be combined into an "intervention package". These interventions can be added to the causal map established in step 4.1, revealing what their expected effect would be (see Figure 12).

An alternative approach is to design interventions tailored to a specific shock (driver of change). Based on literature and previous interviews with stakeholders, the facilitator(s) propose a set of intervention measures (Annex 12) which are then discussed by each stakeholder group. Each group then prioritizes which interventions (top 5) should be implemented for their particular process (see Figure 13). The same approach can be repeated for other shocks (drivers of change).

Data sources

- Stakeholders knowledge (including their desires and visions for the future)
- Stakeholder and governance analysis (step 2.1)
- Resilience assessment (step 3.1), prioritized outcomes and shocks (step 4.1)

Expected outcome

Stakeholders have designed concrete interventions for building resilience. Either to increase the overall resilience of the identified food system or tailored to a specific shock (driver of change).

Further support

- List of generic value chain development activities (Annex 11)
- Multi-criteria assessment for prioritization: UK government: Multi-criteria analysis: a manual. London, UK, Department for communities and local government: 168 p., 2009
- Designing interventions in value chains: LINK methodology: A participatory guide to business models that link smallholders to markets. Lundy, M. et al. CIAT publication N° 380, Cali, Colombia, 2012.

Intervention	Rationale	Who	Cost, duration
Technological progress in sugar beet breeding	Improve yields and input efficiency, reduce sensitivity to climate change	Breeders, research institutes, government office agriculture Environmental NGO's in case of GMO options, social/agricultural concerns in case of excessive breed and seed patenting	$$ decades
Technological progress in sugar beet and sugar processing and storing	Reduce waste and losses	Input providers (machinery etc.), primary and secondary processors, research institutes By-product users and processors	$$ decades
Trade measures	Protect the existence and income of domestic sugar beet production to avoid total dependence on imports	Government office agriculture WTO, EU, secondary processors, importers/traders	$ years
Direct payments	Support the agricultural income of domestic sugar beet production	Government office agriculture Taxpayers	$$$ years
Improved value chain organization	Contract farming could ensure domestic production in a free market	Processors, farmers, inter-profession, professional organizations Processors, farmers	$ years
Taxation of sugar in foods	Increase price of unhealthy foods, reduce unhealthy food consumption, contribute to healthcare costs	Government office health Sugar producers, primary and secondary processors, consumers	$ years
Health and eating lifestyle awareness raising and education	More health-conscious consumers will reduce health impacts of sugar consumption and drive sugar consumption down	Government office health, government office education, retailers, health insurances Sugar producers, primary and secondary processors	$$ decades

Figure 11*:* Identified interventions of interest for the Swiss sugar value chain. Adapted and extended from A. Zweifel, 2014. Who: green = enabling stakeholders, red = opposing stakeholders. Cost: $ = relatively low, $$ = significant, $$$ = relatively high. Duration = lag time for intervention to be achieved and effects to be felt.

→ Key interpretation points (Figure 11):

- Various interventions can be applied by different stakeholders, targeting different weaknesses of the Swiss sugar value chain, and with varying costs and lag times.
- No single intervention will be favourably viewed by all stakeholders, so compromises will have to be found

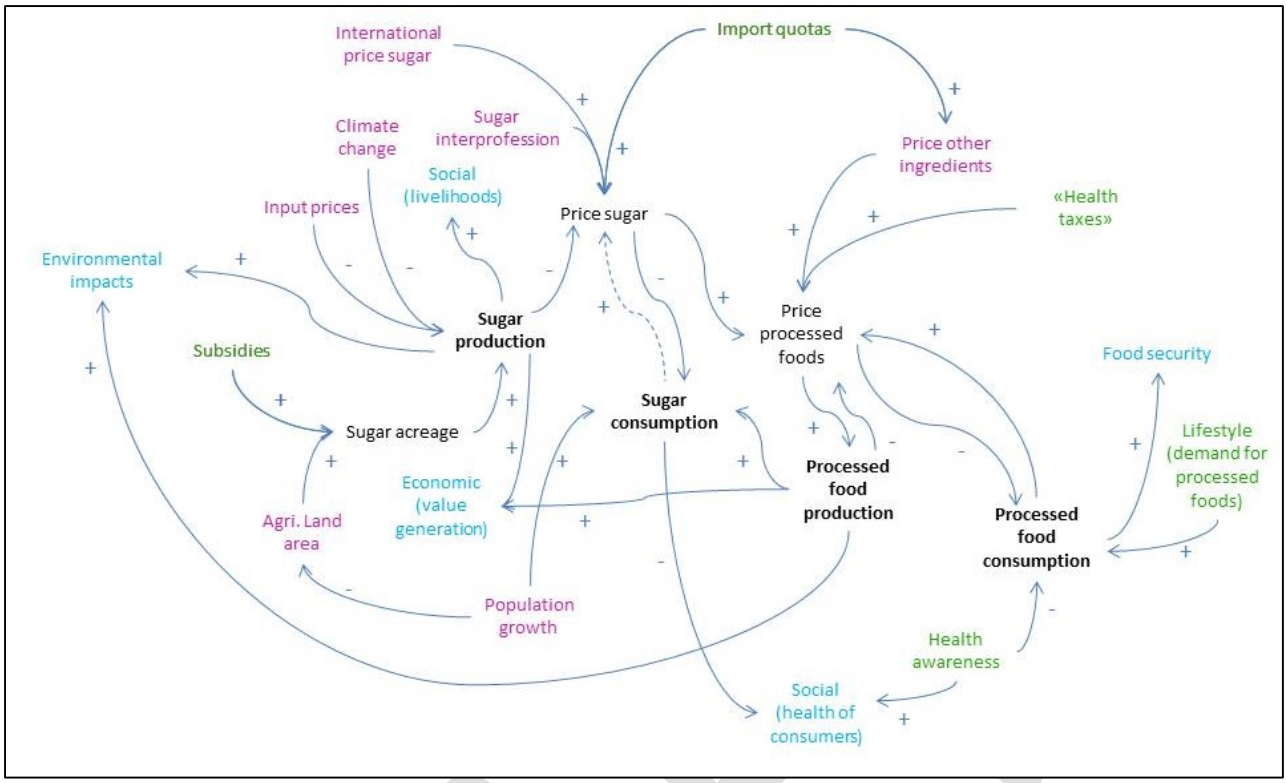


Figure 12: Causal map of Swiss sugar value chain, including possible intervention and leverage points. Pink = external drivers; blue = outcomes; green = possible leverage points; bold = value chain activities.

→ Key interpretation points (Figure 12):

- Leverage points include governmental intervention through subsidies and trade control, or surrounding health awareness and lifestyles of consumers.

Process / Intervention	Input supply	Production			Trade	Processing & Retail	Consumption
		Farmers	Cooperatives	Experts			
Alternative income sources	**1**	4	**1**	4	-	7	**1**
Savings	3	-	2	2	-	3	5
Stocks	-	**1**	-	3	-	**1**	2
Insurance	-	2	-	-	2	-	4
Water harvesting techniques	7	5	3	5	-	-	-
Drought resistant varieties	-	3	4	**1**	-	-	-
Government support	-	-	-	-	3	5	3
Early warning systems	-	-	-	-	**1**	4	6
Self-organisation and trust	4	-	-	-	-	2	-
Ability to express diverse opinions	5	-	-	-	-	6	-
Promotion of improved techn.	6	-	-	-	-	-	-
Infrastructure quality	2	-	-	-	-	-	-

Figure 13: Interventions to overcome droughts proposed by the workshop participants (from Hauenstein, 2015). Numbers represent priority of intervention proposed by stakeholder groups

→ **Key interpretation points (**Error! Reference source not found.**):**

- Alternative income sources, savings, stocks and insurance solutions are seen by most stakeholders as key intervention measures
- Experts and farmers thought similar about which interventions should be implemented, but prioritised them differently.

Step 4.3 - Formulate scenarios

Objective

Scenarios are formulated in order to present alternative plausible futures, in the context of large uncertainties of what the future will really be like. Stakeholders construct a limited set of coherent, comprehensive, internally consistent and mutually distinctive scenarios, which combine both prioritized drivers of change and prioritized interventions. These scenarios illustrate the possible development of the food system and its drivers, by describing what is expected to change in the system, in case of a particular combination of a driver of change and an intervention.

