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Institute of Agricultural Sciences
Department of Environmental Systems

Assessing the resilience of the tef value chain in Ethiopia

Master Thesis

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Executive Summary

Food security around the globe is increasingly challenged by multiple factors, ranging from long-term stresses, like climate change or population growth, to unexpected shocks, like natural disasters or economic crises. In order to address these challenges, the concept of food system resilience was developed to better understand and assess the ability of food systems to deal with various types of shocks.

In this study, the resilience of the tef value chain in Ethiopia was assessed. Based on a methodological approach developed by the SAE-Group of ETH Zurich, the tef value chain was identified, its resilience performance assessed and interventions to improve the resilience developed. Data was generated through literature research, stakeholder- and expert interviews as well as a stakeholder-workshop.

Resilience of the tef value chain was found to be quite heterogeneous, differing considerably between the different components 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. In contrast, the informal seed and farm implement supply is quite resilient, as supply chains are extremely short, actors have big autonomy and production capacities and stocks are large and well distributed. Farmers often plant tef as a cash and security crop, since tef shows a very high value-cost ratio and advantageous qualities to overcome shocks. On the other hand, tef production contributes substantially to soil depletion, farmers lack knowledge on this and other issues and productivity of tef is low compared to other crops. With demand for tef growing stronger than productivity, tef prices have been increasing progressively and tef has become unaffordable for many Ethiopians. However, consumers substitute tef with cheaper cereals such as maize or wheat to cope with increasing tef prices and dependency on tef as a staple food is accordingly reduced. Traders, in contrast, profit from rising commodity prices, and profitability of tef trade is generally high. However, there is no official price information and quality grading system available for tef, making trust (reported to be generally low) a major component for tef trade and reducing the resilience for all post-production steps of the value chain. Finally, the processing & retail step shows an overall good resilience performance due to a large number of processors distributed throughout the whole country with big and flexible spare capacities, diverse income sources and limited dependency on tef.

In order to identify potentials to improve the resilience of the tef value chain, a workshop was held where stakeholders developed resilience interventions for a drought scenario. Main propositions 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.

Even though the increasing tef prices of the past years have made tef more of a luxury food item than a staple crop for many Ethiopians, its importance for food security re-

mains substantial in Ethiopia. To date, only 36 percent of the tef production is marketed, with the rest being produced by subsistence farmers for self-consumption. For the farmers producing tef as a cash crop, rising tef prices are an opportunity to increase income and consequently purchase cheaper cereals to cover the daily food needs.

The tef export ban, which was imposed in 2006, is expected to be lifted in the near future. In the short term, such an elimination would probably pose a risk to food security in Ethiopia due to higher tef prices for consumers. However, lifting the export ban also offers an opportunity for almost all tef value chain actors to profit in the long term. In the best case, the gradual elimination of the export ban could result in an increasing commercialization of smallholder farmers, a widespread adoption of improved farming techniques including mechanization of farms and finally higher tef production in Ethiopia. Accordingly the food security situation in Ethiopia could actually improve in the long run.

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At this point I would like to thank the large number of people, which have supported me during the realization of this thesis.

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Summary of initial proposal

Introduction

Food systems are increasingly exposed to various drivers of change, ranging from sudden shocks (economic crisis, political conflicts, etc.) to long-term stressors such as climate change (Ericksen 2008). As a consequence, food security, as the major function of food systems, increasingly comes under pressure. To address these challenges, the concept of resilience serves to understand and assess the ability of food systems to absorb, maintain and recover from various types of shocks (Tendall et al. 2015).

In this study, the resilience of the tef (*Eragrostis tef*) value chain will be addressed. Being produced and consumed almost entirely in Ethiopia, its value chain is much less complex than other staple food chains. This allows for a complete and consistent assessment of all processes within the tef value chain. On the other hand, tef is one of the most important crops for Ethiopia's agricultural economy, both in terms of consumption and production (Worku et al. 2014). Its high nutritional qualities and the absence of gluten make tef increasingly known even outside Ethiopia, which increases the demand for tef (Andersen and Winge 2012). Furthermore, farmers obtain a relatively high share of the profits within the value chain (Minten et al. 2013). Tef grows in a greater altitudinal range than any other cereal in Ethiopia (Katema 1997) and is able to withstand harsh climate conditions such as droughts or waterlogging (ATA, MoA, EIAR 2013). These features make this crop, at first sight, a commodity of high interest for food security, which may cope well with natural disturbances.

However, besides frequent natural disasters, the tef value chain was repeatedly exposed to economic and political impacts in recent years. For instance, in 2006, the Ethiopian government imposed an export ban on tef to counteract a continuing price boom of the commodity (Demeke and Di Marcantonio 2013). And in 2007/2008 price for tef skyrocketed, quadrupling the average price during the period since 2000 (ATA, MoA, EIAR, 2013). Evidently, these shocks have an impact on a wide range of tef value chain actors. But how does the tef value chain as a whole react to such shocks, or in other words, how resilient is the Ethiopian tef value chain to multiple types of shocks?

Objectives

The following objectives shall be addressed in this study:

- To assess the degree of resilience of the tef value chain in Ethiopia.
  - To identify the main actors, activities and outcomes of the value chain
  - To determine the most relevant shocks that affect or could affect the value chain in the future
  - To identify the strengths, weaknesses and leverage points of the tef food value chain
- To develop in a participatory approach potential solutions to increase the resilience of the tef value chain.

- To test the implementation of the SAE Guidelines for designing food system resilience and pay particular attention to the resilience indicators needed for analyzing the tef value chain.

Research question

- What is the resilience degree of the tef value chain in Ethiopia?
- Which interventions can increase the resilience of the tef value chain and to what extent can they support food security and poverty reduction in Ethiopia?

Methodology

The research methodology will be based on the SAE guidelines for designing food system resilience and will be adapted to the specific case of the tef food value chain in Ethiopia. It includes:

- Value chain identification through material and financial flow analyses as well as mapping of the activities and the spatial distribution of the value chain.
- Stakeholder identification using power-interest and/or stakeholder network diagrams.
- Identification of major outcomes (e.g. food security, income generation) of the value chain, for instance by using the causal mapping concept.
- The development of a list of key resilience indicators to determine how resilient the tef value chain is.
- Identification of drivers of change that (could in the future) affect the tef value chain.

Data collection will take place on the one hand through literature review; on the other hand, most of above-named steps require interaction with tef value chain stakeholders, either to gather additional information or to validate and further develop conceptions. This will be done in the form of qualitative interviews with key informants of the tef value chain in Ethiopia. Finally, a stakeholder workshop will be organized, where actors will discuss the resilience of Ethiopian tef value chain and develop potential solutions to make it more resilient. Therefore, a two-month field trip to Ethiopia is scheduled.

Expected results

- Concrete understanding of the tef value chain and its level of resilience.
- Identification of potential solutions to improve the resilience of the tef value chain
- Provide a showcase example of designing food system resilience including the identification of key resilience indicators for tef
- Increased collaboration/partnership between ETH and EIAR and NutrAfrica

Declaration of Originality

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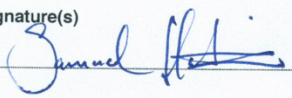
14.11.2015	

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Abbreviations

AISE	Agricultural Input Supply Enterprise
ATA	Ethiopian Agricultural Transformation Agency
BoARD	Bureau of Agriculture and Rural Development
CSA	Central Statistical Agency
DRMFSS	Disaster Risk Management Food Security Sector
DZARC	Debre Zeit Agricultural Research Center
EIAR	Ethiopian Institute of Agricultural Research
ESE	Ethiopian Seed Enterprise
FAO	Food and Agriculture Organization
FEWSNET	Famine Early Warning System Network
GoE	Government of Ethiopia
GTP	Growth and Transformation Plan
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
MoA	Ministry of Agriculture
RSEs	Regional Seed Enterprises
RBoAs	Regional Bureaus of Agriculture
SAE	Sustainable Agroecosystems
UN	United Nations
WFP	World Food Program of the United Nations

1. Introduction

1.1. Background

Worldwide, urbanization is rapidly increasing, especially in developing countries. From 30 percent in the 1950s, the amount of the world population living in cities has reached more than 50 percent in 2010 (cf. UN Population Division 2010). However, people in urban areas are much less likely to grow their own food and therefore rely on food systems to meet their dietary needs. Food systems again are increasingly exposed to various drivers of change, ranging from sudden shocks (economic crisis, political conflicts, etc.) to long-term stressors such as climate change (Ericksen 2008). As a consequence, food security, as the major function of food systems, increasingly comes under pressure. In order to address these challenges, the concept of food system resilience was developed to better understand and assess the ability of food systems to deal with various types of shocks (Tendall et al. 2015).

In Ethiopia, the issue of food security is still of high prominence. Nationwide food shortages have occurred almost once a decade in the last 50 years (cf. Berry 2003, Williams and Funk 2011) and according to the UN Food and Agriculture Organization (FAO), International Fund for Agricultural Development (IFAD), World Food Program of the United Nations (WFP) (2015), 32% of the total population in Ethiopia was estimated to be undernourished in 2014-16. A possible explanation for the remaining high food insecurity may be found in the low productivity of Ethiopian agriculture (Zerihun et al. 2014), with smallholder farmers cultivating 95% of the farmland (Gebre-Selassie and Bekele 2012) using mostly traditional farming practices and nearly no mechanization. Further, crop production in Ethiopia is largely rain-fed (only 2% of cropland is irrigated) and therefore highly vulnerable to environmental and climatic shocks. Accordingly, variability of yields and prices for agricultural goods are among the highest in the world (Shahidur et al. 2009, World Bank 2006a). The occurrence of such climatic shocks in Ethiopia has significantly increased over the last 30-60 years, showing an overall increase in mean temperature (cf. Funk et al. 2011, 2012), decrease in rainfall (cf. Williams and Funk 2011, Funk et al. 2008) and a higher frequency of droughts and heavy rainfall events (cf. Funk *et al.* 2008; Williams and Funk 2011, Lyon and DeWitt 2012). Furthermore, food production and security in Ethiopia is challenged by an enormous population growth (being among the ten fastest growing countries in the world), leading to diminishing farm sizes and increasing pressure on natural resources like forests or soils, with Ethiopia being one of the most severely erosion-affected countries in the world (Zelleke et al. 2010).

In consideration of these challenges for food security in Ethiopia, the resilience of the tef (*Eragrostis tef*) value chain will be examined in this study. Tef is one of the most important crops for Ethiopia's agricultural economy, being the most cultivated (3.016 million ha) and commercialized (36% of total production) crop in Ethiopia (cf. Worku et al. 2014, Minten et al. 2013). Further, tef is a staple food for about 60% of the population (ATA, MoA, EIAR 2013) and its high nutritional qualities and the absence of gluten make

tef increasingly known even outside Ethiopia (Andersen and Winge 2012). Being endemic, tef is quite resistant to diseases and pests and also able to withstand harsh climate conditions such as droughts or waterlogging (ATA, MoA, EIAR 2013). Furthermore, farmers obtain a relatively high share of the profits within the value chain (Minten et al. 2013). These features make tef, at first sight, a commodity of high interest for food security, which may cope well with natural disturbances.

However, besides frequent natural disasters, the tef value chain was repeatedly exposed to economic and political impacts in recent years. For instance, in 2006, the Ethiopian government imposed an export ban on tef to counteract a continuing price boom of the commodity (Demeke and Di Marcantonio 2013). In 2007/2008, the price for tef nevertheless skyrocketed, quadrupling the average price since 2000 (ATA, MoA, EIAR 2013). Evidently, these shocks have an impact on a wide range of tef value chain actors. But how does the tef value chain as a whole react to such shocks? Or in other words, how resilient is the Ethiopian tef value chain to multiple types of shocks?

Being produced and consumed almost exclusively in Ethiopia, the tef value chain is much less complex than other staple food chains. This allows for a complete and consistent assessment of all processes within the tef value chain. Combined with its importance for food security in Ethiopia, the tef value chain therefore serves as a unique showcase to evaluate the resilience of a food value chain. However, due to its minor role for global agriculture, tef has been largely neglected by the global scientific community. Even in Ethiopia, public attention and funding for tef research has been marginal compared to other crops and accordingly, very little information is available on the crop. Nevertheless, Ethiopia's government recently showed increasing interest in the crop and a national tef strategy was launched in 2013. The strategy aims to improve productivity, profitability and sustainability of the tef production. It follows a value chain approach, planning interventions and research on multiple levels of the tef value chain (ATA, MoA, EIAR 2013). Even though the final goal of the strategy is to improve food security, the perspective of resilience in the face of multiple kinds of shocks is not considered. However, with frequency of such shocks being expected to increase in the near future, a resilience assessment of the tef value chain is an imperative need.

1.2. Objectives

The following objectives were addressed in this study:

- To identify the main tef value chain actors, activities and their spatial distribution.
- To describe the context of the tef value chain including the most important drivers of change and the role tef is playing for food security in Ethiopia.
- To determine the most relevant shocks that affect or could possibly affect the tef value chain in the future.
- To assess the resilience of tef value chain and its different processes.
- To develop potential interventions to increase the resilience of the tef value chain for a specific shock scenario (drought) by applying a participatory approach.

- To test the implementation of the Sustainable Agroecosystems (SAE) Guidelines for designing food system resilience and pay particular attention to the resilience attributes needed for analyzing the tef value chain.

1.3. Research questions

- What role does tef play for food security in Ethiopia?
- What is the resilience of the tef value chain in Ethiopia?
- Which interventions can increase the resilience of the tef value chain and to what extent can they support food security and reduce poverty in Ethiopia?

1.4. Methods

The resilience assessment of the tef value chain is based on a methodological approach developed by the SAE-Group of the Swiss Federal Institute of Technology ETH Zurich. In a first step, the SAE-resilience guidelines were adapted to the specific case of the tef value chain in Ethiopia and the limited resources (mainly time) and data available for the study. After identifying the tef value chain and its context through mapping, stakeholder analysis and identification of shocks and drivers of change, the resilience of the tef value chain was assessed using an extensive questionnaire divided into different resilience attribute categories. Three different sources of data were explored, namely literature, semi-quantitative and qualitative stakeholder and expert interviews as well as a workshop with different actors of the tef value chain. The interviews served to deepen understanding on the tef value chain, validate existing information and generate answers for the resilience assessment questionnaire. The main purpose of the workshop was to develop possible interventions to increase the resilience of the tef value chain, using a participatory approach. With the compiled data, the resilience questionnaire was answered question by question and finally a resilience rating was given for each value chain step and attribute.

1.5. Expected results

- Concrete understanding of the tef value chain in its context.
- Profound knowledge on the resilience performance of the tef value chain and its processes.
- Identification of potential interventions to improve the resilience of the tef value chain for the case of droughts.
- Provide a showcase example of designing food system resilience including the identification of key resilience attributes for tef.
- Increased collaboration/partnership between ETH, EIAR and NutrAfrica

1.6. Structure of the thesis

The thesis is structured as follows:

Chapter 1: Introduction into the topic and identification of the main objectives, research questions and expected results of the thesis

Chapter 2: Short background and definition of food system resilience

Chapter 3: Overview of the Methods used in this study

Chapter 4: Results of the thesis, including:

- 4.1.1. Introduction in the context of the tef value chain
- 4.1.2. Short Background on tef
- 4.1.3. Discussion on the role of tef for food security in Ethiopia
- 4.1.4. Identification of drivers of change affecting the tef value chain
- 4.1.5. Material flow analysis of the tef value chain
- 4.1.6. Mapping the spatial distribution of the tef value chain
- 4.1.7. Identification of the most important actors of the tef value chain
- 4.1.8. Documentation of the most important shocks for the tef value chain
- 4.2. Resilience assessment of the tef value chain in Ethiopia
- 4.3. Building resilience in case of a drought

Chapter 5: Discussion

Chapter 6: Conclusion

2. Food system resilience

2.1. Resilience concepts

The concept of resilience is becoming increasingly popular in many disciplines, ranging from ecology, through psychology to engineering (Fan et al. 2014). Resilience thinking in the field of ecology has its origins from Holling (1973), defining it as "the ability of a system to return to its equilibrium state after a temporary disturbance". Later, the concept of resilience was adapted to socio-ecological systems and definitions of resilience were subsequently refined to match these fields. While Hollings definition concentrates on the ability of a system to *recover* from a certain shock, later concepts focus more on the capacity of a system to *withstand* a disturbance in the first place (Anderies et al. 2013). Resilience concepts developed for socio-ecological systems further include components such as the capacity of a system to *absorb* a certain disturbance (cf. Carpenter et al. 2001), the rate of *recovery* of a system (cf. Adger, 2000) or the capability of a system to *adapt* to changing circumstances (Walker et al. 2004).

Recently, resilience thinking has also been adopted for food systems. In the food system resilience concept by Tendall et al. (2015), all components mentioned above are brought together, determining if a system is more or less resilient (see **Figure 1**). This can be illustrated with the example of a forest affected by a fire. The resilience of the system is in the first place determined by the robustness of the forest against bushfires (e.g. by the amount of underwood prone to catch fire). Further, the capacity of the forest to absorb a fire (e.g. tolerance of tree species to fire) as well as the rapidity of the system to recover from a fire (e.g. amount of tree seeds surviving the fire and growth rate of regrowing trees) determine the resilience of the forest. Finally, the forest also needs to be able to adapt to long-term changes in order to be resilient, for instance by adapting to climate change (e.g. through new tree species) without losing its ability to overcome fires. However, rather than determining the resilience of forests, the concept defined by Tendall et al. (2015) was designed to capture the resilience of food systems.

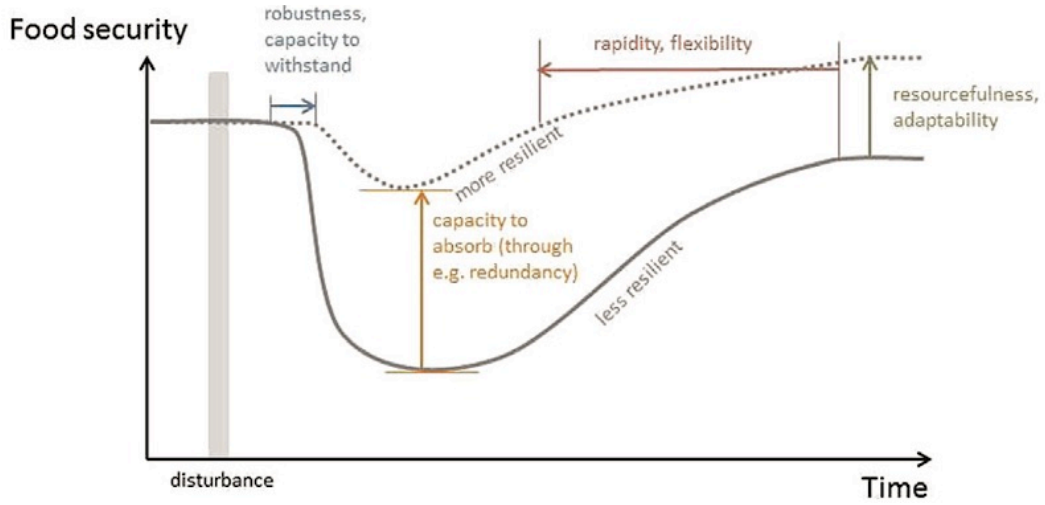


Figure 1: Components of food system resilience (Tendall et al. 2015)

2.2. Food systems and value chains

When talking about food systems and food value chains, they are frequently understood as a one-dimensional and linear chain of activities from production to consumption, including some intermediate steps of processing and marketing (cf. Ericksen 2008, Kaplinsky and Morris 2001, Pinstrup-Andersen 2012). However, in reality, food systems are much more complex. They consist of a set of biophysical (e.g. soil fertility) and social elements (e.g. farmers, government), which are connected through various processes (e.g. regulation, depletion)(Pinstrup-Andersen and Watson 2011). Often they exist of various convoluted subsystems that interact across temporal and spatial scales and contain many feedback loops (Pinstrup-Andersen 2012). These subsystems can be attributed to different domains with different dynamics, such as the ecological domain (balance between pests and beneficial insects or nutrient cycles), the social domain (lifestyle changes or different food preferences) or the political or economic domain (state market interventions, quality standards) (Darnhofer 2010). Therefore, food systems should rather be seen as dynamic and behavioral systems that can be influenced by internal and external factors (Pinstrup-Andersen and Watson 2011).

Food systems, no matter if on a local, regional or global scale, provide a multitude of outcomes. Outcomes may be positive or negative, indirect or unintentional (Ericksen 2008). Often outcomes are at the same time inputs to the food system, as it is the case for many environmental features. Food systems activities contribute to environmental outcomes, for instance biodiversity, climate change, nutrient cycles, etc. which then again can affect food systems activities such as the agricultural production. Other major outcomes of food systems concern social and economic fields, such as employment and income generation, health and nutrition services, cultural identity, etc. However, the principal outcome of food systems is undoubtedly food security. According to the World Food Summit 1996, food security is defined as “the condition, when all people have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life at all times, without undue risk of losing such access“ (World Food Summit 1996). In other words, the principal goal of food systems is to ensure sufficient, appropriate and accessible food to all (Tendall et al. 2015).

2.3. Food systems and change

Worldwide, food systems increasingly come under pressure from various drivers of change (Ericksen 2008). On the one hand, there are various slow but major long-term stressors affecting food systems, such as population growth, urbanization, globalization or climate change. Along with population growth, demand for food is steadily rising and putting increasing pressure on natural resources such as land, soils or water. The constant growth of urban areas leads to a change in consumption patterns (e.g. more convenient food) and an increasing number of people relying totally on functioning food value chains (Godfray et al. 2010, Kennedy et al. 2004). Both, consumers and producers are increasingly embedded in a globalized food market, in which national and international factors play relative more important roles than local factors (Ericksen 2008). Final-

ly, climate change affects food production in multiple ways, ranging from gradual temperature changes to higher frequency of extreme weather events such as droughts or storms. Such events can be categorized as sudden shocks, which constitute another major threat to food systems. Besides natural disasters, these shocks can also have social (e.g. wars and conflicts), political (e.g. regime change) or economic origins (e.g. economic crises). It has been shown that social-ecological systems often pass by far the majority of their time in periods of gradual change and are only episodically interrupted by shorter disturbances. However, these short disturbances may totally reconfigure the system (Gunderson and Holling, 2002).

Summarized it can be stated that food systems are exposed to a multitude of changes, ranging from short-term shocks to long-term stresses, being internal or external, structural or cyclical and with multiple origins. Disturbances may even interact and cause cumulative impacts (Tendall et al. 2015). In order to continue to provide food security and other outcomes in the face of such drivers of change, food systems have to be able to deal with certain shocks and disruptions (Kopainsky et al. 2013). In other words, food systems have to be resilient.

2.4. Food system resilience

2.4.1. Definition

In order to address the challenges described in the previous chapter, Tendall et al. (2015) developed a conceptual framework for food system resilience, which is based on the following definition:

"Resilience is the capacity over time of 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."

Besides acknowledging time as an intrinsic factor of resilience, the definition also respects the complex nature of food systems, often existing of many convoluted subsystems that interact across temporal and spatial scales (Tendall et al. 2015). Food system resilience as defined above is explicitly tied to the functional goal of a food system to ensure food security, as it was defined by World Food Summit 1996 (see chapter 2.2). As stated by Tendall et al. (2015), the concept hence includes a normative definition of resilience, ensuring that the outcomes of a food system implicitly have to be favorable in order for the system to be resilient. Finally, the definition also takes into account the big variety of possible and even unforeseen disturbances that can affect a food system (Tendall et al. 2015).

2.4.2. Food system resilience and sustainability

When discussing the concept of resilience in food systems, it is inevitable to mention the theory of sustainability. Sustainability has been generally defined as the capacity of meeting today's needs without compromising the future capacity to achieve them (Brown et al. 1987). As Godfray et al. (2010) state, it is now generally accepted that food systems must become fully sustainable. From a biophysical perspective, this implies the

use of resources at rates that do not surpass the capacity of earth to replace them (Godfray et al. 2010) as well as the conservation of the environment. Therefore, for instance the dependency on non-renewable inputs such as fossil fuels is by definition unsustainable (Godfray et al. 2010). However, food systems do also implicate social and economic aspects that need to be considered when talking about sustainability. Gliessmann (2007) for instance includes social equity and economic viability among the different food system actors in his definition of sustainable food systems.

Figure 2: Resilience and sustainability as complementary concepts **(**Tendall et al. 2015).

In the food system resilience concept defined by Tendall et al. (2015), sustainability is understood to be complementary to resilience (see **Figure 2**). While sustainability implies preserving the capacity of a system to function in the future, resilience can be defined as the capacity of a system to continue providing a function despite disturbances and shocks (Tendall et al. 2015). For the concrete example of food systems, resilience implies that food security is guaranteed even if a food system is affected by a disturbance (e.g. by falling back on an irrigation system in case of a drought). A sustainable food system on the other hand involves that food security can be guaranteed even in the future (e.g. by maintaining ground water levels and soil fertility despite irrigation).

2.4.3. Importance of the food system resilience concept

As already mentioned, food systems and food value chains are increasingly exposed to multiple drivers of change. Combined with the intrinsic dynamic nature of food systems and the rapid changing environment, it is therefore crucial to continuously adapt food systems in order to ensure food security. It is important to make food systems resilient.

In order to pursue such adjustments, decision makers thus need to be able to analyze food systems, understand their dynamics, risks, outcomes etc. Due to the extremely complex and dynamic nature of food systems, this however requires adequate assessment tools. By defining the concept of food system resilience, Tendall et al. (2015) made a first step towards such a methodology. In a next step, this concept should be transposed into a concrete framework to assess the resilience of a food system and finally enable the elaboration of interventions to improve its resilience (Tendall et al. 2015).

3. Methods (& case study description)

3.1. SAE resilience assessment guidelines

The resilience assessment of the tef value chain is based on the methodological approach developed by the SAE-Group of the Swiss Federal Institute of Technology ETH Zurich. The methodology consists of a guideline, which gives concrete suggestions on how to assess food system resilience step by step and design interventions that aim to improve the resilience. In order to satisfactorily capture the complexity of food systems, the guideline is based on a holistic and participatory approach.

In a first step, the approach proposed in the SAE guidelines was adapted to the specific case of the tef value chain in Ethiopia. Due to restricted resources (mainly time) and limited data available on the topic, the present study mainly focuses on the resilience assessment of the value chain and only briefly touches the resilience intervention design. The modified approach can be seen in Table 1.

Table 1: Adapted guideline steps to assess the resilience of the tef value chain

Stage	Step	Chapter
1 Problem identification and framing		Research plan 2. Introduction 3. Food system resilience
2 Definition of the system	2.1 Define system in its context	5.1.1 Context of the tef value chain 5.1.2 Tef and its role for food security in Ethiopia
	2.2 Identify drivers	5.1.3 Drivers of change
	2.3 Map system	5.1.4 Material flow analysis 5.1.5 Spatial distribution of the tef value chain
	2.4 Analyze stakeholders	5.1.6 Actors in the tef value chain
	2.5 Identify shocks	5.2 Shocks affecting the tef value chain in Ethiopia
3 Resilience assessment	3.1 Assess resilience	5.3. Resilience of the tef value chain in Ethiopia
4 Formulation of interventions	4.1 Design interventions	5.4. Building resilience of the tef value chain

After framing the problem (1) by developing the research plan for the thesis, the system under study had to be defined (2). In a first step, the context of the tef value chain was identified (2.1) (e.g. the social and economic settings surrounding the value chain actors) and the role of tef for food security in Ethiopia was clarified. As these settings aren't static, the most important drivers of change (2.2) affecting the tef value chain were identified. Further, the tef value chain was mapped (2.3), conducting a material flow analysis, identifying the most relevant processes and determining the spatial distri-

bution of the chain. Later on, the most important stakeholders had the opportunity to validate these maps. In a next step, important actors and stakeholders of the tef value chain were identified (2.4) using a snowball sampling approach (cf. Reed et al. 2009) and their interactions, influences and importance in the value chain were analyzed. As a last step of defining the system, most important shocks affecting the tef value chain were determined (2.5) and classified according to their effect on the different value chain processes.

In a next step, the resilience assessment of the tef value chain was undertaken. Therefore an extensive questionnaire is provided in the guidelines. The questionnaire consists of qualitative questions, which are assigned to different attribute categories. The different resilience attribute categories are described in Table 2**.** In a first step, the resilience questionnaire was adapted for the different processes (not all questions suited all processes) and then answered the best possible with the available data. As reliable data on the topic is very limited, qualitative assessment techniques were used to answer the resilience questions. The complete catalogue of questions with respective answers for each process are listed in the Appendix 1.

Later, resilience performance for each attribute and process of the value chain was evaluated. Therefore a rating method with a five-tier scale was introduced (cf. Figure 3). Since data collection was mostly carried out using qualitative techniques, qualitative criteria were also used to evaluate the data. Besides the resilience score, a rating scale for the data basis and the importance of an attribute for the resilience performance of the whole process was given. Finally, a weighed resilience score was compiled for each process and attribute, combining the resilience scores with the respective importance of the attributes. Very important attributes thereby weighed the respective resilience scores (e.g. converting a low resilience score into a very low resilience score) while rather unimportant attributes reduced resilience ratings (e.g. a high resilience score becoming a medium resilience score). Somewhat important scores left resilience scores unaffected.

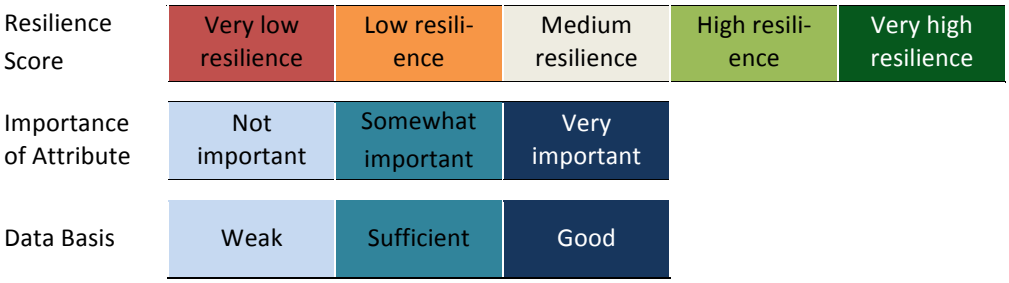


Figure 3: Rating scale for the resilience assessment

In a last step, interventions (4.1) to improve the resilience of the different processes in the tef value chain for a specific scenario (drought) were developed in a stakeholder workshop (see chapter 3.2).

Table 2: Attributes of the resilience assessment questionnaire (adapted)

Attribute	Description	Number of questions
Buffering capacity	- Spare capacities (infrastructure, financial, etc.) of the activity and supporting activities (logistics, communication) in case of increased demand respectively a shock. - Existence and distribution of stocks of inputs and products.	8
Environmental capital	- Capacity of environmental resources to react to changes - Impacts of the different activities on environment - Nutrient and waste balances of the activities - Existence of measures to protect environment against impacts from activities	9
Connectivity	- Connectivity among different actors of the value chain and - Availability of support services (logistics, communication) to enable connectivity. - Length and complexity of the value chain and specific supply chains - Dependency of the activity on single inputs/processes/actors with no alternatives	7
Diversity	- Spatial distribution of actors, activities or input sources. - Diversity of income sources, marketing/supply channels, ways to conduct an activity, varieties, sources of nutrition, etc.	10
Equitability	- Existence and fairness of rights, regulations, entitlements, land tenure policies, dispute resolution mechanisms, etc. affecting the different activities. - Equitability (generational, gender, ethnical, etc.) of access to inputs, land, food, etc.	8
Exposure to pressure	- Frequency of exposure to shocks and capacity of the activity to overcome them.	5
Governance capacity	- Government support for the activity in case of shocks - Capability, responsiveness and sense of responsibility of governance to react to disturbances and future challenges of the different activities. - Transparency, legitimacy and representativeness of governance.	12
Information and learning	- Knowledge base and education level of actors - Investment in knowledge generation of actors (e.g. through extension services) - Access of actors to information (e.g. price) and early warning systems for shocks - Existence of accountability procedures, quality control mechanisms, etc. - Level of trust among actors - Capacity of actors to learn from previous experiences	15
Profitability and financial capital	- Commercial viability/profitability of the activity - Possibility for activity to generate funds for investment (e.g. through savings, credits) - Reliance of activity on distortionary subsidies or other sources of income - Exposure of the activity to financial risks (e.g. outstanding debts) - Insurance of the activity against damages/losses	9
Self-Organization	- Autonomy and control of the actors over the activity and resources - Ability of actors for self-organization, networking and to show self-initiative - Capacity and motivation of actors to react during and re-establish function after a shock	8
Transformability	- Openness of the activity, its leaders and the surrounding culture to change. - Opportunity for experimentation and innovation among actors.	4
Total		95

3.2. Data collection

Three different sources of data were used to carry out the resilience assessment. In a first step, literature research was done on the topic. However, as tef is nearly only grown in Ethiopia and has been largely neglected by international science community until now, very limited literature is available on the topic. Consequently, data had to be collected on-site, and therefore a 2-month field trip to Ethiopia was undertaken. Compilation of data was mainly done through interviews with different representatives from the tef value chain. Interviews can roughly be grouped in stakeholder-interviews (e.g. with input suppliers, farmers, traders, consumers, etc.) or experts-interviews with representatives from government institutions (Ministry of Agriculture (MoA), Agricultural Transformation Agency (ATA), Disaster Risk Management Food Security Sector (DRM-FSS), etc.) or researchers from different institutions such as the Ethiopian Institute of Agricultural Research (EIAR), the International Food Policy Research Institute (IFPRI), Universities or the Famine Early Warning System Network (FEWSNET). Besides gaining further understanding on the tef value chain and the resilience performance of its actors, the goal of the interviews was to validate existing information and access new data. Stakeholder-interviews were carried out in a semi-quantitative way using question-

Figure 4: Tef value chain workshop participants

naires (see Appendix 2) and usually some follow-up questions, while expert interviews were totally qualitative with interviews being recorded. All in all, 35 stakeholder- and 16 experts were interviewed.

Finally, a workshop was organized to bring together different stakeholders from the tef value chain and discuss the resilience topic from different points of view. Overall 26 participants took part in the workshop, with 19 of them being direct stakeholders of the value chain and 7 experts from different fields of expertise. Participants were grouped according to their activity in the value chain, finally making up 8 different groups representing all major steps of the tef value chain and two workshop sessions were held. In a first session, groups had to identify the 5 most important shocks affecting their activities and explain how exactly these shocks affect them. The focus of the second session was set on “resilience building” and participants had to come up with interventions to improve the resilience of their activity in case of a drought (see detailed program in Appendix for more information). Finally, groups presented their results (posters) from the two sessions followed by an open discussion among all participants.

Outcomes from the workshop were multiple. On the one hand, information on shocks, shock scenarios and potential interventions in case of drought was generated and later used in the resilience assessment of the tef value chain (see chapters 4.1.8, 4.2, 4.3). On the other hand, awareness on the resilience problematic was enhanced among the different exponents of the tef value chain and therefore directly contributed to building resilience in the tef value chain in Ethiopia.