Procedure

Many steps required for scenario formulation and analysis are covered in the preceding steps of these guidelines. The following additional points are specific to scenario formulation per se and are executed by either the facilitator(s) or/and local experts:

- Identification of the variables describing the scenarios (drivers and interventions of interest)
- Identify the two to three levels these variables can have in the future scenarios (e.g. for population growth: level 1 = no population growth, level 2 = UN mean estimate, level 3 = UN higher estimate).
- Construct a limited set of plausible combinations of the variables and their possible levels: the compatibility of each level of variable A with each possible level of each other variable is assessed, and so on until all possible combinations of variable levels have been assessed for compatibility. Each set of combinations forms a possible scenario.
- Check consistency of scenarios (e.g. using a consistency ranking matrix, see (Annex 13) based on how compatible their variable levels are, which indicates how plausible these scenarios are.
- Estimate how much impact each scenario would have on the food system under study (are the changes and effects expected to be large?)
- Based on both the consistency and the expected impact of scenario, select a limited set of scenarios (for example 3) which provide a range of possible futures of interest, and are internally consistent and mutually distinctive.

Data sources

Stakeholder experience and observations, current observed and projected trends in drivers (e.g. FAO outlooks, various national foresight studies etc.), interventions considered in step 4.2.

Expected outcome

Scenarios for building resilience have been developed for specific shocks (drivers of change).

Further support

- Consistency matrix for scenario formulation (Annex 13)
- Formative scenario analysis: Scholz, R. & Tietje, O. Embedded Case Study Methods. Sage Publications, Thousand Oaks, U.S.A., 2002, pp.392.
- Selection of a limited number of consistent scenarios: Tietje, O. Identification of a small reliable and efficient set of consistent scenarios. European Journal of Operational Research 162, 2005, pp. 418-432.

Driver of change	Affected variable	Impact on the variable		
		Scenario 1: Protectionism	**Scenario 2: Growing scarcity**	**Scenario 3: Free trade**
Demographics	Population growth	Medium scenario	Medium scenario	Low scenario
Climate change	Climatic effect on beet growth	Slight increase in yield fluctuation	Heavy increase in yield fluctuation	Slight increase in yield fluctuation
Resource scarcity (soil degradation, water resources, nutrients, fuel)	Costs of production	Decreasing resource availability; higher costs and increasing volatility	Decreasing resource availability; higher costs and increasing volatility	Constant availability; Costs stay on same level
Economic crises: food prices and volatility	World sugar price and volatility	World sugar price stay on constant level; Increasing volatility	Slight increase in world sugar price; increasing volatility	Increase in world sugar price; constant or lower volatility
Lifestyle changes	Domestic sugar intake	Increase in net sugar consumption	Increase net sugar consumption	Decrease in net sugar consumption
Innovation in science/technology	Technological progress in agricultural production	Constant yield improvement as in past years	Technological advance; Increased yield and lower input	Constant yield improvement as in past years
Land use change	Availability of crop land	Constant crop land	Decrease in crop land as in past years	Constant crop land
Globalization	Liberalization of world trade	Lower cooperation between countries (bilateral alliance), protectionism	Multilateral agreements, increased strategic alliances	Predominant liberalisation, toward global free trade agreement
Political interventions: European Union support for agriculture	European sugar price	European sugar price stays at constant level	Decrease in European sugar price	Decreasing European sugar price; level of world sugar price

Figure 14: adapted from Zweifel, A. (2014): Scenarios of drivers of change in the Swiss sugar value chain, developed according to the method of Tietje (2005).

→ **Key interpretation points (Figure 14**Error! Reference source not found.**):**

- Three major scenarios can be identified, grouping various consistent trends of several of the main identified drivers.

Step 4.4 - Analyse scenario impacts on food system outcomes and resilience

Objective

The extended impacts of the scenarios, on resilience, on different outcomes, and over different time horizons, are identified ex-ante:

- The impacts of the changes in drivers on the system outcomes and resilience
- Whether the interventions have the desired effects
- Whether trade-offs and synergies arise among the outcomes and with resilience

Procedure

This step can be more or less quantitative depending on the level of detail required, and the available resources (time, data, modelling capacity). Quantitative approaches of interest include system dynamic modelling and/or agent-based modelling: this provides quantified outcomes of scenarios based on quantified causal links between elements of the system. However, this also requires the availability of a model sensitive to the scenario variables and covering the outcomes of interest, an experienced modeller, and high-quality input data.

Qualitative approaches include an estimation of the effect of scenarios on outcomes and resilience indicators by the stakeholders in a guided process, for example using a causal map. The assessment approaches used in steps 4.1 can of course be applied again here, keeping in mind possible changes caused by the scenarios in step 4.3. The trend in the outcomes and resilience (e.g. strong increase, increase, steady, decrease, strong decrease) expected to be caused by the scenarios can be estimated (see Figure 15 and Figure 16). Such qualitative approaches may however fail to capture complex interactions and unexpected effects and trade-offs (although quantitative models do not guarantee that they capture complexity either, since they are only as good as the (known) parameters accounted for by the modeller).

A further method is companion modelling, where the system is simulated as a game, which stakeholders “play” and where scenarios can be introduced as new rules: this dynamic simulation of the system allows making use of stakeholders implicit knowledge, experience and decision-making behaviour to assess what the effect of scenarios would be on system outcomes, for contexts with high complexity and low data availability.

Data sources

Available simulation models, literature (impact of similar interventions in similar cases), stakeholder knowledge.

Expected outcome

A clear understanding about whether the proposed interventions lead to the desired outcome of enhancing the resilience of the identified food system.

Further support

- Georgiadis, P., Vlachos, D., Iakovou,E. (2005). "A system dynamics modeling framework for the strategic supply chain management of food chains." Journal of Food Engineering 70(3): 351-364.

Value chain stage	Variable	Scenario 1: protectionism	Scenario 2: growing scarcity	Scenario 3: free trade
Prices	Beet price (CHF/t)	Steady	Decrease	Decrease
	Swiss sugar price (CHF/t)	Increase	Decrease	Decrease
	EU sugar price (CHF/t)	Decrease	Decrease	Decrease
	World sugar price (CHF/t)	Steady	Increase	Increase
Agricultural production	Cultivation area (ha)	Decrease	Strong decrease	Strong decrease
	Sugar beet production (t)	Increase	Strong decrease	Strong decrease
Processing	Sugar production CH (t)	Increase	Strong decrease	Strong decrease
Storage & imports	Total storage (t)	Steady	Increase	Steady
	Sugar import (t/a)	Steady	Strong increase	Strong increase
Losses & waste	Cumulated food waste (t/a)	Steady	Strong decrease	Strong decrease

Figure 15: adapted from Zweifel, A. (2014): Expected effect of 3 scenarios on selected variables of the Swiss sugar value chain, based on a dynamic simulation model. This is not an exhaustive list of outcomes. Blue = increase in variable; grey = no change in variable; orange = decrease in variable.

Trend	Intervention				
	Technological progress		State support		Value-chain organization
	Breeding	Processing & storing	Trade measures	Direct payments	Market organization
Decrease in domestic sugar price	✗	✗	✓	✗	✗
Decrease in domestic sugar beet price	✗	✗	✓	✗	✓
Decrease in agricultural production outcome	✓	✗	✓	✓	✓
Fluctuations in sugar beet yield due to climate change or resource scarcity	✓	✗	✗	✗	✗
Decrease in domestic sugar production	✓	✓	✓	✓	✓
Substitution of domestic with imported sugar	✗	✗	✓	✗	✗
Decreasing domestic demand for sugar	✗	✗	✗	✗	✗

Figure 16: adapted from Zweifel, A. (2014): For the case of the Swiss sugar value chain: ability of proposed interventions (= columns) to reverse negative trends (= rows) observed in the scenarios. Green tick = able to reverse trend, red cross = unable to reverse trend. Based on a dynamic simulation model.

→ Key interpretation points (Figure 15, Figure 16):

- The scenarios are expected to have strong effects on several variables of the Swiss sugar value chain. Further effects on social and environmental outcomes also need to be assessed.
- Proposed interventions are not individually sufficient to address these effects, thus a further iteration in intervention design is required.

Step 4.5 - Evaluate results

Objective

- Communication of summarized results of the resilience design process to stakeholders, validation of these results by the stakeholders.
- Evaluation of the assessment process: was it successful? How did the process and the results impact the stakeholders' decision-making in practice?
- Identification of the need for more quantitative and detailed analysis of particular steps/outcomes (e.g. most critical and uncertain steps).
- Where desired, establish monitoring and reporting mechanisms to capture the long-term effects of interventions that are applied in practice.

Procedure

This step must be participatory, in form of a workshop. Results of the assessment and summary of the process may be prepared before-hand by the facilitator(s), but the actual evaluation stage needs to be performed by the stakeholders.

If an intervention (or combination of interventions) is actually implemented after this assessment has been fully completed, monitoring and reporting processes of its outcomes should be established with the stakeholders before the assessment process is brought to a close. This monitoring and reporting should result in available documentation, which can serve as a basis for further improvements in the future and as a basis for learning from experience, and creating empirical evidence for the effect of interventions in food systems.

Data sources

All steps

Expected outcome

Stakeholders report success and challenges of building resilience of the identified food system and suggest potential measures for iterative improvement.

Further support

- Iterative intervention design and assessment, implementation, monitoring: LINK methodology: A participatory guide to business models that link smallholders to markets. Lundy, M. et al. CIAT publication N° 380, Cali, Colombia, 2012.

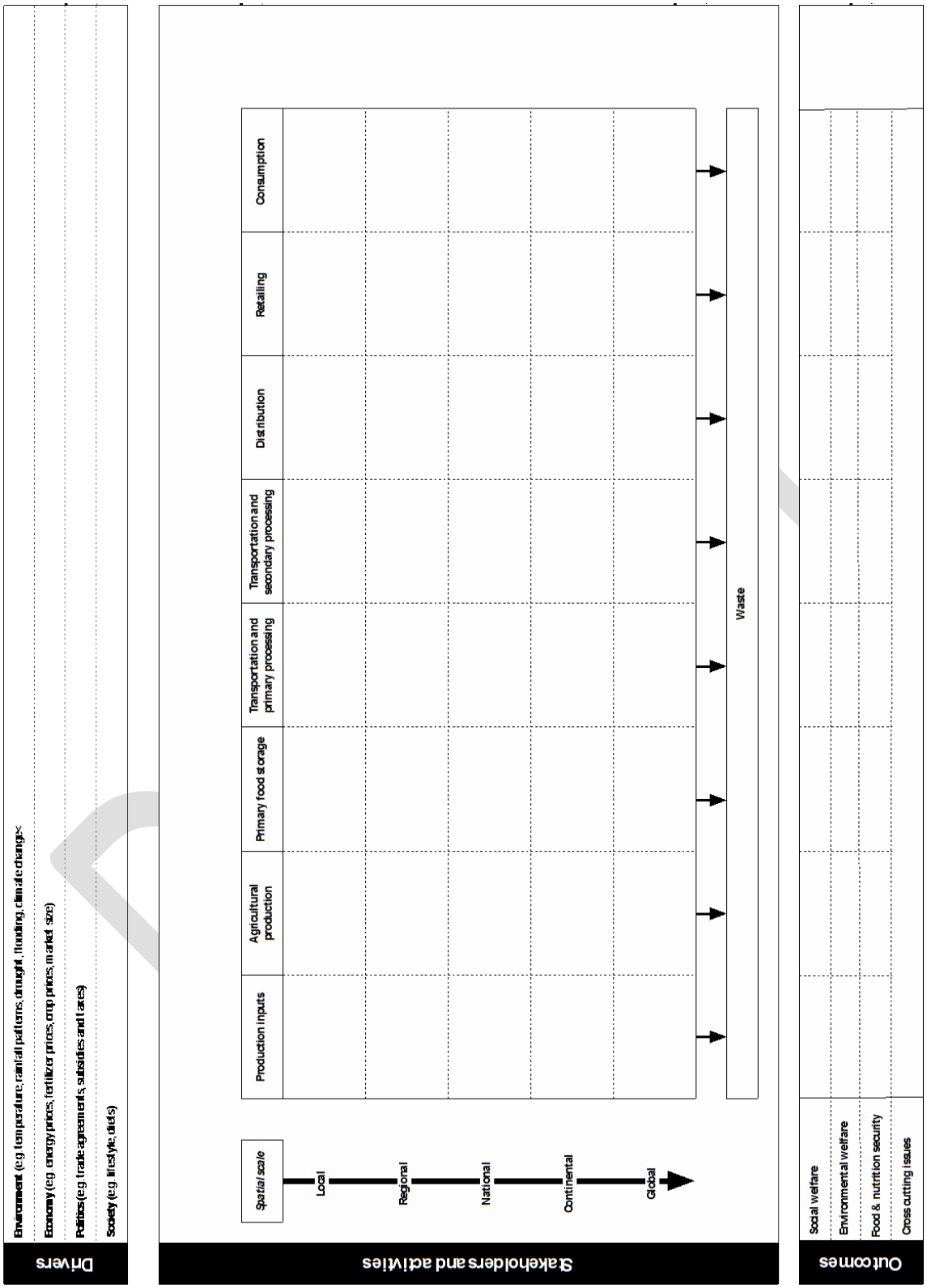
Annexes

Annex 1. List of potential stakeholders in food systems and their characteristics of interest

Stakeholders	Number of actors	Market power	Political power	Interests	Freedom to operate	Resources available
Crop breeders						
Extension officers						
Seed companies						
Agrochemical companies						
Farm machinery companies						
Farmers						
Agricultural labourers						
Commodity producers (non-food farmers: textiles, energy, wood etc.)						
Collection, storage and distribution actors (local, national, international)						
Transporters						
Packers						
Millers						
Crushers						
Refiners						
Processed food manufacturers						
Traders (local, national, international)						
Wholesalers						
Informal retailers						
Supermarket chains						
Grocery stores						
Farmer markets						
Restaurants, hotels						
Fast food companies						
Street vendors						
Automatic vendor operators						
Home delivery services						
Consumers (subsistence households)						
Consumers (rural households)						
Consumers (urban households)						
Consumers (abroad)						
Taxpayers						
Voters						
Government offices (environment)						
Government offices (economy)						
Government offices (agriculture)						
Government offices (development and cooperation)						
Government offices (food security)						
Government offices (national security)						
Government offices (education)						
Government offices (research)						

Government offices (health)						
Politicians						
Political parties						
Standard-setting organizations						
Certification and accreditation organizations						
Cooperatives (e.g. farmers)						
Professional associations (farmers, processors etc.)						
Consumer associations						
Labour associations, syndicates						
Other lobbies						
Environmental NGO's						
Social NGO's						
Research institutions						
Donors, aid agencies						
Other civil society organizations						
International organizations (ILO, WTO, UN, WHO etc.)						
Health insurances						
Health and pharma industry						
Waste processors						
By-product users and processors						
Finance and banking service providers						
Insurances (production, infrastructure etc.)						
Media						
Infrastructure providers						
Communication service providers						
Tourism industry						
Marketing industry						
…						

Annex 2. Template for food system mapping



Annex 3. List of potential drivers of change in food systems

- Land cover changes, land use changes
- Changes in soil fertility (nutrient balance, organic matter content, erosion)
- Climate change (both shifts in means, and in variability)
- Changes in atmospheric composition (e.g. CO_2 levels)
- Weather-related shocks (e.g. hurricanes, droughts, floods)
- Other natural hazards and processes (e.g. earthquakes, avalanches, volcano eruptions, solar cycles, sea level, currents and salinity)
- Changes in water availability (quantity and quality)
- Changes in nutrient availability and cycling
- Changes in resource scarcity (nutrients, fuels, water, land)
- Changes in biodiversity
- Prices and price fluctuations (agricultural products, energy, fertilizers etc.)
- Changes in market size and type (local, international)
- Globalization
- Trade agreements
- Subsidies and taxes
- Federal budget and debt
- Trade protection measures (e.g. contingencies, import/export bans)
- Economic crises and crashes
- Political regulations (environmental protection, social protection, labour rights, health regulations etc.)
- Political regime change
- War and conflict
- Demographics (e.g. population growth, population ageing, urbanization)
- Lifestyle changes (e.g. wealth increase, working time, family structure, eating habits)
- Changes in diets
- Changes in cultural norms
- Scientific and technological innovation
- Epidemics (human, crops, and livestock)
- Invasive species
- …

Annex 4. Application example, tef

Application example: Assessing the resilience of the tef value chain in Ethiopia

Drawn from Hauenstein 2016

Context

In this study, the resilience of the tef value chain in Ethiopia was assessed. Based on the guidelines of the ETH Zurich, the tef value chain was identified, its resilience performance assessed, and interventions to improve the resilience developed.