4. Results

4.1. Tef value chain in Ethiopia

4.1.1. Context of the tef value chain

The issue of food security is still of high prominence in Ethiopia. Nationwide food shortages occurred almost once a decade in the last 50 years (1973; 1982-1984; early and late 1990's, 2002-2003, 2011) (Berry 2003, Williams and Funk 2011). According to FAO (2015), 32% of the total population in Ethiopia is estimated to have been undernourished in 2014. Over the past years, around 7 million people faced chronic food insecurity and additionally up to 4.5 million require emergency food assistance every year, as they were affected by disasters such as droughts, floods or extremely high food prices (cf. Zerihun et al. 2014, Funk et al. 2012). To provide this food assistance, Ethiopia has over the past decades become increasingly dependent on international food aid (Shahidur et al. 2009). Over the last ten years, food aid constituted about 4-7 percent of total cereal consumption in Ethiopia (Minten et al. 2012).

A possible explanation for the remaining high food insecurity may be found in the structure and role of agriculture in Ethiopia. Ethiopia relies mostly on domestic food production to cover the food needs of its population, with only about 10 % of cereals being imported (Minten et al. 2012). However, productivity of Ethiopian agriculture is limited. Smallholder farmers are cultivating 95% of the farmland and producing more than 90% of the total agricultural output (Gebre-Selassie and Bekele 2012). Yields are still at a very low level (2.22 t/ha in average for cereals in 2013) compared to the world average (3.85 t/ha in 2013) or industrialized countries like the United States (7.34 t/ha in 2013) (World Bank 2015). However, productivity in Ethiopia has steadily improved over the past years, surpassing the average cereal yields of the least developed countries (UN classification) in the last 3 years (1.98 t/ha in 2013) (World Bank 2015). The low productivity of Ethiopia agriculture is mostly owed to limited use of improved farming practices and inputs such as fertilizer (Zerihun et al. 2014). Further, crop production in Ethiopia is largely rain-fed (only 2% of cropland is irrigated) and therefore highly vulnerable to environmental and climatic shocks (World Bank 2006a). Accordingly, variability of yields and prices for agricultural goods are among the highest in the world (Shahidur et al. 2009).

On the other hand, agriculture is still the backbone of the Ethiopian economy, making up 42.7% of the GDP in 2013, about 70% of the export earnings and over 80% of the employment in Ethiopia (Zerihun et al. 2014). Therefore, agriculture in Ethiopia is not only crucial for food security but also a major source of livelihood.

4.1.2. Background on tef

Within the Ethiopian food production, tef plays an essential role. 6.62 million farmers grow the crop that occupies 22 percent of the total cultivated area (Worku et al. 2014) and is second only to maize in terms of production (see Table 3). Being produced by 43 % of all Ethiopian farmers (Worku et al. 2014) and regarding the fact that it is a very la-

bor-intensive crop (Setotaw 2013), tef production is a source of employment and livelihood for an estimate 25-30 million people. Further, tef is the most commercialized crop in Ethiopia with approximately 36% of the total produced tef being marketed (Minten et al. 2013). The popularity can be explained with its high price (see Table 3), making tef attractive as a cash crop for farmers. Combined with the high share of the final price obtained by the farmers (approx. 80%), income from tef is much higher than income from other cereals and even 34% higher than income from coffee, the major export crop in Ethiopia (Minten et al. 2013, Worku et al. 2014). Finally, tef is also the crop of highest value in the country, estimated at about 2.5 billion USD for the total production in 2013/14 (Worku et al. 2014).

Table 3: Production facts of tef and other major cereals in Ethiopia

			Quantities (mln ql)				Value
	Producers (mln)	Area (1,000 ha)	Production	Market surplus	Yield (ql/ha)	Price (Birr/kg)	Production (Bio USD)
Tef	6.61	**3016**	44.1	**13.1**	14.6	**11.03**	**2.52**
Maize	**8.81**	1994	**64.9**	7.2	**32.5**	4.75	1.59
Wheat	4.74	1605	39.3	7.2	18.7	7.71	1.57
Sorghum	4.79	1677	38.3	3.9	22.8	6.42	1.27
Barley	4.46	1019	19.1	2.4	18.7	6.95	0.69
Total cereals	13.42	9849	215.9	35.2			8

Source: Adapted from Worku et al. 2014 and CSA agricultural sample surveys 2013/14.

However, compared to the other major cereals in Ethiopia, yields of tef are relatively low (see Table 3), for instance not even half of the yield of maize (Worku et al. 2014). Reasons for these low yields can be found in the high pre- and post-harvest losses (each 25-30%), which reduce the final tef yields by up to 50% (Fufa et al. 2013). Furthermore, tef can be classified as an "orphan" crop that has been largely neglected by the global scientific community and therefore remained excluded from plant science advances (ATA, MoA, EIAR 2013). However, despite the low yields, tef remains very popular among Ethiopian farmers, amongst others for the following reasons:

i. Tef realizes higher prices than other major cereals and therefore serves as a cash crop for many farmers (Fufa et al. 2013).
ii. Tef straw also fetches high prices as it is the most preferred feed source for livestock and is used as construction material (Alemu 2013).
iii. Tef is endemic and therefore little affected by diseases and pests and can be stored for a long period of time without being attacked by storage pests (ATA, MoA, EIAR 2013).
iv. Tef can be grown under drought-stressed and waterlogged conditions, performs well on different soil types and has a short growing period – it therefore often serves as a security crop for Ethiopian farmers (ATA, MoA, EIAR 2013).

In terms of consumption, tef is just as essential in Ethiopia, being daily staple food for about 60% of the population (50 million people) and responsible for about 15% of all calories consumed (ATA, MoA, EIAR 2013). Further, prepared as *enjera* (a kind of flat-bread), tef is the most preferred crop in the diet of Ethiopians and plays an integral role in culture and tradition (Wondimu and Tekabe 2001). Tef is also nutritionally very rich, as it contains high levels of energy and micronutrients (especially iron), is gluten free and has the highest amount of protein among cereals consumed in Ethiopia (ATA, MoA, EIAR 2013). Its consumption can therefore contribute to prevent many diseases resulting from unbalanced diet, such as anemia, obesity or diabetes (ATA, MoA, EIAR 2013).

Table 4: Urban versus rural per capita consumption of cereals in 2011

	National		Urban		Rural	
	kg	Share (%)	kg	Share (%)	kg	Share (%)
Tef	34	9.4	**81**	**25.5**	24	6.6
Maize	**51**	**14.3**	18	5.7	**58**	**15.7**
Wheat	25	7.0	18	11.1	23	6.3
Sorghum	28	7.9	12	3.6	32	8.7
Barley	10	2.7	4	1.1	11	3.0
Five major cereals	148	41.3	150	47	147	40.3

Source: Worku et al. 2014.

4.1.3. Tef and its role for food security in Ethiopia

Over the past years, tef has experienced a tremendous price increase (**Figure 5**). For many Ethiopians, tef has therefore become unaffordable for daily consumption and poor and even middle-income households have begun mixing tef with other cereals such as maize, wheat or sorghum to make enjera (Berhane et al. 2011, Fufa et al. 2011). The share of tef in total cereal consumption has accordingly declined from 31% in 1961 to 18% in 2012, although tef remains the most preferred cereal in Ethiopia (Demeke and Di Marcantonio 2013). As the price of tef is nowadays more than twice as high as the cheapest cereal, tef has become rather a luxury than a staple food in parts of Ethiopia. From a food security perspective, maize, wheat and sorghum are nowadays more critical than tef (Demeke and Di Marcantonio 2013). Tef shows highest income elasticity among all cereals, implying that an increase in income leads to a disproportional increase in tef consumption (Worku et al. 2014). In fact, in poorer, rural areas, tef is nowadays often only consumed during special festivities, offered to special guests or consumed by older family members (Berhane et al. 2011). For wealthier urban population, however, tef remains an almost daily food item and per capita tef consumption in urban areas is more than three times higher than in rural areas (see Table 4).

For tef farmers on the other hand, higher tef prices are an incentive to grow the grain as a cash crop and sell it on the market. In fact, in recent years incentives to grow tef for sale have improved as relative prices for tef increased while the price of other staple crops such as maize has decreased (Demeke and Di Marcantonio 2013). For the 6.61-million tef farmers and the approximately 25-30 million people depending indirectly on tef production, higher tef prices therefore are an opportunity to obtain higher incomes. Consequently their purchasing power to acquire cheaper cereals rises, and along with it, the food security level in the country. Since the commercialization rate of tef is already the highest among all crops in Ethiopia and tef producers receive a relative high share of the final retail price compared to other crops, the effect of such a price increment on food security is even more probable.

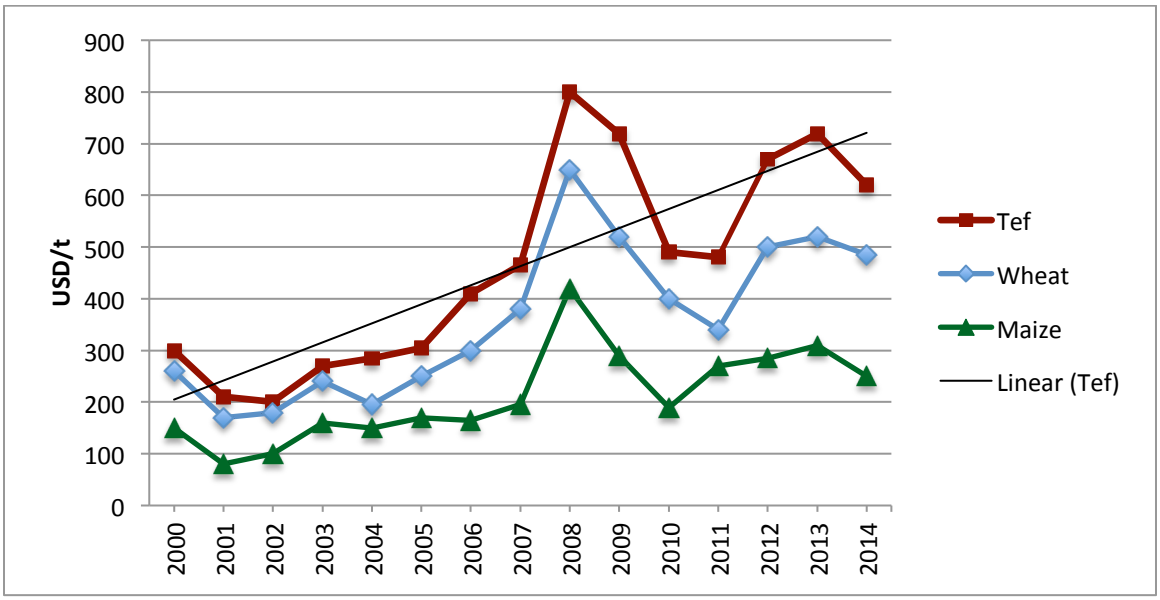


Figure 5: Trends of cereal crops wholesale prices at Addis Ababa market **(**adapted from Abraham 2015).

4.1.4. Drivers of change

The circumstances surrounding the tef value chain in Ethiopia are gradually changing. The following chapter shall therefore give an overview over the most important drivers of change affecting the tef value chain and its actors.

4.1.4.1. Population growth

At the moment, Ethiopia is one of the 10 fastest growing countries worldwide. From 18 million people in 1950, its population increased to almost 100 million in 2015 (UN Population Division 2015). Even though population growth rate is decreasing more than the Sub-Saharan average, it still lies at 2.5 (EU e.g. 0.3) and population is expected to reach 188 million by 2050 (Worku et al. 2014, UN Population Division 2015). As it can be seen in **Figure 6**, the population density varies strongly throughout the country, with popula-

tion concentrating on the highlands and the rift valley. Comparing the population distribution in Ethiopia (**Figure 6**C) with the tef production areas (**Figure 6**A), it becomes obvious that tef is predominantly grown in areas with the highest population densities of Ethiopia. These are at the same time the areas with the highest population growth (cf. Funk et al. 2012).

Impacts of this high population growth on the tef value chain are manifold. Besides increasing demand for tef, population growth affects tef farmers by putting increasing pressure on natural resources such as land, forests or soils, especially in the population-dense highlands (cf. Tedesse and Headey 2012).

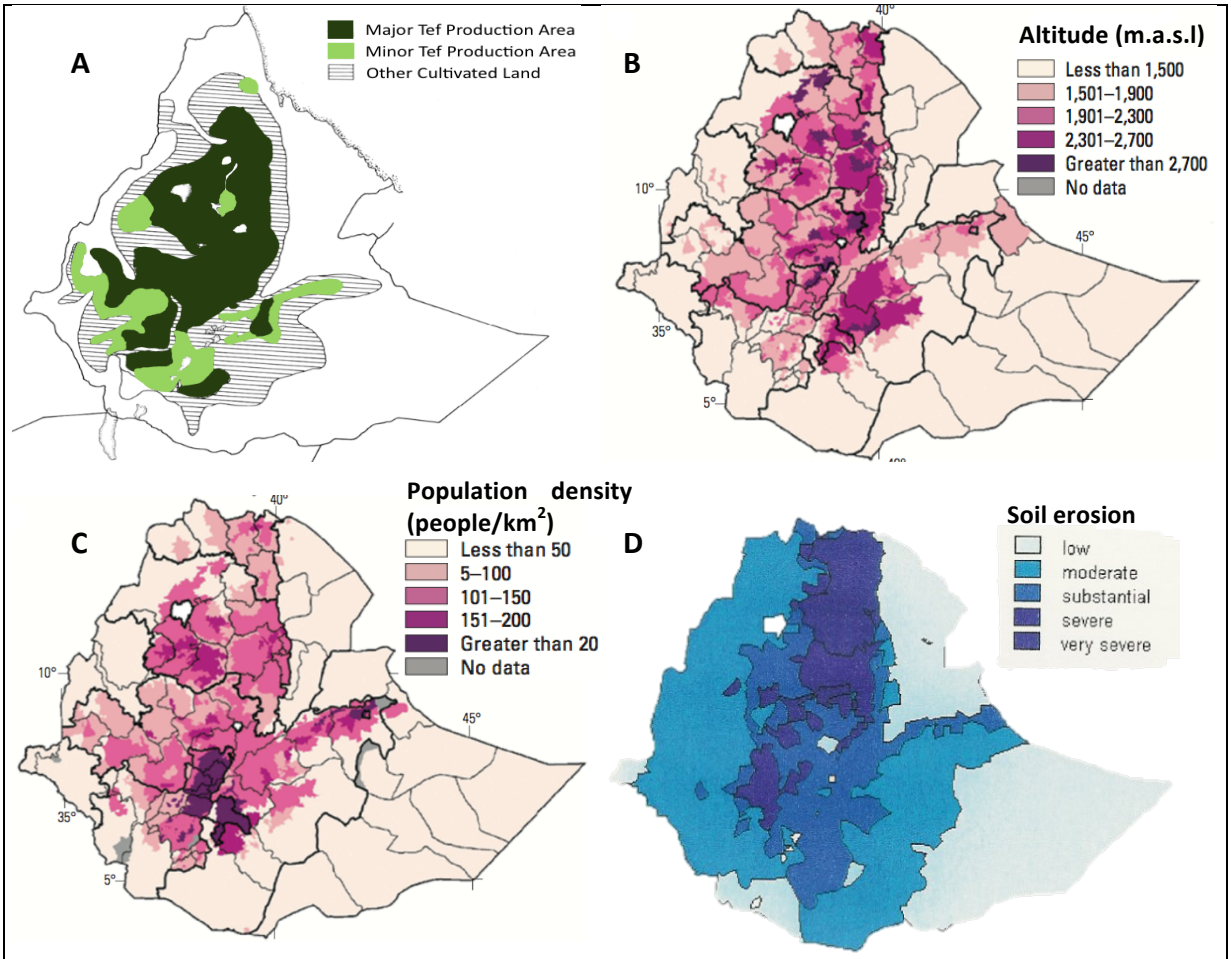


Figure 6: Background information on tef production and drivers of change in Ethiopia.
A: Major tef production regions in Ethiopia and Eritrea (adapted from Katema 1997).
B: Altitude, in meters above sea level (adapted from Funk et al. 2012).
C: Population density based on the 2007 Population Census (adapted from Funk et al. 2012).
D: Regional extent and level of soil degradation in Ethiopia (adapted from Hekkeling 1989).

4.1.4.2. Land shortage

Like population density, farm sizes in Ethiopia show big variation throughout the country. While there are large areas of mostly unpopulated land in Ethiopia's lowland peripheries, the population-dense highlands face extreme land shortage and average farm size in some areas (SNNP) has dropped to 0.49 ha by 2012 (cf. Tedesse and Headey 2012, Headey et al. 2014). Average farm size in Ethiopia was 0.96ha in 2011-2012, with nearly 40% of the farmers relying on less than 0.5ha (cf. Headey et al. 2014).

Causes for the diminishing farm sizes can be found mainly in farm inheritance schemes and Ethiopian land tenure system. Land in Ethiopia is owned by the state and cannot officially be sold, exchanged or mortgaged (Gebre-Selassie and Bekele 2012). Basically, the only way of acquiring land is through intrafamily inheritance. Due to the high rates of fertility, younger generations thus inherit much smaller farms than their parents did, even with some emigration (Headey et al. 2014). Another consequence of these farm inheritance schemes and the land tenure system is a high fragmentation of land in Ethiopia (Gebre-Selassie and Bekele 2012, Abate 2015).

The diminishing farm sizes and the high land fragmentation have severe impacts on food security in Ethiopia. While crop yields have been improving in the past years, the farm sizes have decreased at a rate twice as fast (Funk and Brown, 2009). If this trend continues, the per capita cereal production could decline by 28% until 2025 (Funk et al. 2012). Decreasing farm sizes also have a negative impact on the use of improved farming techniques such as crop rotation, intercropping or using fallow periods and consequently soil degradation is generally increasing with diminishing farm sizes (Gebre-Selassie and Bekele 2012, Tesfa et al. 2013).

4.1.4.3. Soil degradation

According to Gete et al. (2010), Ethiopia ranks among the most severely erosion-affected countries in the world. Soil fertility issues are manifold, ranging from topsoil erosion, depletion of nutrients and organic matter until soil salinity and acidification problems (cf. Gete et al. 2010). The highest soil degradation in Ethiopia can be found in the highlands due to the steep topography in combination with the high rain intensities (Berry 2003). In addition to that, these areas show the highest population and livestock densities of the country (Gete et al. 2010). As shown in **Figure 6**, the highlands are also the major tef production area. This coincidence, however, is not surprising, as traditional tef production is known to have a substantial negative impact on soil fertility. Topsoil erosion for instance was shown to be three times greater for tef than for wheat and twice that of maize (Assefa et al. 2009). The major reason for this is the high tillage frequency (more than 5 times in some areas), as a fine seedbed is required for the small tef seeds to germinate (Friew and Lake 2013, Tefera et al. 2002). Further, land preparation for tef occurs during the rainy season, with soils being exposed to high rain intensities, while land preparation for other crops takes places before the main rainy season (Assefa et al. 2009).

Additionally tef contributes significantly to the organic matter depletion problem in Ethiopia. The main cause for this is the widespread use of dung as fuel source, as only 15 percent of all Ethiopians have access to electricity and firewood is scarce (Gete et al. 2010, World Bank 2006b). Since tef straw is of high value as animal feed and as construction material, tef is cut very close to the ground when harvested (Kebebew 2015). Therefore, nearly all tef plants biomass is removed, which further contributes to the organic matter depletion.

4.1.4.4. Climate change

Another driver of change affecting food security in Ethiopia is climate change. Observed climate trends indicate that in many areas of Ethiopia seasonal mean temperature has increased (Funk et al. 2011, 2012), rainfall decreased (mainly between March and May/June) (Williams and Funk 2011, Funk et al. 2008) and frequency of droughts and heavy rainfall has increased over the last 30-60 years (Funk *et al.* 2008; Williams and Funk, 2011, Lyon and DeWitt 2012). Climate projections for the future generally show a continuation of these trends (cf. Niang and Ruppel 2014) leading to a higher frequency of heat waves (Conway and Schipper 2011), heavy rainfall events (Seneviratne *et al.* 2012) as well as higher rates of evaporation and a wide range of rainfall spatial pattern changes (Conway and Schipper 2011).

Ethiopia is particularly exposed to possible adverse impacts of climate change as a large proportion of the population is dependent on agriculture for employment and food security (Admassu et al. 2013) and agriculture is greatly weather reliant with limited irrigation possibilities (Minten et al. 2013). The consecutive failure of spring rains over the past years (see Figure 7) is of special concern for food security in Ethiopia, as it affects long cycle crops like maize or sorghum that rely on both spring and summer rains. These crops account for approx. 50% of the national crop production and show substantially higher yields than short cycle varieties (Funk et al. 2005). As a consequence, short cycle crops like tef might in the future become more important for food security in Ethiopia.

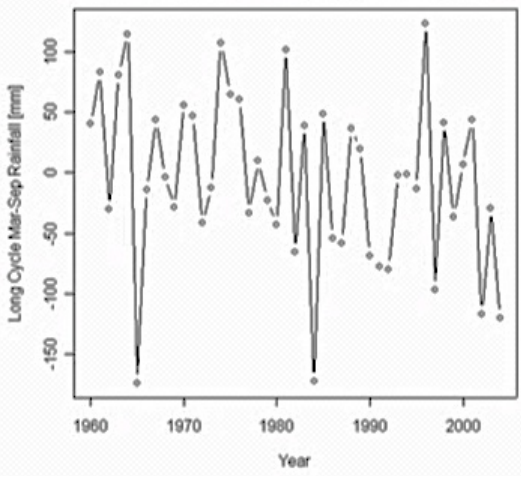


Figure 7: March-Sep rainfall totals for long cycle crop regions in Ethiopia (1960-2010) (Funk et al. 2005).

Tef is generally known to be quite well adapted to different biotic and abiotic stresses, such as waterlogging, drought or pests and disease infestations (ATA, MoA, EIAR 2013). It is therefore often used as a security crop in drought prone areas, ensuring at least some yield in drought years whereas other crops would show total failure (Abate et al. 2005, Kebebew 2015). However, droughts and unexpected, heavy rainfall events (especially at the end of a growing season) can also have devastating consequences on tef yields (Mengitsu and Mekonnen 2012, Ayele 2015) making climate change an important driver of change affecting the tef value chain.

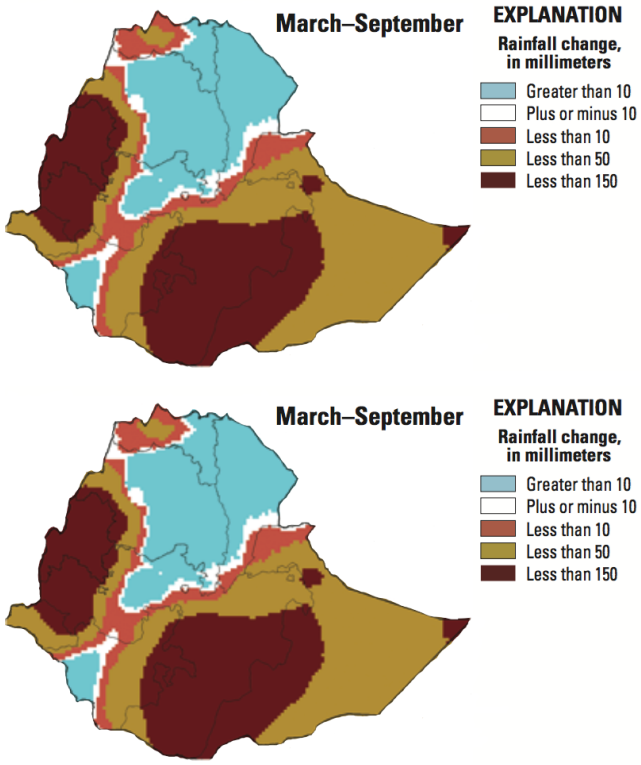


Figure 8: Observed and projected changes in rainfall and temperature in Ethiopia. Calculated projections for 2010-2039 are based on observed changes in temperature and rainfall patterns from 1960-2009 (adapted from Funk et al. 2012).

4.1.4.5. Urbanization

Finally, urbanization is another factor that has direct implications on the tef value chain. Even though less people live in cities in Ethiopia compared to other developing countries in Africa, the urban population has been growing steadily in recent years (World Bank 2006a). In 2013, 18.6 % of the Ethiopian population lived in urban areas and by 2050, urban population is expected to make up nearly 40% of the total population (see **Figure 9**)(UN Population Division 2014).

People in urban areas are much less likely to grow their own food and therefore depend on food systems. To ensure future food security in Ethiopia, well-functioning food value

chains as well as an increase in commercial surplus production by the farmers is crucial (Minten et al. 2013). This is even more important for tef, as tef consumption in urban areas is three times higher than in rural areas (see Table 4). With increasing urbanization, demand for tef is therefore likely to increase in Ethiopia. Finally, urbanization is often accompanied by a lifestyle change, which in case of tef has led to an increase in demand for ready-to-eat enjera and the more expensive white tef (Worku et al. 2014).

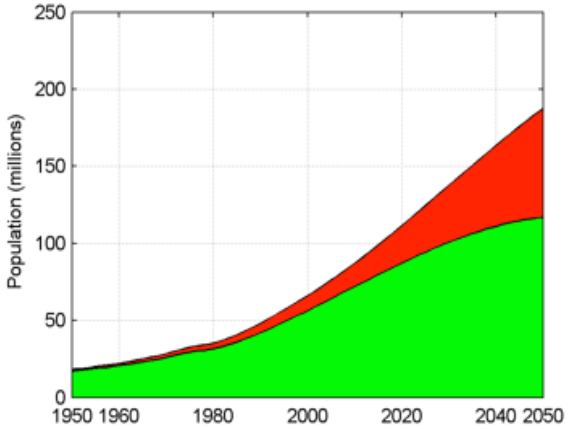


Figure 9: Urban and rural population in Ethiopia (United Nations Population Division 2014).

4.1.5. Material flow analysis

The tef value chain in Ethiopia can be divided into five major steps, namely input supply, production, trade, processing & retail and consumption. Since tef processors are usually also selling their own products, processing and retail are grouped in one step. On the other hand, trade is assigned an own process, as it is a crucial step in the value chain with many actors involved. As shown in **Figure 10**, the majority of tef production is dedicated for self-consumption or seed purpose by the farm households. However, according to Minten et al. (2013), 36 % of all tef is destined for market.

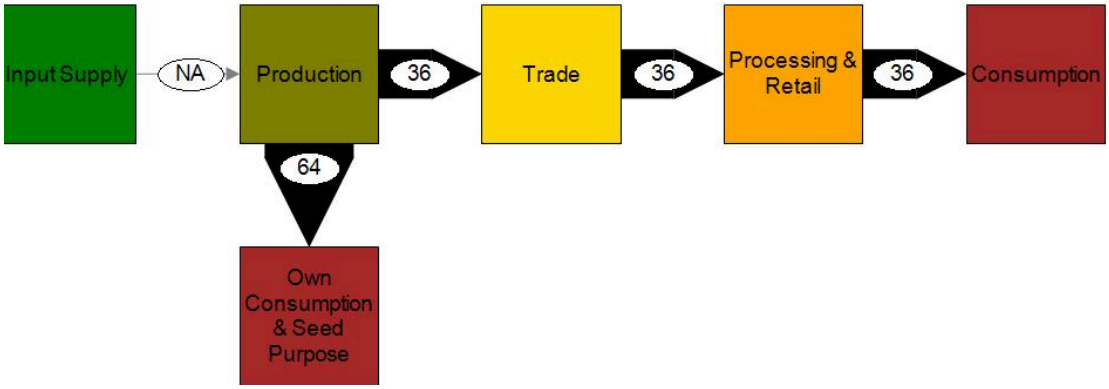


Figure 10: Processes of the tef value chain. Material flows in % of total tef production (adapted from Minten et al. 2013).

Input supply

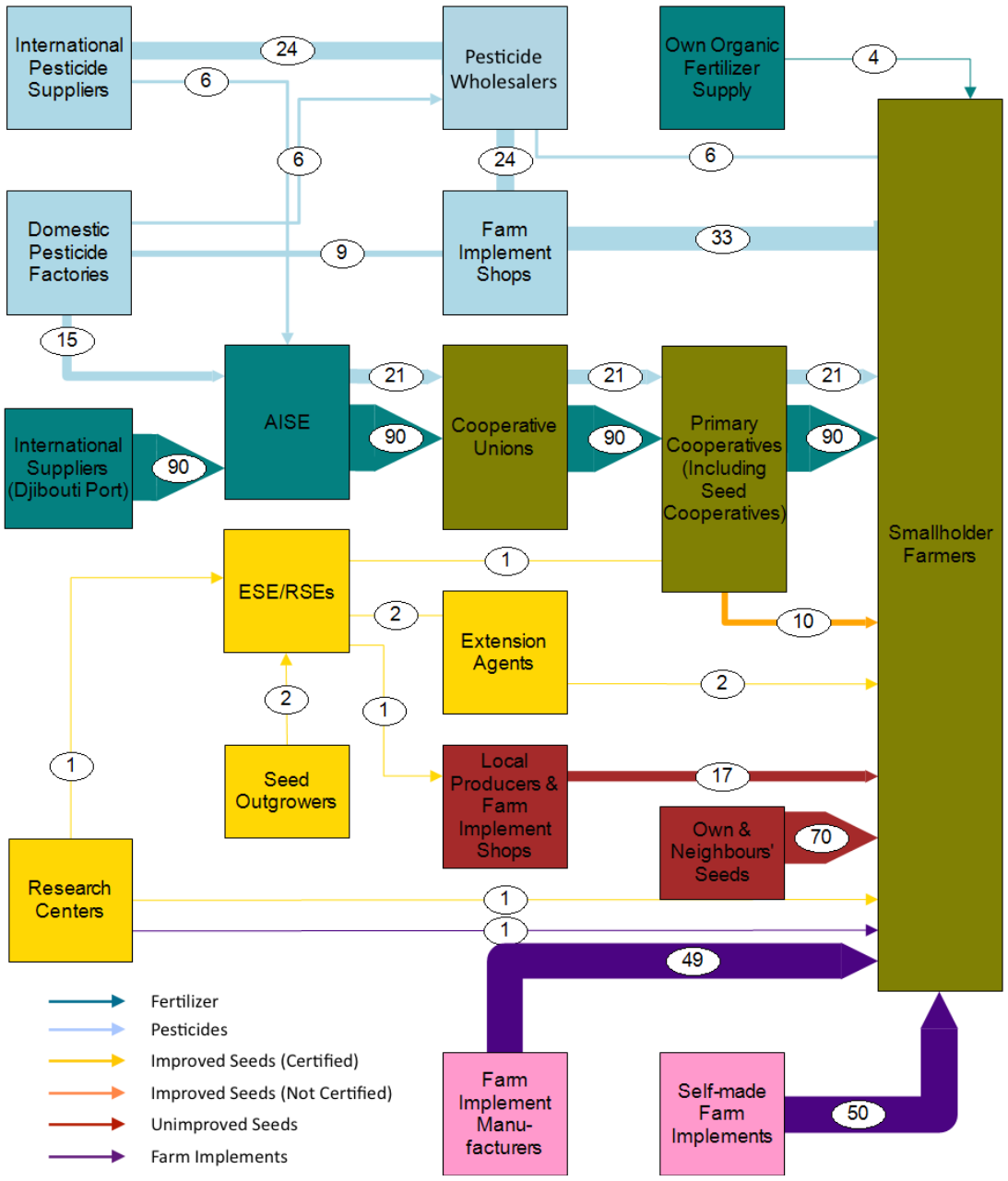


Figure 11: Material flows of the input supply. Numbers represent the % of tef farmers using a certain input (e.g. 60% of tef farmers using pesticides). AISE stands for the Ethiopian Agricultural Input Supply Enterprise while ESE resp. RSEs represent the Ethiopian respectively Regional Seed Enterprises. (Authors calculations based on Begna 2015, DZARC 2013, Setotaw 2011, Sherif 2013, Minten et al. 2013 and expert interviews).

Main inputs necessary for tef production are fertilizer, seeds, pesticides and farm implements. In order to have easier access to inputs, the majority of farmers in Ethiopia are organized in cooperatives. Primary cooperatives and cooperative unions thus play a

major role in the input supply for tef production, mainly for fertilizer and pesticide supply.

Inorganic fertilizer is a crucial input for tef production and nearly 90% of tef farmers are estimated to make use of it. However, due to limited financial means and access to credits, fertilizer use rates are often below recommended rates (Melekot 2015, Minten et al. 2013). Supply is totally state controlled, with the Agricultural Input Supply Enterprise of Ethiopia (AISE) enjoying monopoly power on fertilizer imports and cooperatives being the sole distributors (Shahidur et al. 2012). Organic fertilizer is only used by a small number of farmers, since dung and crop residues face competitive uses (fuel source, animal feed, building material) (cf. Gete et al. 2010, Admasu et al. 2009).

Tef seed supply can be divided in a formal and an informal seed sector. The formal sector supplies farmers with improved and certified tef seeds while the informal sector mainly consists of unimproved local tef varieties (MoA, ATA 2013). As shown in Figure 11, about 90% of all tef farmers obtain their seeds from the informal seed sector, through own saved seeds, from neighbor farmers or from local seed suppliers and markets (cf. Setotaw 2013). Share of formal seed supply is minimal (ca. 5%), with major suppliers being extension agents, research centers and farm implement shops. Seed cooperatives also supply improved seeds, however, they are not certified and cooperatives therefore represent the intermediate seed sector (MoA, ATA 2013). The share of improved varieties used by farmers is generally assumed to be higher than represented in the actual supply (about 35% according to Minten et al. 2013), as improved tef seeds can easily be reproduced by the farmers due to the self-pollinating nature of tef (Dawit et al. 2010).

About 60% of all tef farmers are estimated to use pesticides (Setotaw 2013). However, application is infrequent as insecticides are only applied when pest invasions occur and herbicides are often substituted by hand-weeding (depending on labor costs) (Ayele 2015, Setotaw 2015). The supply chain is rather complex, with major suppliers being small pesticides shops and the AISE-cooperative channel. Domestic pesticide plants provide about half of the pesticides, while the rest is imported (Tenna 2015).

Finally, tef farmers typically use traditional farm implements such as plough, sickle, forks, fans or sieves to produce tef (Friew and Lake 2013). These are often made by the farmers themselves or by local manufacturers. In the past years, efforts have been made to introduce improved farm implements including moldboard plough, row-seeder, mechanical broadcaster, broad-bed maker or mechanical threshers (ATA, MoA, EIAR 2013). However, supply with such farm implements is until today nearly inexistent (cf. ATA, MoA, EIAR, 2013).

However, the portrayed input supply system in Figure 11 is only a simplification of reality. In fact, especially the formal seed and fertilizer system are much more complex than shown here, including actors involved in demand estimation, price and market regulation, knowledge dissemination or the input credit system. Detailed maps of improved seed and input credit system can be found in the Appendix 3, 4.