Practical approach

Data was generated through literature research, stakeholder- and expert interviews as well as an on-site 1-day stakeholder-workshop. Stakeholders interviewed included tef farmers, tef traders, tef millers, enjera producers. Experts interviewed included Ethiopian researchers and government officials.

A sub-selection of indicators was used based on an iterative selection of relevance during stakeholder interviews. Each question was answered using one or more varying data sources (stakeholder and expert interviews, workshop, secondary data e.g. reports and scientific publications, see col. V).

Typically, the most appropriate sources of data for each question were: most efficiently secondary data (literature, reports) verified by expert interviews for whole food system-level questions; and most efficiently expert interviews for specific activity-level questions, completed preferably through surveys or actor interviews to verify expert opinion and collect very local additional knowledge. In cases where insufficient knowledge was available otherwise, secondary data focusing on the specific activity was used (this was however sometimes out-of-date or focused only on one aspect relevant for the complete resilience assessment).

Some questions were reformulated for the specific case of tef, and for specific stakeholders (see col. U). The questions were split into shorter questionnaires for each activity in the value chain (i.e. using cols. I-M), resulting in approximately 30 questions per stakeholder.

Results

The resilience of the tef value chain was found to be quite heterogeneous, differing considerably between the diverse steps of the value chain. Lowest scores were achieved by the formal input supply system, as supply with many improved inputs is unprofitable, shows heavy government involvement, chronic supply shortages and high dependency on single actors and processes. Main propositions to improve resilience include alternative income sources, savings and stocks, the adoption of improved farming technologies (e.g. drought resistant varieties or water harvesting techniques) as well as the need for early warning systems and government support.

Examples of application difficulties

- The time expenditure per interview was high; in total 2 months were required for data exchange in Ethiopia. An additional 2 months were necessary for preparation of the participatory work in Ethiopia, and 2 months for the secondary data analysis. It was not possible time-wise to access a statistically significant number of respondants. Expert data was therefore prioritized over stakeholder interview data, although each data source contributed complementary information. Digitalization of the questionnaires and distribution and local adoption with automatic data centralization (e.g. approach used by Choptiany et al. 2014) would extend the data collection capacity.
- Primary and secondary data often corroborated each other, showing how they can be combined to optimize efficiency. However, some contradictions between data sources did arise (e.g. for questions "27. Are fair dispute resolution mechanisms accessible to all?", "42.2 Is access to land or land tenure for the activity regulated and equitable?", "19.1 Are crop rotations used?", "16.4 Are sources of nutrition varied and diverse?").
- Some questions could not be answered due to lack of data (e.g. "46. Is there room for actors to have and express diverse opinions?").
- Some questions consisted of sensitive issues and were difficult for stakeholders to answer objectively (e.g. criticism of the government).
- Some questions showed effects on resilience which could be both good and bad (e.g. question "6. Are crop, livestock and forest production systems connected, and used symbiotically?": these systems clearly are used in an interlinked way by tef farmers in Ethiopia, where manure, fuel, fodder and soil is cycled between the different systems. However this also creates a high dependancy on these other systems, thus exposing tef production to shocks in the livestock and forestry system).

Annex 5. Preliminary list of resilience indicators for food value chains, general

Resilience attributes	Questions	Sustainability dimension(s)				Food system process(s) concerned							Temporal stage				Reference or source of inferral
		Natural	Economic	Social	Institutional	Input supply	Agricultural production	Processing/Manufacturing	Retail	Consumption	FS		Pre	Short	Mid	Long	
Buffering capacity	Does the process have spare capacity (infrastructural, technical, financial) in case of shock?		x			x	x	x	x	x				x			IISD 2013
	Do supporting activities (e.g. logistics, communication, finance and banking) have spare capacity in case of shock?		x			x	x	x	x	x				x			Cutter 2010
	Does the process maintain stocks of inputs and/or of products?		x			x	x	x	x	x				x			IISD 2013
	Is there spare capacity of natural resources in case of shock?					x	x	x	x	x							IISD 2013
	Are stocks maintained throughout the food system?		x								x			x			IISD 2013
	Is there access to disaster management organizations?				x						x		x	x	x		Monastyrnaya 2015
Environmental capital	Are resources in good condition (natural but also built resources such as transport, energy and communication infrastructure)?	x				x	x	x	x	x			x				IISD 2013
	Are there measures (e.g. management, stewardship, planning, protection schemes) which are enforced to protect or restore natural resources and habitats?	x				x	x	x					x				Milman 2008, Oudenhoven 2010, Pingali 2005
	Does the process avoid or mitigate critical emissions or impacts on the environment (e.g. on ecosystems, resources, human populations)?	x				x	x	x					x				Choptiany 2013
	Are resources (soil, water, land, fuel, forests, minerals, nutrients…) using rates below regeneration rates rather than at rates depleting those resources?	x				x	x	x					x				Choptiany 2013, Oudenhoven 2010
	Is the nutrient balance on the farm positive (no nutrient depletion)?						x						x				Choptiany 2013
	Is the nutrient balance on the farm balanced (no nutrient import)?	x					x							x			Choptiany 2013
	Are internal sources of nutrients used (e.g. mulch, green manure, organic manure, legumes)?	x					x							x			Choptiany 2013
	Are there sufficient resources (natural and built) to meet increases in demand in the next 50 years?	x	x			x	x	x	x	x			x			x	Milman 2008
	Are wastes reused and recycled?	x				x	x	x	x	x			x				Choptiany 2013
	Are the crop or livestock varieties used adapted to local environmental and socio-economic conditions?	x				x	x						x				Choptiany 2013
	Are natural input resources available, accessible and affordable?	x				x	x	x	x	x			x				Monastyrnaya 2015
	Does optimization of the process consider other criteria than just cost-efficiency?		x			x	x	x	x				x				Gupta 2010
Exposure to pressure	Are crops or livestock bred for resistance to diseases?	x				x	x									x	Choptiany 2013
	Has the process been exposed to shocks in the past?	x	x	x		x	x	x	x	x						x	Choptiany 2013
	Did the process recover rapidly from shocks in the past?	x	x	x		x	x	x	x	x					x		Cranfield 2003, IISD 2013
Good governance	Are input resources equitably accessible (e.g. accross generations, ethnies, genders, religions)?	x	x	x		x	x	x	x	x			x				IISD 2013
	Are supporting activities (e.g. logistics, communication, finance and banking, credit and saving services) equitably accessible (e.g. accross generations, ethnies, genders, religions)?			x		x	x	x	x	x			x				Cutter 2010, Pingali 2005
	Is the government stable?				x						x		x			x	Hauenstein 2016
	Are there peace-building efforts?				x						x		x				Pingali 2005
	Is governance recognized, accepted, legitimate, accountable and representative?				x						x		x				Gupta 2010
	Can all actors participate in decision-making and governance in an equitable way?				x						x		x			x	IISD 2013, Choptiany 2013, Gupta 2010, Biggs 2012
	Is governance transparent?				x						x		x			x	IISD 2013, Biggs 2012
	Is the governance structure simple and consolidated?				x						x		x				Oudenhoven 2010, Cutter 2010
	Do different governance units (e.g. different government departments) collaborate to address related issues in a coordinated way?				x						x		x	x	x	x	Biggs 2012

	Are policies, institutions and organizational services sufficiently decentralized (e.g. are there rural institutions, rural financial systems)?				x						x		x	x			IISD 2013, Pingali 2005, Biggs 2012
	Is governance fair (e.g. fair rights, regulations, laws, institutional rules, policies, organizational activities, entitlements)?			x							x	x					IISD 2013, Choptiany 2013, Gupta 2010
	If the process negatively affects other stakeholders, do they receive adequate compensation?	x		x		x	x	x	x			x					Choptiany 2013, Biggs 2012
	Are fair dispute resolution mechanisms accessible to all?				x						x	x					IISD 2013
	After a shock, are actors able and motivated to re-establish function timely?			x	x	x	x	x	x	x			x	x			IISD 2013, Milman 2008, Gupta 2010
	Is long-term planning used (e.g. in supply and demand management, in strategic decisions, in policy-making)?		x			x	x	x	x	x		x					Milman 2008, Gupta 2010, Biggs 2012
	Are there plans to manage any risks, hazards and emergency situations (e.g. supply shortage, process disruption, labour disruption, food quality and epidemics, market fluctuations etc.)?				x	x	x	x	x	x	x		x	x	x		Milman 2008, Cutter 2010, Gupta 2010, Pingali 2005
	Is there capability to establish priorities and mobilize resources for action during a shock?				x	x	x	x	x	x			x				IISD 2013
	Is there strong leadership in times of crisis?			x		x	x	x	x	x	x		x	x			Biggs 2012
	Is there capability to identify and anticipate problems?				x	x	x	x	x	x		x					IISD 2013
	Are actors able and motivated to improve management practices and restructure if necessary?				x	x	x	x	x	x						x	*IISD 2013, Milman 2008*
	Do the actors have a health status (physical and mental) allowing them to conduct their process without restriction?			x		x	x	x	x	x		x					Choptiany 2013, Cutter 2010
	Are there protective measures used to protect health of laborers?			x							x	x	x				
	Do the actors have access to healthcare and/or health insurance?			x		x	x	x	x	x		x					Choptiany 2013, Cutter 2010
	Does total income allow the actors to lead a healthy and decent life?			x		x	x	x	x	x		x					Choptiany 2013
	Is profit distributed fairly throughout the food system?		x								x		x	x			Choptiany 2013
	Are there formal and informal policies, programs and measures to support actors before, during and after a shock?			x	x	x	x	x	x	x		x	x	x			Gupta 2010
	Is there food aid available in case of shocks (e.g. food or cash-based)?			x	x					x			x	x			Pingali 2005
	Is there seed and input relief available in case of shocks?		x		x	x	x						x	x			Pingali 2005
	Are there social rehabilitation programmes?			x	x						x			x			Pingali 2005
	Is there asset redistribution in times of crisis?		x		x						x		x				Pingali 2005
	Are refugees and displaced people reintegrated after shocks?			x	x						x			x			Pingali 2005
	Are there social safety nets?			x	x						x		x	x			Pingali 2005
	Are there programmes to improve rural food production?		x		x		x					x				x	Pingali 2005
	Are there investments in rural infrastructure?		x								x	x					Pingali 2005
	Are there investments in rural markets?		x								x	x					Pingali 2005
	Does the actor have autonomy and control over the process and necessary resources?				x	x	x	x	x	x			x	x			Milman 2008
	Are authority over and resposibilities for resources clearly defined?				x	x	x	x	x	x		x	x	x			Milman 2008
	Is access to land or land tenure for the process regulated and equitable?				x	x	x	x	x			x					Alinovi et al., 2008
	Is self-organization, networking, initiative and association among actors enabled?				x	x	x	x	x	x			x	x			IISD 2013, Gupta 2010
	Are there numerous grass-roots organizations (e.g. associations, cooperatives, networks, agreements, collaborations) relating to the process under study?				x	x	x	x	x	x			x	x	x		Choptiany 2013
Information, learning	*Are communication channels reliable?*		x								x	x	x				Monastyrnaya 2015
	Is the knowledge base of the actors sufficient to conduct the process?			x		x	x	x	x	x		x					Choptiany 2013, Gupta 2010, Cutter 2010
	Is there investment in education and knowledge development of actors?			x	x	x	x	x	x	x		x				x	Choptiany 2013, Gupta 2010, Cutter 2010
	Are good quality extension and advisory services available?				x	x	x	x	x	x		x					Choptiany 2013
	Do the actors have several years or decades of experience in their process?			x		x	x	x	x			x					Choptiany 2013
	Do the actors have a high level of education?			x		x	x	x	x	x		x					Choptiany 2013, Gupta 2010, Cutter 2010
	Is there access to education?			x							x	x					Monastyrnaya 2015
	Is there collaboration between actors, universities, research institutions?				x	x	x	x	x	x		x					Choptiany 2013
	Are there early warning systems for shocks?				x	x	x	x	x	x		x					Gupta 2010
	Are records kept (of past experiences, techniques, knowledge, shocks)?				x	x	x	x	x							x	Choptiany 2013
	Is there access to information about the state of the food system, resources, and supply chains (e.g. market prices, weather, capacity)?	x	x		x	x	x	x	x	x		x					IISD 2013, Milman 2008, Biggs 2012, Choptiany 2013
	Are performance, capacity and quality monitored throughout the food system and its supply chains?				x						x	x					Milman 2008, Kopainsky 2012, Biggs 2012
	Is there monitoring of food security and vulnerability?				x					x		x					Pingali 2005

	Is there monitoring of environmental resources that only change slowly (e.g. soil fertility, soil erosion, water quality and quantity, hydrological regimes, climate change, nutrient depletion, etc.)?	x				x						x				Biggs 2012, Heller 2003
	Is an atmosphere of trust and respect cultivated between actors?			x							x	x				IISD 2013, Biggs 2012
Modularity	Are crop, livestock and forest production systems connected, and used symbiotically?	x				x							x	x		Kopainsky 2012, Choptiany 2013
	Is the process conducted by multiple actors?		x		x	x	x	x					x			Monte Verita conference 2015
	Would a failure of this process leave other food system activities unaffected?			x	x	x	x	x	x				x			IISD 2013, Biggs 2012
	Does the process avoid dependency on single inputs, suppliers, or buyers, with no alternative?		x		x	x	x	x	x				x			IISD 2013, Choptiany 2013, Biggs 2012
	Does the process depend on a mix of internal, externally local and imported inputs?		x		x	x	x	x	x				x			IISD 2013, Choptiany 2013, Biggs 2012
	Are products distributed via multiple channels and markets?		x		x	x	x	x					x	x		Choptiany 2013
	Are suppliers spatially distributed?		x		x	x	x	x	x				x			
	Are sources of nutrition varied and diverse?	x			x				x				x	x		IISD 2013
	Are inputs always sourced from diverse sources?		x		x	x	x	x	x				x			Oudenhoven 2010, Choptiany 2013
	Is the food system relatively small and simple?		x							x			x	x		Choptiany 2013
	Are there diverse ways of producing the product?		x		x	x	x							x		Choptiany 2013
	Is the farm and landscape diverse (e.g. patchy, mosaic pattern, heterogeneous conditions of soil, ecosystems, topography, and microclimate)?	x				x							x			Choptiany 2013, Biggs 2012
	Are crop rotations used?	x				x						x		x		Choptiany 2013
	Are different crops and livestock types used?	x				x							x	x		Biggs 2012
	Are different varieties of the same crop or livestock used?	x				x							x			Choptiany 2013
	Does the process have spatially distributed sites?		x		x	x	x	x					x			Gupta 2010
	Are supporting activities (e.g. logistics, communication, finance and banking) sufficiently available in the food system?		x		x	x	x	x	x	x			x	x		Milman 2008, Cutter 2010
	Is income generated by diverse activities or products?		x		x	x	x	x	x				x	x		Choptiany 2013, Biggs 2012
	Is there room for actors to have and express diverse opinions?			x	x	x	x	x	x						x	Gupta 2010, Biggs 2012
Profitability & financial capacity	Is the process insured against damages or losses (e.g. insurance of income, production, infrastructure or personnel)?		x		x	x	x	x	x					x		Choptiany 2013
	Does the process have access to funds for investment, maintenance, and expansion (e.g. through savings, financial services such as credit, allocation of more of household budget etc.)		x		x	x	x	x	x			x				Milman 2008, Choptiany 2013, Pingali 2005
	Is the financial flow permanent throughout the year?		x		x	x	x	x	x			x	x	x	x	
	Is there a strong labour market?		x	x						x			x	x		Pingali 2005, Gupta 2010
	Can labour force be adapted to fluctuations in product demand?									x						
	Is there sufficient labour force to conduct the process?				x	x	x	x								
	Does the process avoid exposure to substantial financial risks (e.g. outstanding debt, risky investments)?		x		x	x	x	x	x			x				Milman 2008
	Is the process viable without other sources of income?		x		x	x	x	x					x	x		Choptiany 2013
	Is the process viable without subsidies?		x		x	x	x	x	x				x	x		Choptiany 2013
	Does the process generate a net positive profit?		x		x	x	x	x	x			x				Heller 2003, Cabell 2012
	Is the process still viable in case of sudden drops in demand?		x		x	x	x	x					x			Heller 2003, Cabell 2012
Transformability	*Can assets and structures be converted and modified in case of shocks (e.g. capital is not locked up in specific assets)?*		x		x	x	x	x	x				x	x	x	IISD 2013
	Are lessons learnt from previous experiences, is process modified in consequence?			x	x	x	x	x	x						x	IISD 2013, Gupta 2010, Biggs 2012
	Does the process and its leaders show openness to change?			x	x	x	x	x	x						x	IISD 2013, Milman 2008
	Is it easy to profoundly change values, ways of thinking or doing things in the surrounding culture?			x	x	x	x	x	x						x	IISD 2013, Milman 2008, Biggs 2012
	Are there nutrition intervention programmes?			x					x			x				Pingali 2005
	Is there opportunity for experimentation and innovation?		x		x	x	x	x	x			x			x	Oudenhoven 2010
	Is the attitude towards doubts, uncertainty and failures open and constructive?			x	x	x	x	x	x			x			x	Gupta 2010, Biggs 2012