Production & post-production steps

Tef production in Ethiopia is today only done by small-scale farmers (Worku et al. 2014). The vast majority of the tef surplus production is sold to traders and only a very limited amount is marketed through cooperatives or directly to consumers (Minten et al. 2013). Traders are usually small-scale entrepreneurs and brokers play a crucial role in linking rural and urban traders (Fufa et al. 2013).

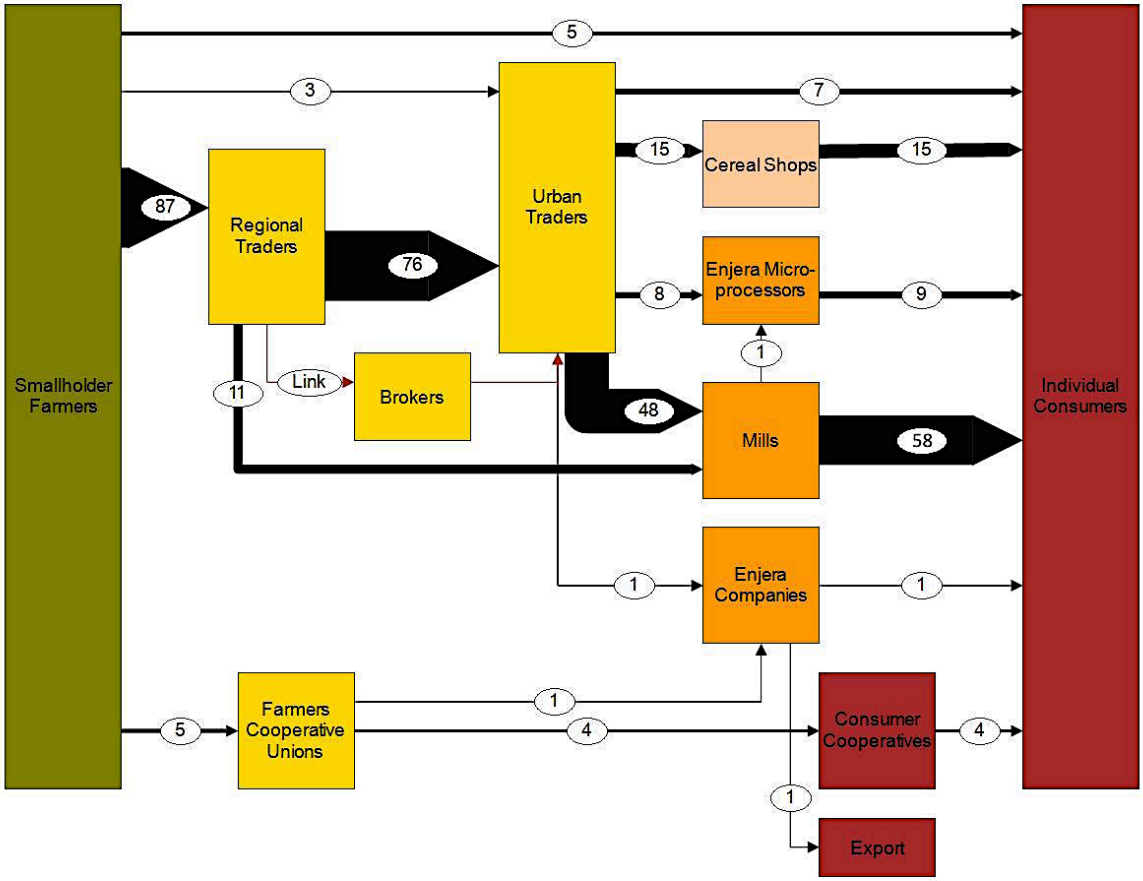


Figure 12: Material flows for the post-production steps. Material flows in % of total marketed tef (authors calculations based on Minten et al. 2013, Woldu et al. 2013 and expert interviews).

The processing step of the tef value chain consists mainly of mills and a small enjera production sector. Mills in rural areas give milling service only (customers bring their own tef), while urban mills also buy tef from traders and act as retailers (Setotaw 2015). Enjera is mainly produced by one-woman businesses called microprocessors and a small share (about 2%) by big enjera companies (ATA, MoA, EIAR 2013). Latter produce for big scale consumers (hotels, colleges, restaurants) and for export (about 1%), while micro-processors usually produce their enjera for special events (e.g. weddings), big scale consumers or for sale in small grocery shops and markets (Ayele 2015, Ashagrie 2015). Processors often sell their products directly to consumers, therefore retail is also included in this value chain step. The only retailers in a classical sense are cereal shops, selling about 15% of the total marketed tef.

The big majority of enjera is produced by households themselves, which usually buy tef on the market, let it mill and make their own enjera (cf. Fufa et al. 2011). They are therefore also the biggest consumers of tef. Some urban consumers are further organized in consumer cooperatives, with the goal to achieve better and more stable food prices (Ayele 2015).

4.1.6. Spatial distribution of tef value chain

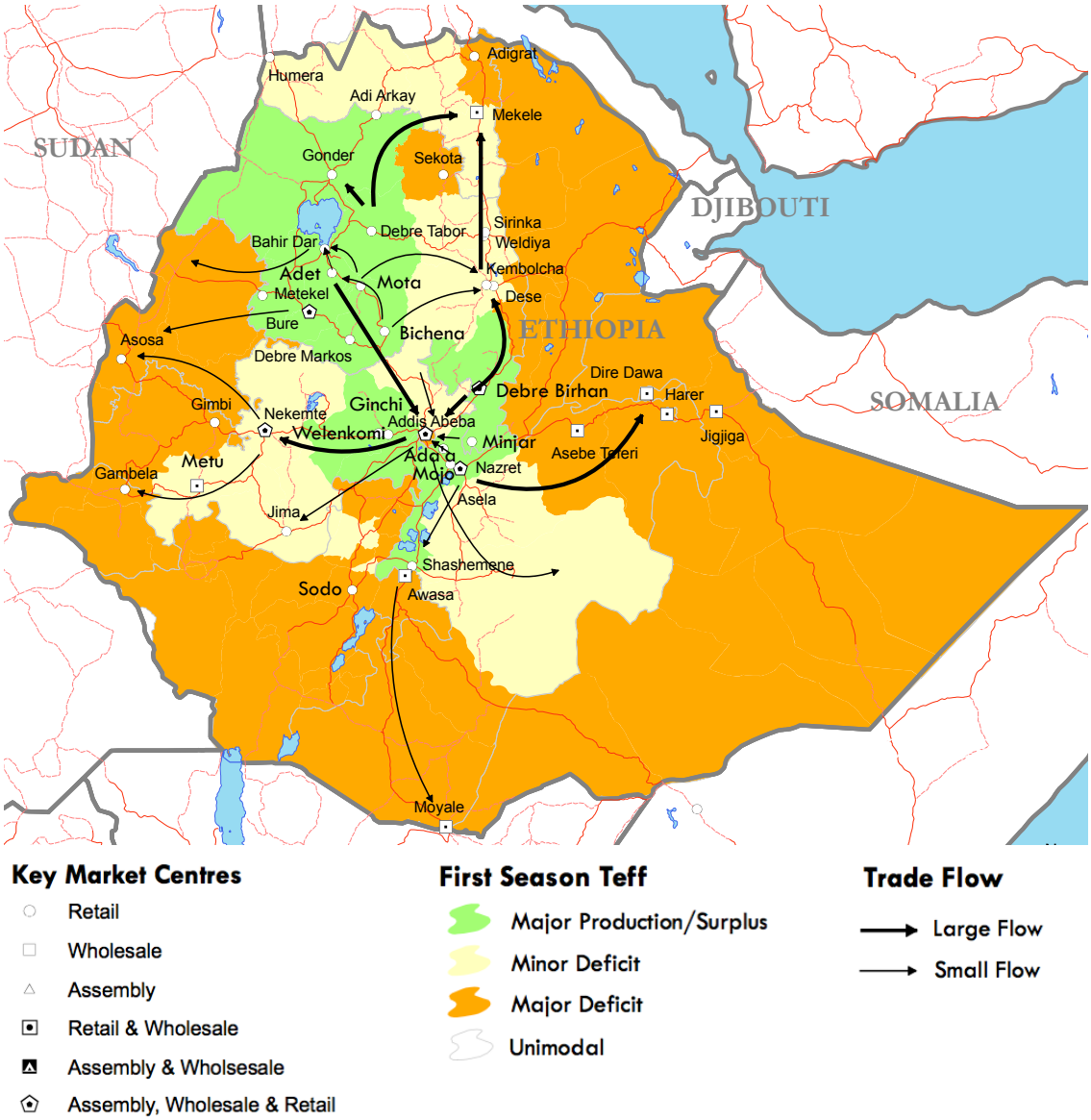


Figure 13: Spatial distribution of production, trade and retail of tef (FEWS NET 2013).

As shown in
Figure 13, the major production zones of tef in Ethiopia are situated in the highlands and the rift valley. The regions of Oromia and Amhara account for 85% of the total tef production (with 48% and 37% respectively), whereas other regions only play a minor role (cf. Worku et al. 2014). Within the high production zones, there are some main as-

sembly points for surplus tef (Mojo/Nazret, Nekemte, Debre Birhan, Bure and Addis Ababa) and from there tef is distributed to major cities throughout the country. However, as obvious in
Figure 13, Addis Ababa is the most important tef hub and it is estimated that more than 70% of the marketed tef is passing through Addis Ababa channels and markets (ATA, MoA, EIAR 2013, Minten et al. 2013).

4.1.7. Actors in the tef value chain

Based on literature sources as well as expert and stakeholder interviews, the most important actors of the tef value chain were identified. For each process, the major players, their number, main functions and their approximate market share were compiled. The market share refers to the estimated percentage of the total turnover volume in a specific market (e.g. tef market, inorganic fertilizer market) captured by one player (respectively group of players). The number of players combined with the market share gives an indication on the specific market power of the different actors (e.g. only 1 player coming up for 100% of the inorganic fertilizer supply emphasizing the monopoly power of AISE). However, the list is only a brief overview over the different actors in the tef value chain and in fact there are many more actors involved in the different processes.

Table 5: Main actors of the tef value chain in Ethiopia

Process	Player	Number of actors	Tasks/Function	Market share	
Improved seed supply	ESE & RSEs)	6	Certified seed production and marketing, coordination of seed production by cooperatives	3%	Of total tef seed supply
	Seed propagators	ca. 1,000	Seed multiplication for ESE & RSEs		
	Cooperative seed producers	ca. 100	Improved seed production (not certified), seed marketing, demand estimation	10%	
	Research institutes	ca. 5	Breeding, basic seed production (100%), dissemination of improved seeds		
	Extension agents	ca. 60,000	Dissemination of improved seeds, demand estimation, seed distribution	2%	
	Farm implement shops	ca. 10,000	Seed marketing	10%	
	RBoAs, MoA	6	Seed demand estimation		
Informal seed supply	Tef farmers	ca. 6,000,000	Reproduction of own seeds and farmer to farmer seed exchange of local and improved varieties	75%	
Fertilizer supply	AISE	1	Fertilizer import & distribution to cooperatives	100 %	Of inorganic fertilizer
	RBoAs, MoA	6	Estimate fertilizer quantity, marketing and distribution of fertilizer, credit guarantees		

	Tef Farmers	ca. 1,000,000	Organic fertilizer production (ca. 4% of farmers use organic fertilizer)		
Pesticide Supply	Farm implement shops	ca. 10,000	Purchase pesticides form big pesticide dealers and factories	55%	Of total pesticide supply
	Big pesticide dealers	5-10	Purchase pesticides from factories, sell it to farm implement shops and farmers	10%	
	AISE	1	Distribution of pesticides from factories to farmer cooperatives	35%	
Traditional farm implements supply	Tef farmers	ca. 6,000,000	Make implements with own materials or bought components (e.g. ploughshare)	50%	Of total farm implements supply
	Local manufacturers	ca. 10,000	Produce farm implements and sell them to farmers	49%	
Improved farm impl. supply	Research institutes	ca. 3	Development and distribution of improved farm implements	1%	
Production	Smallholder Farmers	6,530,000	Production	100% of tef production	
	Primary Cooperatives	ca. 65,000	Fertilizer, pesticide and seed storage and distribution, issue credits and collect loans, organize farmers, tef marketing	5% of tef sales	
	Cooperative Unions	ca. 330		100% of fertilizer distribution	
	Agricultural Laborers	ca. 1,000,000	Day laborers mostly for weeding and harvesting tef		
Trade	Local assemblers	ca. 5,000	Collect tef at farm gate and sell it to traders	8%	Of total tef trade
	Rural traders	ca. 10,000	Buy tef from farmers and assemblers and sell it to urban traders	52 %	
	Brokers	ca. 10,000	Connect rural with urban traders		
	Urban traders	ca. 5,000	Buy tef from rural traders, sell it to mills, big scale and individual consumers	40 %	
Processing & retail	Urban millers	ca. 1,000	Buy tef from traders, mill it and sell flour to customers	40 %	Of tef milling
	Rural millers	ca. 10,000	Usually only give milling service (customers bring their own tef)	60 %	
	Enjera Companies	10-20	Produce enjera for export or domestic big scale consumers	1%	Of enjera production
	Enjera Microprocessors	ca. 100,000	Mostly single women producing small amounts for big scale consumers, special events or sale at small shops	10 %	
Consumption	Individual consumers	ca. 50,000,000	Buy tef and produce own enjera (89 % of total enjera production)	97 %	Of total tef consumption
	Big scale consumers	ca. 50,000	Restaurants, Hotels, Colleges, etc. Purchase tef but also enjera	2%	
	Consumer cooperatives	ca. 300	Purchase big amounts of tef and distribute it to members at better price.	2%	

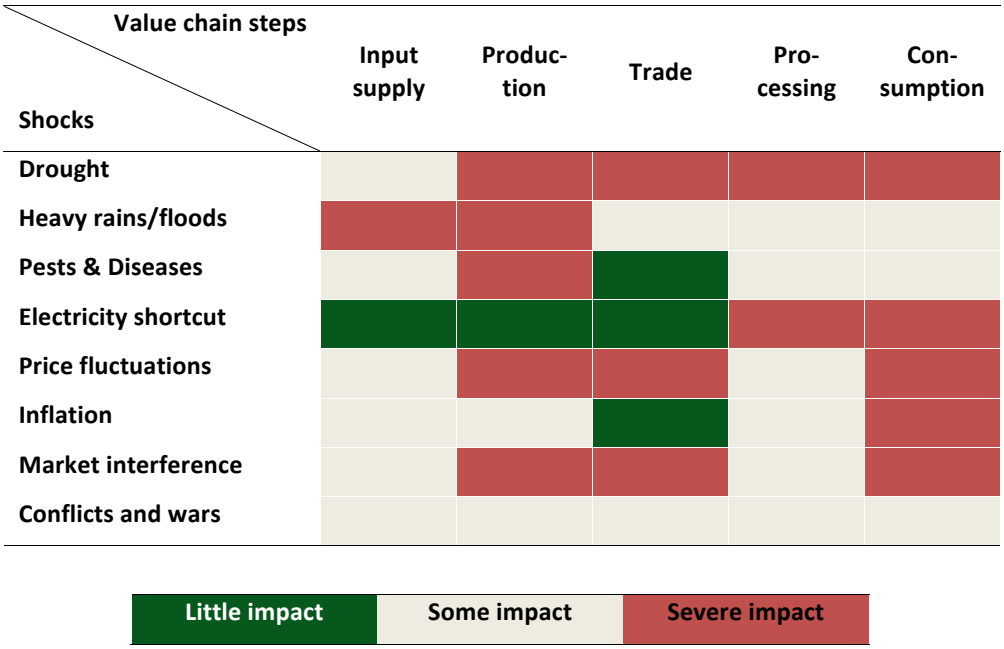
	International consumers	ca. 1,000	Purchase enjera	0.3 %	

Sources: Adapted from Central Statistical Agency (CSA) (various years), Minten et al. 2012, 2013, ATA, MoA, EIAR 2013, stakeholder and expert interviews.

4.1.8. Shocks affecting the tef value chain in Ethiopia

The tef value chain is repeatedly exposed to multiple kinds of shocks. The shocks described below were identified based on expert and stakeholder interviews as well as the stakeholder workshop. However, number of potential shocks for the tef value chain is nearly infinite, and the selected list only represents the most frequent shocks with biggest impact on the value chain.

Table 6: Most important shocks affecting the tef value chain



Source. Value chain workshop and stakeholder and expert interviews.

Droughts

Undoubtedly, drought is the most important shock affecting the tef value chain. A great number of experts, workshop groups (4 out of 8) and visited farmers (6/7) mentioned drought as the major concern for their respective activity. Analogously, many literature sources see drought as major threat for food security in Ethiopia (cf. Williams and Funk 2011, Admassu et al .2009). Severe drought incidences have occurred in Ethiopia nearly once a decade in the last 60 years (1957-8, 1964-6, 1971-75, 1984-85, 1990-92, 1999-2000, 2002-03, 2009, 2011) (cf. IRI 2007, World Bank 2006a, Funk et al. 2005, Viste et al. 2013). In recent years, the frequency of droughts even seems to be increasing and spring and summer rains in parts of Ethiopia have dropped by 15-20 percent over the past 40 years (Funk et al. 2012).

Tef is generally known to be quite drought resistant and is often designated a security crop (Abate et al. 2005). This is due to various features, such as a relatively short growing period, its C4 metabolism and its small water demand (Kebebew 2015, Ayele 2015). However, especially early and late season droughts can have devastating consequences on tef yields (Mengitsu and Mekonnen 2012). Early season droughts may cause poor or delayed germination and fertilizer to remain inaccessible for plants (Ayele 2015). Late season droughts cause irreversible yield losses (Mengitsu and Mekonnen 2012). Tef farmers are obviously most affected by droughts, however, higher tef prices and lower supply affect all subsequent steps of the tef value chain. Seed suppliers face the same risk as farmers. Further, severe droughts have in the past led to the collapse of the fertilizer credit system, as credits were not paid back by farmers. As a consequence the regions restricted credit access for farmers in the following years (Melekot 2015).

Heavy rains/floods

Strong rains and floods can be stated as the second most important shock affecting the tef value chain, as it was mentioned by experts, workshop groups (5 out of 8), visited farmers (3/7) and visited seed suppliers (2/2). Even though impacts from strong rain incidents on tef production are far less important than from droughts, the tef value chain is still affected in many ways. For instance, the transportation system is highly affected, as 90 percent of Ethiopia's roads are dry-weather roads, which become impassable after heavy rains (cf. World Bank 2006a). This is mainly a problem for the farm input distribution, as fertilizer and improved seeds are often distributed in a short timespan before the start of the rainy season. In the past, farmers were repeatedly confronted with failure of timely delivery of fertilizer and improved seeds, which can have severe consequences for tef production (Ayele 2015).

Strong rain incidents are mostly a problem for tef production due to flooding along riverine areas, accompanied by waterlogging and sedimentation (World Bank 2006a). Further, strong rains at the beginning of the tef growing season often cause soil erosion and scouring of tef seeds and fertilizer (Ayele 2015). Unexpected rains at the end of the growing season can lead to lodging, grain shattering and even germination of the mature grains (Kebebew 2015, Ayele 2015). Summarized, rain incidents cause delays in planting, reduce yields and compromise tef quality especially if rains occur around harvest time. This is especially important as flood events in Ethiopia are expected to become more frequently in the future (see chapter 4.1.4.4).

Pests, diseases and weeds

Pest, disease and weed problems were mentioned as another major concern for tef production. All visited seed suppliers and 5 out of 7 farmers reported to occasionally have problems with pest outbreaks and 3 workshop groups listed it as a major shock. Bogale et al. (2013) even mentioned diseases, insects and weed as the number one cause for low yields of tef. As a consequence of changes in climate and farming practices, pest incidences for tef are expected to increase (Ayele 2015).

Among the biotic stresses, insect pests seem to be the major concern for tef production, with shoot fly, ants, tef red worm, degeza bush cricket and tef grasshopper as most im-

portant exponents (cf. ATA, MoA, EIAR 2013). Yield loss estimates due to different tef insect-pests range from 10-30%, however, the estimates are very old and probably overstated (Tebkew 2013). Diseases are reported to be less of a problem for tef as it is an endemic crop. If still affected, tef rust, head smudge, damping-off and helminthosporium leaf spot are predominant diseases (Ayele 2013, Katema 1997, Kebebew 2015). Finally, weeds can cause severe yield losses for tef (up to 65%), especially if left uncontrolled at its early growth stages (Kassahun and Tebkew 2013). Further, weeds reduce grain quality, complicate harvesting and account for the highest labor requirement of all tef cultivation steps (Kassahun and Tebkew 2013).

Inflation

Inflation is one of the most cited economic shocks affecting the value chain actors, as 6 out of 8 workshop groups, 2 out of 3 processors, 3 out of 3 consumer cooperatives and many experts mentioned. As can be seen in **Figure 14**, inflation in Ethiopia showed high variation over the past decade, with three periods where inflation exceeded 20%. Reasons for the high inflation periods were among others, monetary expansion and abrupt commodity price increments (Zerihun et al. 2014).

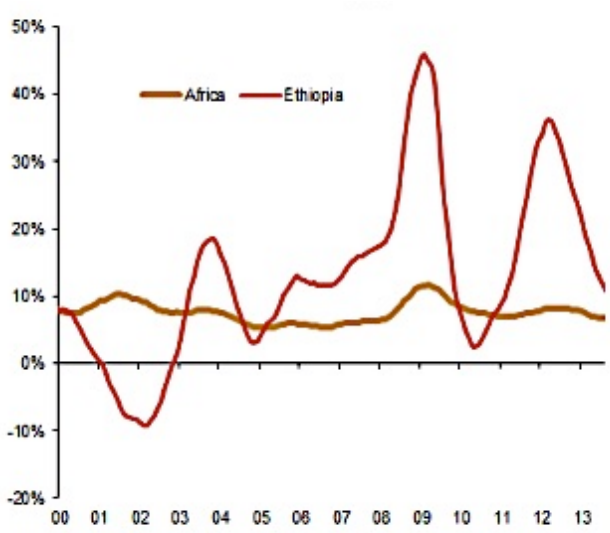


Figure 14: Macro inflation in Ethiopia from 2000 to 2013 (Euler Hermes 2014).

The consequences for the Ethiopian economy and the tef value chain are manifold and complex. First, high rate of inflation compared to the low rate of inflation among Ethiopia's trading partners leads to a currency appreciation, and domestic currency is estimated to have been overvalued on average 20% during the period of 2005-2010 (Demeke and Di Marcantonio 2013). Concerning the tef value chain, this is especially problematic due to higher prices for imported fertilizer and pesticides, challenging the adoption of improved technologies by farmers (Demeke and Di Marcantonio 2013, Zerihun et al. 2014, Ayele 205). Setotaw (2015) reported that farmers in the past shifted from tef production to legumes as a consequence of rising fertilizer prices. As stated by Minten et al. (2012), food price inflation was in the past usually even higher than overall macro inflation. Therefore consumers and overall food security were strongly affected

by the high inflation rates.

Tef price fluctuations

Besides general macro inflation, increasing prices for tef, respectively the high variability of tef prices was mentioned as another major constraint for actors of the tef value chain. Nevertheless, price fluctuations of tef are more a result of deeper underlying causes than a hazard itself. However, many stakeholder, experts and workshop groups (4 out of 8) mentioned the strong price fluctuations of tef as a major shock for their respective activities. As can be seen in **Figure 5** and **Figure 15**, tef prices not only showed high variability over the past years but also revealed significant seasonality throughout the years. Reasons for these price fluctuations are multiple, ranging from unusually high yields in 2000-2002 to a widespread drought in 2003, over an international food price spike in 2008 and a general high price inflation post 2008 (Minten et al. 2012). Just as diverse are the consequences of these price fluctuations for the tef value chain. While the huge price increment is mainly a problem for tef consumers, the big price fluctuations complicate planning for enjera producers, millers, traders and farmer cooperatives (Ayele 2015, Kebebew 2015, Ashagrie 2015, Yergalem 2015). If prices are low, farmers again have no incentive to produce tef.

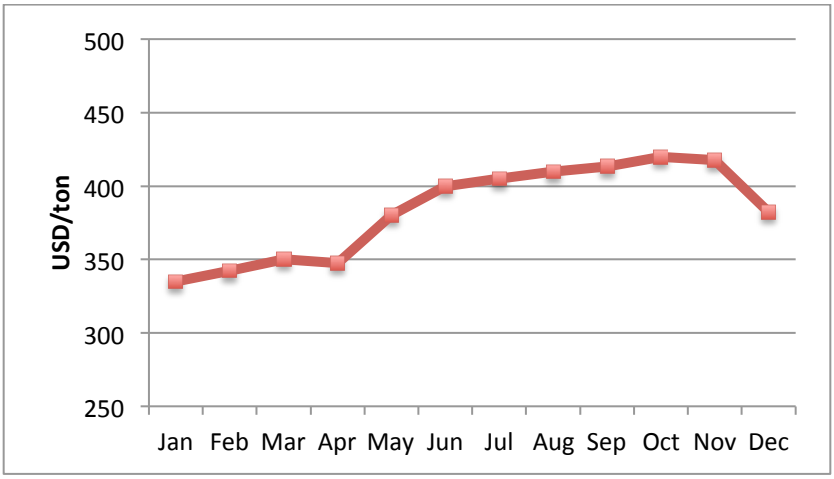


Figure 15: Monthly average price of white tef from 2007 to 2010 (adapted from Setotaw 2013).

Market interventions by government

Government interventions in the tef market are considered as another threat for different actors of the tef value chain (3/8 workshop groups, 4/5 traders and several experts). The Derg Regime (1976-1990) for instance tried to discourage tef production in Ethiopia because of its low yields compared to other crops. Further, government at that time controlled cereal trade and fixed prices at artificially low rates (Demeke and Di Marcantonio 2013). The current government has officially withdrawn from cereal market interventions, however, in recent years it repeatedly intervened and 2006 officially banned tef export (cf. Minten et al. 2012, Demeke and Di Marcantonio 2013).

The effect of such market interventions on the tef value chain are diverse and in the past ranged from disincentives for farmers to produce tef, store tef or apply yield improving technologies, to lower prices and along with it, enhance food security for consumers (cf. ATA, MoA, EIAR 2013, Ayele 2015, Kebebew 2015). The question also arises what will happen when the tef export ban gets lifted, as foreseen by the government (Solomon 2015). Incentives to produce, trade and consume tef then again could shift completely.

Conflicts or wars

Even though conflicts were rarely mentioned to be an issue in Ethiopia and for the tef value chain specifically, recent history gives another impression. Besides various inner conflicts such as the civil war against the Derg Regime (1974-1991) or the Ogaden insurgency (1995-2008), the Federal Democratic Republic of Ethiopia was involved in several conflicts with neighboring countries such as Eritrea (1998-2000) and Somalia (2006-2009 and 2011-2012). Effects of these or possible future conflicts on the tef value chain are difficult to estimate. However, Ayele (2015) reported that for instance the civil war under the Derg Regime had severe impacts on agricultural production, with low or no production in affected areas and interrupted input and output supply chains. As Ethiopia is totally landlocked, it is further dependent on neighboring countries, for instance on Djibouti port for fertilizer imports (Gebre-Selassie and Bekele 2012). International conflicts can therefore have severe consequences for the tef value chain, as in the case of the conflict with Eritrea, which was a major market for Ethiopian tef traders until the war in 1998 (Demeke and Di Marcantonio 2013).

4.2. Resilience of the tef value chain in Ethiopia

4.2.1. Whole value chain

The whole value chain resilience assessment comprises information that concerns all steps of the tef value chain. For instance, information on the general surroundings of the tef value chain like the governance system in Ethiopia is discussed here. Further, some questions which can only be answered for the chain as a whole are answered here, for instance on the complexity and length of the value chain. The assessment is less extensive than for other processes as the amount of questions per attribute is limited and some attributes are not considered at all.

Attribute	Resilience score	Weighed score	Importance of attribute	Data Basis
Buffering capacity				
Connectivity				
Equitability				
Governance capacity				
Information, learning				

Figure 16: Resilience scores for the whole value chain.

Connectivity

Information about the length and complexity of the value chain is somewhat inconsistent. While Demeke and Di Marcantonio (2013) consider tef value chain as long with many small operators and multiple handovers, Minten et al. (2013) found it to be shorter than generally presumed, involving on average only three intermediates from farmer to consumer and farmers obtaining a high share (about 80%) of the final consumer price. Considering that only about one third of all tef is marketed and the rest is produced for own consumption, the connectivity from producer to consumer can generally be considered as good.

Governance capacity

Even though Ethiopia is officially a democracy, actual government is far from being representative, as the ruling party and its allies won 546 out of 547 parliamentary seats in the last election in May 2015. Governance is little participatory, and prior to the elections in 2015, leaders and supporters of the opposition parties as well as journalists and bloggers were arrested and prosecuted (Human Rights Watch 2015). Transparency in Ethiopia is limited. It ranked the 110th place out of 183 countries regarding the corruptions perceptions index in 2013. However, as Zerihun et al. (2014) state, there is a culture of intolerance to corruption in Ethiopia and corruption in the public sector is claimed not to be pervasive.

In any case, governance structure in Ethiopia is strongly hierarchical and top-down driven (Minten 2015). As mentioned by Minten (2015), the advantage of this very "rigid" organization is the consistent implementation of government decisions in Ethiopia. For instance, the agricultural extension system was scaled up in only 6 years, establishing over 8500 farmer training centers and training 63000 development agents (Zelleke et al. 2010, Minten 2015). The same applies to major issues such as poverty reduction or food security, where government of Ethiopia (GoE) has implemented various programs and measures (cf. Zerihun et al. 2014). Further, the government seems willing and capable to address major future challenges, for instance by establishing programs to cope with climate change (Admassu et al. 2013), population growth (Tedesse and Headey 2012), or soil degradation (Sherif 2015, Kebebew 2015). GoE also made significant efforts to put in place coping mechanisms for its people in case of food insecurity situations due to disturbances such as droughts or floods (IRI 2007). However, these programs still mostly focus on responding to disturbances (such as food aid programs) instead of preventing them or better preparing people for shocks (IRI 2007, World Bank 2006a).

Regarding the tef value chain, GoE seems to have recognized its importance and potential for increasing food security in Ethiopia and the Agricultural Transformation Agency of Ethiopia (ATA) denominated tef as a priority crop in 2011 (Tareke et al. 2013). In terms of resilience, some of the main bottlenecks of the tef value chain have been identified by ATA, MoA and EIAR in the National Tef Strategy of 2013. For instance, GoE recognized the poor performance of the formal input supply system, the low adoption rate of improved farming techniques or the need for more market transparency and standardization of tef (see governance capacity section of the respective processes for more information).

Buffering capacity

Due to its high value and fluctuating prices, storage of tef implicates substantial financial risk (Minten 2015). Tef stocks are therefore unevenly distributed throughout the value chain, with most of the tef being stored on farms and sold continuously over the year (Minten et al. 2012, Minten 2015). Actors of post-production (traders, processors & retailers and consumers) however only keep very limited tef stocks (Fufa et al. 2011, Abate 2015).

Equitability

Accessibility to dispute resolution mechanisms for actors is mostly given, however, equitability and independence of such mechanisms are disputable. As stated by Zerihun et al. (2014), Ethiopia's regulatory system is generally considered as fair and property and contractual rights are usually protected (Zerihun et al. 2014). However, concerning politically motivated trials, hearings are not considered as fair (Amnesty International 2015) and on the ranking on judicial independence by Transparency International, Ethiopia ranks 93rd out of 175 countries in 2012.

Ethnical or gender inequalities seem to play a minor role in the tef value chain in Ethiopia. Apart from some pronounced familiar and ethnical networks playing a role in tef trade, there are no other examples of ethnical dependencies or barriers known, which would hamper connectivity between actors. However, as mentioned by an expert, political orientation can play a role for the access of actors to inputs, land, credits, permission, extension services etc. Similarly, Amnesty International (2015) and Human Rights Watch (2015) report methods of GoE to enforce political control on the population to include politicizing access to jobs, education opportunities and development assistance. To what extent actors are finally confined in their activities through such measures and how these measures affect the resilience of the system is however difficult to judge.

Information and learning

In the past years, Ethiopia has established an early warning system for anticipation of multiple shocks affecting food security. Thanks to this system, Ethiopia is much better prepared for disasters, as for instance in 2003, when 13 million Ethiopians were affected by a drought but a major famine was avoided (IRI 2007). However, the early warning system up to now in most cases focuses on preparedness for food emergency relief ra-

ther than providing rural communities with information on how to mitigate and cope with droughts or other disasters (IRI 2007, Zinet 2015).

As part of the early warning system, there are yield assessments for major crops carried out twice a year to generate yield forecast (Seid 2015). However, the quality of tef is only monitored infrequently throughout the value chain and traders and processors reported it to be one of the major problems for them. Quality awareness among producers seems to be limited (Abate 2015) and contamination with sand or weeds is frequent.

As there are no labels available and adulterations with sand are difficult to recognize, trust is a major factor when buying tef. This is further emphasized by the fact that accountability procedures are rarely available in Ethiopia. As mentioned by various exponents, trust between actors seems to be a major constraint in the tef value chain, especially towards traders and farmer cooperatives (stakeholder interviews, ATA, MoA, EIAR 2013, Fufa et al. 2011).

4.2.1.1. Improved inputs supply

The supply of improved inputs such as inorganic fertilizer, pesticides or improved seeds and farm implements achieves an overall low resilience score. Pesticides and especially fertilizer is widely used by tef farmers in Ethiopia, whereas only few farmers rely on improved seeds and farm implement supply. Therefore, a stronger emphasis is given to the ratings of fertilizer and pesticide supply.

Attributes	Fertiliz-er	Pesti-cides	Impr. Seeds	Impr. imple-ments	Overall impr. inputs	Weigh-ed score	Impor-tance of Attrib.	Data basis
Buffering capacity								
Environ. Capital								
Connectivity								
Diversity								
Equitability								
Exposure to pressure								
Governance capacity								
Information, learning								
Profitability & fin. cap.								
Self-Organization								
Transformability								

Figure 17: Resilience scores for the supply of improved inputs.

Exposure to pressure

Since fertilizer and improved seeds are usually delivered in a short time span before the rainy season, supply delays or early rains in remote areas have in the past repeatedly led to unavailability of these inputs at planting time (Ayele 2015). However, while farmers often reject producing tef without fertilizer, they can usually fall back to the informal

seed sector if the supply of improved seeds fails (Setotaw 2015, Ayele 2015). In the improved seed sector, new varieties are selected based on tef yield, quality and lodging resistance, while little breeding is done to improve tef resistance against diseases or abiotic stresses (Kebebew 2015, Demissie 2015).

Pesticide suppliers reported repeated shortages in pesticide supply and the absence of maintenance services was also reported to be a problem for farm implement supply (Fufa et al. 2011). However, in both cases tef production is not affected severely, since there are alternative ways of conducting the activities when improved farm implements are not available.

Governance capacity

Autonomy and freedom to operate is very limited in the current fertilizer supply system. However, due to the central planning (and backup), total failure of the system is improbable. Further, MoA and ATA have lately addressed some of the major constraints of the fertilizer system, planning to improve flexibility in the fertilizer distribution, install a new fertilizer credit system and lower dependency on international sources by building their own fertilizer factories (MoA, ATA 2013, ATA, MoA, EIAR 2013, Melekot 2015). Similarly, the GoE has recognized the poor performance of the formal seed sector, identified it as a priority area of focus and launched several initiatives to address these problems in the country's seed system (MoA, ATA 2013, Dawit et al. 2013, Shahidur et al. 2013). In the national tef strategy, the development of improved farm implements by public and private enterprises, the dissemination of knowledge on benefits of improved technologies as well as integrated pest management and the encouragement of pesticide production are major visions to improve the tef value chain (ATA, MoA, EIAR 2013). Over the past years, special attention has been given to the development of row planters, harvesters and mechanical threshers (ATA 2014).

Environmental capital

Fertilizer and pesticide application can have various negative impacts on the environment such as surface and ground water pollution, soil acidification and soil organic matter depletion (Admasu 2009). Impacts of fertilizer and pesticide use were nevertheless reported to be minor in Ethiopia as application rates are generally low (Kebebew 2015, Abate 2015, Setotaw 2015, Ayele 2015). However, as mentioned by Admasu (2009) and Kebebew (2015), awareness and knowledge regarding environmental impacts of fertilizer are largely non-existent in Ethiopia (neither for farmers or experts) and impacts therefore might actually be higher than reported. The same applies to pesticides, as training given to farmers on pesticide issues is very limited (Amera and Abate 2008) or not applied (Sherif 2015) and impact of misuse of pesticides on health and environment was reported to be worrying (Amera and Abate 2008). Further, regulations on fertilizer and pesticide use are insufficient or not enforced appropriately in Ethiopia, which increases the risk of misuse (Amera and Abate 2008, Kebebew 2015).

Equitability

In the fertilizer and improved seed supply sector, decision-making is generally organized top-down. The decision on how much fertilizer is imported and distributed to cooperatives is taken solely by the Bureau of Agriculture and Rural Development (BoARD) and farmers cannot decide independently how much fertilizer they want to use (Shahidur et al. 2013, Abate 2015). Similarly, farmers' needs and suggestions are rarely incorporated in tef variety development (seed suppliers interviews). Pesticide and fertilizer application can have negative impacts on third parties, for instance due to water contamination or direct exposure to chemicals during application.

Information and learning

Investment in education and extension services was reported to have contributed significantly to increasing fertilizer application rates in Ethiopia (Admasu 2009). But the lack of awareness on the benefits of the use of improved seed and farm implements seems to be a major reason for the low adoption rates of these inputs (ATA, MoA, EIAR 2013, Fufa et al. 2011, Setotaw et al. 2013). In any case, investment in research on improved technologies and breeding is still inadequate, considering the importance of tef in Ethiopia and the high potential of improving tef yields by these measures (Kebebew et al. 2013, Fufa et al. 2011).

As tef has been set as a priority crop by ATA in 2011 (Berhe et al. 2013), main resilience bottlenecks in the input supply of the tef value chain have been identified and addressed. Fields of improvement include the establishment of a new input credit system and domestic fertilizer plants, alternative production and distribution channels for improved seeds and farm implements as well as the promotion of new extension approaches to increase adoption rate of improved technologies (ATA, MoA, EIAR 2013, Dawit et al. 2013, Melekot 2015).

Self-organization

As a consequence of the total government control over the fertilizer supply chain (Shahidur et al. 2013, Abate 2015, Sherif 2015), there is little room for self-organization and initiative among actors. For instance in 2011, several regional cooperative unions wanted to break out of AISE and import fertilizer by forming a regional federation of cooperatives. The MoA, however did not allow this (Shahidur et al. 2013).

In the improved farm implements and seed sector, self-organization and networking is generally enabled, even though the GoE still interferes in several spheres such as pricing, marketing or seed demand assessment. On the other hand, self-organization and initiative seem to be enabled adequately in the pesticides supply, as state interventions and regulations are minimal.

Connectivity

The dependency of tef farmers on improved inputs is varying. Access to fertilizer for instance is crucial for tef production (Ayele 2015, Kebebew 2015) and farmers in the past switched from tef to other crops when fertilizer prices rose (Setotaw 2015). At the moment, tef farmers have no practical alternatives to inorganic fertilizer since dung and crop residues cannot be used as organic fertilizer due to competitive uses (animal feed,

construction material) (Kebebew 2015, Ayele 2015, Gete et al. 2010, Berry 2003). Dependency of farmers on pesticides, improved seeds and farm implements is in contrast much smaller, as hand weeding, unimproved seeds and traditional farm implements represent realistic alternatives. However, traditional technologies often implicate higher production costs and lower productivity (ATA, MoA, EIAR 2013).

The supply chains are also quite distinctive for the different inputs. However, all show some critical dependencies or bottlenecks. Fertilizer for instance, has to be imported completely through Djibouti port (ATA, MoA, EIAR, 2013) while supply and distribution are solely carried out by AISE and farmer cooperatives (Shahidur et al. 2013, Tenna 2015, Ayele 2015). Bottlenecks in transport capacities (from Djibouti port to central warehouses) and poor transport infrastructure in remote areas have repeatedly led to delays in fertilizer supply in the past (cf. Zelleke et al. 2010, Tenna 2015, Minten 2015, Ayele 2015). Supply with improved farm implements and seeds is highly dependent on a few research institutes. All the visited seed companies reported shortage of basic tef seeds from EIAR as their biggest constraint. The farm implement supply chain is extremely simple while the formal seed distribution system contains many unnecessary complexities, causing delays and supply shortages (ATA, MoA, EIAR, 2013). The supply chain for pesticides contains multiple distribution channels (see Figure 11), however, shortages and delays in pesticide supply were reported as well.

As mentioned before, transport infrastructure in remote areas of Ethiopia is often poor. However, overall logistics and communication support services have improved considerably over the past years. Due to a large road investment program embarked by the GoE, most high-production areas are well accessible by now and transport costs have dropped at the end of the decade to half (or even lower) the costs that were charged in 2001 (Minten et al. 2012, Zelleke et al. 2010). However, density of paved roads in Ethiopia (35.8 km of road per 1000 km^2 of arable land) is still far below the Sub-Saharan average for low-income countries of 86.6 km per 1000 km^2 (Foster and Morella 2010). Since 90% of Ethiopia's roads are unpaved, many of them are impassable during rainy season (World Bank 2006a, Ayele 2015).

Mobile phones have also become widely available in Ethiopia over the past decade, enhancing connectivity between actors (Minten et al. 2012). In a survey conducted by Minten et al. (2012), only traders at the Addis Ababa cereal market had cell phone coverage in 2000, but by 2005 nearly 100 percent of the visited traders throughout the country had access to it. However, while this development has made access to price information widely available for traders and brokers by now, penetration and use of mobile phones by farmers remains one of the lowest in Africa (Minten et al. 2012). As all the different steps of the tef value chain rely to some extent on transport and communication infrastructure, these findings apply for all of them.

- *Buffering capacity*

All improved input supply chains face bottlenecks in terms of storage and financial capacities of involved actors (ATA, MoA, EIAR 2013, stakeholder interviews). As a conse-

quence, inputs are rarely stored by suppliers (for pesticides and seeds) or stocks not evenly distributed and coordinated (in case of fertilizer stocks at cooperatives)(Shahidur et al. 2013, Tenna 2015, Ayele 2015).

The production of improved seeds and farm implements is up to date very limited in quantity and quality while the few suppliers all face financial restrictions (ATA, MoA, EIAR 2013, Alemu et al. 2013, stakeholder interviews). Therefore, the sector has little spare capacities to maintain supply in case of a shock. Farmers and farm implement suppliers also reported to face periodically supply shortages for pesticides. However, as pesticides can be purchased on international pesticide markets as well, buffering capacity is higher. The fertilizer supply is not affected by production limitations as all fertilizer is imported from the international fertilizer market. However, there are bottlenecks in transport capacities from Djibouti port to central warehouses (cf. Zelleke et al. 2010, Tenna 2015, Minten 2015). Due to the restricted time slot available for fertilizer distribution to remote areas (before the start of the rainy season) (Ayele 2015), buffering capacity for fertilizer distribution is also limited.

In general though, transport and communication support services seem to have sufficient spare capacities in case of increased demand, as transport costs have dropped significantly over the past years and trucks are widely available throughout the country by now (cf. Minten et al. 2012, Zelleke et al. 2010). These findings again can be applied for all steps of the value chain.

The same is true for the availability of labor force, which is generally very high in Ethiopia and the different activities don't face any constraints in finding enough human resources in case of increased demand. However, costs for labor have been rising consistently over the past years, since competitive sectors require more manpower (Kebebew 2015, Setotaw 2015, farmers interviews).

- *Diversity*

A further resilience constraint is the low diversity within the fertilizer supply chain. Only one distribution channel for fertilizer is available since import and distribution is solely permitted for AISE (with monopoly control) and farmer cooperatives (Shahidur et al. 2013, Abate 2015, Kebebew 2015). There is no domestic production of fertilizer and all fertilizer has to be imported (ATA, MoA, EIAR, 2013).

Pesticides on the other hand are distributed through multiple channels while actors are quite diversified and domestic factories are available besides international pesticide suppliers (Tenna 2015, pesticide supplier interviews). The repertory of available pesticides for tef is very limited, especially for herbicides where practically only 2-4-D was used over the past decades. As a consequence, many resistant broad leaf weeds have emerged (ATA, MoA, EIAR 2013). However, since hand weeding is necessary for tef in any case (against grass weeds), there is at least some sort of integrated weed control applied.

- *Profitability and financial capital*

Profitability is a major constraint for supply chains of improved inputs. The reliance of the different chains on indirect subsidies is highest among the whole tef value chain. Breeding and production of improved tef seeds and farm implements is exclusively done by state research centers and therefore rely on public funding. Further, seed companies as well as farmer cooperatives involved in fertilizer, pesticides and seed distribution get operational and financial support as well as tax reliefs (stakeholder interviews). Indirect subsidies make up about 15% of the fertilizer retail price (Shahidur et al. 2013). Further, the fertilizer supply chain in Ethiopia involves a long and complex credit system (see Appendix 4) with various inefficiencies and leakages (Melekot 2015). Defaults of the system have in the past put a strain on regional budgets (accumulating to over 500 million US$ by 2013) and accordingly many regions restricted credit access for farmers, forcing them to pay all or at least 75% of the fertilizer in cash in advance (Melekot 2015).

Since fertilizer supply is totally state controlled, margins for farmer cooperatives are fixed, profits limited and for small primary cooperatives fertilizer trade is often unprofitable (Shahidur et al. 2013). Profitability in pesticide supply is also low, as margins and demand for pesticides seems to be limited (pesticide suppliers' interviews, ATA, MoA, EIAR 2013). In the improved seed supply, the major problem affecting profitability is the self-pollinating nature of tef. Farmers can recycle improved seeds and demand for certified seeds is accordingly low (seed supplier interviews). Tef seed production is at the moment a loss making business for seed companies and as a consequence investment in tef seed production is limited (Demissie 2015, Shahidur et al. 2013).

Transformability

As the fertilizer supply system is totally state controlled, there is no real opportunity for experimentation or innovation. The formal seed sector is officially open for the private sector (Spielman et al. 2011). However, pricing and marketing of the seeds is still made centrally by the GoE (Dawit et al. 2013), demand for improved tef seeds is limited and profitability of self-pollinating crops is low. Hence, there are little incentives for the private sector to invest in tef seed production. Similarly, the major problem in the improved farm implement supply system is the missing innovation and investment from the private sector. Domestic machine industry is weak, incentives for investment low and access to seed capital for importing or developing technology restricted (Abate 2015).

4.2.2. Unimproved seeds and farm implements supply

As shown in Figure 11**,** still about 90% of the tef farmers obtain their seeds from the informal seed sector, mostly through own saved seeds, from neighbor farmers or from local seed suppliers. Similarly, nearly all farmers use traditional farm implements, as improved farm implements are only available very infrequently.

Figure 18: Resilience scores for the supply of unimproved inputs.

Attribute	Informal seed supply	Traditional farm implements	Overall unimpr. inputs	Weighed score	Importance of attribute	Data basis
Buffering capacity						
Environmental capital						
Connectivity						
Diversity						
Equitability						
Exposure to pressure						
Governance capacity						
Information, learning						
Profitability & fin. cap.						
Self-Organization						
Transformability						

Buffering capacity

The informal sector has nearly unlimited capacities to supply seeds in case of increased demand, as seeds usually just represent a part of the normal tef yield of farmers. Stocks are kept at farms and cooperatives throughout the whole country and are therefore easily accessible for farmers. As seeds are available locally, transportation and communication capacities are irrelevant for the informal seed sector.

Traditional farm implements (e.g. plough) are often manufactured by the farmers themselves or by local manufacturers. Therefore, basic materials such as wood, plastic bottles or grass stems (for weaving fans) are used and are abundantly available. Other implements such as sickles or forks as well as integral parts of the implements like the metallic ploughshare are supplied by domestic and international producers, which have plenty spare capacities (Kebebew 2015).

Connectivity

Since seeds and farm implements are often produced by neighbors, local manufacturers or by farmers themselves, the value chain for these inputs is very simple and usually involves no logistics or communication support services (Sherif 2013). The informal seed market is usually limited to particular local community structures, what makes it somewhat isolated (and reliant on a limited number of suppliers) but at the same time more flexible than the formal seed sector (Sherif 2013, MoA, ATA 2013). The informal input supply system can be seen as a backup for the improved inputs supply system, as yields with unimproved inputs are somewhat lower but a failure of the informal system is highly unlikely.

Diversity

The diversity of the informal seed sector is very high as there is a huge range of tef varieties in Ethiopia, adapted to different agro ecologies and produced all over the country by well diversified farmers. The large variety of exchange mechanisms used in the informal seed sectors (i.e. cash, exchange in kind, barter, gifts or transfer based on social

obligations) enhances access, particularly for households that have limited cash resources (Sherif 2013).

Similarly, traditional farm implements are produced throughout the whole country and by different actors. The visited farm implement suppliers do all sell a wide range of products, they have diverse groups of customers (e.g. home gardens, commercial farms, small scale farmers, etc.) and usually have alternative income sources.

Self-organization

Self-organization and initiative seems to be enabled adequately as state interventions and regulations in the informal seed and farm implements market are minimal. The informal seed system further plays a key role in strengthening social ties within the communities, as trust is generally high among actors (Sherif 2013). This also reduces transaction costs in the seed supply (Sherif 2013).

Equitability

Actors of the informal input supply system have high freedom to operate, as there are few regulations or laws affecting them. However, as informal seed market is usually limited to particular community structures, social relationships with particular groups, families or ethnicities are more important than in the formal seed system (MoA, ATA, 2013). This can lead to social dependencies or barriers and hamper connectivity.

Exposure to pressure

Informal seed production is exposed to the same weather risks as tef production and therefore commonly affected by droughts, floods or pest outbreaks. However, weather events have to be very extreme and cause total yield loss in order to affect seed production. Further, tef seeds can be stored very easily and are rarely affected by storage pests (Fufa et al. 2013). The production of traditional farm implements is rarely exposed to disturbances and since such implements are required only every few years, seasonal supply shortages play a minor role.

Profitability and financial capital

Both, informal seed and farm implement production by the farmers is usually not profit-oriented, as it is mostly done for own use. Producing unimproved seeds or farm implements is not direct profitable for the farmers; however, the activities do also not imply any financial risk for farmers. Since improved seeds can be reproduced by the farmers without big yield losses, buying improved tef seeds every few years can be very beneficial for them. Farm implement suppliers reported margins to be very low and they often rely on alternative income sources.

Environmental Capital

The informal tef sector is characterized by a huge diversity of local tef varieties, which are usually well adapted to local environmental conditions (Kebebew 2015, Ayele 2015). Since tef is a self-pollinating crop, farmers can even reproduce improved tef varieties by themselves without yield or quality losses (Abate 2015, Spielman et al. 2011).

The use of traditional instead of improved farm implements usually manifests itself in lower efficiency and productivity. In case of the traditional plough, the higher tillage frequency compared to improved ploughs can however lead to higher soil erosion rates.

Governance

As the sector is informal, GoE has little interest to intervene in it and actors therefore have high autonomy. However, ATA has recognized the knowledge gap of farmers in seed reproduction techniques. Hence, there might be future investment in training on this matter (MoA, ATA, 2013).

Information and learning

Farmers are often not aware of the best selection techniques to maintain genetic uniformity of improved varieties and neither know how to improve the performance of existing local varieties (MoA, ATA 2013). Therefore, self-reproduced seeds are often of lower quality, achieve lower yields and show poorer germination rates (ATA, MoA, EIAR 2013).

Transformability

In the informal seed sector, innovation is rather limited as the link to the sources of improved seed varieties is weak (Sherif 2013). In addition there is a lack of adequate knowledge on seed selection techniques, financial limitations and little incentives to invest in seed production due to the low profitability. Similar conditions apply for the traditional farm implement sector and innovation and investment from the private sector in this segment were reported to be low (Abate 2015).

4.2.3. Production

Attribute	Resilience score	Weighed score	Importance of attribute	Data basis
Buffering capacity				
Environmental capital				
Connectivity				
Diversity				
Equitability				
Exposure to pressure				
Governance capacity				
Information, learning				
Profitability & fin. cap.				
Self-Organization				
Transformability				

Figure 19: Resilience scores for tef production.

Diversity

Since tef can be grown under diverse agro-climatic conditions, it is grown in almost all regions in Ethiopia and production sites are therefore well distributed (ATA, MoA, EIAR, 2013). Tef is predominantly grown by small-scale farmers, which are well diversified, typically grow 3-4 other field crops, some horticulture and always keep some livestock (Ayele 2015, Sherif 2015). Therefore, tef farmers usually have multiple income sources and many of them also engage in off-farm activities to generate some extra revenue (Abate and Setotaw 2010, farmer interviews). This farm type leads to a quite high landscape diversity what adds to the generally high biodiversity in Ethiopia (Gebre-Selassie and Bekele 2012, Zelleke et al. 2010). Further, there exists a huge diversity of tef varieties in Ethiopia, generally well adapted to environment and quite resistant to diseases (Mengitsu and Mekonnen 2012, Kebebew 2015).

However, the small farm and plot sizes hamper the use of crop rotations. Even though crop rotations are typically applied by tef farmers (Katema 1997, Kebebew 2015, Setotaw 2015, farmer interviews), the system is not efficiently practiced (ATA, MoA, EIAR, 2013). Tef production is still predominantly done in the traditional way, partly because major farming challenges for tef remain unsolved (e.g. mechanical harvesting due to lodging. Other reasons include the low adoption rates of or alternative cropping systems (e.g. conservation tillage, relay cropping) or inadequate supply with improved inputs (e.g. mechanic threshers, herbicides) (Fufa et al. 2011, Kassahun and Tebkew 2013). As a consequence, tef production is still highly dependent on single inputs like labor forces, inorganic fertilizer or oxen.

Profitability and financial capital

Tef producers are not directly subsidized. However, inputs are to some extent indirectly subsidized and farmers get additional support through extension system or through farmer cooperatives' support. On the other hand, due to the export ban, tef prices in Ethiopia are far below the world price and tef producers are therefore discriminated while tef consumers are protected (Demeke and Di Marcantonio 2013).

Table 7: Estimates of farm-level production costs in Ada'a area

Practice	Amount of input required/ha	Price (Birr/unit)	Total cost/ha	% share
Land preparation (person-days)	20	30	600	10.8
Seeding rate (kg)	30	15	450	8
Fertilizer (DAP in kg)	100	11	1100	19.8
Fertilizer (Urea in kg)	100	9	900	16.2
Weeding (person days)	24	30	720	13
Herbicide (lts)	1	77	77	1.4
Harvesting (person-days)	30	30	900	16.2
Gathering and piling (person days)	3	30	90	1.6

Threshing (person- days)	24	30	720	13
Total cost (Birr)			5.557	100

Source: Fufa et al. 2011. The table only shows the estimated production costs for a specific tef growing area within Ethiopia. Production costs and amounts of inputs can vary significantly for other regions of Ethiopia. In 2015, 1 USD corresponded approximately 20 Birr.

However, tef production is still a profitable business for most farmers as it fetches the highest value-to-cost ratio of all crops produced in Ethiopia (Setotaw 2015, Ayele 2015, Demeke and Di Marcantonio 2013). This, despite the fact that tef production is very labor intense (as it remains almost entirely un-mechanized) and labor costs consequently are disproportionally high compared to other crops (cf. Fufa et al. 2011, Kebebew 2015). Incentives to grow tef as a cash crop have improved in the past years, as prices for tef (sold by farmers) have increased while that of other staple crops (bought by farmers for consumption) has declined (Demeke and Di Marcantonio 2013). However, the big investments (labor and fertilizer, see Table 7) required for tef production pose a certain financial risk to farmers, especially considering the relatively high variability of tef prices. Further, farmers in general do not have an insurance and only little savings (Abate 2015, farmer interviews). On the other hand, tef is known as a security crop, and the risk for a total yield loss is lower than for other crops (ATA, MoA, EIAR 2013, Kebebew 2015).

Exposure to pressure

Tef farmers are frequently exposed to various disturbances such as droughts, floods or pest outbreaks but also input shortages and price fluctuations (Ayele 2015, Kebebew 2015, farmer interviews). As a consequence of the frequent exposure to pressure (and its endemic nature), tef varieties are relatively well adapted to biotic and abiotic stresses (ATA, MoA, EIAR 2013). Tef is therefore often used as a security crop in drought prone areas, ensuring at least some yield in drought years whereas other crops would show total failure (Abate et al. 2005, Kebebew 2015). However, while tef cultivation area might therefore even expand in drought years, it is highly sensitive to shortages or price increments of fertilizer. According to Setotaw (2015), farmers in the past switched from tef to other crops like chickpea or pulses when fertilizer prices rose.

Smallholder farmers in Ethiopia generally seem to have various mechanisms to overcome bad years. Coping mechanisms include expansion of income sources (e.g. charcoal production, off-farm income sources), sale of livestock or other assets, change of consumption patterns (e.g. from tef to maize) or reliance on savings or loans (Yosef 2015, farmers interviews). However, access or knowledge on how to access loans seems limited and saving culture not very popular in Ethiopia (Abate 2015).

Connectivity

Tef farmers generally have multiple channels and suppliers to access inputs like seeds or farm implements. However, farmers rely heavily on cooperatives as the sole suppliers of inorganic fertilizer and as a central supplier of improved inputs (Minten et al. 2012). For

selling their tef, farmers rely on local assemblers or traders and there are only limited alternative distribution channels (see **Figure 12**) (Minten et al. 2012, Worku et al. 2014).

Connectivity or access for farmers to tef market is strongly determined by transportation costs and is therefore declining simultaneously with distance from urban centers (cf. Minten et al. 2012). As farmers travel on average 1.5 hours to sell their tef and as only 36% of tef is sold to markets, access to market overall seems to be limited (cf. Minten et al. 2013).

Of course, tef production is a crucial step in the tef value chain and a failure in this activity would cascade down the whole chain. A failure in tef production would also have important impacts on livestock production since tef and livestock production are strongly linked. Tef production relies heavily on oxen as draft-force as it is a very cultivation-intense crop. On the other hand, tef straw is the preferred feed source for livestock and fetches relative high market prices (Kebebew 2015, Abate et al. 2005).

Governance capacity

Tef has been declared as a priority crop by ATA in 2011 (Berhe et al. 2013). The overall vision stated in the national tef strategy paper released in 2013 by ATA, MoA and EIAR, proposes a "sustainable increase in smallholder tef farmer productivity and profitability while providing high quality output" and many of the planned interventions therefore directly target the production step of the tef value chain. Proposed interventions address many of the constraints identified in the resilience assessment, such as improving input supply bottlenecks, reform the input credit system, promote efficient cropping systems (crop rotation, relay cropping) or alternative marketing channels (cf. ATA, MoA, EIAR 2013)

In case of disturbances, GoE so far has mostly concentrated on emergency (food) aid and little disaster prevention has been undertaken (IRI 2007, World Bank 2006a). However, according to Zinet (2015), priorities in disaster and risk management have been changing in the past years, and visited farmers reported from some prevention measures like soil conservations programs being implied.

Self-organization

Self-organization among farmers is generally possible and in case of farmer cooperatives even promoted by GoE (Abate 2015, Yergalem 2015). However, initiative among farmers in this respect seems limited, for instance concerning consolidation of fields or common acquisition of farm machinery (Abate 2015). Farmers further have sufficient autonomy, but concerning land tenure, only use and not ownership rights are guaranteed (Gebre-Selassie and Bekele 2012).

Transformability

As stated by Ayele (2015) and Minten (2015), the adoption of new production techniques by Ethiopian farmers is generally a slow process. However, regarding tef, farmers are much more open for change. Some of the biggest extension successes in Ethiopia (such as the adoption of the Quncho variety (cf. Kebebew et al. 2013)) were realized for

tef production (Kebebew 2015, Sherif 2015). Due to the high prices farmers can fetch for tef, they are more willing to invest resources, capital and energy in tef production (Kebebew 2015, Setotaw 2015). However, openness for change is not unlimited and for instance farming practices like conservation tillage, reduced seed rate, adequate fertilizer rate or change in planting calendar were only poorly adopted by tef farmers (Fufa et al. 2011, ATA, MoA, EIAR 2013, Mengitsu and Mekonnen 2012, Ayele 2015).

However, the lack of innovation or change is often caused by structural problems, such as limited access of farmers to improved technologies and credits, low financial incentives (e.g. unattractive tef prices due to export ban) or the problem of very small and fragmented plots making mechanization unprofitable (farmers' interviews, workshop, Demeke and Di Marcantonio 2013, Abate 2015).

Buffering capacity

Of all value chain processes, the biggest stocks of tef are kept by the production step (cf. Minten et al. 2012). Tef grain is usually stored on farms up to one year and sold continuously over this period of time (Minten 2015, Setotaw 2015, farmer interviews). Therefore stocks of (unimproved) seeds are also widely available where fertilizer, pesticides or other improved inputs are in contrast rarely stored on farms.

Farmers usually have little savings (farmers' interviews, Abate 2015, Setotaw 2015) and credit access for farmers is currently severely limited (Zelleke et al. 2010). As a consequence of the widespread failure of the existing input credit system, farmers nowadays can often purchase fertilizer only with cash (Melekot 2015). In case of a shock (e.g. heavy rain at planting time requiring reseeding and fertilizer application), farmers therefore have difficulties accessing inputs to continue growing tef, and buffering capacity of the farmers is accordingly limited.

Over the past decade, tef production has increased by 163%, mostly due to expansion in area under cultivation (50%) and increase in yield levels (73%) (Worku et al. 2014). However, in the same period of time, tef prices have multiplied by a factor of four (see **Figure 5**). This indicates that the tef production cannot keep pace with the increasing demand. With production already being limited at status quo, it is hence very unlikely that demand for tef can be covered in case of a shock (e.g. a widespread drought). Buffering capacity of the tef production step is consequently restricted.

Farmers' interviews gave a quite representative picture on the major limitations to enhance tef production with access to land, improved inputs and capital reported to be the main bottlenecks. While there is little opportunity to expand the tef growing area in the traditional tef production regions in the highlands (due to high population density and small farm size), there seems some spare land available in non-traditional areas in the lowlands (Kebebew 2015). However, in order to meet the increasing demand for tef it is crucial to increase tef yields. This can only be done by the adoption of improved tef production technologies such as improved seeds, fertilizer, or mechanization (Setotaw 2013, Fufa et al. 2011). However, supply with such improved inputs faces various bottlenecks and yield enhancing farming practices are not sufficiently disseminated or

poorly applied (ATA, MoA, EIAR, 2013). Further, limited use of improved inputs is also linked to financial constraints of farmers (Melekot 2015).

Equitability

As mentioned in chapter 4.1.4.2, growing land scarcity is a major constraint in Ethiopia and existing land tenure policies are a major cause for this. The existing land tenure system only grants user and not ownership rights to farmers, hence land cannot be sold, exchanged or mortgaged (Gebre-Selassie and Bekele 2012). Farmers have very limited possibilities to acquire more land (Abate 2015). However, an informal land market seems to have emerged lately (Abate et al. 2005) but contracts are only of short term and insecurity for farmers therefore high (Abate 2015).

Environmental capital

As mentioned in chapter 4.1.4.3, the traditional tef growing practice has negative impacts on soil fertility, owed to the high tillage frequency and nearly total removal of organic matter. Currently applied tef production practices are therefore in many cases not sustainable in terms of soil fertility. Further, nutrient balance on farms is negative as manure is often used as fuel source (Gete et al. 2010) and fertilizer demand of farms is often not adequately covered by supply (Kebebew 2015). Fertilizer and pesticide use represent further sources of critical environmental impacts. This is especially problematic since regulations to protect resources such as soil; forests or water bodies are often inexistent or not sufficiently enforced in Ethiopia (Kebebew 2015).

Information and learning

The extension system in Ethiopia is well established and features a very high density in extension agents (Zelleke et al. 2010, Minten 2015). Even though nearly 100% of the farmers have access to extension services, its effectiveness seems limited (Sherif 2013). The major constraint is a top-down instead of participatory and demand driven extension approach. Extension agents further often lack knowledge on diversification of farming systems, agricultural marketing, and communication skills (Spielman et al. 2011, Sherif 2013). Consequences are, among others, low adoption rates of improved technologies (Kebebew et al. 2013, Spielman et al. 2011) and lack of trust in extension agents (farmer interviews). Further, awareness on negative environmental impacts of pesticide and fertilizer use, as well as knowledge on soil conservation seems to be low among farmers (cf. Zelleke et al. 2010, ATA, MoA, EIAR 2013, Amera and Abate 2008). As mentioned by Melekot and ATA, MoA, EIAR (2013), farmers also lack knowledge on improved farming techniques as well as on access to credits and inputs, hampering the adoption of new farming practices.

A further constraint faced by small-scale farmers in Ethiopia is limited access to appropriate early warning systems for natural shocks. Weather and seasonal climate forecasts are widely available but not detailed enough to cover farmers' needs (ATA 2014). Farmers therefore generally make little use of weather forecasts (cf. Gebre-Selassie and Bekele 2012).

4.2.4. Trade

Attribute	Resilience score	Weighed score	Importance of attribute	Data basis
Buffering capacity				
Environmental capital				
Connectivity				
Diversity				
Equitability				
Exposure to pressure				
Governance capacity				
Information, learning				
Profitability and fin. cap.				
Self-Organization				
Transformability				

Figure 20: Resilience scores for tef trade.

Profitability and financial capital

Apart from some indirect subsidies to farmer cooperatives, tef trade is not subsidized. Margins in overall cereal market in Ethiopia have declined significantly over the past decade, and so have margins for tef (Fufa et al. 2011). However, as reported by different experts and by visited traders, trading tef is still more profitable than trading other crops. Visited traders reported the income from tef trade to be enough to support the whole family and even to generate some savings from it.

The risk of trading tef seems calculable despite of traders not being insured and price fluctuation of tef being relatively high (traders' interviews, ATA, MoA, EIAR 2013). However, tef prices have generally increased in the past decade and most of the transactions in tef trade are paid immediately in cash (Minten et al. 2013).

Governance capacity

As part of the national tef strategy, ATA, MoA and EIAR (2013) have developed a set of interventions to overcome the major bottlenecks at the trade step of the tef value chain. Interventions include better linkage between tef producers and consumers (through cooperatives), improving market transparency and enforcing standardization of tef quality (ATA, MoA, EIAR 2013). The long-term plans therefore address some of the major resilience constraints of the trade step of the tef value chain.

Self-organization

Actors generally have autonomy and are able to organize themselves. GoE even supports farmer cooperatives in establishing linkages with potential customers (Yergalem 2015, Ayele 2015).

Buffering capacity

There is very little stocking of tef going on among traders (usually only enough to satisfy petty trade during the day), which is probably a consequence of limited financial capaci-

ty of the traders (Fufa et al. 2013, Minten et al 2013, traders' interviews). Higher transport costs during the harvest period further indicate somewhat limited transport capacities (Minten et al. 2012). However, overall buffering capacity of the tef trade step is sufficient because the performance of cereal markets in Ethiopia has significantly improved over the past years (Minten et al. 2012).

Diversity

Even though production and assembling of tef is evenly distributed throughout the country, tef trade is highly concentrated on Addis Ababa. An estimated 70% or more of the marketed tef is passing through Addis Ababa channels and markets (ATA, MoA, EIAR 2013, Minten et al. 2013). All visited traders are trading various crops and often have alternative non-trade income sources.

Environmental Capital

Apart from pollution caused by transporting tef, there are no negative impacts of tef trading known on environment.

Equitability

In tef trade, family, kin and ethnic relationship seem to play an important role. For instance, urban brokers/traders often obtain a majority of their supplies from the zones that they are originally from, indicating that family networks are still an important factor at that level (Minten et al. 2013).

Exposure to pressure

Tef traders have been exposed to various disturbances in the past, such as the tef export ban to Eritrea in 1998 and the complete export ban since 2006. Traders involved in export marketing lost their most important income source from one day to the next. However, as it seems, traders are able to adapt to changing circumstances and to remain profitable despite declining margins (traders' interviews).

Connectivity

Tef value chain in Ethiopia was recently found to be shorter than generally thought, involving on average only three intermediates from farmer to consumer (Minten et al. 2013, Fufa et al. 2013). However, tef marketing relies heavily on small traders and brokers because alternative marketing channels are limited and direct sales from farmers to consumers make up only 7% and to farmer cooperatives only 1-2% of all transactions (Minten et al 2013). The poor involvement of cooperatives in tef trade can be explained with a low price flexibility, a poor linkage to consumers, distrust among farmers and incapability of cooperatives to pay farmers immediately in cash (Ayele 2015, Sherif 2015, Yergalem 2015, cooperative interviews). As tef is increasingly becoming a cash crop and consumed by urban population, the trade step of the value chain is also progressively gaining on importance.

Transformability

The absence of grading systems and the big importance of trust in tef marketing complicate bulking and large scale operations in tef trade (Demeke and Di Marcantonio 2013).

Small-scale operators therefore still dominate the tef market (ATA, MoA, EIAR 2013). Additionally, innovation is further hampered by high price volatility, the lack of reliable market information, the capital-intensive nature of tef and the inadequate contract enforcement mechanisms (Demeke and Di Marcantonio 2013).

Information and learning

The trade step of the tef value chain shows a very low resilience score for the *information and learning* attribute, as there is no well-established price information and quality grading system available (Minten et al. 2012, ATA, MoA, EIAR 2013, Fufa et al. 2013). Consequently there exists an information asymmetry between market actors, as traders are well connected through personal networks (ATA, MoA, EIAR 2013). Additionally, purity of tef is difficult to control since tef grains are very small. As a consequence, trust is an essential component in tef trade. For instance, brokers play a very important role in the tef trade because long-term relationships of brokers with sellers and buyers are the best guarantee not to be cheated (Fufa et al. 2013). However, trust among tef trading partners was generally reported to be low (stakeholders, Abate 2015, Fufa et al. 2011).