Annex 6. Tailored questionnaire for tef farmers in Ethiopia

Questionnaire: Farmers

Name: _____
Phone Nr.: _____
Location: _____

Farm size: _____ ha
Tef area: _____ha
Years of experience in tef production _____
Nr. of family members working on farm: _____
How often are you eating enjera per day? _____
What amount of tef do you use in this enjera? _____%
What is your total production of tef per year? _____quintals
What amount of tef do you keep for seed purposes? _____kg/year
What amount of tef do you keep for own consumption? _____kg/year

What is the biggest constraint/problem for you in tef production?

_____
_____
_____
_____
_____
_____
_____
_____

INPUTS

1. How much do you depend on the following inputs? Are there alternatives?

	Alternatives	(little - - - a lot)
Fertilizer	_____	☐☐☐☐☐
Seeds	_____	☐☐☐☐☐
Insecticides	_____	☐☐☐☐☐
Fungicides	_____	☐☐☐☐☐
Herbicides	_____	☐☐☐☐☐
Lime	_____	☐☐☐☐☐
Oxen	_____	☐☐☐☐☐
Thresher	_____	☐☐☐☐☐
Fuel	_____	☐☐☐☐☐

Packing Material _____ ☐☐☐☐☐

Other: _____ ☐☐☐☐☐

2. Are input resources **affordable** throughout the whole year? (no - - - - - yes)

Fertilizer ☐☐☐☐☐

Pesticides ☐☐☐☐☐

Seeds ☐☐☐☐☐

Farm implements ☐☐☐☐☐

Lime ☐☐☐☐☐

Fuel ☐☐☐☐☐

Packing Material ☐☐☐☐☐

Draft forces ☐☐☐☐☐

Other: _____ ☐☐☐☐☐

3. Are there sufficient **quantities** of inputs accessible throughout the whole year?

(never - - -always)

Fertilizer ☐☐☐☐☐

Pesticides ☐☐☐☐☐

Seeds ☐☐☐☐☐

Farm implements ☐☐☐☐☐

Lime ☐☐☐☐☐

Fuel ☐☐☐☐☐

Packing Material ☐☐☐☐☐

Draft forces ☐☐☐☐☐

Other: _____ ☐☐☐☐☐

4. Do you maintain stocks of inputs and products?

	no	1 month	½ year	> 1 year
Fertilizer	☐	☐	☐	☐
Pesticides	☐	☐	☐	☐
Seeds	☐	☐	☐	☐
Farm implements	☐	☐	☐	☐
Lime	☐	☐	☐	☐

Fuel	☐	☐	☐	☐
Packing Material	☐	☐	☐	☐
Draft forces	☐	☐	☐	☐
Tef	☐	☐	☐	☐
Other: _____	☐	☐	☐	☐

5. In case of increased demand for tef (higher tef prices), would you have the capacity to increase tef production?

(no - - - - yes)

Land	☐ ☐☐☐☐
Labour forces	☐ ☐☐☐☐
Inputs	☐ ☐☐☐☐
Funding for inputs & labour forces	☐ ☐☐☐☐
Draft Forces	☐ ☐☐☐☐
Storage Capacities	☐ ☐☐☐☐
Other: _____	☐ ☐☐☐☐

6. Is there sufficient labour force available for tef production and can the labour force be adapted to fluctuations?

☐ ☐☐☐☐

Has this changed over the past years? _____

7. From your perception, how is the health status of the labour forces (including you)?

(bad - - - - good)

☐ ☐☐☐☐

8. In your opinion, are the following resources on your farm in good condition?

Soil	☐ ☐☐☐☐
Water system	☐ ☐☐☐☐
Livestock/oxen	☐ ☐☐☐☐
Buildings	☐ ☐☐☐☐
Energy sources	☐ ☐☐☐☐
Transport infrastructure	☐ ☐☐☐☐
Communication infrastructure	☐ ☐☐☐☐

9. What possibilities do you have to access to credits? Which ones do you use?

	Available	Used

Cooperative Banks	☐	☐
Micro Finance Institutes	☐	☐
Private Moneylenders	☐	☐
Rural Saving Cooperatives (RUSACOS)	☐	☐
Informal systems	☐	☐
Other: _____	☐	☐

10. How often are you making use of these credit systems? (never - - - every year)

☐☐☐☐☐

MARKET

11. Do you/can you sell your tef to various buyers? (only 1 - - - > 20)

☐☐☐☐☐

12. Do you/can you purchase your inputs from **various** suppliers? (only 1 - - - >20)

Fertilizer	☐☐☐☐☐
Pesticides	☐☐☐☐☐
Seeds	☐☐☐☐☐
Farm implements	☐☐☐☐☐
Pesticides	☐☐☐☐☐
Fuel	☐☐☐☐☐
Packing Material	☐☐☐☐☐
Draft forces	☐☐☐☐☐
Other: _____	☐☐☐☐☐

13. Is there an atmosphere of trust between you and the traders?

☐☐☐☐☐

14. Above which tef price is tef production profitable for you?

_____Birr/quintal

15. Do you have access to market price information?

☐☐☐☐☐

16. How is physical access to market? (road, transport means)

Distance to next market: _____h ☐☐☐☐☐

AGRONOMIC PRACTICES

17. Do you use crop rotations?

☐☐☐☐☐

18. Are your tef fields distributed geographically/unclustered?

☐☐☐☐☐

19. Do you use multiple tef varieties every year? Yes ☐ No ☐

20. Do you use improved tef varieties? Yes ☐ No ☐

21. Are there any government laws, regulations which affect your tef production? (Social, Economic, Environment)

_____
_____
_____
_____
_____

22. Do you have access to extension and advisory services/education?

☐☐☐☐☐

23. Do you make use of these services?

☐☐☐☐☐

INCOME

24. Is the income from your farming activity sufficient/can the whole family live from this income?

☐☐☐☐☐

25. Does your farming activity give you the possibility to generate savings?

☐☐☐☐☐

26. Does **tef production** give you the possibility to generate savings?

☐☐☐☐☐

27. How much of your income derives from tef production?

Tef grain: _____%
Tef straw: _____%

28. How much does your livestock depend on tef straw?

☐ ☐☐☐☐

29. Is your income generated by **diverse** products/crops?

☐ ☐☐☐☐

30. Does your household income rely on non-farm activities as well? (can the farm household not survive without other income sources?)

☐ ☐☐☐☐

31. Is it a financial risk for you to plant tef? (E.g. due to price volatility, dependency on traders, high investments?)

☐ ☐☐☐☐

32. Do you have any kind of insurance for the case of loss of:

	Formal	Informal	no	yes
Infrastructure	☐	☐	☐	☐
Personnel	☐	☐	☐	☐
Crop failure (incl. tef)	☐	☐	☐	☐
Livestock	☐	☐	☐	☐

DISASTERS/SHOCKS

33. Which types of disturbances/disasters **which affected tef production** have you witnessed in the past? (if none, what would be potential shocks?)
(E.g. pest outbreaks, droughts, floods, economic shocks, livestock shortage,...)

1. _____
2. _____
3. _____
4. _____
5. _____

34. Did it take long for you to recover from these disturbances; did it take long until **tef production** recovered from these disturbances?