4.2.5. Processing & Retail

As can be seen in **Figure 12**, tef processing is done by mills and enjera producers. Enjera production is mainly done by microprocessors and only a small part is produced by big enjera companies (about 1%). However, the big majority of enjera is produced by the households themselves (cf. Fufa et al. 2011).

Attribute	Resilience score	Weighed score	Importance of attribute	Data basis
Buffering capacity				
Environmental capital				
Connectivity				
Diversity				
Equitability				
Exposure to pressure				
Governance capacity				
Information, learning				
Profitability and fin. cap.				
Self-Organization				
Transformability				

Figure 21: Resilience scores for processing and retail.

Diversity

Visited millers all process a variety of crops, even though tef is usually the main income source. Microprocessors often have alternative income sources (e.g. small shops) or only produce enjera as alternative income (Bekele 2015). Hence, from all processors, only

the big enjera companies are specialized and rely on enjera business only. Further, microprocessors and mills are distributed throughout the whole country (Setotaw 2015). With exception of electricity, water and milling stones, all inputs for processors can be purchased from various sources (processors interviews).

Connectivity

The dependency on the single inputs of electricity, firewood and tef for enjera production is also one of the main constraints for the connectivity of the processing & retail step. While enjera producers can substitute tef to some extent by other cereals and electricity by firewood or vice versa, millers have no alternatives to electricity (except for own electricity supply through generators). On the other hand, dependency of other value chain actors on the processors is small as households can mill tef or produce enjera by themselves (ATA, MoA, EIAR 2013). Further, processors are well connected and have many individual customers and tef suppliers. Besides the wholesale channel, there are only few alternative ways for processors to purchase tef (ATA, MoA, EIAR 2013).

Equitability

As there was no discrimination for access to inputs reported and no negative impacts of the activity on third parties are known, equitability rating for the processing step is also rather high.

Self-organization

Self-organization among actors is generally possible and enjera companies even get support from GoE to establish linkages to farmer cooperatives (Bekele 2015). Except for the limited control over electricity and water access, actors have sufficient autonomy (processors interviews).

Environmental capital

Another positive aspect of tef processing is that nearly no waste is produced as tef milling for instance gives a 99% return in flour (Almayehu 2001). If still some waste is produced, it is usually recycled in form of animal feed or dried enjera (processor interviews). While there are no negative impacts of the activity known on environment, both milling and enjera production on firewood ovens can affect health of processors due to daily exposure to high fine dust levels.

Buffering capacity

Biggest constraints for processing capacities of processors and retailers were reported to be electricity and financial shortages. Due to the latter, there are generally little stocks of inputs (tef, firewood, water, spare parts, etc.) and products (enjera, tef flour) kept by them (processors interviews). In case of a supply shortage of one of these inputs, buffering capacities among processors are limited.

However, while single processors may have limited capacities to absorb a shock, the whole processing & retail step has a considerably higher buffering capacity. This is main-

ly owed to the large number of microprocessors and millers distributed throughout the country with big and flexible spare capacities. In case of a disturbance affecting some processors (e.g. blackout in one district), there are plenty alternative processors available with sufficient spare capacities. Further, processors regularly have low reliance on transport and communication services since mills often only give milling service (in rural areas) and microprocessors produce for nearby customers.

Governance capacity

In the national tef strategy, ATA, MoA, EIAR (2013) recognize the big potential of the tef-processing sector to develop new products made from tef, as they have already been developed in other countries. However, long term plans for the tef-processing sector are still vague. Further, there are plans to resolve the electricity bottlenecks in the country, with big power plants being constructed currently (Bekele 2015).

Profitability and financial capital

Even though milling margins were reported to be higher for tef than for other crops, they declined significantly over the past decade (Minten et al. 2012). Except for enjera exports, enjera companies and microprocessors reported margins to be small and decrease even further when tef prices rise. Nearly all visited processors reported to have financial constraints. Hence, there is only a little opportunity for them to generate funds for investments (e.g. in backup systems). However, financial risk for processors is at the same time small, as mills (giving only milling service) and microprocessors don't have to undertake big investments. Apart from some technical support for enjera companies, the tef processing step is overall not subsidized (Ashagrie 2015).

Transformability

As margins in enjera production and tef milling are small, incentives for innovation are limited. However, there is some support from government institutions for tef processors (Bekele 2015). Food preferences, for instance the affinity for white enjera, are very difficult to change (Ashagrie 2015). Hence, new products made with red tef or mixed with other cereals are not accepted well, even though it would be advantageous for health (processors interviews).

Exposure to pressure

As reported during the interviews with processors, millers and enjera producers are frequently exposed to disturbances. Most important shocks are: Electricity shortcuts (nearly weekly, sometimes for several days), water shortage (a few times a year), fluctuating and rising tef prices and quality constraints of tef. From all the processors, only the enjera companies and big mills reported to have backup mechanisms for such disturbances such as generators or firewood ovens against electricity shortcuts, own water sources, some tef stocks or long term contracts with tef suppliers against price fluctuations. But backup systems are expensive (generators) or affect the quality of enjera (water, firewood ovens) and come along with losses of income or customers. The big majority of the processors have no backup systems due to financial constraints and hence disturbances often cause financial losses.

Information and learning

Quality of tef was also mentioned as a main problem for enjera producers as it affects the quality of enjera. There is no quality grading system available for tef and quality varies throughout the year but also between suppliers, as quality awareness among farmers and cooperatives is often poor (Ashagrie 2015, Bekele 2015). As a consequence, trust plays a major role for purchasing tef and was reported to be a main cause why direct links between enjera and tef producers rarely exist (processors interviews, Fufa et al. 2011, ATA, MoA, EIAR 2013).

4.2.6. Consumption

Connectivity

As mentioned in chapter 4.1.3, tef is nowadays more of a luxury than staple food in Ethiopia, therefore dependency of people on tef is not as heavy as on other cereals such as maize, wheat or sorghum (Berhane et al. 2011). However, for the urban population, tef remains an almost daily food item (Fufa et al. 2011). Connectivity of tef consumers is overall good as individual consumers have many options for purchasing tef or enjera. Even though transportation services show seasonal and geographical variation, tef consumption levels show little variation over space, indicating appropriate connectivity through transport services (Minten et al. 2013, Berhane et al. 2011).

Attribute	Resilience score	Weighed score	Importance of attribute	Data basis
Buffering capacity				
Environmental Capital				
Connectivity				
Diversity				
Equitability				
Exposure to pressure				
Governance capacity				
Information, learning				
Profitability & fin. cap.				
Self-Organization				
Transformability				

Figure 22: Resilience scores for tef consumption.

Diversity

Enjera can be made with different cereals, but as tef gives the best result, it is the preferred ingredient (Baye 2014). Due to the increasing prices for tef, poorer households have recently begun mixing tef with other cereals such as maize, wheat, sorghum and rice to make enjera (Berhane et al. 2011, Fufa et al. 2011).

In Ethiopia, people often consume what they produce and therefore quantity and diversity of calories, proteins and nutrients are often inadequate (Tafere et al. 2010, Berhane et al. 2011). Tef is nutritionally very rich as it contains high levels of energy and micronu-

trients (especially iron), is gluten free and has the highest amount of protein among cereals consumed in Ethiopia (ATA, MoA, EIAR 2013). Its consumption is therefore more favorable than the consumption of cheaper cereals such as maize or wheat.

Environmental capital

Consumption of tef has no direct critical emissions on the environment. Further, the regular consumption of tef can be beneficial on health as it is nutritionally the most valuable staple grain in Ethiopia (Fufa et al. 2011).

Exposure to pressure

Increasing prices are the major shock for tef consumers. In the past, tef consumers have repeatedly been exposed to price hikes of tef, caused for instance through production shocks or an overall food inflation. In such situations, people today usually switch from tef to cheaper cereals such as maize or rice. Since importance of tef as a staple food has decreased and there are other crops available at much lower prices, impacts of such tef price shocks on food security are less severe than in the past (Ayele 2015).

Self-organization

Self-organization among consumers is generally possible and GoE even encourages the formation of consumer cooperatives. However, these cooperatives have limited autonomy as they indirectly depend on government subsidies and face strict regulations (consumer cooperative interviews).

Equitability

As prices for tef are rising, income becomes a determining factor for tef consumption. Apart from this factor, access to tef in Ethiopia seems equitable.

Governance capacity

The relatively low importance for food security is also the main reason for the lack of programs to support tef consumption in Ethiopia. However, the overall vision for the tef value chain in the national tef strategy includes the provision of high quality tef at an affordable price for tef consumers (ATA, MoA, EIAR 2013). Furthermore GoE encourages the formation of consumer cooperatives with the goal to procure lower and more stable prices for consumers (Ayele 2015).

In case of disturbances/price hikes for tef or other staple food items, GoE used various instruments in the past such as an export ban, food subsidies or food rationing (cf. Worku et al. 2014). However, most of the measures only had an indirect and limited effect on tef prices.

Buffering capacity

Consumption is mainly constrained due to the restricted purchasing power of consumers and the limited tef production capacities (see chapter 4.2.3) leading to increasing tef prices over the past decade (Worku et al. 2014). Further, tef availability shows seasonal variations, with highest prices during the rainy season just before the harvest (Minten et al. 2013, consumer cooperative interviews). Consumers only keep very limited amounts

of tef stocks due to financial and storage capacity constraints, as seen at the visited consumer cooperatives. However, tef farmers are at the same time tef consumers and they often keep some tef stocks (see chapter 4.2.3).

Information and learning

As reported in chapter 4.2.4 tef suppliers usually have an information advantage compared to tef consumers and trust plays a major role when purchasing tef. As reported by visited consumer cooperatives, trust in suppliers is often low.

Transformability

Tef is deeply rooted as a staple crop in Ethiopian society and people show a strong preference for tef compared to other staple cereals (Berhane et al. 2011). In order to improve food security, former governments have repeatedly tried to discourage tef consumption and production in Ethiopia, as tef fetches much lower yields compared to other crops. All of these attempts failed and demand for tef is actually on the rise (Demeke and Di Marcantonio 2013, Ashagrie 2015). Further, consumers have unique preference for specific varieties of tef based on production area, color, taste or enjera preparation practices (Fufa et al. 2011). For instance, there is a strong preference for white tef compared to red or mixed tef, even though red tef was shown to be nutritionally richer (containing higher iron and calcium levels) than white tef (Minten et al. 2013, Baye 2014). However, even for standard white tef, preferred brightness of the color varies from production region to production region (Fufa et al. 2011). As mentioned by Fufa et al. (2011), these varying but pronounced preferences among consumers make it difficult to achieve economies of scale within the tef trading system.

Profitability and financial capital

Purchasing power of Ethiopian consumers has decreased over the past decade due to strong food price inflation (Abate 2015). For tef, the price hike has been even more extreme than for other crops and consumption of tef-enjera has become difficult for most middle and lower income households in Ethiopia (cf. Fufa et al. 2011). Visited consumer cooperatives all reported financial constraints and low purchasing power for acquiring tef.

Tef consumption is not directly subsidized. However, along the tef value chain there are various indirect subsidies applied by the GoE. Consumer cooperatives for instance are supported in different ways and are being promoted by the government. They further distribute subsidized goods (sugar, wheat flour, palm oil) for the GoE and are often strongly dependent on this income source to subsidize their other activities such as tef distribution (consumer cooperative interviews, Ayele 2015).

4.2.7. Summary

4.2.7.1. Summary by value chain steps

Value chain step	Improved	Unimproved	Production	Trade	Processing	Consump-	Whole value

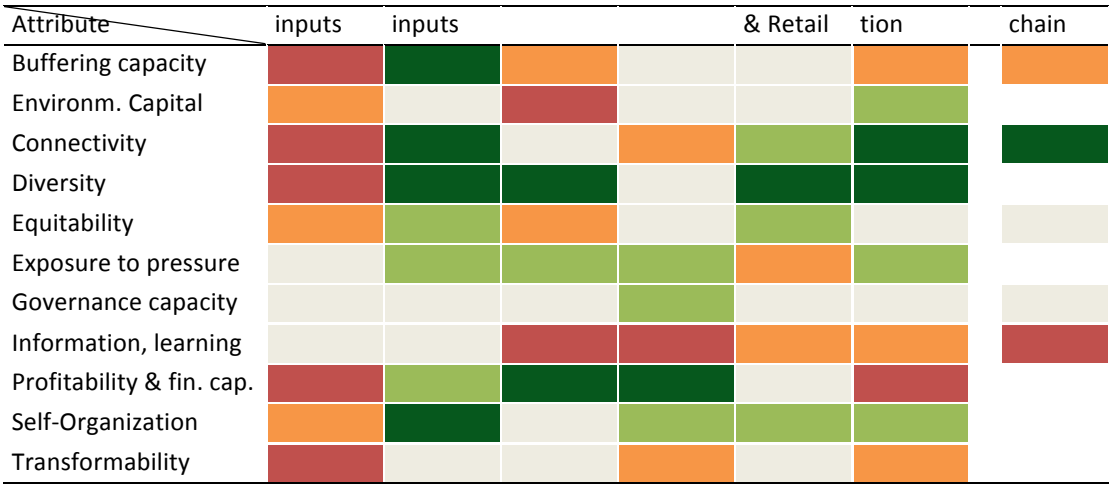


Figure 23: Weighed resilience scores for all tef value chain steps.

Input supply

The resilience performance of the input supply system is characterized by a big discrepancy between improved and traditional farm inputs. The supply of improved inputs, such as inorganic fertilizer, pesticides or improved seeds and farm implements achieves the lowest resilience rating of all activities.

A major contributor to this low score is the *fertilizer* supply system, which is totally controlled by the government and relies on one sole fertilizer importer and distributor for the whole country. Fertilizer is further a very essential input for tef farmers with no practicable alternative. Resilience scores for diversity and connectivity are therefore very low, even emphasized by the heavy geographical dependency on Djibouti port and transport capacity bottlenecks. Further, actors have little autonomy and the system therefore shows low capacity for self-organization and transformability. Finally, profitability of the system is also poor, as it relies on indirect subsidies and fertilizer distribution is often an unprofitable business for cooperatives.

Other improved inputs such as *improved seeds* and *farm implements* face chronic shortages in supply and therefore imply a very low buffering capacity. This is especially problematic as improved tef seeds and farm implements are considered to have the highest potential to improve tef yields.

In contrast, the supply with traditional farm inputs like unimproved seeds or traditional farm implements achieves a very high resilience score. These inputs are often produced by the farmers themselves or purchased from neighbor farmers or local manufacturers. Therefore the supply chains are extremely short and simple and do not depend on any supporting services (e.g. logistics). Production sites and stocks are well distributed throughout the country and buffering capacity and connectivity scores are hence very high. Further, there is a huge diversity of tef varieties that are well adapted to their specific environment. Since tef is a self-pollinating plant, even improved varieties can be self-reproduced by the farmers and autonomy of the farmers is accordingly very high.

Production

The tef production step shows an ambiguous resilience performance. Attributes like *environmental capital* and *information/learning* for instance have a low rating as traditional tef production contributes excessively to soil depletion. In addition knowledge on soil conservation, improved farming techniques or pesticide and fertilizer use is very limited among farmers. Further, *buffering capacity* is low because tef production cannot keep pace with the steadily growing demand for tef. Causes for the low production of tef are, amongst others, the limited adoption of improved farming techniques (which is partly because of an ineffective extension system) and inadequate access to improved inputs, land and capital.

On the other hand, the production step also achieved some very high resilience scores. *Profitability* of tef production is for instance high, as it shows the highest value-cost ratio of all cereals produced in Ethiopia and is therefore often produced as a cash crop. Tef production is frequently *exposed to disturbances*, which can normally be well managed as tef is known as a security crop. Further, tef is usually grown by small-scale farmers that are highly diversified and therefore add to a high *diversity* on the landscape level.

Trade

The trade step of the tef value chain shows a very low resilience score for the *information and learning* attribute because there is no well-established price information and quality grading system available. Consequently, there exists an information asymmetry between market actors and trust becomes a major component for tef transactions. These structural problems further hamper *transformability* and innovation of the tef trade, which is additionally restrained by the high price volatility and capital-intensive nature of tef. Further, tef trade has a low rating for *connectivity* as alternative marketing channels are limited and dependency on traders and brokers is high.

On the positive side, actors of the tef trade step are able to adapt quite well to the changing market circumstances and tef trade is a profitable business despite the declining margins. Actors have a lot of autonomy, cooperatives even get some government support to establish linkages with customers and government addresses some of the major resilience constraints of the tef trade step in its long term plans.

Processing & Retail

Processors are frequently exposed to shocks like electricity shortcuts. However, they rarely have backup systems (e.g. generators) for such cases and hence face income losses and quality problems (enjera producers). Enjera quality problems can also origin in poor tef quality due to the lack of an official grading system for tef. Therefore resilience ratings for *exposure to pressure* and *information/learning* are low.

On the positive side, *diversity* scores are very high for the processing & retail step, as there is a huge number of microprocessors and millers with diverse income sources, suppliers and customers well distributed throughout the country. Further, *connectivity* score is high as processors are well connected and dependency on the processors is overall small, as enjera can be produced by the households themselves.

Consumption

Profitability score for the consumption step of the tef value chain is very low, as purchasing power of Ethiopian consumers has generally decreased over the past decade due to strong food price inflation and price hikes of tef have been even more extreme than for other crops. Accordingly, consumption of tef-enjera has become difficult for most middle and lower income households in Ethiopia. Consequently *buffering capacity* is also rather limited among tef consumers as they only keep very limited amounts of tef in stock. As tef is deeply rooted as a staple crop in Ethiopian society, preferences for tef compared to other staple cereals are very difficult to change (as shown in the past). *Transformability* score is therefore low.

On the other hand, people have recently begun mixing tef with other cereals such as maize, wheat, sorghum and rice to make enjera whereby peoples' dependency on tef has decreased. *Connectivity* of tef consumers is overall good, as individual consumers have many options for purchasing tef and because a majority of the tef is consumed by the farmers themselves. Further, tef is nutritionally very rich compared to other cereals and its consumption therefore increases *diversity* of nutrition.

4.2.7.2. Summary by resilience attributes

Buffering capacity:

The buffering capacity among the value chain activities is very heterogeneous. Due to the huge number of actors and their big spare capacities, the *traditional farm implement supply* achieves very high scores. The other processes, however, are characterized by limited stocks and financial capital and limitations in production and supply of products.

Environmental capital

The main constraints concerning environmental capital are the negative impacts of tef *production* on soil fertility and the emissions caused by fertilizer and pesticide application. The other value chain steps have little impact on the environment.

Connectivity

Overall, resilience scores for connectivity are good with best scores for *unimproved input supply* and (own) *consumption* due to the very short value chains for the respective activities. The improved input supply achieves a very low score since there are some transportation bottlenecks known in the fertilizer and seed supply and since the essential fertilizer supply is relying completely on one sole supplier.

Diversity

Accordingly, diversity score for improved input supply is also low, as there are no alternative fertilizer suppliers. In addition, all fertilizer has to pass through Djibouti Port and the AISE central warehouses. Overall, the diversity score is still very good as most activities are carried out by a huge number of actors, which are usually quite diversified and have different income sources.

Equitability
Generally equitability plays a minor role in the tef value chain. For the *production* step however, the existing land tenure policies are a major constraint as they only grant user and not ownership rights to farmers and land cannot be sold, exchanged or mortgaged. Further, in the *improved input supply* as well as the extension system, decision-making is strongly top down driven, giving the actors little autonomy.

Exposure to pressure
Generally, actors of the tef value chain are frequently exposed to pressure (fluctuating prices, environmental stresses, electricity shortcuts) and most of them can overcome them quite well due to various coping mechanisms. *Processors* (mostly millers) are an exception as very few of them have backup systems against the frequent electricity shortcuts.

Governance capacity
Governance capacity is somewhat difficult to evaluate. GoE has in the past years raised attention on tef and in the "National Tef Strategy" (ATA, MoA, EIAR 2013) some of the major resilience bottlenecks were identified. However, it is difficult to estimate how many of the planned interventions will finally be put into practice.

Information/learning
Resilience score for Information/learning is rather low, owed to inefficiencies in the extension system and the generally low knowledge and awareness of actors on different topics (e.g. soil conservation, improved farming techniques, credit system). Tef *trade* (including *processors* and *consumers*) lacks an official price information and quality grading system, making trust a crucial factor when trading tef.

Profitability and financial capital
Profitability scores are especially high for tef *production* and *trade*, as these two value chain steps are, at the moment, profiting most from rising tef prices while *consumers* suffer from high tef prices. Many actors in the *improved input supply* face the problem of unprofitable businesses and often rely on subsidies.

Self-organization
With the exception of fertilizer supply, which is totally state controlled, self-organization among actors is possible throughout the tef value chain and actors usually have sufficient autonomy and motivation to organize themselves.

Transformability
There is generally sufficient motivation and openness for change among tef value chain actors. However, actors often face economic (e.g. start capital) or social (e.g. tradition) barriers to implement such changes. In the *improved input supply*, transformability is hampered by the strong government involvement.

4.3. Building resilience of the tef value chain

This section relies on results from the resilience workshop. Among other tasks, actors were asked to develop interventions to better overcome a shock, which was in this specific case, a drought. Potential interventions were designed in groups according to the different activities of the participants (for more details see chapter 2).

Input supply

The input supply group at the workshop consisted of suppliers of improved seeds and pesticide. Therefore, only the formal input supply sector was represented and no exponent of the fertilizer supply chain was present. To understand the selection of interventions made by the group, it must be considered how input suppliers are affected by such a shock. Seed suppliers face similar drought consequences as tef famers, namely lower yields and quality of tef seeds. Consequently, their income gets reduced and they possibly face a lower demand for tef seeds. Similar applies for pesticide suppliers, which definitely face lower demand and thus income losses.

Table 8: Interventions to overcome droughts proposed by the workshop participants

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

Numbers represent the priority of the interventions proposed by the stakeholder groups.

Accordingly, main interventions proposed by the input suppliers aim to better overcome financial shortages such as developing alternative income sources or accumulate savings. Further, promotion of improved technologies (e.g. improved seeds and pesticides) and improved trust among actors were reported to be important. The Latter must be understood in the sense that lack of trust in extension agents or cooperatives is seen as a main reason for low adoption rates of improved technologies among farmers. Further, water harvesting techniques and infrastructure quality were mentioned to be important measures to overcome droughts for input suppliers. While first obviously aims at seed producers, transport infrastructure was mentioned to be a major constraint in the distribution of all improved inputs, causing delays and higher product prices. Finally, freedom to express diverse opinions was mentioned as another capacity, which helps to overcome a drought.

Production

There were three different groups focusing on possible interventions for the tef production step, namely farmers, farmer cooperatives and an expert group. The potential interventions found by the three groups were surprisingly consistent. Financial aspects also played a major role in their considerations whereas all of them listed savings as a major measure to overcome droughts. Besides savings in monetary form, groups also mentioned stocks of seeds and crops (as food stocks or fodder) to be important. Further, alternative income sources were stated to be essential in case of a drought. They can either come from off-farm activities (e.g. construction work) or from diversification on the farms, preferably through non-weather-dependent activities such as livestock production (poultry, fattening, etc.). The third group of measures stated by actors can be summarized in the use of improved farming technologies, including drought resistant varieties and water harvesting techniques.

Trade, Processing & Retail and Consumption

The actors of the post-production steps of the tef value chain (trade, processing & retail, consumption) all proposed quite similar measures to overcome a drought. The reasons for the similarity can probably be found in the related consequences that these different actors face in case of an aridity which are a lower availability, quality and higher prices for tef. As a consequence, these value chain steps will be discussed together.

Similar to the previous groups, processors and consumers considered savings and stocks of inputs (mainly tef) to be important in case of a drought, probably in order to be less affected by increasing tef prices. Similar considerations may apply for the choice of insurance, alternative income sources, respectively a diversification of their activities (e.g. produce alternative products besides enjera) to overcome a drought.

While the interventions mentioned for the production step mainly rely on self-initiative of the actors, post-production exponents all find government support to be a crucial element to overcome a drought. For instance, all three groups cited government support before, during and after a drought. Similarly, all of them see the necessity of an early

warning system, either organized by the government or through direct information exchange between the different value chain actors (e.g. farmer cooperatives directly warn consumer cooperatives that the yields are estimated to be low). Both, traders and consumers further mentioned the adoption of improved technologies among farmers to be an important measure for their activity to be less affected by droughts. This probably implies promotion of such technologies by the government. Finally, tef processors also mentioned self-organization, trust among actors as well as freedom to express diverse opinions to be important qualities for their activity in case of a drought.

Summary

Regarding the whole tef value chain, most frequently mentioned interventions were alternative income sources, savings and stocks. For tef production, stakeholders furthermore agreed on the adoption of improved technologies such as water harvesting techniques and drought resistant varieties as major interventions for farmers. Traders, processors & retailers and consumers further expressed a need for early warning systems and state support, to better overcome a potential drought.

5. Discussion

5.1. Tef and its role for food security in Ethiopia

As described in chapter 4.1.3, tef is not a typical food security crop in Ethiopia. The continuously increasing prices have made it unaffordable for daily consumption for a big part of the population and tef has become more a luxury crop than a staple food in Ethiopia. From a food security perspective, maize, wheat and sorghum are today more critical than tef, as their prices are only about half of the price for tef (cf. Demeke and Di Marcantonio 2013).

This limited importance for food security has some implications on the resilience rating of the tef value chain. The consumption process is affected in a positive way as dependency of consumers on tef is reduced due to diverse alternative cereals available at lower prices. In case of a shock affecting the tef value chain with higher tef prices as a consequence, consumers can nowadays easily switch to other cereals for making daily enjera. However, besides being the most preferred crop among Ethiopians, tef is also nutritionally much richer than alternative cereals such as maize or wheat. Accordingly, a change from tef to other cereals can imply negative consequences for health of the consumers, especially for poor households that usually have little diversified diets.

However, when discussing the role of tef for food security in Ethiopia, it must be borne in mind that today only ca. 36% of the total tef production is marketed. Hence, over 60% of all tef is directly consumed by the farm households and consequently plays a crucial role for food security of these farmers. While these subsistence farmers rely little on a functioning (post-production) tef value chain, the poor resilience performance of the improved input supply system directly affects them. With respect to the widespread soil degradation and the diminishing farm sizes, the introduction of sustainable yield enhancing technologies for tef are crucial for these farmers to maintain food security.

Finally the transformation of tef from a staple crop to a luxury food item also brings along some promising opportunities for tef farmers. By selling tef and purchasing cheaper cereals, the food security situation of tef farmers improves because more calories are available per household. Further, higher tef prices implicate the possibility for farmers to generate higher revenues. With about 25-30 million people depending directly on tef production, higher tef prices followed by an increasing commercialization of smallholder farmers represents a unique opportunity to directly increase the living standard of rural communities in Ethiopia.

5.2. Tef value chain and droughts

Drought is undoubtedly the most important shock affecting the tef value chain and consequently special attention has been given to it in this thesis (see chapter 4.1.8 and 4.3). Still, the question remains how resilient the tef value chain really is in case of a drought.

From all processes of the tef value chain, the input supply step is probably least affected by a potential drought. Only seed suppliers face direct consequences, as they mostly re-

ly on rain fed seed production. About 90% of all seeds are derived from the informal seed sector. This sector is characterized by a large buffering capacity (since normal tef grain can be used as seed), large and well-distributed stocks as well and flexible exchange mechanisms (i.e. cash, exchange in kind, barter) (cf. Sherif 2013). A total failure of the informal seed sector as a consequence of a drought is therefore highly unlikely. However, unimproved seeds from the informal seed sector often show lower yields and poorer quality than certified seeds from the formal seed sector, which even provides some specific drought tolerant tef varieties. Unfortunately, the formal seed sector faces severe capacity problems and accordingly, a very low market share, as investment in breeding and tef seed production is still insufficient in Ethiopia.

Not surprisingly, the most drought-affected tef value chain step is production, even though tef is usually known to be relatively drought-resistant compared to other crops. It has been shown that tef is especially susceptible to droughts during its early and late growth stages (cf. Mengitsu and Mekonnen 2012). While reseeding is usually possible after early droughts (if rain sets in), late droughts typically lead to irreversible yield losses. Late droughts usually implicate bigger economical losses for the farmers, as investments (e.g. fertilizer, labor costs for weeding) have already been undertaken. In the past, droughts therefore have repeatedly led to the failure of the input credit system, as farmers were not able to pay back the credits (Melekot 2015). However, tef rarely shows total yield failure as often at least some straw can be harvested. Even though typical tef farmers in Ethiopia are quite diversified, all their crops rely on one major rainy season and hence all are vulnerable to droughts. On the other hand farmers always keep some livestock (which can be sold in case of droughts) and often some household members are involved in non-farm activities as alternative income source.

The consequence of a drought for the subsequent steps of the tef value chain is most probably a higher tef price. As explained in the previous chapter, consumers in this case usually switch from tef to cheaper cereals such as maize to produce enjera. Traders and millers are typically quite diversified and sell multiple crops, but tef is still the most profitable. Consequently, a drought also affects these actors, resulting in lower turnovers and incomes. Especially regional traders, brokers and assembler might suffer from a drought as probably multiple crops are affected in their catchment area.

Summarized, it can be said that the majority of the tef value chain is quite resilient to droughts. Of all processes, tef production is most affected by a potential dry spell. However, due to a quite drought tolerant nature of tef and various coping mechanisms among tef farmers to overcome such a shock, the tef production step is also quite resilient to droughts.

5.3. Tef value chain and export ban

The tef export ban was imposed by the GoE in 2006, with the goal to reduce the pressure on the rapidly rising tef prices (ATA, MoA, EIAR 2013). However, according to GoE, the tef export ban was only an interim arrangement and shall be lifted within the next

few years (Solomon 2015). In this section, the consequences of a suspension of the export ban for the different actors of the tef value chain will be discussed.

In general, the effect of the elimination of the export ban on the tef value chain is similar to the consequences of a drought as the main result would be an increase of tef prices. Consequently consumers would suffer from reduced affordability of tef and processors would face lower turnovers and incomes. However, as shown before, tef can be substituted with cheaper alternative cereals to make enjera and consequently overall consequences for the consumption and processing sectors can be expected to be rather minor.

In contrast to a drought scenario, there are also actors that would profit from an abolition of the tef export ban. Traders for instance, generally benefit from increasing commodity prices and tef exporting was reported to have been a very lucrative business in the past. Possibly, some processing and retail actors would also become involved in exporting tef products (e.g. tef flour) and profit from unhindered tef exports. In the best case, this development could provide an important impetus for technological innovation in the whole tef processing industry in Ethiopia. However, tef farmers would benefit most prominently from lifting the export ban on tef. If prices of other staple cereals would increase relatively less than tef prices, farm households could generate higher incomes and their food security situation would probably improve (cf. chapter 5.1). The better financial situation among farmers as well as the higher tef prices as incentive to increase productivity could further result in improved technology adoption among tef farmers. With tef production still being largely unmechanized and including huge pre- and post harvest losses (about 50% of tef yields), such a technology adoption (e.g. fertilizer, pesticides, row seeders, mechanical threshers) by the farmers would have the potential to dramatically increase tef yields. This again could improve the food security situation in Ethiopia. Since international tef market demands for certain quality standards, the abolishment of the export ban would also bring along the incentive to implement a tef quality grading system in Ethiopia. A tef quality grading system plays a crucial role in facilitating tef trade in Ethiopia as trust and long-term relationships (e.g. with brokers) would become less important.

As it becomes obvious from this discussion, the elimination of the export ban does not simply pose a risk to food security in Ethiopia because of higher tef prices for consumers. Actually, it offers an opportunity for almost all value chain actors to profit in the long-term. In the best case, the elimination of the ban results in an increasing commercialization of smallholder farmers, a widespread adoption of improved farming techniques including mechanization of farms and finally higher tef production in Ethiopia. Accordingly the food security situation in Ethiopia would actually improve in the long run. However, a sudden abolishment of the export ban would probably result in huge price increases in the short-term with many adverse effects for the different actors of the tef value chain. Therefore, it is advisable to reduce the export ban gradually instead of abrupt, and accompany it by supporting measures.

5.4. Resilience building and way forward

As mentioned in chapter 2, the final goal of the food system resilience concept is not only to assess the resilience of food systems but rather to make food systems more resilient. To do so, a detailed resilience assessment is however an essential precondition. At the stakeholder workshop, a first attempt of building resilience in the tef value chain was undertaken, using a participatory approach. Still, the different stakeholder groups designed interventions just for a specific drought scenario. Further, actors had limited knowledge on the resilience condition of the tef value chain, apart from their own experience. In this section, the interventions developed by the value chain actors are therefore compared and complemented with the key findings of the resilience assessment for the tef value chain in the face of multiple kinds of shocks.

Value chain actors mentioned *alternative income sources* as the most important intervention to make their activities more resilient to droughts. In the resilience assessment though, stakeholders throughout the value chain were found to generally have quite diverse income sources. For instance, tef farm households always plant various crops, keep some livestock and often even generate some income from temporary off farm activities. Therefore, the choice made by the workshop participants probably represents rather a popular measure among actors to better overcome shocks than an urgent need of actors for more diversification.

The only value chain step that shows a strong need for more diversification is the fertilizer supply system. As tef farmers have no practical alternatives to inorganic fertilizer and the supply depends totally on imports and one sole supplier (AISE), the fertilizer supply system is very vulnerable to potential shocks. In order to make the system more resilient, there is a strong necessity to increase the diversity of distribution channels and market players, the spatial diversity of production sites (e.g. by constructing domestic fertilizer plants) as well as to enhance the diversity of nutrient sources for tef farmers (e.g. organic fertilizer, by reducing competitive uses for dung).

The second and third most frequently mentioned interventions are *savings* and *stocks*. Both can be ascribed to the resilience attribute of buffering capacity. In contrast to diversity, this attribute achieves quite low resilience ratings for all value chain steps, amongst other reasons due to limited stocks of inputs kept throughout the value chain. The limited stocks are often caused by financial limitations of actors, as they have little savings and restricted access to credits. Therefore, promoting savings and improving access to credits (and creating awareness on it) are two key measures to increase the buffering capacity of the tef value chain actors. At the same time, these measures could enhance innovation and technology adoption throughout the value chain.

Insurance is another intervention cited by various value chain actors. With the exception of some big enjera and input supply companies, actors of the tef value chain are not insured against losses. Access of the predominantly small-scale actors to insurances (e.g. micro- or index-insurances) could significantly help them to overcome shocks, particularly when considering the limited savings, stocks and assets held by actors.

Stakeholders of the production and input supply steps further considered *improved farming techniques* such as *drought resistant varieties* or *water harvesting techniques* to be crucial components for them to overcome droughts. In fact, the low adoption of improved farming techniques by tef farmers is a key resilience bottleneck of the tef value chain and the main reason for the relatively low yields of tef. A main cause for this limited adoption is the poor performance of the improved input supply sector, both in terms of resilience and supply volume. The farmers therefore have to purchase the vast majority of their inputs (seeds and farm implements) from the informal input supply sector. In contrast to the formal input supply, the informal sector is overall very resilient. It consists of a huge number of well distributed, autonomous and highly diversified players, features a huge diversity of products (tef varieties) and contains short and simple supply chains with various exchange mechanisms and low dependency on logistics and communication services. The informal sector therefore serves as a showcase example on how a resilient supply system could be organized.

Besides improving the formal input supply system, measures to improve the adoption of new farming techniques and the resilience of the tef production step should include; i) land reforms to encounter diminishing farm sizes and land fragmentation (impeding mechanization), ii) create awareness on the benefits of improved farming techniques among farmers, iii) create financial possibilities for farmers to purchase technologies and iv) give special attention to the promotion of soil conservation techniques to reduce soil depletion through tef production.

The actors of the post-production steps further mentioned a need for *early warning systems* and *government support* to overcome droughts. Over the past years, Ethiopian government has established an extensive early warning system for multiple kinds of shocks affecting food security. However, the early warning system as well as the overall disaster support system from the Ethiopian government mostly concentrates on emergency relief (mostly food aid) in case of a shock. From a resilience perspective this policy is sub-optimal, as it creates a dependency of the population on international food aid. Rather, government support should focus on the prevention and mitigation of shocks as well as on measures to increase the capacity of actors to withstand, absorb and recover from shocks.

Finally, some stakeholders also considered *trust among actors* and the ability of actors to *self-organize* and *express diverse opinions* to be important to overcome a shock. In fact, trust plays a crucial role in tef trade, as there is no price information and quality grading system available for tef. As trust was further reported to be low among stakeholders, the lack of a price information and quality grading system leads to inefficiencies in tef market and hampers connectivity. The latter also depends on the ability of actors to self-organize. By promoting self-organization and introducing a quality grading and price information system for tef, the tef value chain could be made both more resilient and efficient.

Overall, the interventions developed by the tef value chain stakeholders turn out to address some of the most crucial resilience bottlenecks of the tef value chain. However, the suggestions discussed above remain a very rough selection of the most urgent interventions. Basically, for each resilience deficit identified in the resilience assessment, an intervention would have to be developed. In order for these possible solutions to be sustainable and address the right issues, they have to be developed based on a solid data basis. However, despite the crucial role tef plays for food security in Ethiopia, very little is known on the vulnerability and resilience of the tef value chain. Accordingly, the present study is the first resilience assessment done on the tef value chain in Ethiopia. Data basis for the evaluation was often rather thin, based on the limited literature available and a range of qualitative stakeholder and expert interviews. The present study should hence be seen as a first impression on the resilience of the tef value chain in Ethiopia, rather than representing a profound final judgment on the topic. Considering the urgency and the huge potential of possible interventions in the tef value chain, more detailed investigation on the issue is necessary. For instance, quantitative resilience assessment of the different value chain steps should be undertaken.

6. Conclusion

The concept of food system resilience was developed to better understand and assess the ability of food systems to deal with various types of shocks. In this study, the resilience of the tef value chain in Ethiopia was assessed. Based on a methodological approach developed by the SAE-Group of ETH Zurich, the tef value chain was identified, its resilience performance assessed and interventions developed to improve the resilience.

Resilience performance of the tef value chain was found to be quite heterogeneous, differing considerably between the single value chain steps and specific resilience attributes. On the positive side, the tef value chain is characterized by a huge number of mostly small-scale actors, which are well distributed throughout the country, generally quite diversified, autonomous and able to self-organize. Actors are commonly well connected (with multiple suppliers and customers) and rarely show dependency on single inputs. Further, stakeholders are frequently exposed to disturbances and usually have various coping mechanisms to overcome such shocks.

Nevertheless, the tef value chain also shows some distinct resilience weaknesses. For instance, no price information and quality grading system exists for tef, causing information asymmetries and making trust a crucial factor for tef transactions. Buffering capacity of actors to absorb shocks is limited, as they rarely keep stocks of inputs and often face financial constraints (e.g. little savings, limited credit access). The latter also limits transformability and innovation of actors, and actors often face economical (e.g. start capital), social (e.g. tradition) or regulatory barriers. Another resilience bottleneck was identified for the input supply system, with improved input supply showing heavy government involvement, high dependency on single actors and processes, insufficient funding on tef research and chronic supply shortages. The latter is one of the major reasons for the still very low productivity of tef, as the big majority of tef farmers purchase (unimproved) seed and farm implements through the informal input supply system. While the informal system shows very high resilience scores, it is at the same time responsible for the lower yields and high pre-and post-harvest losses (up to 50% of the total tef yields). Further challenges for the adoption of improved farming techniques range from inappropriate land tenure policies, deficits in the extension system, low awareness on the benefits of such techniques to financial limitations of farmers to purchase inputs.

In order to improve the resilience of the tef value chain, a workshop was held where stakeholders developed resilience interventions. Main propositions include alternative income sources, savings and stocks, the adoption of improved farming technologies (e.g. drought resistant varieties) as well as the need for early warning systems and government support. However, the interventions were only designed for a specific drought scenario and actors had limited knowledge on the resilience performance of the tef value chain. In order to build resilience in a sustainable way, intervention design should be based on a solid resilience assessment, which addresses multiple kinds of shocks. As the data basis of the present work was rather sparse and resources limited, more detailed investigation on the resilience of the tef value chain is needed.

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Interviews

The following persons were interviewed personally between June and August 2015. A big thank to all of them for taking the time to answer all my questions so extensively.

Abate Bekele (PhD)	Senior researcher and agricultural economist at DZARC. Debre Zeit.
Ayele Gebreamlak (PhD)	Director of tef and rice value chain program at the Ethiopian Agricultural Transformation Agency (ATA). Addis Ababa.
Bart Minten (PhD)	Program Leader of the Ethiopia Strategy Support Program (ESSP) at the International Food Policy Research Institute (IFPRI). Addis Ababa.
Bekele Mekuria	Director of the Cereals & Pulses Processing Directorate at the Food and Beverage and Pharmaceutical Development Industry Institute (EFDR). Addis Ababa.
Dimissie Mitiku	Former researcher DZARC and member of Amuari High Yield Varieties & Agricultural Products PLC (private tef seed company). Debre Zeit.
Kebebew Assefa (PhD)	Tef breeder/ geneticist, national tef research coordinator at DZARC. Debre Zeit.
Melekot Haile	New input credit system program leader. Agricultural Transformation Agency (ATA). Addis Ababa.
Setotaw Ferede (PhD)	Agricultural economist at DZARC. Debre Zeit.
Sherif Aliy	Research & extension specialist at DZARC. Debre Zeit.
Solomon Chanyalew (PhD)	Tef breeder and director of the Debre Zeit Agricultural Research Center (DZARC). Debre Zeit.
Tenna Alemu	Member of the Ministry of Agriculture of Ethiopia (MoA). Expert on the input supply system. Addis Ababa.
Yakob Seid (PhD)	National Technical Manager of Famine Early Warning Systems Network (FEWS NET). Addis Ababa.
Yirgalem Eneyew	Member Federal Cooperative Agency at the Ministry of Agriculture of Ethiopia (MoA). Addis Ababa.
Zewdu Ashagrie (PhD)	Researcher at Food Science and Nutrition Center, College of Natural Sciences, Addis Ababa University. Addis Ababa.
Zinet Ahmed	Member of the government of Ethiopia's Disaster Risk Management Food Security Sector (DRMFSS). Addis Ababa.

8. Appendices

Appendix 1. Resilience questionnaires with answers.

Whole value chain

Question	Rating	Answers	Attribute
Are storage systems distributed throughout the value chain?		Abate: No big storage system for tef throughout the tef value chain.	Buffering capacity
		Ayele: Uncommon for cooperatives to have big stocks, but some specific ones have up to 10 000 t of tef.	
		Minten: Generally, there is some tef stored throughout the value chain, but most of it is stored on farms, due to very easy storage of tef. Little storage by traders, since storing is risky and requires big investment.	
		Fufa et al. 2011: "There is very little apparent stocking of Tef with Ehel Berenda traders, only enough to satisfy petty trade during the day. Storage of Tef could not be observed at any point along the value chain, either with traders at surplus areas or with millers at Addis Ababa. "	
		Demeke and Di Marcantonio 2013: "Teff can also be stored for many years without being seriously damaged by common storage insect pests."	
		Minten et al. 2012: "releases by the producer of teff stocks in storage over the year is rather smooth, and distress sales are of minor importance"	
		Minten: "Storage in the value chain is mostly happening on farms. Farmers often sell other cereals first and keep tef since it's easy to store and prices rise during the season."	
		Fufa et al. 2011: "However, we learned from the field visits that the costs associated with Tef stocking is minimal compared to any other crops due to low vulnerability of the crop to pests, especially weevils."	
Is there sufficient labor force available for the activities and can it be adapted to fluctuations?		Kebebew, Setotaw, Sherif: "At the moment, no problem of labor force supply. But with more literate children, less people want to work in agriculture. Also competitive sectors increase cost of labor, mainly in urban and periurban areas, where most of the tef is produced"	Buffering capacity
		ATA, MoA, EIAR 2013: "At farm-level, the most important challenge facing tef production is its labor requirement and the associated costs.	
		Abate: "Labor cost is increasing during harvesting time (if rain forecasted, price increases) (from 70B to 150 B). Problem of young people not wanting to work on farm anymore → solution: Mechanization, semimecanization.	
		Expert group at workshop: Labor cost increase and low productivity of labor leading to higher production costs is one of the major problems.	
Is the value chain between producer and consumer very long and complex?		Demeke and Di Marcantonio: "The teff value chain is long and involves too many small operators"	Connectivity
		Minten et al. 2012: "...we find—in contrast to conventional wisdom—that value chains are relatively short and that average farmers obtain a high share, of about 80 percent, of the final consumer price in the major terminal market, Addis Ababa."	
		Fufa et al. 2011: "Supply chain integration is also another measure of market efficiency to understand how closely producers and consumers are linked. Cereal markets in Ethiopia in general are considered to be long and complex (Rashid and Asfaw, 2011). The Tef supply chain is characterized by the heavy involvement of brokers and middlemen. "	
		Fufa et al. 2011: "Long supply chains and low transparency of market operations are some of the reasons for high price mark-ups observed in the Tef marketing. There are frequently 5 or more handovers of Tef between producers and consumers, with each trader or broker taking a profit margin as well as incurring transport and storage costs. "	
		For the 2/3 of not marketed tef, no value chain is needed or if it is very simple.	
Are there ethnical, gender, familiar dependencies/barriers which hamper connectivity?		Zerihun et al. 2014: "The government has actively mainstreamed gender as a cross-cutting issue through joint planning between sectorial line ministries and the Ministry of Women, Children and Youth Affairs. Such strategies have led to reduced gender disparities, especially in education. Ethiopia recorded about 40% improvement in its gender parity index in primary school enrolment from 1991 to 2013, and is near complete gender parity at the primary school level. "	Equitability
		Zerihun et al. 2014: "There are still areas where the government must make a concerted effort to improve the status of women. The participation rate of women in business and in decision making is low. The literacy level of women is markedly lower than that of men (63% for men and 47% for women). "	
		Minten et al. 2013: "Family, kin, and ethnic relationship are often presumed to be important in agricultural trade (Gabre-Madhin 2001; Fafchamps and Minten 1999). Table 3.2 shows that urban brokers/traders work with a rather limited number of suppliers—seven on average over a 12 month period—and that they procure almost two-thirds of their supplies from the zones that they are originally from. This suggests indeed tight, and often family, networks at that level. On the other hand, only 7 percent of the retailers work with suppliers that are originally from the same	

		zones as theirs.	
		Sherif: "No ethnical barriers/tensions in tef growing areas (only in pastoral areas)."	
		Sherif: "Women are neglected in traditional rural households. For instance, women don't plow, decisions are mostly taken by men. These cultural barriers are slowly changing (on farms with young farmer sin power, women plow sometimes, women are part of decision-taking process). In extension, women and male have right to same access to extension, but in reality extension nearly only given to male farmers."	
		ATA 2014: Throughout Ethiopia, female farmers make up roughly half of the agricultural workforce; however when it comes to access to vital resources and opportunities, women's interests remain vastly underrepresented. For example, female farmers only account for a mere 15% of agricultural cooperative membership in the country.	
Are dispute resolution mechanisms fair and independent? Are dispute resolution mechanisms accessible to all?		Zerihun et al. 2014: "Ethiopia's regulatory system is generally considered fair. Secured interests in property are protected and enforced. Investment, business, and other licenses can be obtained from the Ethiopian Investment Agency in a matter of hours. Proposed national laws are generally circulated for public comments prior to enactment. Disputes may be settled by means agreeable to both parties. Property and contractual rights are recognized and there are commercial and bankruptcy laws. Although efforts are underway to strengthen its capacity, Ethiopia's judicial system is overburdened, poorly staffed, and inexperienced in commercial matters."	Equitability
		Human Rights Watch 2015: "Ethiopia is continuing to develop sugar plantations in the Lower Omo Valley, clearing 245,000 hectares of land that is home to 200,000 indigenous people. Indigenous people continue to be displaced without appropriate consultation or compensation. Households have found their grazing land cleared to make way for state-run sugar plantations, and access to the Omo River, used for growing food, restricted. Individuals who have questioned the development plans face arrest and harassment. Local and foreign journalists have been restricted from accessing the Omo Valley to cover these issues."	
		Expert: "If you want to do good business, you have to support government, if not, government makes it difficult for your business to expand. There are cooperatives which had to close down because they were supporting opposition. There are different instruments GoE uses to control people who are supporting opposition, such as access to credits, access to land, access to extension, fertilizer etc.	
		Amnesty International 2015: "The government used multiple channels and methods to enforce political control on the population, including politicizing access to job and education opportunities and development assistance, and high levels of physical and technological surveillance."	
Are there long-term plans (e.g. 50 years) to manage supply, demand and capacity?		ATA, MoA, EIAR 2013: "Overall Vision for the Tef Value Chain: An efficient and well-functioning tef value chain that enables a sustainable increase in smallholder tef farmer productivity and profitability while providing high quality output at an affordable price to tef consumers. "	Governance capacity
		Gebre-Selassie and Bekele 2012: "The Government of Ethiopia has devised the current national development strategy called Agricultural Development Led-Industrialization (ADLI). ADLI takes agriculture as the engine of national economic growth. Through ADLI, the country plans to end up with rapid and sustainable economic growth and independence from foreign food aid. The Government's strategy is to achieve these development objectives through an agriculture-centered rural development programmed. The strategy is also taken as means of eliminating the country's food aid dependency, ...it will both promote national economic development (i.e. expand the domestic market) and minimize the country's vulnerability to external shocks"	
		Fufa et al. 2011: "Over the past few years, the Ethiopian government has designed and implemented several economic development plans, notably the Sustainable Development and Poverty Reduction Plan (SDPRP), which covered the years 2002/03 to 2004/05 and a Plan for Accelerated and Sustainable Development to End Poverty (PASDEP) that ran from 2005/06 to 2009/10. Based on the experiences gained from the previous two plans, the Growth and Transformation Plan (GTP) has been adopted as a national planning document for the years 2010/11-2014/15 (MoFED, 2010). The priorities determined for the agricultural sector include: i) increasing capacity and extensive use of labor; ii) increasing agricultural land utilization; iii) linking specialization with diversification; iv) strengthening the agricultural marketing system; and v) scaling up best practices in the sector (MoFED, 2011). According to the plan, the Ethiopian Government aims to double agricultural production in the five years. "	
		Minten: " In the past there was little attention given to tef. But since 3 years GoE pays more attention to tef, ATA set tef as a priority crop 3 years ago."	
		Berhe et al. 2013: "In the year 2011, the Ethiopian government through its newly established Agricultural Transformation Agency (ATA) gave special focus to tef improvement. Plans have been put in place to demonstrate, along with improved varieties, several promising and productivity enhancing technologies "	
Is there capability to identify and anticipate prob-		CLIMATE CHANGE: Admassu et al. 2013: "Knowledge of expected adverse effects of climate change has led to the establishment of the Ethiopian National Forum for Climate Change, established in July 2008, which is playing a significant role in bringing the potential impact of climate change to the attention of political leaders and the public. Several other initiatives are in place:	Governance capacity

lems, establish priorities, mobilize resources for action? /Are there plans to address any risks from hazards and emergency situations with scripts for actors in case of such an event?		the National Policy on Disaster Prevention and Preparedness, the Plan for Accelerated and Sustainable Development to End Poverty, the National Adaptation Programme of Action, and the Disaster Risk Management Policy. "	
		POPULATION GROWTH: Tedesse and Headey 2012: The federal government of Ethiopia clearly recognizes the importance of reducing fertility rates. A National Population Policy was initiated in 1993 when the current government took power, with the general objective of harmonizing the relationship between population dynamics and other factors that affect the country's development. The specific objectives of the policy include raising the contraceptive prevalence rate among married women from 4 percent in 1990 to 44 percent by 2015, raising the age of marriage from 15 to 18 years, and reducing the total fertility rate from 7.1 children in 1990 to 4 children in 2015. However, the most recent Demographic and Health Surveys (DHS) data show achieving these targets is at best a remote possibility. For example, in 2005 only 15 percent of married women used either a traditional or a modern method of contraception. And while infant mortality rates declined significantly (from 217 to 123 deaths per 1,000 live births between the late 1980s and 2004) the decline in fertility rates has only been modest , declining to 5.4 children in 2005 (CSA 2005)."	
		MInten 2012: To address these different shocks, the government has traditionally intervened in markets through purchases, storage, and sales by the EGTE. The EGTE purchases grains when prices are low and releases them when prices reach a certain ceiling. However, the quantities bought and sold are usually around 2–3 percent of total marketed quantity in the country and are thus not expected to have had significant effects on prices overall. There were four direct responses to high food price increases in 2007 and 2008 (Dorosh and Rashid 2012): (1) imposition of an export ban, (2) re-introduction of urban food rationing, (3) informal suspension of local procurement by the World Food Program (WFP) and others, and (4) direct government imports for open market sales and price stabilization. In an effort to reduce food price inflation in 2011, the government imposed price caps on 17 basic food commodity items in the beginning of that year.6 However, given that these price caps had negative consequences on the availability of some of the food items, that decision was reversed in June 2011 for most crops	
		Zerihun et al. 2014:"Ethiopia has achieved significant gains in poverty reduction and all aspects of human development. It is among the countries in sub-Saharan Africa making the fastest progress towards the MDGs. The government's commitment to poverty-focused spending has led to substantial progress in improving access to basic services and significant gains in social indicators. Overall, Ethiopia is on track to meet 6 MDGs (1, 2, 3, 4, 6, and 8) and likely to meet the other 2 MDGs (5 and 7). The progress so far recorded is attributed to strong commitment by the government and its development partners to the MDGs and to the overarching national development plans – the Plan for Accelerated and Sustained Development to End Poverty (PASDEP) and GTP.	
		Zelleke et al. 2012: "Government spending in extension has also established over 8,500 Farmer Training Centers (FTCs) and trained 63,000 Development Agents (DAs) from 2002 – 2008."	
		Zerihun et al. 2014: "With the consistent implementation of the poverty-reduction initiatives, pro-poor spending continues to rise (70% in 2012/13). As a result, poverty in Ethiopia has declined at an annual average of 2.32 % since 1995. The proportion of people living below the poverty line fell from 45.5% in 1995/96 to 29.6% in 2010/11 and is estimated to have further declined to 27.8% in 2012. "	
		Zerihun et al. 2014: "Impressive results in health-service expansion have been achieved. … Primary school enrolment rates increased from 68% in 2004/05 to 85.7% in 2012/13. "	
		IRI 2007: "After experiencing consecutive drought events in 1957-58, 1964-65, 1972-73 and 1983-84, the Ethiopia government put in place national institutional arrangements comprising policies and procedures for drought management. The Ethiopia government recognized drought as the most important climate- related disaster affecting the economy and gave its mitigation high priority. The Disaster Prevention and Preparedness Agency headed by the Deputy Prime Minister, reflected the seriousness of the issues it addressed and the priority the government gave to the mitigation of drought. Other elements of the preparedness strategy were the Emergency Food Security Reserve, the Disaster Prevention and Preparedness Fund, and the Logistics Department. "	
		IRI 2007: "Ethiopia has made significant efforts to put in place, coping mechanisms for its people by implementing the Safety Net Programme. The objective of the programme was two-fold: First, to provide households with enough income (cash/food) to meet their food gap and thereby protect their household assets from depletion during drought situations, second, to build community assets to contribute to addressing root causes of food insecurity. 11The Productive Safety-Net Programme (PSNP), launched in 2005, is an important policy initiative by the Ethiopia government and donors to shift millions of chronically food- insecure rural people from recurrent emergency food aid to a more secure and predictable, and largely cash-based, form of social protection. The PSNP represents a serious and innovative attempt on the part of the Government of Ethiopia to move away from responding to chronic hunger through emergency appeals towards a more predictable response with predictable resources for a predictable problem."	

		ATA 2014: "Due to a variety of bottlenecks in the existing credit system, many of Ethiopia's farmers are unable to afford the full package of input recommendations, limiting their yield and output. To address this, the ATA, MoA and RBoAs are working to popularize an overhauled input credit model. "	
		ATA 2014: "Beyond input credit, the overall financial system in the rural areas of Ethiopia needs significant enhancement. The Rural Financial Services Program (RFS) is an initiative developed by the Government of Ethiopia to provide rural communities with increased access to a wide variety of financial services in an efficient, scalable and financially sustainable manner. This effort seeks to vastly increase access to input credit; aggressively accelerate mobilization of savings; provide risk mitigation strategies that reduce the guarantee burden on regions and provide farmers with support in case of catastrophic events; and develop improved mechanisms to deliver financial services more efficiently to rural communities (i.e., mobile, electronic platforms, etc.). Over the last year, the strategy for this program has been created through collaboration with various government stakeholders, including the Ministry of Agriculture and the Economic Policy & Analysis Unit in the Ethiopian Development Research Institute (EDRI). It has now been transferred to the ATA for refinement and implementation."	
		ATA 2014: "At harvest time, many Ethiopian farmers face high cash needs, since they have to repay a range of costs incurred during the production process (e.g., inputs, labor, etc.). Given their need for cash and a lack of buyer options, they have little bargaining power and will often accept cash payment at a farm-gate price significantly lower than the full value of their output. To address this, work was initiated with USAID's AGP-AMDe project to launch a locally based receipt platform called the Community Warehouse Receipt System. This system allows farmers to deposit their commodities at cooperative warehouses as collateral, in order to access output marketing loans from local MFIs, which will be repaid after the commodity is sold. The system is being piloted in two woredas in the Amhara Region, with two unions and four primary cooperatives participating."	
Is the governance structure complex and fragmented?		Minten: There is a strict top-down hierarchy in Ethiopian governance. Organization is rather complex.	Governance capacity, transparency
Is governance recognized, accepted, legitimate and representative?		The Guardian, 2015: Ethiopia's ruling party and its allies achieved a clean sweep in last month's general election, winning all 546 parliamentary seats, the final results showed.	Governance capacity, transparency
		The Addis Standard 2015: "Accordingly, EPRDF have won 500 of the 547 seats in the national parliament while its allies won 46 seats. The unaccounted one seat is from the Bonga constituency where independent parliamentarian Dr. Ashebir has contested. The Board said it will announce the result in due course."	
Is governance participatory?		Amnesty International 2015: "The government used multiple channels and methods to enforce political control on the population, including politicizing access to job and education opportunities and development assistance, and high levels of physical and technological surveillance."	Governance capacity, transparency
		Amnesty International 2015: " Ethnic Oromos continued to suffer many violations of human rights in efforts to suppress potential dissent in the region. Large numbers of Oromo people continued to be arrested or remained in detention after arrests in previous years, based on their peaceful expression of dissent, or in numerous cases, based only on their suspected opposition to the government."	
		Human Rights Watch 2015: "Hopes that Ethiopia's government would ease its crackdown on dissent ahead of the May 2015 elections were dashed in 2014.Instead the government continued to use arbitrary arrests and prosecutions to silence journalists, bloggers, protesters, and supporters of opposition political parties; police responded to peaceful protests with excessive force; and there was no indication of any government willingness to amend repressive legislation that was increasingly condemned for violating international standards, including at Ethiopia's Universal Periodic Review at the United Nations Human Rights Council....Security forces have harassed and detained leaders and supporters of Ethiopian opposition parties. In July, leaders of the Semawayi ("Blue") Party, the Unity for Democracy and Justice (UDJ), and the Arena Tigray Party were arrested. At time of writing, they had not been charged but remained in detention."	
Is governance transparent and accountable?		Zerihun et al. 2014: "Corruption in the public sector is claimed not to be pervasive. There is a culture of intolerance to corruption. Anti-corruption campaigns have been intensified and a good number of government officials have been prosecuted through the legal system. However, according to the 2013 Index of Economic Freedom, Ethiopia ranked 118th out of 183 on freedom from corruption. According to Transparency International, Ethiopia ranked 111th in 2013 on its index of perceptions of corruption, compared to 113rd in 2012."	Governance capacity, transparency
Are there early warning systems for disturbances?		IRI 2007: "Even more serious was Ethiopia's early warning system which was primarily designed to advice on food security and identify areas where food was needed but did little to advice the local farmers and pastoral communities of impending drought and appropriate action to take, often after the effects of drought had escalated to famine.	Information, learning

		Today, Ethiopia is much better prepared for drought. The country has developed an early warning system with a shift from food aid relief to drought anticipation based on advance climate information in the form of seasonal climate outlooks provided by the IGAD Climate Prediction and Applications Centre (ICPAC) and Ethiopia's NMA, with response mechanisms and systems put in place by the Ethiopia government, which have proved to be effective where the impacts of drought are lessened. In 2003 more than 13 million Ethiopians were affected by drought, but a major famine was avoided as a result of the shift from reactionary to anticipatory responses by the government of Ethiopia.	
		IRI 2007: ""The early warning system, in most cases, deals with preparedness for food emergency relief rather than providing the rural communities with advance information for mitigating and coping with drought. It is an emergency relief, food-oriented, reactive, and slow forecast when compared to climate forecast, which is in principle considered proactive in predicting and providing information on drought and climate change. DPPC is working in collaboration with the Regional Drought Monitoring Center, IGAD Regional Early Warning Unit, FEWSNET, WFP and other international as well as national organizations, such as the National Meteorology Service Agency (NMSA) to receive and employ user tailored climate forecast and provide proactive information for timely mitigation and coping with drought."	
		IRI 2007: "The impacts of drought can be reduced through mitigation and preparedness. The government of Ethiopia has made significant progress in shifting its early warning system from reactionary to anticipatory in disaster situations. In the last decade, investment in early warning systems has paid off, and aid agencies have information available about rainfall, vegetation and trends in food prices. However, prevention should be about sustained investment in long-term solutions that reduce vulnerabilities, not just in predicting emergencies but in equipping local communities to adapt to the impacts of drought and accrue resilience to future more frequent and severe impacts. Strengthening capacity at NMA in all areas: Human skill, Infrastructure, institutional and process would go far in an effective early warning system and reducing vulnerability to prevent famine."	
Is an atmosphere of trust and respect cultivated between actors?		ATA, MoA, EIAR 2013: "Lack of trust in the market is identified as the most important reason for the persistence of small grain traders, whose long-term relationships (especially with tef sellers) are the best guarantee that buyers and sellers will not be cheated. At present, some farmers and consumers believe that traders are not fully benefiting farmers, but rather are exploiting them. This is a major driver behind organizing farmers into formal associations, such as cooperative unions"	Information, learning
		One of the major problems for the tef value chain that emerged from the workshop was lack of trust between actors. Especially problematic is also the lack of trust in cooperatives that was reported.	
		Some visited farmers reported trust in cooperatives and traders to be a problem.	
		Fufa et al. 2011: "Moreover, most of the Tef produce is sold to local assemblers that farmers report are using unfairly calibrated weighing scales. Traders may also manipulate Tef prices using various mechanisms such as collusion and the use of privileged information, especially during the harvest months when there is a Tef glut on the market."	
Is there collaboration between actors, universities, research institutions?		Sherif 2013: "In general, the reported major limitations of the e diverse agricultural extension approaches implemented in Ethiopia are: (i) poor research-extension linkages; (ii) limited set of technologies and technical information; (iii) lack of market integration; iv) lack of well-planned and need-based timely training; (v) failure to address gender; (vi) weak monitoring and evaluation system; (vii) poorly organized credit service delivery system; and (viii) lack of consultation with farmers on the implementation of the packages."	Information, learning
Are performance, capacity and quality monitored throughout all points in the value chain?		Minten et al. 2013: Weighing happens at every level, at the time of purchase as well as sales. Quality assessments are also done for each transaction. This is usually done through visual checks or by rubbing the teff. Some of the agents report to even chew the teff to determine its quality "	Information, learning
		Mnten et al. 2013: "origin of the teff (i.e. the woreda) as that is also often seen as an important determinant of quality, though difficult to verify objectively."	

Fertilizer supply

Questions	Rating	Answer	Attribute
Does the activity have spare capacity (infrastructure,		**Infrastructure:** no spare capacity. At status quo, there are already bottlenecks in storage capacity at the central warehouses of AISE (Tenna) and cooperative union base (Yirgalem).	Buffering capacity
		Admasu 2009: "Primary cooperative stores are largely owned by the cooperatives themselves; but most are in poor condition, made out of mud and sticks, and many of them lack enough space to	

technical, know-how, financial) in case of increased demand?		store properly fertilizer products or cereals when all fertilizer is sold out."	
		Financial capacity: somewhat spare capacities: Government is involved in all steps of the fertilizer chain and finances the gross purchase on international fertilizer market, therefore no financial constraints exist(Tenna). However, this also means a dependency on state budget and additional financial means for fertilizer purchase have to be authorized by government institutions. Therefore financial spare capacities are rather limited.	
		Admasu 2009: "This huge quantity of fertilizer import requires large sum of foreign currency which the country is currently not able to finance alone, hence the allocation of US$ 250 million by the World Bank."	
		Fertilizer supply to farmers: Somewhat spare capacity. Inconsistent answers! As various experts stated (Tenna, Dr. Setatow, Dr. Abate, ...), the fertilizer demand of farmers can not be covered throughout the whole country at the moment. Farmers apply less than recommended fertilizer, because amount of fertilizer supplied per farmer is controlled (Abate) and often farmers don't have financial capacity to purchase sufficient fertilizer. (Tenna, Admasu 2009)	
		ATA, MoA, EIAR, 2013: "As discussed earlier, unions and primary cooperatives are major distribution channels for inputs. However, capacity limitations restrict their ability to actively engage in the supply and distribution of much-needed inputs. These limitations include financial, transportation equipment and logistics, and storage facilities, etc. "	
		Shahidur et al. 2012: "However, fertilizer availability (import plus change in stocks) far exceeded total use, resulting in large carry-over stocks reaching almost half a million tons in 2012"	
Do supporting activities (logistics, communication) have spare capacity in case of increased demand, are they equitably accessible?		**Logistics:** Already at status quo there is a bottleneck in transport capacity from Djibouti port to the central warehouse. There are not enough trucks available when a shipload of fertilizer arrives and therefore transportation costs also rise (Tenna, Minten).	Buffering capacity
		Accessability: Minten et al. 2012:"Ethiopian government embarked on a large road investment program since it came to power and there is currently an unprecedented level of infrastructure development in Ethiopia...The results show that the mean and median of transport costs dropped at the end of the decade to half—or even lower—the costs that were charged in the beginning of the decade."	
		Zelleke et al. 2012: "While the reach of road networks and cooperatives to most high-production areas has improved significantly in recent years, access to very remote areas is limited; accordingly, fertilizer may be unaffordable, not available on-time, or simply unavailable in these hard-to- reach areas."	
		Communication: Mobile phones have become widely available in Ethiopia (Minten et al. 2012) and communication infrastructure in Ethiopia is therefore sufficiently available. However, there still are some capacity problems in the mobile phone network at the moment, making the the network somewhat unreliable. (own expirience)	
Do input resources have spare capacity in case of increased demand and are they equitably accessible?		**Fertilizer supply from international markets: .++: FAO, 2015: "**Over the next five years, the global capacity of fertilizer products, intermediates and raw materials will increase further."	Buffering capacity
		Accessability: FAO, 2015: "The World Bank Index of Fertilizer Prices (2010=100) forecasts a decline of almost 15 percent in 2014 and an additional 1.5 percent in 2015."	
		Blanco, 2011: "Fertilizer prices are expected to remain high. The expected long-term rise in fossil energy prices will increase the cost of supplying fertilizers. Rising energy costs would increase both the cost of producing fertilizers and the cost of delivering to the farmers."	
Does the activity maintain stocks of inputs and/or of products?		Information on stocks is inconsistent: Shahidur et al. (2012) find that there are large carry-over stocks (from one year to the next) located at the cooperative unions, e.g. nearly 500 000 tons in 2012 at a total fertilizer use of 650 000 in the same year.	Buffering capacity
		At the same time, experts indicated that demand for fertilizer can not be covered in some regions (Tenna, Abate) and that there exist problems in distributing fertilizer in time to all parts of the country, leading to shortages (Ayele, Tenna).However, they also explained that low fertilizer use rates of farmers are often due to lack of finances to purchase fertilizer (Setatwo, Tenna) and therefore availability would not be the main cause for the supply shortage.	
		Since the fertilizer is not stored in the long-term in the central warehouses of AISE, stocks are probably not distributed evenly throughout the country and therefore do not coincide with fertilizer demand of each region.	
Are input storage systems distributed throughout the value chain?		Yes. Fertilizer can be stored at the central warehouses of AISE(7 thorough the country), at the cooperative unions or the primary cooperatives (Shahidur et al. 2012)	Buffering capacity
		Admasu 2009: "The main AISE warehouses are located in Addis Ababa, Adama (Nazareth), Mojo, Kombolcha, Mekelle, Bahir Dar and Nekempte; smaller stores are also found in other towns such as Shashemene, Hosanna, Arsi Negele, Wollaita Sodo and Asela."	
		However, there are no warehouses available at Djibouti port, which could alleviate the transportation bottleneck when a shipload of fertilizer arrives.	
		As mentioned by experts, there are also capacity problems at the central warehouses (Tenna) and cooperative unions (Yirgalem).	