(short - - - - - long)

1. ☐ ☐☐☐☐
2. ☐ ☐☐☐☐
3. ☐ ☐☐☐☐

35. In case of such a potential disaster (e.g. livestock loss, tef yield loss), are you able to re-establish function by your own? (savings, stocks, etc.) (no - - - - -yes)

☐ ☐☐☐☐

36. Did you in the past after such disturbances modify anything in your farming practices to be better prepared for future disturbances? What?

_____
_____
_____

37. Are there programs/measures from the government to support you before (prevent), during and after such disturbances? (e.g. warning systems, disaster intervention measures, financial aid, etc.)

Before _____
_____
_____

During _____
_____
_____

After _____
_____
_____

38. Are there informal programs/measures from community to support you before, during and after such disturbances? (e.g. idir system, community support for recovering from disasters, etc.)

Before _____
_____
_____

During _____
_____
_____

After _____
_____
_____

Annex 7. List of possible outcomes of food systems

- Food security:
  - Food availability
  - Access to food
  - Food utilization
- Ecosystem stocks (natural resources)
- Ecosystem services
- Ecosystem flows
- Degradation or enhancement of soil, water, biodiversity, habitat quantity and quality (e.g. erosion, nutrient leaching, eutrophication, toxic contamination of soils and water bodies, deforestation, acidification, biodiversity loss etc.)
- Contribution to or mitigation of global climate change (e.g. greenhouse gas emission, changes in land surface albedo, carbon sequestration)
- Health and nutrition status of actors, consumers
- Income generation (farmers, labourers, national GDP)
- Fairness of wages (compared to other regions, other sectors)
- Livelihoods, generation of employment opportunities
- Social cohesion or destabilization
- Equitability (between genders, races, religions, ethnic minorities, nations, generations etc.)
- Slavery and child labour
- Diseases and epidemics
- Diet-related health problems (cardio-vascular disease, obesity, diabetes, undernutrition, malnutrition, undernourishment, stunting, mental retardation etc.)
- …

Annex 8. Prioritization matrix of food system outcomes

	Environmental welfare							Economic performance		Food security, health and nutrition							Socialwelfare					
	Ecosystem stocks (natural	Ecosystem services	Ecosystem flows	Nutrient availability & cycling	Degradation or enhancement of soil, water, biodiversity, habitat quantity	Contribution to or mitigation of	...	Income generation (farmers,	...	Food availability	Access to food	Food utilization	Health and nutrition status of actors,	Diet-related health problems	Diseases and epidemics	...	Fairness of wages	Livelihoods, generation of	Social cohesion or destabilization	Equitability	Slavery and child labour	...
Spatial level																						
Temporal level																						
Production inputs																						
Agricultural production																						
Primary food storage																						
Transporting and primary processing																						
Transporting and secondary processing																						
Distribution																						
Retailing																						
Consumption																						

Food system outcomes can occur at different spatial levels (local, regional/national, international/global) and over different temporal levels (short term, medium term, long term), e.g. different time lags or rates of change. For each food system activity (segment in the value chain), the contribution to each outcome is estimated. Contribution can be strong (2), intermediate (1) or low/none (0). Filling in the entire matrix of issues and food system activities reveals those outcomes

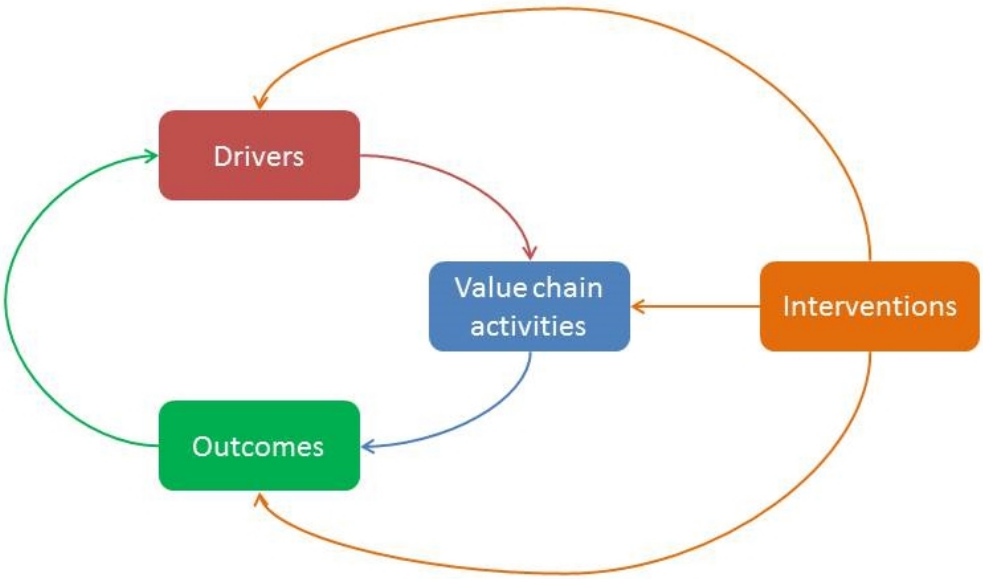
that are particularly affected by the food system, and thus helps prioritize outcomes on which to focus. Adapted from Downing and Franklin (2004)

Annex 9. Prioritization matrix of food system drivers

	Environment							Economy			Politics				Society					
	Land cover & soils	Climate variability & means	Water availability & quality	Nutrient availability & cycling	Biodiversity	Sea level, currents & salinity	…	Prices (energy, fertilizer, crops…)	Market size (domestic, export)	…	Trade agreements	Subsidies and taxes	Decision-making processes	…	Demographics	Lifestyle	Diets	Cultural norms	Science & technology	…
Spatial level																				
Temporal level																				
Production inputs																				
Agricultural production																				
Primary food storage																				
Transporting and primary processing																				
Transporting and secondary processing																				
Distribution																				
Retailing																				
Consumption																				

This matrix of possible drivers of change illustrates how hot spots of exposure can be identified in a food system. Drivers of change can affect different spatial levels (local, regional/national, international/global) and be relevant on different temporal levels (short term, medium term, long term). For each food system activity (segment in the value chain), the exposure of this activity to a driver is estimated. Exposure is strong (2), intermediate (1) or low/none (0). Filling in the entire matrix of drivers and food system activities reveals those activities that are particularly exposed to the various drivers and thus helps prioritize drivers to which exposure will be lessened through the design and implementation of interventions. Drivers are based on Downing and Franklin (2004); Darnhofer, Fairweather et al. (2010); Ericksen (2008).

Annex 10. Template for causal mapping



Adapted from Ericksen, Bohle et al. (2010). All relevant drivers, food system activities, outcomes, and interventions should be mapped individually, and linked individually by arrows based on causal mechanisms

Annex 11. List of generic value chain development activities

Relevant value chain segment	Strategy	Comments
Same segment/food system activity	Improve process	Improving efficiency or reducing negative externalities; this includes delivering on delivery schedules, invoicing, improving client management, reducing wastage, etc.
	Improve product	Moving into more 'sophisticated' products with increased unit value, through complying with buyer requirements for physical quality, certification, food safety standards, traceability, packaging, etc. Alternatively, shifting from producing for high-value markets to bulk-commodity markets based on economies of scale could also increase rewards or reduce risks.
	Improve volume	Increasing the amount of product sold, through increases in yield or area.
Several segments and nodes	Functional upgrading	Functional upgrading refers to a situation when producers take on a new function in the value chain, either by performing downstream activities (for example, grading, processing, bulking up, transporting or advertising), or by engaging in upstream functions such as the provision of services, inputs or finance. Functional upgrading normally leads to vertical integration (when a stakeholder performs more than one value-chain function), except when the producer decides to abandon primary production in order to focus on the new function.
	Functional downgrading	Functional downgrading is where the producer moves one node down the chain (for example, from processing his product to focus back on production because of the low profitability of processing).
Improve value chain coordination	Vertical contractualization	Vertical contractualization (two stakeholders, different segments, e.g., farmers and wholesalers, co-op and retailer, etc.) means 'getting a better deal' through closer and longer term business ties with buyers. It represents a move away from spot or repeated market-type transactions to an increasing use of contracts between producers and other chain stakeholders. It often involves 'learning from buyers' (about market requirements rather than prices) and 'interlocking contracts' where sales contracts include embedded services from the buyer (extension, credit, fertilizers, ice boxes, etc.). The benefits of contracts may include reduced price risks, access to price premiums, improved access to market information, inputs and finance or reduced marketing costs. But contracts also involve higher performance requirements, for example in respect of quality, volume, and certification, which can be difficult and costly to meet.
	Horizontal contractualization	Horizontal contractualization (same stakeholders, same segment – for example, farmer groups, co-ops) describes agreements among producers to co-operate over input provision, marketing (for example, bulking produce for sale, identification of buyers), certification, and crop insurance in order to reduce costs, increase revenues or mitigate individual risks. Such collective action is often a precondition for increasing contractualization vis-à-vis buyers and can also strengthen producers' bargaining power.
…		

Sources: Bolwig, Ponte et al. (2010); Riisgaard, Bolwig et al. (2010)

Annex 12. List of possible interventions for enhancing resilience in English and Amharic

Group:

		Rating
Diverse income sources	የተለያዩ የገቢ ምንጮች	
Diverse input sources	የተለየዩ ግብዓት አቅራቢዎች	
Diverse output sources (clients)	የተለያዩ ተጠቃሚ ደንበኞች	
Quality of input sources	የግብዓቶች ጥራት	
Quality of output sources	የምርት ጥራት	
Quality of infrastructure	የኢፍራስትራክቸር ጥራት	
Stocks of inputs	ስቶር ለግብዓት	
Stocks of outputs (products)	ስቶር ለምርት	
Savings (in form of money or other assets)	ቁጠባ (ገንዘብ ወይም ሌላ ንብረት)	
Independence in decision-making process of your activity	በስራችሁ የመወሰን ሙበት	
Insurance (formal or informal)	ኢንሹራንስ (ሐጋዊ/ሐጋዊ ያልሆነ)	
Early warning systems for disturbances	ቅድመ ማስጠንቀቂያ	
Support from government **before** shock (money, material, knowledge,…)	አደጋ ከመከሰቱ በፊት የመንግስት ድጋፍ (ገንዘብ፤ዕቃ፤ዕዉቀት፣ወዘተ)	
Support from community **before** shock (money, material, knowledge,…)	አደጋ ከመከሰቱ በፊት የማህበረሰብ ድጋፍ (ገንዘብ፤ዕቃ፤ዕዉቀት፣ወዘተ)	
Support from family **before** shock (money, material, knowledge,…)	አደጋ ከመከሰቱ በፊት የቤተሰብ ድጋፍ (ገንዘብ፤ዕቃ፤ዕዉቀት፣ወዘተ)	
Support from government **during** shock (money, material, knowledge,…)	አደጋ በሚከሰትበት ግዜ የመንግስት ድጋፍ (ገንዘብ፤ዕቃ፤ዕዉቀት፣ወዘተ)	
Support from community **during** shock (money, material, knowledge,…)	አደጋ በሚከሰትበት ግዜ የማህበሰብ ድጋፍ (ገንዘብ፤ዕቃ፤ዕዉቀት፣ወዘተ)	
Support from family **during** shock (money, material, knowledge,…)	አደጋ በሚከሰትበት ግዜ የቤተሰብ ድጋፍ (ገንዘብ፤ዕቃ፤ዕዉቀት፣ወዘተ)	
Support from government **after** shock (money, material, knowledge,…)	አደጋ ከተከሰተ በኃላ የመንግስት ድጋፍ (ገንዘብ፤ዕቃ፤ዕዉቀት፣ወዘተ)	
Support from community **after** shock (money, material, knowledge,…)	አደጋ ከተከሰተ በኃላ የማህበረሰብ ድጋፍ (ገንዘብ፤ዕቃ፤ዕዉቀት፣ወዘተ)	
Support from family **after**shock(money, material, knowledge,…)	አደጋ ከተከሰተ በኃላ የቤተሰብ ድጋፍ(ገንዘብ፤ዕቃ፤ዕዉቀት፣ወዘተ)	
Ability of self-organization	የድርጅታችሁ ሀቅም	
Ability to express diverse opinions	የተለያዩ ሃሳቦችን የማፍለቅ ችሎታ	
Trust between actors	ባለድርሻዎች መካከል መተማመን	

Others/ሌሎች _____

_____

_____

_____

Please rate the indicators according to their importance to overcome a drought for your activity.
(1= not important ---- 5 = very important)

Annex 13. Consistency matrix for scenario formulation (example)

Driver	Level	Drivers and levels																								
		1			2		3		4		5			6		7			8		9			10		
			b	c	a	b	a	b	a	b	a	b	c	a	b		b	c	a	b		b	c		b	c
1 Population growth	a High growth scenario				0	0	0	0	0	0	0	0	0	0	0	0	-1	2	0	0	-2	2	2	0	0	0
	b Medium growth scenario				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	c Low growth scenario				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	-1	-1	0	0	0
2 Climate change	a Moderate global temperature rise ~2°C; slight increase in weather variability	0	0	0			0	0	1	1	0	0	0	-1	1	0	0	0	0	0	0	0	0	0	0	0
	b Global temperature rise of 3-4°C: increasing weather variability	0	0	0			0	0	1	1	0	0	0	-1	1	0	0	0	0	0	0	0	0	0	0	0
3 Resource scarcity	a Constant resource availability; Prices stay on same level	0	0	0	0	0			1	0	0	0	0	1	-1	0	0	0	0	0	1	-1	-1	0	0	0
	b Decreasing resource availability; higher prices and increased volatility	**0**	0	0	0	**0**			1	**2**	**0**	0	0	-2	**2**	0	0	**0**	0	**0**	-1	**1**	1	**0**	0	0
4 Technological progress in CH	a Constant yield improvement as in past years	0	0	0	1	1	1	1			0	0	0	0	0	0	0	0	0	0	0	0	0	1	-1	0
	b Technological progress => Increased yield and lower input	0	0	0	1	1	0	1			0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	-1
5 International cooperation and liberalization of world trade	a Multilateral agreements	0	0	0	0	0	0	0	0	0				1	-1	0	0	0	-1	1	0	0	0	0	-1	2
	b Lower cooperation between countries	0	0	0	0	0	0	0	0	0				-1	2	0	0	0	1	-2	0	0	0	0	0	-1
	c Predominant liberalisation	0	0	0	0	0	0	0	0	0				1	-2	0	0	0	-2	1	0	0	0	0	-1	2
6 World sugar price volatility	a Constant or lower volatility	0	0	0	-1	-1	1	-2	0	0	1	-1	1			0	0	0	-1	2	0	0	0	1	0	0
	b Increased volatility	**0**	0	0	**1**	1	-1	**2**	**0**	0	-1	**2**	-2			0	0	**0**	**2**	-1	**0**	0	0	0	**0**	0
7 Domestic sugar intake	a Constant net sugar consumption	0	0	0	0	0	0	0	0	0	0	0	0	0	0				0	0	0	0	0	0	0	0
	b Decrease in net sugar consumption	-1	0	0	0	0	0	0	0	0	0	0	0	0	0				0	0	0	0	0	0	0	0
	c Increase in net sugar consumption	2	0	0	0	0	0	0	0	0	0	0	0	0	0				0	0	0	0	0	0	0	0
8 European support for agriculture	a Constant level of support	0	0	0	0	0	0	0	0	0	-1	1	-2	-1	2	0	0	0			0	0	0	1	-1	1
	b Decrease in level of support	0	**0**	0	**0**	0	**0**	0	**0**	0	1	-2	**2**	**2**	-1	0	**0**	0			**0**	0	0	1	-1	**1**
9 Availability of Cropland	a Constant agricultural land	-2	-1	2	0	0	1	-1	0	0	0	0	0	0	0	0	0	0	0	0				0	0	0
	b Decrease in agricultural land as in past years	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	[illegible]	[illegible]
	c Heavy decrease in agricultural land	2	1	-1	0	0	-1	1	0	0	0	0	0	0	0	0	0	0	0	0				0	0	0
10 Swiss governmental support	a Constant support for agriculture	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	2	1	0	0	0			
	b Lower support for agriculture	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
	c Higher support for agriculture	0	0	0	0	0	0	0	0	-1	2	-1	2	0	0	0	0	0	1	1	0	0	0			

Illustrative example of a scenario consistency matrix, for the case of the Swiss sugar value chain (Zweifel 2014). Consistency of different levels in possible drivers is rated pairwise, from highly inconsistent/impossible combination (-2) to highly consistent/correlated (2).