		Admasu 2009: "Primary cooperative stores are largely owned by the cooperatives themselves; but most are in poor condition, made out of mud and sticks, and many of them lack enough space to store properly fertilizer products or cereals when all fertilizer is sold out."	
Is there sufficient labor force available for the activity and can it be adapted to fluctuations?		Sherif, Setatow, Kebebew: "Generally no labor shortage in Ethiopia."	Buffering capacity
		See whole value chain	
Are resources(infrastructure) in good condition		Storage: As mentioned by Tenna, warehouses are often in bad condition, leading to spoilage of fertilizer.	Capital (physical)
		Admasu 2009:"It is important to note, though AISE Stores are declared to be of good standard (structurally)."	
		Cooperative unions: Admasu 2009: "Almost all keep their fertilizer inside rented stores. Those rented from government are spacious and structurally up to standard. However, those rented from individuals are mostly sub-standard, small in size and congested due to lack of proper space."	
		Primary cooperatives: Admasu 2009: "Primary cooperative stores are largely owned by the cooperatives themselves; but most are in poor condition, made out of mud and sticks, and many of them lack enough space to store properly fertilizer products or cereals when all fertilizer is sold out. Store congestion and long vertical rows of fertilizer sacks/stacks due to shortage of space during peak fertilizer supply period severely limit circulation of air inside the stores thus creating situation of short breath and respiratory complications."	
		Transport: World Bank, 2007: "Only 25 percent of Ethiopia's area is served by a modern road transport system, and only a real- timely small percentage of those roads are paved and generally passable year round. Unpaved roads are extremely vulnerable to floods, landslides, and gully erosion."	
Are there sufficient resources to meet increases in demand in next 50 years (natural and built)?		Phosphorus: - :Van Vuuren et al. (2010:"...Rapid depletion of extractable phosphorus rock is not very likely; in worst-case scenarios about 40-60% of the current reserves would be extracted by 2100." Nitrogen and Potassium as other main nutrients for tef can be produced synthetically (nitrogen) or have very large reserves (potassium reserves are estimated to last at leas 500 years).	Capital (physical)
		Nitrogen and Potassium as other main nutrients for tef can be produced synthetically (nitrogen) or have very large reserves (potassium reserves are estimated to last at leas 500 years).	
Are resource (soil, water, land, fuel, forests, minerals…) use rates below regeneration rates rather than depleting them?		Phosphorus: - :Van Vuuren et al. (2010:"...Rapid depletion of extractable phosphorus rock is not very likely; in worst-case scenarios about 40-60% of the current reserves would be extracted by 2100."	Capital (environmental)
		Nitrogen and Potassium as other main nutrients for tef can be produced synthetically (nitrogen) or have very large reserves (potassium reserves are estimated to last at leas 500 years).	
		ATA 2014: "Preliminary findings from the mapping work conducted in 162 woredas shows that, in addition to nitrogen and phosphorus, sulfur, potassium, boron and zinc nutrients are deficient in many areas. This data indicated that one compound fertilizer (NPS) and five blended fertilizers (NPSB, NPKSB, NPSZnB, NPKSZnB, and NPSZn) are needed to address the key nutrient deficiencies in the tested soils. In connection with this, Ethiopia began importing new fertilizer ingredients for the first time in more than four decades, in order to distribute to farmers as blends. At the same time, to further enhance blended fertilizer availability, five fertilizer blending plants are being constructed in four of the country's major regions (Tigray, Amhara, Oromia and SNNP) to deliver customized, field-level soil nutrients to Ethiopia's smallholder farmers."	
Are there critical emissions/impacts which the activity has on the environment/ecosystems/resources?		Kebebew, Setatwo, Ayele: "Farmers allocate more fertilizer for tef than for any other crops, since it is a cash crop", therefore tef production is also responsible for relatively higher share of potential negative fertilizer impacts on natural resources.	Capital (environmental)
		Kebebew, Abate, Setatow: "no negative impacts of fertilizer use reported so far, since application rate generally low and below recommended rate.	
		Admasu 2009: Possibilities of surface and ground water pollution due to fertilizer handling and use. But due to low fertilizer application rate in Ethiopia, its occurrence is very minimal. Future fertilizer demand indicates a growing trend; hence the likelihood of negative environmental impacts in the years to come."	
		Kebebew: "Some areas use up to 400kgN/ha instead of the recommended 100kgN/ha", therefore nitrogen leaching is most probably an issue in some parts of the country.	
		Admasu 2009: "None of the AISE main stores assessed on this study are located close or inside ecological values such as a known protected area, wetland resources, natural or cultural heritage site, important habitat or species migration route."	
		Admasu 2009: "Luxury or excessive application of fertilizer is not a problem of Ethiopia's small holder farmer; but balanced nutrient supply is a problem. Application of Nitrogen bearing fertilizer (Urea) without Phosphorus or Potassium as practiced by some farmers leads to dangerous accumu-	

		lation of nitrate in the soil. Nitrogen supplied as fertilizer can not be fully utilized by the plant as absence of Phosphorus or Potassium becomes the limiting factor leading to its accumulation and pollution of the environment."	
		Admasu 2009: ""Repeated inorganic fertilizer application (without additional organic amendment) enhances activities of soil microorganisms for short duration, increasing mineralization of existing soil organic matter and depletion of carbon out of soil. Loss of soil organic carbon (humus) reduce the capacity of soil to maintain its natural nutrient reserves (fertility), deteriorate soil structure, weaken its resistance to erosion (increase erosion), reduce vegetation/biomass cover and consequently worsening land degradation situation. This is very real in Ethiopia's small holder farming condition, where total removal of crop residue out of the field is a norm for fuel and/or animal feed, and application of yard manure is almost absent as it is also a source of fuel in rural households across the country. As a result, the soil is deprived of its much needed ingredient to maintain its natural buffering capacity (safeguarding its nutrient reserves) and the vicious circle continues."	
		Admasu 2009: "The farmer's observation of declining soil fertility/productivity as a result of continuous inorganic fertilizer use can also relate with the aggravation of soil acidity due to nitrogen bearing inorganic fertilizer use and consequently, unavailability of nutrients essential for plants, the most important limiting nutrient being phosphorus."	
		Admasu 2009: "Information regarding environmental and social impacts of fertilizer use is surprisingly non existent in all places visited, individuals and institutions consulted and interviewed. Many believe that the amount fertilizer used by the small holders is so small to cause pollution or affect ecological and social values and warrant an impact assessment study. This view is not only of those engaged on importation and distribution of fertilizer products, but also of those individuals in research and regulatory institutions."	
		Kebebew: "generally low awareness and knowledge on negative fertilizer impacts (e.g. on water quality)"	
Do the actors have a good health status (physical and mental)?		Admasu 2009: "Physical injuries and blackening of the shoulder on the laborers while loading and unloading fertilizer, respiratory ailments such as breathlessness, cough and whizzing (whistling) due to dust in the store and out side the store as a result of truck movements, and skin and eye allergies due to contact with fertilizer products. All these are happening because laborers are not provided with required protective gears and lack of training on safety and health precautions."	Capital (social)
		Admasu 2009: "In most of these central warehouses, the working force is provided with little or no protection gears (masks, hand gloves, overalls, helmets, etc.), exposing them to frequent physical injuries, respiratory ailments due to dust, skin and eye allergies due to contact with fertilizer products, etc. "	
		Health concerns in Ethiopia are often linked to under nutrition, mostly affecting rural areas and subsistence farmers. People working for AISE or cooperatives can be assumed to be less affected by these concerns. Therefore health status of the fertilizer supply actors is estimated to be sufficient. In interviews throughout the tef value chain, health status was generally reported to be good.	
Does the activity engage with multiple suppliers, buyers, and fellow stakeholders?		Suppliers: Fertilizer is purchased from international fertilizer market, therefore a wide range of suppliers is available.	Connectivity
		Buyers: Since nearly all farmers are buyers, the amount of customers is huge.	
		Fellow stakeholders: Since the whole fertilizer value chain is state controlled, there are no fellow stakeholders.	
Is the value chain between input producer and farmers very long and complex?		Shahidur et al. 2012:" Despite the long chain, fertilizer prices in Ethiopia appear to be very competitive. ...The fertilizer value chain in Ethiopia involves numerous actors who perform three broad sets of activities: (1) import planning, (2) import execution, and (3) marketing and distribution." -:	Connectivity
		Melekot: "The fertilizer credit system is long and complex. Overall the incentives and accountability mechanisms are completely misaligned and create an inefficient system with significant leakages and defaults."	
Do logistics and communication support services enable appropriate connectivity?		**Logistics:** There is a bottleneck in transport capacity from Djibouti port to the central warehouses. There are not enough trucks available when a shipload of fertilizer arrives and therefore transportation costs also rise (Tenna, Minten).	Connectivity
		Admasu 2009: "Major constraints of fertilizer and other inputs use in Ethiopia among others include: Infrastructural problems."	
		Ayele: "In the past, there has repeatedly been delays in fertilizer supply to cooperatives. This was mostly the case for remote areas, but sometimes even high production regions were affected. Reasons for delays were often impassable roads due to floods, landslides, etc. Fertilizer is generally distributed in a quite short time slot before rainy season. Any delays or early rains can therefore have the consequence that fertilizer doesn't arrive at the cooperatives and in time for planting season. This is mainly a problem for DAP, which has to be applied before or during planting time to be accessible for plants."	
		Minten et al. 2012:"Ethiopian government embarked on a large road investment program since it came to power and there is currently an unprecedented level of infrastructure development in Ethi-	

		opia...The results show that the mean and median of transport costs dropped at the end of the decade to half—or even lower—the costs that were charged in the beginning of the decade."	
		Zelleke et al. 2012: "While the reach of road networks and cooperatives to most high-production areas has improved significantly in recent years, access to very remote areas is limited; accordingly, fertilizer may be unaffordable, not available on-time, or simply unavailable in these hard-to- reach areas."	
		Ayele: "In the past, there has repeatedly been delays in fertilizer supply to cooperatives. This was mostly the case for remote areas, but sometimes even high production regions were affected. Reasons for delays were often impassable roads due to floods, landslides, etc. during the rainy season. "	
		Demeke and Di Marcantonio 2013: "On the other hand, transport costs from farm gate to wholesale market in Addis Ababa were found to be high and this is attributed to the use of smaller trucks rather than bigger trucks and bulk transport systems. In addition to building roads, the government should facilitate the transition from small scale to large scale grain transport, storage and trading practices."	
		Abate and Setatow 2010: " About 57% of the sampled farmers confirmed that roads and transport services have made it difficult for them to sell their products in nearby towns."	
		Visited farmers need 20 minutes until 2 hours of travelling time to sell their tef. During rainy season roads to their villages are sometimes blocked and villages only accessible by donkeys.	
		Minten et al. 2013: "...Transportation costs and remoteness matter enormously in agricultural markets in developing countries (Teravaninthon and Raballand 2009; Deichmann, Shilpi, and Vakis 2009; Fafchamps and Shilpi 2003; Gollin and Rogerson 2010; Alavi et al. 2012). ...We note overall clear decreases in teff prices the farther that farmers are located from the terminal market. While at the time of the survey the share of the producer price in the final retail price of the most traded teff quality (the white variety) close to the city reaches over 90 percent, this drops to 80 percent for the most remote farmers.....In all the eight cases, this hypothesis cannot be rejected, indicating that teff producer prices drop in line with transportation costs....Figure 5.2 (left side) shows how production, commercial surplus, and consumption per teff producing household vary with transportation costs to Addis Ababa. We see the highest commercial surpluses achieved by farmers that face the lowest transportation costs. Commercial surplus decreases to almost zero for those farmers that are most remote; these farmers drop to subsistence levels."	
		World Bank 2006: "Current limited access to transportation and markets undermines incentives for surplus agricultural production and reinforces the highly vulnerable subsistence-oriented structure of the economy. ...A notable characteristic of the network is that most all-weather roads radiate from the capital, Addis Ababa, to major towns. Direct links between regions are rare, which discourages inter- regional trade. The cost of building and maintaining roads is high because of rugged topography and torrential tropical rains. Because of this high cost, the systems expand slowly and many new roads are left unpaved.	
		World Bank 2006: "Today 90 percent of Ethiopia's roads are dry- weather roads that cannot be used effectively during the four-month-long wet season. The reliance of the economy on this small network of mostly dry-weather roads makes commerce highly vulnerable to floods and heavy rainfall. When it rains in remote areas, farmers can produce crops but often cannot get them to markets.	
		World Bank 2006: "Road density in Ethiopia is one of the lowest in Africa: At 27 kilometers of roads per 1,000 square kilometers of land it is well below the African average of 50 kilometers per 1,000 square kilometers. Some 70 percent of farms were reported to be more than half a day's walk from an all-weather road in 2002 (FDRE 2002) and 17 kilometers to the nearest commercial transport (World Bank 2005b). "	
		Communication: Mobile phones have become widely available in Ethiopia (Minten et al. 2012) and communication infrastructure in Ethiopia is therefore sufficiently available. However, there still are some capacity problems in the mobile phone network at the moment, making the network somewhat unreliable. (OWN EXPIRIENCE)	
		Minten et al. 2012: "The access to mobile phone changed in important ways price transmission between traders, farmers, and brokers. More deals are also done on the phone and some traders now start bypassing wholesale markets as the center of trade. It is possible that the spread of mobile phones has also led to more entry into trade....The paper shows the apparent importance of roads and mobile phones in fostering closer integration of markets, to the benefits of producers as well as consumers. "	
Are there any single inputs/processes/stakeholders that this activity depends upon, with no alternative?		Inputs: So far, all fertilizer is imported and therefore dependency on external inputs is total.	Connectivity
		ATA, MoA, EIAR, 2013: "Inorganic fertilizer is not produced domestically but rather procured from international sources."	
		Stakeholders: Shehidur et al. 2012: "Two key components of the policy reform of 2008 are (1) granting monopoly control over fertilizer imports to the Agricultural Input Supplies Corporation, the government's input marketing agency, and (2) carrying out marketing and distribution of fertilizer exclusively through farmers' organization."	
		Kebebew, Abate: "Fertilizer supply totally dependent on government."	
Would a fail-		Tef farmers are highly dependent on fertilizer (Setatow) and tef accounts for the highest fertilizer	Con-

ure in this activity cascade to the whole system?		use of all crops in Ethiopia (Shahidur et al. 2012) .	nectivity
		According to Setatow, farmers in the past switched from tef to other crops like chickpea or pulses when fertilizer prices raised due to inflation, which emphasizes the dependency of the tef value chain on fertilizer.	
		Additionally, synthetic fertilizers can hardly be substituted in Ethiopia, since dung and crop residues are used as fuel source or animal feed and therefore can not be used as an organic fertilizer source (Kebebew, Ayele).	
Does the activity rely on other sources of income? Is income generated by diverse activities/products?		Setatow: "AISE works on profit base."	Diversity
		Admasu 2009: "This huge quantity of fertilizer import requires large sum of foreign currency which the country is currently not able to finance alone, hence the allocation of US$ 250 million by the World Bank."	
		Shahidur et al 2012: "Lower interests, no spoilage allowance and storage costs, and very low margins for the primary cooperatives imply that government will have to pay for these costs at some point in time. ...If the implicit supports and the costs of carry-over stocks are added, the cost of fertilizer promotion policies averaged about $105 million, equivalent to about 15 percent of the retail price." The system therefore relies to some extent on indirect subsidies as a source of income.	
		Shahidure et al. 2012: "If the cost estimates are reasonable, smaller primary cooperatives are clearly losing money from fertilizer distribution. ...Primary cooperatives that fund fertilizer distribution with alternative revenue sources will have no incentive to continue dealing in fertilizer."	
		Melekot: "Regional governments give loan guarantees for fertilizer credits in the region. In the past, credits were often not paid back and therefore regions budget affected (accumulated to over 500 million $)."	
Are there diverse ways of producing the product/conducting the activity?		**Production:** There is no fertilizer production in Ethiopia and all fertilizer is imported at the moment.	Diversity
		However, as stated by www.worldbulletin.net, 17.4.14: "Ethiopia is currently building five fertilizer plants at a total cost of over $2.8 billion, the Ministry of Industry said on Wednesday. The factories, expected to begin production in 2017, will also enable some import substitution,..."	
		Organic fertilizer: A possible alternative to import of synthetic fertilizer would be the use and production of organic fertilizer in Ethiopia. However, organic fertilizer use faces various constraints such as competitive uses of dung and crop residues as fuel source respectively animal feed or building material (Kebebew, Zelleke et al. 2010, Berry 2003)	
		Admasu 2009: "An average rate of application of organic amendments is still a very small fraction (about 100 kg per each small farmer per year) as compared to the total requirement of the product. Research conducted on Holeta red soil applying 12 -18 ton/ha of farm yard manure was found to be as effective as 100 kg/ha DAP (N18 P20), and 200 kg of bone meal was 85% effective as compared with 100 kg/ha DAP. Due to land degradation problems (soil erosion, removal of crop residue for animal feed and fuel and burning of animal dung), soil with organic matter content below 2% (even below 1% in many areas) is wide spread in the country."	
		Import and Distribution: Shehidur et al. 2012: "Two key components of the policy reform of 2008 are (1) granting monopoly control over fertilizer imports to the Agricultural Input Supplies Corporation, the government's input marketing agency, and (2) carrying out marketing and distribution of fertilizer exclusively through farmers' organization." Therefore, no alternative ways of importing and distributing fertilizer are allowed at the moment.	
Are products sold/distributed via multiple and diverse channels and markets?		Import and Distribution: Shehidur et al. 2012: "Two key components of the policiy reform of 2008 are (1) granting monopoly control over fertilizer imports to the Agricultural Input Supplies Corporation, the government's input marketing agency, and (2) carrying out marketing and distribution of fertilizer exclusively through farmers' organization." Therefore, no alternative ways of importing and distributing fertilizer are allowed at the moment.	Diversity, redundancy
		Shahidur et al. 2012: "In 2011, several regional cooperative unions wanted to break out of AISE and requested the MoA to import fertilizer by forming a regional federation of cooperatives. The MoA, however, decided that allowing three or more cooperative federations to import would inefficient. Therefore, the AISE was nominated again as the sole importer of fertilizer on behalf of farmers' cooperative unions."	
		Kebebew, Abate: "Fertilizer supply totally dependent on government."	
		ATA, MoA, EIAR, 2013: "Limited alternative distribution models: There are limited alternative distributors beyond cooperatives. By comparison, in recent years, the horticulture and vegetable sectors have made substantial achievements in this regard and are relatively better positioned in distributing inputs, with multiple distribution channels. In the last few years, an increasing number of local and international companies distribute vegetable and horticultural seeds and fertilizers, using multiple channels, such as through direct marketing, cooperatives, and NGOs, etc."	
Does the activity have multiple production sites/lines/machines which are spatially		There is no fertilizer production in Ethiopia and all fertilizer is imported at the moment. However, as stated by www.worldbulletin.net, 17.4.14: "Ethiopia is currently building five fertilizer plants at a total cost of over $2.8 billion, the Ministry of Industry said on Wednesday. The factories, expected to begin production in 2017, will also enable some import substitution,..."	Diversity, redundancy
		Blanco, 2011:"The production of fertilizers is characterized by a high and increasing level of concentration. As Gregory and Bumb (2006) point out, this trend can be explained because the fertilizer	

distributed? Are components substitutable?		industry is a capital-intensive industry with economies of scale in production and a high requirement of raw materials (particularly natural gas, phosphate rock, and potassium salts), which represent a high share of production costs.	
		However, even though fertilizer production is concentrated on a few countries, it is still spatially well distributed across the world.	
		Fertilizer can be stored at the central warehouses of AISE (7 throughout the country), at the cooperative unions or the primary cooperatives (Shahidur et al. 2012). Therefore storage locations are distributed throughout the whole country.	
Are there equitable/fair rights, regulations, etc. in the governance of the activity?		Little information found. Besides monopoly position and little autonomy for cooperatives and farmers on fertilizer supply, regulations seem equitable	Equitability
Can diverse actors participate in decision-making?		The decision on how much fertilizer is purchased and distributed to cooperatives is taken solely by BOARD (Shahidur et al. 2012, Abate). Farmers and cooperatives therefore cannot decide independently how much fertilizer they need.	Equitability
Are impacts caused by the activity borne by other actors who do not receive benefit/compensation?		Admasu 2009: "Potential fire and explosion hazards are predicted mainly at the primary cooperative level due to storage of nitrate containing fertilizers together with other products such as lime, and decomposition of fertilizer material as result of lack of aeration or store congestion. To date, no such incidence has been reported so far. However, in the future due to increased demand and flow of fertilizer products, the chance for such incidence to happen is evident...Physical injuries and blackening of the shoulder on the laborers while loading and unloading fertilizer, respiratory ailments such as breathlessness, cough and whizzing (whistling) due to dust in the store and out side the store as a result of truck movements, and skin and eye allergies due to contact with fertilizer products. All these are happening because laborers are not provided with required protective gears and lack of training on safety and health precautions.."	Equitability
		Admasu 2009: Most fertilizer stores do not comply with health and safety standards established by Ethiopian Standard (ES) for fertilizer products, thus resulting in to health and safety hazards to staffs and laborers working in them	
		Admasu 2009: Possibilities of surface and ground water pollution due to fertilizer handling and use. But due to low fertilizer application rate in Ethiopia, its occurrence is very minimal. Future fertilizer demand indicates a growing trend; hence the likelihood of negative environmental impacts in the years to come."	
Are small disturbances tolerated rather than avoided can they be managed?		Ayele: "In the past, there has repeatedly been delays in fertilizer supply to cooperatives. This was mostly the case for remote areas, but sometimes even high production regions were affected. Reasons for delays were often impassable roads due to floods, landslides, etc. Fertilizer is generally distributed in a quite short time slot before rainy season. Any delays or early rains can therefore have the consequence that fertilizer doesn't arrive at the cooperatives and in time for planting season. This is mainly a problem for DAP, which has to be applied before or during planting time to be accessible for plants."	Exposure to pressure
Has the activity been exposed to disturbances in the past?		Yes, multiple. For instance floods, inflation, droughts (fertilizer can not be accessed by plants without in solid form), etc.	Exposure to pressure
Are there long-term plans (e.g. 50 years) to manage supply, demand and capacity?		www.worldbulletin.net, 17.4.14: "Ethiopia is currently building five fertilizer plants at a total cost of over $2.8 billion, the Ministry of Industry said on Wednesday. The factories, expected to begin production in 2017, will also enable some import substitution,..."	Governance capacity
		Admasu 2009: "The National Fertilizer Strategy and Action Plan (NFSAP) has an overall objective of enhancing fertilizer use through curtailing the major bottlenecks of the fertilizer sector in the period 2008-2015. It is inline or is an addendum to the National Fertilizer Policy issued in 1993 with objective of liberalizing the fertilizer sector. It envisages increasing fertilizer demand and using efficiency, ensuring timely supply of fertilizers in appropriate quality and quantity with competitive price, and exploiting and utilizing locally available fertilizer resources thereby increasing sustainable agricultural productivity."	
		In the national tef strategy paper from ATA, MoA, EIAR, 2013, the following interventions are planned for the fertilizer supply: "Enable flexibility in the fertilizer shipping, inland transport, and distribution process to lower costs. Provide policy, financial, and organizational support to promote the use of inputs. Promote use of organic fertilizer as a cost-effective alternative to inorganic, internationally-sourced fertilizer."	
		There is also a new fertilizer credit system being planned and tested by ATA at the moment, to replace the existing inefficient system with significant leakages and defaults.	

		Minten et al. 2012: "Fifth, the government has strongly supported the establishment of cooperatives in the last decade. At the end of the last decade, they were almost the sole providers of improved inputs in the country. However, while they have been successful in organizing farmers towards the commercialization of export crops such as coffee, they have been less successful in output markets of cereal crops (as is also often the case in other countries). Moreover, they seem to be over their peak and the shares of cooperatives in cereal wholesale markets have seemingly declined in the last couple of years. "	
Are the responsibilities for resources/conveyance/activity clearly defined?		Credit system: Melokot: "Overall, the incentives and accountability mechanisms in the existing input credit system are completely misaligned and create an inefficient system with significant leakages and defaults. Regional governments provide 100% credit guarantee to the Commercial Bank of Ethiopia which limits the incentives for the Bank to pressure the borrowers to repay their loans. Cooperatives function as financial institutions at the retail level - a role for which they don't have the capacity, the systems, or the appropriate incentives to efficiently undertake. Loan collection takes place through multiple sets of interactions (primary cooperatives collecting from farmers, cooperatives unions collecting from primary cooperatives, etc.), so ultimate responsibility for collections is diffused."	Governance capacity
		Except from the input credit system, the responsibilities in the fertilizer supply system seem to be quite clearly defined. However, information on this matter is scarce.	
Does the actor have autonomy, control and ownership over the activity, and his own resources?		ATA, MoA, EIAR, 2013: "Inorganic fertilizer is not produced domestically but rather procured from international sources." Therefore, fertilizer supply in Ethiopia is at the moment totally dependent on imports.	Governance capacity
		Abate, Setatow, Sherif: "Fertilizer supply is totally state controlled and farmers can not decide independently how much fertilizer the want to use"	
		Bureau of Agriculture estimates fertilizer demand for each region (Abate, Shahidur et al. 2012), therefore cooperatives and farmers have no power to enforce their actual needs.	
Are there plans to address any risks from hazards and emergency situations with scripts for actors in case of such an event?		None known	Governance capacity
Is there collaboration between actors, universities, research institutions?		Little involvement of research in fertilizer supply.	Information, learning
Is the attitude towards doubts, etc. open and constructive?		government involved, but open for some changes (credit system,...)	Information, learning
Is there investment in education and knowledge development of actors?		Farmers: Sherif, Zelleke et al 2010:"Government spending in extension has also established over 8,500 Farmer Training Centers and trained 63,000 Development Agents from 2002 – 2008.	Information, learning
		Zelleke et al. 2010: Dissemination of knowledge regarding soil fertility is poor, with few farmers aware of what soil fertility issues are relevant to them."	
		Admasu 2009: Farmers do receive training by development agents stationed in kebeles on the correct rate and time of fertilizer application; on other fertility improvement methods such crop rotation, organic fertilizer (compost) and green manure use, etc.	
		Minten: "Extension system was scaled up very fast and there is a high density of extension agents by now."	
		Melekot: "Development agents give extension on credit system."	
		Yirgalem: " There are not enough delegates to provide training to all cooperatives (only one agent per kebele but a lot of cooperatives per kebele).	
		Admasu 2009: "Fertilizer use situation in Ethiopia demonstrates a continuously incremental trend reaching close to 600,000 tons during 2009/2010 cropping season. This is due to the fact that an extensive extension work has been done by the government, particularly the Ministry of Agriculture within the last four to five decades."	
Is the knowledge base of actors sufficient? Do they have a high level of education		Credit system: -: Malekot: "One reasons that farmers don't use recommended fertilizer rates is the lack of knowledge about credit access (e.g. people think that a credit from government doesn't have to be paid back)."	Information, learning
		Cooperatives: -: Shahidur et al 2012: "Primary cooperatives have limited managerial skills. Most managers of these cooperatives have only a primary level of education but have the responsibility of doing challenging tasks with limited resources and weak infrastructure."	
		Farmers: -: Zelleke et al. 2010: Dissemination of knowledge regarding soil fertility is poor, with few farmers aware of what soil fertility issues are relevant to them. For example, some woreda workers	

		interviewed on field visits were well aware of the importance of locally tailored fertilizer dosages, but had no idea whether these will be developed or when and by whom.	
		ATA, MoA, EIAR, 2013: "Farmers have insufficient knowledge of and financial ability to purchase and use inputs, such as fertilizer and seed"	
		Kebebew: "farms do not have much knowledge on fertilizer impacts on water quality."	
		Admasu 2009: "Information regarding environmental and social impacts of fertilizer use is surprisingly non existent in all places visited, individuals and institutions consulted and interviewed. Many believe that the amount fertilizer used by the small holders is so small to cause pollution or affect ecological and social values and warrant an impact assessment study. This view is not only of those engaged on importation and distribution of fertilizer products, but also of those individuals in research and regulatory institutions."	
		Admasu 2009: "Major constraints of fertilizer and other inputs use in Ethiopia among others include: 3. Weak research- extension-farmer linkages. 10. Lack training/knowledge gap among dealers."	
		AISE: Admasu 2009: "Store managers, supervisors, etc., in fertilizer stores lack proper training with regard to fertilizer handling, health and safety precautions. Moreover, most of these stores do not provide protective devices.."	
		Admasu 2009: "Almost all of the farmers confirmed that the actual application rate depends on the level of soil fertility of the plot as judged by the farmer themselves, topographic condition, type of crop, early crop stand for split application (Urea) as well rainfall condition during a given crop season."	
Are lessons learnt from previous experiences, is activity modified in consequence?		ATA 2014: "Due to a variety of bottlenecks in the existing credit system, many of Ethiopia's farmers are unable to afford the full package of input recommendations, limiting their yield and output. To address this, the ATA, MoA and RBoAs are working to popularize an overhauled input credit model. This new framework shifts the lending emphasis away from cooperatives and unions, and instead channels input credit through microfinance institutions (MFIs) and other qualified lenders with the necessary capabilities, systems, and risk mitigation mechanisms. At the same time, the new model reduces the need for physical cash, replacing it with a voucher system designed to streamline the flow of funds while adding increased accountability and transparency. "	Information, learning
		ATA, MaO, EIAR 2013: "For fertilizer, there are also adjustments that can be made, although arguably these levers are more challenging to change than those related to seed."	
		ATA 2014: In the areas of access to inputs, innovations such as the Fertilizer Blending and Direct Seed Marketing projects aim to improve the availability of high quality seeds and fertilizers to farmers across Ethiopia. The Fertilizer Blending project envisions the creation of five regionally based fertilizer blending facilities that leverage the data generated by the EthioSIS and woreda level soil fertility mapping initiatives to identify and produce complex fertilizers within Ethiopia. The fertilizer blends provided by these facilities will enable smallholder farmers to access many nutrients that previously had not been available from the standard DAP and UREA mix that they have been using for decades. This project works with Cooperative Unions (woreda level farmer associations) to own and operate the blending facilities as commercial ventures.	
		ATA 2014: "These reviews have identified bottlenecks in fertilizer procurement, demand estimation, adoption/affordability, and last-mile distribution. Based on these studies, the MoA and ATA have identified several opportunities for improvement of the system, which are now being prioritized and pursued. These opportunities include diversifying ports, reducing seasonal peak demand by changing ordering timing, improving and expanding the trucking sector, developing ICT tracking systems, expanding hours at the border crossing, and organizing 24/7 offloading of trucks in Ethiopia. A further analysis is also underway on last mile distribution."	
Is an atmosphere of trust and respect cultivated between actors?		Some distrust reported from farmers towards cooperatives. But other than that little information on trust in fertilizer supply.	
Does the activity rely on distortionary subsidies?		Fertilizer in Ethiopia is not subsidized anymore, however, there are indirect subsidies. Interest rates on fertilizer credits are fixed by government below national lending rate and there is no allowance for storage costs, spoilage and the margins for cooperatives are set much lower than the market rates. Additionally costs for carry-over fertilizer stocks are sustained by the government, and therefore fertilizer promotion policies by the government finally make up about 15% of the fertilizer retail price. (Shahidur et al. 2012)	Profitability
Does input supply generate net positive profit and is it still profitable in case of changes in		(Shehidur et al. 2012): For small primary cooperatives, fertilizer trade is unprofitable, since margins are dictated by the Bureau of Agriculture and Rural Development. Cooperative unions can make small profits from fertilizer trade, but margins are also small and fixed	Profitability
		Melekot: "Regional governments give loan guarantees for fertilizer credits in the region. In the past, credits were often not paid back and therefore regions budget affected (accumulated to over 500 million $).	
		Indirect subsidies: -- "Interest rates on fertilizer credits are fixed by government below national	

de-mand/price?		lending rate and there is no allowance for storage costs, spoilage and the margins for cooperatives are set much lower than the market rates. Additionally costs for carry-over fertilizer stocks are sustained by the government, and therefore fertilizer promotion policies by the government finally make up about 15% of the fertilizer retail price. (Shahidur et al. 2012)	
		Setatow: "AISE works on profit base."	
		Shahidur et al. 2012: The results indicate that the fertilizer value chain in Ethiopia is competitive relative to its neighbors. When retail prices of fertilizers in US dollars are compared, the prices of DAP and urea in Ethiopia are 12–35 percent lower than in four of its neighboring countries (Kenya, Uganda, Rwanda, and Tanzania). The price difference shrinks if all implicit government supports in Ethiopia are factored in, but still remain significantly lower (8–25 percent).	
Does the activity rely on other sources of income?		(Shehidur et al. 2012): For small primary cooperatives, fertilizer trade is unprofitable, since margins are dictated by the Bureau of Agriculture and Rural Development. Therefore, primary cooperatives often have to cross-subsidize fertilizer distribution.	Profitability
Does the activity have/give possibility to generate funds for investment, maintenance, expansion,		Since the whole fertilizer supply chain is state controlled, there is little freedom to generate funds for investment. For small primary cooperatives, fertilizer trade is even unprofitable, since margins are dictated by the Bureau of Agriculture and Rural Development. Cooperative unions can make small profits from fertilizer trade, but margins are also small and fixed (Shehidur et al. 2012)	Capital (financial)
		Admasu 2009: "This huge quantity of fertilizer import requires large sum of foreign currency which the country is currently not able to finance alone, hence the allocation of US$ 250 million by the World Bank."	
Is the activity exposed to substantial financial risks (e.g. outstanding debt)?		Melekot: "Regional governments give loan guarantees for fertilizer credits in the region. In the past, credits were often not paid back and therefore regions budget affected (accumulated to over 500 million $). As a consequence, regions imposed regulation on fertilizer credit system, only allowing farmers to purchase fertilzer on cash (in some cases a maximum of 25% of the fertilizer was given on credit)."	Capital (financial)
		Tenna, Shahidur et al. 2012: "Government is involved in all steps of the fertilizer supply chain,"	
		Tenna: "Fertilizer supply has high priority for government" therefore, financial risks are burdened by government, but in case there are state budget constraints, fertilizer supply is also affected.	
Is the activity insured against damages/losses through disasters/shocks (?		Cooperatives: Yirgalem: "In general, cooperatives have no insurance for infrastructure, stocks, etc."	Capital (financial)
		Cooperative interviews: Cooperative unions all had insurance on stock and infrastructure. Primary cooperative had no insurance at all.	
		No information on AISE, but since controlled by government, risks are most probably covered my state budget.	
Are wages/incomes fair? Are wages/incomes "living wages"?		On cooperative level, wages seem to be fair, as reported in the interviews with cooperative managers.	Capital (financial)
		Shahidur et al 2012: "A primary cooperative dealing in 100 tons of fertilizer will get total revenue of $690, or about ETB 12,000. The salary of security staff (generally two people are needed) can consume this entire revenue. A primary cooperative would have to close for the lack of operating funds under such circumstances.	
		Monocot: "There is a lot of money being lost due to corruption in the fertilizer credit system. Most of it probably embezzled on the administration level." This might be an indication that wages are too low.	
Is self-organization, networking, initiative, association among actors enabled?		Shahidur et al. 2012: "Two key components of the policy reform of 2008 are (1) granting monopoly control over fertilizer imports to the Agricultural Input Supplies Corporation, the government's input marketing agency, and (2) carrying out marketing and distribution of fertilizer exclusively through farmers' organization. ...In 2011, several regional cooperative unions wanted to break out of AISE and requested the MoA to import fertilizer by forming a regional federation of cooperatives. The MoA, however, decided that allowing three or more cooperative federations to import would inefficient. Therefore, the AISE was nominated again as the sole importer of fertilizer on behalf of farmers' cooperative unions."	Self-organization
		ATA, MoA, EIAR, 2013: Institutional constraints limit the effectiveness of inputs suppliers and distributors	
Are actors able and motivated to re-establish function after a disruption?		Generally yes, as government is involved and depends on support from rural population. Credit system as negative example, as it collapsed in many areas due to droughts or other shocks and regions imposed stricter credit access rules, therefore basically impeded access to credits for farmers (Melekot=. Cooperatives get trust problem if they deliver fertilizer too late.	Self-organization
Is there opportunity for experimentation and inno-		Shahidur et al. 2012: "Two key components of the policy reform of 2008 are (1) granting monopoly control over fertilizer imports to the Agricultural Input Supplies Corporation, the government's input marketing agency, and (2) carrying out marketing and distribution of fertilizer exclusively through farmers' organization. ...In 2011, several regional cooperative unions wanted to break out of AISE	Transformability

vation?		and requested the MoA to import fertilizer by forming a regional federation of cooperatives. The MoA, however, decided that allowing three or more cooperative federations to import would inefficient. Therefore, the AISE was nominated again as the sole importer of fertilizer on behalf of farmers' cooperative unions."	
Does the activity and its leaders show openness to change, has this been shown in the past?		Rather not. But no direct data found on this issue.	Transformability

Seed supply (improved and unimproved)

Questions	Rating	Answer	Attribute
Does the activity have spare capacity (infrastructure, technical, know-how, financial) in case of increased demand?		**Formal sector:** OSE reported shortage in own land in suitable agroecologies to multiply seeds.	Buffering capacity
		On private seed supplier reported liquidity problems since seeds from outgrowers have to be purchased at harvesting time but can not be sold until beginning of next planting season and branding is also expensive.	
		RSEs always plan to produce 20% more seeds than the estimated demand for the case of increased demand through shocks (e.g. reseeding after drought, flood, pests).	
		Abate, Sherif: "higher demand than supply in improved tef seeds/ improved tef seed shortage."	
		One private seed supplier reported liquidity problems since seeds from outgrowers have to be purchased at harvesting time but can not be sold until beginning of next planting season and branding is also expensive.	
		ATA, MoA, EIAR, 2013: "Production of seed is inconsistent, containing high variability in quality and quantity produce. The major challenge facing seed production is an insufficient supply of seeds. This is partly due to the absence of efficient seed demand assessment systems and processes. ...ATA, MoA, EIAR, 2013: "Across the regions, 25 woredas experienced a shortage of seed while only 5 received a surplus. This scan suggests that the current gap between demand for improved varieties and local supply is also location specific. As Exhibits 15 and 16 show, supply and demand in recent years exhibited a consistent problem with seed shortages, especially in Oromia and Tigray. "	
		ATA, MoA, EIAR, 2013:Though numerous improved tef varieties have been released, farmers have complained about the availability of the right quantity and seed, at the right time and place, from both the **formal and informa**l seed sectors.	
		ATA, MoA, EIAR, 2013: "In addition, the public seed enterprises (ESE, RSEs) and the AISE face similar constraints. ...Seed enterprises currently have inadequate production facilities, in terms of farm machinery and implements, seed processing and storage facilities (cold rooms), seed testing labs, and vehicles for transportation. Gaps in skilled staff areas include plant breeders, seed technologists, pathologists, and entomologists, among others.	
		Alemu et al. 2013: "The performance of the formal tef seed system in terms of uptake of released varieties, and narrowing the gap between the national average productivity and the crop's average productivity level is low under farmers' conditions. This is mainly due to limited involvement of formal actors in the production and distribution of tef seed."	
		Table 3.1. Seed supply shortfalls in Ethiopia, 2005–08 Crop / Supply as a percent of official demand 2005 / 2006 / 2007 / 2008 Wheat 20 38 23 24 Maize 53 28 60 48 Teff 5 12 22 19 Barley 16 18 10 7 Sorghum Na 7 16 48 Source: MoARD, various years. Spielman et al. 2011	
		Sherif 2013: "Regarding tef, the major limitations in the seed system include lack of farmers' preferred varieties, limited capacity of the public seed enterprises, and little involvement of the private sector in the seed business.	
		Fufa et al. 2011: "Not all farmers have access to most recent improved varieties, cutting yield by 25-50%."	
		During the farmers interviews, 4 out of 7 farmers reported unavailability of improved tef seeds to be one of their main constraints.	
		MoA, ATA 2013:Formal sector: Bottleneck identified: "Current varietal release and registration process has severe capacity constraint. Seed producers lack capacity for internal quality control. Seed production volume does not satisfy farmers' demand. Limited availability of early generation seed. Delayed seed processing and delivery by seed producers. "	

		MoA, ATA 2013: **Intermediate sector** bottlenecks: " CBSPs lack capacity to produce sufficient volume of seed to satisfy demand gaps. CBSPs have low seed recovery rates from their member farmers due to poor business planning."	
		ATA, MoA, EIAR, 2013: "As discussed earlier, unions and primary cooperatives are major distribution channels for inputs. However, capacity limitations restrict their ability to actively engage in the supply and distribution of much-needed inputs. These limitations include financial, transportation equipment and logistics, and storage facilities, etc.	
		Informal sector: ATA, MoA, EIAR, 2013: "Farmers that lack access to BS or C1 seed often self-multiply using their previous year's grain, however maintaining quality standards in this manner is challenging. Often, these seeds are local varieties of lower quality, exhibiting lower potential yield, greater exposure to diseases, poor germination, and contamination during post-harvest processing.	
		The informal seed sector has nearly unlimited capacities to supply seeds in case of increased demand, since these seeds are produced by the farmers themselves or exchanged between farmers. Even though yield potential of informal seeds is generally substantially lower, the supply of tef seeds through the informal system is very reliable.	
Do supporting activities (logistics, communication) have spare capacity in case of increased demand, are they equitably accessible?		Seed companies reported system with outgrowers to be complicated, more expensive (than multiplied on own land) and not always reliable (seed outgrowers sometimes sell seeds to traders as grain, if prices are better or they have liquidity problems)	Buffering capacity
		In the workshop, input supplier group (which consisted mostly of seed suppliers) listed infrastructure/transport as the 2 most important problem for their activity, leading to delays in delivery and price increment.	
		In the informal seed sector, the supply chain is very short and simple an reliance on supporting activities therefore low.	
Do input resources have spare capacity in case of increased demand and are they equitably accessible?(improved varieties)		Visited seed companies reported shortage of improved tef seeds from EIAR being the biggest constraint for them.	Buffering capacity
		OSE reported shortage in own land in suitable agroecologies to multiply seeds.	
		Fufa et al. 2011: "Tef has been under-resourced relative to other crops. Breeders have developed improved varieties, but the uptake of these has been limited and there has been little research outside breeding. "	
		MoA, ATA 2013: "Lack of resources in public research system to effectively develop improved varieties and produce breeder seed"	
		MoA, ATA 2013: **Intermediate sector** bottlenecks: "Lack of adequate access to early generation seed (basic or C1)."	
		Fertilizer availability is not granted everywhere in the country. However, high tef production zones are prioritized in distribution as well as tef seed producing farmers and companies.	
Does the activity maintain stocks of inputs and/or of products?		Visited seed companies maintain stocks for a maximum of 6 month. They are often stored at the farms.	Buffering capacity
		Visited farmers in average maintain stocks of seeds for a maximum of 1 year, meaning that they just keep seeds for the next growing season. However, in Boset area, where farmers were affected by droughts in the last two years, farmers had no seed stocks anymore.	
		Resource poor farmers often have little or no seed stocks and use all the remaining stocks for seeding. If reseeding is necessary (e.g. due to drought, flooding), this practice can be devastating. (Sherif)	
		Ayele: If seed supply fails: farmers ask neighbor farmers for seed (informal exchange) so, not improved	
		Cooperatives sometimes have seed stocks (Sherif). Wealthier farmers usually also keep some stocks.	
		Since tef grain can be used as seed at the same time, there are always seed stocks available somewhere in the country.	
Are input storage systems distributed throughout the value chain?		In the informal seed system, seed stocks are kept at farms or farmer cooperatives. Therefore the storage system is distributed throughout the chain. In the formal seed sector, seeds are also stored at cooperatives, seed outgrowers (farms) and seed companies.	Buffering capacity
Is there sufficient labor force available for the activity and can it be adapted to fluctuations?		Visited seed companies never have problems in finding labor forces or seed outgrowers. Generally labor force is highly available in Ethiopia.	Capital (economic)
		ATA, MoA, EIAR, 2013: "In addition, the public seed enterprises (ESE, RSEs) and the AISE face similar constraints. ...Seed enterprises currently have inadequate production facilities, in terms of farm machinery and implements, seed processing and storage facilities (cold rooms), seed testing labs, and vehicles for transportation. Gaps in skilled staff areas include plant breeders, seed technologists, pathologists, and entomologists, among others.	
		See whole value chain	
Are resources in good condition		soil problem, but rest good	Capital

			(physical)
Are there sufficient resources to meet increases in demand in next 50 years?		Big potential to improve yields	Capital (physical)
Are there critical emissions/impacts which the activity has on the environment/ecosystems/resources?		MoA, ATA 2013: Informal sector bottlenecks: "High risk of genetic erosion of local varieties with the increased adoption of varieties developed through the formal sector."	Capital (environmental)
Are the varieties used adapted to local environmental conditions?		Sherif 2013: "Moreover, the scarcity or absence of crop varieties for less favorable, drought-prone environments is worth mentioning."	Capital (environmental)
		Fufa et al. 2011: "Some of the recently released varieties such as Quncho have not been tested for their suitability in certain agro ecologies and were distributed to the farmers directly. As a result, the performance of the variety was found to be poor under farmers' conditions."	
		Since tef is an endemic crop, it is highly adapted to the environment. Additionally, farmers often cultivate their own bred varieties which are selected to fit the local environment. Varieties from informal seed sector are therefore extremely well adapted to the environment.	
		MoA, ATA 2013: Informal sector bottlenecks: "High risk of genetic erosion of local varieties with the increased adoption of varieties developed through the formal sector."	
Does the activity engage with multiple suppliers, buyers, and fellow stakeholders for trade?		The only supplier of improved tef varieties is EIAR.	Connectivity
		Seed companies have plenty of outgrowers producing tef seeds for them (several hundreds up to more than thousand per company).	
		In the informal sector, farmers often use their own seeds or just exchange them with neighbors. Therefore they only engage with few suppliers.	
		Alemu et al. 2013: "The performance of the formal tef seed system in terms of uptake of released varieties, and narrowing the gap between the national average productivity and the crop's average productivity level is low under farmers' conditions. This is mainly due to limited involvement of formal actors in the production and distribution of tef seed."	
		Visited farmers reported that they had several possibilities to access seeds, such as: cooperative unions, primary cooperatives, seed enterprises, farm implement suppliers, development agents, neighbors or also through own production.	
		Sherif: "Use of improved seeds varies a lot depending on access to it (around debre zeit research center, some districts nearly use 100% improved seeds). Where extension agents push improved seed use, application is higher."	
		MoA, ATA 2013: "Due to the isolated nature of the **informal sector,** however, seed exchanging/marketing networks are usually limited to particular community structures. Exchange of planting material or of new varieties occurs through social relationships within a particular cultural group, family or local institutions. Social, economic and cultural conditions tend to shape introduction and exchange of planting materials in farming communities. For instance, wealth plays an important role in seed exchange as farmers who purposefully seek and screen new types tend to be wealthier. In the contrary, poor farmers usually have less access to desired seed types, and as a result, less seed or varietal security. However, the efficiency of local seed markets in the provision of seed greatly depends on a lot of factors such as type of crop, community, etc. and is yet to be understood."	
Is the value chain between input producer and farmers very long and complex?		In the informal sector, farmers often use their own seeds or just exchange them with neighbors. Therefore the value chain is extremely short and simple.	Connectivity
		ATA, MoA, EIAR, 2013: "Current complexities in seed distribution process cause delays and supply shortages	
		ATA, MoA, EIAR, 2013: "As the bridge between activities of the formal and informal seed systems, community-based and cooperative seed producers have the advantage of being more closely linked with smallholder farmers and their needs. Community-based seed system empowerment encourages promotion of new tef seed varieties and will contribute to the effectiveness of improved seed based technology promotion. Participating farmers in a community-based seed production will serve as sources for seed, knowledge, technology transfer, and experience in deploying high yielding, adaptive to biotic and abiotic stress tef seed varieties.	
		ATA, MoA, EIAR, 2013: "The current seed distribution system contains many unnecessary complexities. For seed, there are four key characteristics that should be addressed to improve distribution effectiveness:1. Transportation system involves multiple transaction points that can be streamlined. 2. Lack of capacity of cooperatives. 3. Reliance on the standard demand assessment system. Limited alternative distribution models:	
		Sherif 2013: "Compared to the formal system, the informal system offers farmers easy access to the seed as farmer-to-farmer exchange is primarily based on social relations for information flow and exchange of goods that in some cases may make more flexible than the formal sector. "	
Do logistics and communi-		Ayele: "As for fertilizer, improved seed supply depends on transport system. Seeds are usually delivered in a short period of time before rainy season. Therefore early rains or delays can lead to the	Connectiv-

cation support services enable appropriate connectivity?		unavailability of improved seeds at planting time. In the past, this has happened repeatedly in remote areas."	ity
		Ayele: However, if seed supply fails, farmers usually borrow seeds from neighbor farmers. These seeds are not improved and give lower yields, but tef can still be planted this way. No transportation system is needed in this case.	
		Minten et al. 2013: "The impact of transport costs from urban centers on the adoption of modern inputs is substantial: distance to Addis Ababa affects both the choice to adopt chemical fertilizers and improved seed, especially quncho (DZ-Cr-387)"	
		In the workshop, input supplier group (which consisted mostly of seed suppliers) listed infrastructure/transport as the 2 most important problem for their activity, leading to delays in delivery and price increment.	
		MoA, ATA 2013: Formal sector bottleneck identified: "Producers and distributors lack appropriate access to finance, transport and storage facilities."	
Are there any single inputs/processes/stakeholders that this activity depends upon, with no alternative?		Tef seed companies depend on improved varieties, which are only distributed through EIAR. Visited seed companies reported shortage of improved tef seeds from EIAR being the biggest constraint for them.	Connectivity
		ATA, MoA, EIAR, 2013: "The major challenge facing seed production is an insufficient supply of seeds. This is partly due to the absence of efficient seed demand assessment systems and processes. One cause for this mismatch between supply and demand is the fact that most seed producers do not assess their markets; rather they rely on national demand assessments by the government. While the farmer may have requested a certain type of seed, the actual delivery of that seed is often delayed by a full year due to production. This means that the "actual" demand at the time of purchase may change, due to seasonal climate factors (i.e., later rains that change the needs of a farmer from longer maturity to shorter maturity varieties) or lack of funds.	
		ATA, MoA, EIAR, 2013: "Community-based and cooperative seed producers experience difficulties in securing adequate quantities of early-generation seed of improved varieties, which is allocated only to public enterprises, and are often forced to conduct multiplication activities using certified seed.	
		Demeke M., Di Marcantonio F., 2013:"As the vast majority of farmers use own seed, teff growers rarely require the services of the Ethiopian Seed Enterprise (ESE)"	
		Spielman et al. 2011: "For improved open-pollinated varieties such as wheat and teff, farmers do not necessarily need to purchase seed each season as they would hybrid maize. Rather, they might purchase seed every 4-5 years to replace their stocks of saved seed with seed that has a higher level of purity, and thus better performance when cultivated (Doss et al. 2003)."	
		Spielman et al. 2011: "Fourth, the seed business is often dependent on smallholders themselves as contract growers for ESE's seed multiplication activities, at least for open-pollinated crops....However, changing grain prices—particularly low prices at harvesting time and higher prices in planting time—tempt farmers to default on their seed supply contracts to ESE and hold the seed over for sale as grain to local traders and farmers at planting time. This frustrates ESE's attempt to bulk up seed for certain crops."	
		Spielman et al. 2011: "Finally, it is important to recognize that varietal improvement of many crops in Ethiopia, particularly open-pollinated crops such as wheat, will continue to depend on public breeding and seed production efforts, making the need for organizational reforms in the research system and seed sector as urgent as reforms in the policies governing the seed market itself. "	
		Alemu et al. 2013: "While the national average yield of tef is only 1.1 ton ha-1, the yield using improved varieties range from 1.5 to 2.7 ton ha-1 on research sites and from 1.3 to 2.3 ton ha-1 on farmers' fields (Dawit et al., 2010). "	
		Alemu et al. 2013: "Although the amount of improved tef varieties has been increasing since the late 1990s, only 3-6% of farmers use these improved seeds. This implies that most farmers still rely primarily on farmer-to-farmer exchanges or saved seed."	
		Sherif (2013): "However, the informal seed system is the dominant sector in Ethiopia since about 80-90% of the farmers use their own saved seeds or seeds obtained from their locals (Yonas et al., 2008). "	
Would a failure in this activity cascade to the whole system?		Yes, but failure of informal seed system pretty much impossible.	Connectivity
Does the activity rely on other sources of income?		RSEs are quite diversified. Tef for most of them is just a marginal income source	Diversity
		Variety development totally depends on research funding, which is mostly done through state budget.	
		Tef seed outgrowers are generally normal farmers which produce diverse crops and therefore have several sources of income. The same applies for the informal seed sector.	
		Cooperatives have different sources of income as well.	
		Alemu et al. 2010: "As such, the public sector's hybrid maize sales currently help to subsidize the production of self- pollinated seeds and private sector producers will only move into self-pollinating	

		crops if it becomes a financially viable enterprise."	
Are there diverse ways of producing the product/conducting the activity?		ATA, MoA, EIAR, 2013: "Farmers that lack access to BS or C1 seed often self-multiply using their previous year's grain, however maintaining quality standards in this manner is challenging. Often, these seeds are local varieties of lower quality, exhibiting lower potential yield, greater exposure to diseases, poor germination, and contamination during post-harvest processing.	Diversity
		Alemu et al. 2013: "Although the amount of improved tef varieties has been increasing since the late 1990s, only 3-6% of farmers use these improved seeds. This implies that most farmers still rely primarily on farmer-to-farmer exchanges or saved seed."	
		Sherif (2013): "However, the informal seed system is the dominant sector in Ethiopia since about 80-90% of the farmers use their own saved seeds or seeds obtained from their locals (Yonas et al., 2008). "	
Are products sold/distributed via multiple and diverse channels and markets?		RSEs distribute improved tef seeds via FCUs and PFCs but recently also started distributing seeds via private farm implement suppliers (making up about 30% of the seed distribution).	Diversity, redundancy
		ATA, MoA, EIAR, 2013: "The current seed distribution system relies heavily on cooperative unions as the main distribution points between public seed enterprises and primary cooperatives that interact directly with farmers. In evaluating the effectiveness of distribution channels, there are three main challenges: too many transactions, a reliance on cooperatives that are under-resourced, and a lack of awareness among farmers regarding the benefits of improved inputs use.	
		There are limited alternative distributors beyond cooperatives.	
		Visited farmers reported that they had several possibilities to access seeds, such as: cooperative unions, primary cooperatives, seed enterprises, farm implement suppliers, development agents, neighbors or also through own production.	
		Sherif: "Use of improved seeds varies a lot depending on access to it (around debre zeit research center, some districts nearly use 100% improved seeds). Where extension agents push improved seed use, application is higher."	
		Alemu et al. 2010: "Distribution of seed currently happens only through existing institutions, such as cooperatives and farmer unions, and is a constraint to the meaningful development of the private seed sector. The current inability of companies to market seeds outside of government channels is a major stumbling block to the development of the private seed sector in Ethiopia. "	
		MoA, ATA 2013: Formal sector bottlenecks identified: "Producers lack effective channels to market and distribute their seed. Variable quality of seed available at distribution channels due to limited quality control by regulatory bodies	
		MoA, ATA 2013: Intermediate sector bottlenecks identified: "Lack of adequate and sustainable market for CBSPs"	
Are multiple varieties of the same crop used?		Minten: "Generally, the diversity in tef varieties is huge in Ethiopia. Farmers mostly produce their own "varieties", since they get seeds from their harvest. However, there is also some seed/variety exchange between farmers going on. Often, on one field there is more than one variety grown, since varieties are not pure and seeds exchanged. On village base, the tef variety diversity is already huge."	Diversity
		Minten: "With the use of improved varieties, this diversity will shrink. However, at the moment the use of improved varieties is still minimal."	
		MoA, ATA 2013: Informal sector bottlenecks: "High risk of genetic erosion of local varieties with the increased adoption of varieties developed through the formal sector."	
Does the activity have multiple production sites/lines/machines which are spatially distributed? Are components substitutable?		Sherif: "Use of improved seeds varies a lot depending on access to it (around debre zeit research center, some districts nearly use 100% improved seeds). Where extension agents push improved seed use, application is higher."	Diversity, redundancy
		Tef seeds are being produced at different sites throughout the country: at RSEs which are situated in each regions as well as in seed producing farmer cooperatives which are highly distributed.	
Are there multiple policy options which support back-up systems during a disturbance?		ATA, MoA, EIAR, 2013: "Farmers that lack access to BS or C1 seed often self-multiply using their previous year's grain, however maintaining quality standards in this manner is challenging. Often, these seeds are local varieties of lower quality, exhibiting lower potential yield, greater exposure to diseases, poor germination, and contamination during post-harvest processing.	Diversity, redundancy
		Alemu et al. 2010: "Disaster recovery plan - there is also a need for a well-developed plan for fast, large-scale production in the case of disease (i.e. emergency seed). Options include large seed stocks (which is expensive), or a list of customers from whom grain (of known provenance) can be purchased in case of a disaster. The latter option has been included in the revised seed proclamation."	
Are impacts caused by the activity borne by other ac-		No specific impacts known.	Equitability

tors who do not receive compensation?			
Are there ethnical, gender, familiar dependencies/barriers which hamper connectivity?		MoA, ATA 2013: "Due to the isolated nature of the informal sector, however, seed exchanging/marketing networks are usually limited to particular community structures. Exchange of planting material or of new varieties occurs through social relationships within a particular cultural group, family or local institutions. Social, economic and cultural conditions tend to shape introduction and exchange of planting materials in farming communities. For instance, wealth plays an important role in seed exchange as farmers who purposefully seek and screen new types tend to be wealthier. In the contrary, poor farmers usually have less access to desired seed types, and as a result, less seed or varietal security. However, the efficiency of local seed markets in the provision of seed greatly depends on a lot of factors such as type of crop, community, etc. and is yet to be understood."	Equitability
		Since seeds of the formal sector are distributed via cooperatives and development agents, access to seeds should be fair.	
Are there equitable/fair rights, regulations, etc. in the governance of the activity?		MoA, ATA 2013: "Lack of clear communication, role clarity, and accountability among various research institutions and units. Regulatory institutions lack autonomy and role clarity. Regulatory institutions lack capacity."	Equitability
		In the informal sector, regulations and institutional rules are probably mostly inexistent.	
Can diverse actors participate in decision-making?		Spielman et al. 2011: "Third, deep reforms in the extension system should be explored sooner than later. Such reforms would need to extricate the system away from single-minded, top-down, package approaches to cereal intensification, to more dynamic, responsive, and competitive service provision. However, without such changes, the extension and education system in Ethiopia will become increasingly irrelevant to the needs of intensive, commercial smallholder production systems."	Equitability
		Seed companies complained about a weak linkage between research, seed producers and farmers. According to them, farmers are no really involved in the development of varieties, can not place their suggestions and needs.	
		In the informal sector, farmers can take decisions by themselves.	
Are small disturbances tolerated rather than avoided can they be managed?		RSEs always plan to produce 20% more seeds than the estimated demand for the case of increased demand through shocks (e.g. reseeding after drought, flood, pests).	Exposure to pressure
		Cooperatives sometimes have seed stocks (Sherif). Wealthier farmers usually also keep some stocks.	
		Resource poor farmers often have little or no seed stocks and use all the remaining stocks for seeding. If reseeding is necessary (e.g. due to drought, flooding, ants), this practice can be devastating.	
		Ayele: If seed supply fails: farmers ask neighbor farmers for seed (informal exchange) so, not improved	
Has the activity been exposed to disturbances of different types in the past?		ATA, MoA, EIAR, 2013: "Seed production is vulnerable to droughts. In case of early drought, reseeding might be necessary, which can be a problem since initial seeds (from EIAR) are scarce (Sherif)-	Exposure to pressure
		Spielman et al. 2011: "Third, the seed business is risky because seed production is closely correlated to the same weather risks faced by farmers. Hence, seed production in Ethiopia drops during drought periods just as crop production does. Having said this, seed production on irrigated land can mitigate this risk to some extent, and much of ESE's maize seed production operations and subcontracted production currently take place on irrigated land in the Awash River basin."	
		From shocks mentioned during expert interviews, seed supply chain is mostly affected by drought, floods, pest outbreaks and state budget shocks. The first three shocks accord with the most important shocks for the tef production, since production of tef seeds or tef grain doesn't differ much. Additionally, these three shocks can affect stock of farmers, since the have to reseed tef if they are affected by a early drought, early floods or ants affecting young tef plants. These shocks have repeatedly affected the farmers and seed producers in the past. Budget shocks have an effect on the funding of research/breeding and extension programs. Under the Derg regime for instance, research funds were cut drastically (Abate).	
Did it take long for the activity to recover from past disturbances?		Little information known. But due to the informal seed sector as an alternative, recovery probably did not take long.	Exposure to pressure
Are crops bred for resistance to diseases? And other stresses?		Selection at the moment mostly on yield and lodging resistance. Some selection for drought resistance/ drought escape (early maturing), but marginal compared to other traits. There is no breeding being don on pest resistance of waterlogging whatsoever.	Exposure to pressure
		Sherif 2013: "Moreover, the scarcity or absence of crop varieties for less favorable, drought-prone environments is worth mentioning. "	

		In the informal sector, varieties are to some extent bread for resistance to diseases and even more likely for resistance to environmental stresses such as droughts or waterlogging.	
Are there long-term plans (e.g. 50 years) to manage supply, demand and capacity?		ATA, MoA, EIAR, 2013: "This Strategy primarily focuses on seed and fertilizer as they are believed to have the greatest potential impact on productivity in the near term.	Governance capacity
		MoA, ATA 2013: "Recognizing this fact, the GOE has identified the seed system as a priority area of focus. "	
		ATA, MoA, EIAR, 2013: "Since high-quality seeds – Basic Seed (BS) and Certified Seed 1 (C1) – are in short supply, the Government of Ethiopia has designed a policy to support the multiplication and distribution of a second- tier quality seed, called Certified Seed 2 (C2), which is intended to fill the gap of quality seed in the market	
		Shahidur et al. 2012: "The recent impetus for increasing fertilizer use has been largely driven by the Growth and Transformation Program, which sets annual cereal production targets for each region. Increasing the distribution of chemical fertilizer and improved seed has been the key move for achieving these targets."	
		Shahidur et al. 2012: "Furthermore, production of self-pollinated seed is a loss-making enterprise for the public system, so the private-sector companies have incentives to invest. These problems are well recognized by the government, and several initiatives are under way to address problems in the country's seed system.8 If they succeed, these programs will provide a further boost to fertilizer use in Ethiopia."	
		Alemu et al. 2013: "The poor performance of the Ethiopian seed sector is recognized by the government. The newly established Agricultural Transformation Agency (ATA) gives priority to improve this weak sector. "	
Are the responsibilities for resources/conveyance/activity clearly defined?		MoA, ATA 2013: "Some of the specific challenges associated with seed include the limited capacity and lack of role clarity of the different actors,..."	Governance capacity
		MoA, ATA 2013: "Lack of clear communication, role clarity, and accountability among various research institutions and units.regulatory institutions lack autonomy and role clarity. Regulatory institutions lack capacity."	
Does the actor have autonomy, control and ownership over the activity, and his own resources?		Regions/state gives RSEs some basic restrictions on what to produce (have to produce tef) and how much to produce (but difficult to enforce amount)	Governance capacity
		Spielman et al. 2011: "Fourth, the seed business is often dependent on smallholders themselves as contract growers for ESE's seed multiplication activities, at least for open-pollinated crops....However, changing grain prices—particularly low prices at harvesting time and higher prices in planting time—tempt farmers to default on their seed supply contracts to ESE and hold the seed over for sale as grain to local traders and farmers at planting time. This frustrates ESE's attempt to bulk up seed for certain crops."	
		Alemu et al. 2013: "Even though, different public and private actors are involved in seed production, the pricing and marketing of the seed is made centrally by the government along with provisions of loan. "	
		Actors of the informal seed sector have total autonomy.	
		Alemu et al. 2010: "There is considerable reliance on central planning, in which various state actors receive instructions from the top rather than being encouraged to develop their own decision-making capacities to serve national goals "	
Is the authority responsible over resources/conveyance/activity?		ATA, MoA, EIAR, 2013: "Since high-quality seeds – Basic Seed (BS) and Certified Seed 1 (C1) – are in short supply, the Government of Ethiopia has designed a policy to support the multiplication and distribution of a second- tier quality seed, called Certified Seed 2 (C2), which is intended to fill the gap of quality seed in the market	Governance capacity
		ATA, MoA, EIAR, 2013: "For seed, certified seed should be distributed through efficient and effective distribution systems with multiple channels that meet the needs of farmers and ensures that they have a choice of service providers. The channels should also provide timely access to high quality seeds of improved varieties at sufficient quantities.	
		MoA, ATA 2013: "Recognizing this fact, the GOE has identified the seed system as a priority area of focus. "	
Are there plans to address any risks from hazards and emergency situations with scripts for actors in case of such an event?		Alemu et al. 2010: "Disaster recovery plan - there is also a need for a well-developed plan for fast, large-scale production in the case of disease (i.e. emergency seed). Options include large seed stocks (which is expensive), or a list of customers from whom grain (of known provenance) can be purchased in case of a disaster. The latter option has been included in the revised seed proclamation."	Governance capacity
Are extension		Extension for farmers: Improved seeds are part of the extension package and are being promoted by	Infor-

and advisory services available?		extension agents. However, there is often a shortage in improved seeds. (Sherif, Ayele)	matio n, learn- ing
		ATA, MoA, EIAR, 2013: "Community-based and cooperative producers need to be more strongly linked with the formal seed sector through the research and extension systems, in order to build their ability to produce quality tef seed through access to guidelines, technical assistance and oversight, and training on topics including tef seed production techniques and business management.	
		Spielman et al. 2011: "Nonetheless, the entire body of evidence on agricultural extension suggests that the impact on productivity and poverty has been a mixed experience to date. Although many farmers seem to have adopted the packages promoted by the extension system, up to a third of the farmers who have tried a package had discontinued its use (Bonger, Ayele, and Kumsa 2004; EEA/EEPRI 2006). Indeed, Bonger et al. (2006) also find that poor extension services were ranked as the top reason for non-adoption. "	
		Alemu et al. 2013: "In recent years, different approaches have been followed to strengthen the research- extension-farmers linkages so that agricultural technologies generated by the research system reach the end-users timely and effectively. Among these approaches, the most important are: (i) the pre-extension demonstration and technology popularization undertaken by research centers; (ii) farmers' research groups promoted by research centers and also by Ministry of Agriculture and Rural Development (MoARD); (iii) scaling up of agricultural technologies by research centers in collaboration with other partners,..."	
		Kebebew et al. 2013: "The most important bottlenecks constraining the productivity and production of tef in Ethiopia are:...vi) inadequate research investment to the improvement of the crop as it lacks global attention due to localized importance of the crop coupled with limited national attention; and vii) weak seed and extension system."	
		Setatow et al. 2013: "The research-extension program of the national agricultural research system played key role in the dissemination of the improved tef technologies through on-farm verification, demonstration and popularization. Tef is also considered as a priority crop by the national extension program of the Ministry of Agriculture due to its significance in food security and commercialization."	
		Alemu et al. 2010: "Concerted government spending in extension has also established nearly 10,000 Farmer Training Centers (FTCs) and trained 63,000 Development Agents (DAs) from 2002 – 2008 "	
		Alemu et al. 2010: "Low farmer knowledge about the varieties that do deliver major improvements (e.g. yield increase, disease resistance) is the result of constraints in both research and extension services, which do not prioritize farmer education or promotion of improved seeds as a core activity. Many research institutions fail to produce adequate quantities of newly released varieties for farmer demonstration purposes, and extension agents are not reaching farmers with higher- yielding varieties or improved practices to augment those varieties. "	
Is there collaboration between actors, universities, research institutions?		Seed companies complained about a weak linkage between research, seed producers and farmers. According to them, farmers are no really involved in the development of varieties, can not place their suggestions and needs.	Information, learning
		The nature of the formal system gives a strong link between research institution which develop the varieties and the seed companies, which multiply them.	
Are there early warning systems for disturbances?		none known.	Information, learning
Is the attitude towards doubts, uncertainty and failures open and constructive?		Alemu et al. 2013: "The poor performance of the Ethiopian seed sector is recognized by the government."	Information, learning
Is there an atmosphere of trust cultivated between actors?		As reported from seed companies, there is high trust between them and EIAR.	
		Some distrust between outgrowers and seed companies, since outgrowers sometimes sell seeds to traders instead of seed companies even though they had a contract with them.	
		MoA, ATA 2013: "Due to the isolated nature of the informal sector, however, seed exchanging/marketing networks are usually limited to particular community structures. Exchange of planting material or of new varieties occurs through social relationships within a particular cultural group, family or local institutions. Social, economic and cultural conditions tend to shape introduction and exchange of planting materials in farming communities. For instance, wealth plays an important role in seed exchange as farmers who purposefully seek and screen new types tend to be wealthier. In the contrary, poor farmers usually have less access to desired seed types, and as a result, less seed or varietal security. However, the efficiency of local seed markets in the provision of seed greatly depends on a lot of factors such as type of crop, community, etc. and is yet to be understood."	

Are lessons learnt from previous experiences, is activity modified in consequence?		OSE reported that they promote a new distribution channel for tef seeds throe private farm implement suppliers. The advantage of this channel is the direct information path for feedback from farmers to implement suppliers and RSEs. Thereby the demand and preference of farmers can better be estimated for RSEs.	Information, learning
		OSE hopes for a stronger linkage between researchers and farmers in the future.	
		ATA, MoA, EIAR, 2013: "Since high-quality seeds – Basic Seed (BS) and Certified Seed 1 (C1) – are in short supply, the Government of Ethiopia has designed a policy to support the multiplication and distribution of a second- tier quality seed, called Certified Seed 2 (C2), which is intended to fill the gap of quality seed in the market	
		ATA, MoA, EIAR, 2013: "Community-based and cooperative producers need to be more strongly linked with the formal seed sector through the research and extension systems, in order to build their ability to produce quality tef seed through access to guidelines, technical assistance and oversight, and training on topics including tef seed production techniques and business management.	
		Shahidur et al. 2012: "Furthermore, production of self-pollinated seed is a loss-making enterprise for the public system, so the private-sector companies have incentives to invest. These problems are well recognized by the government, and several initiatives are under way to address problems in the country's seed system.8 If they succeed, these programs will provide a further boost to fertilizer use in Ethiopia."	
		Alemu et al. 2013: "The poor performance of the Ethiopian seed sector is recognized by the government. The newly established Agricultural Transformation Agency (ATA) gives priority to improve this weak sector. "	
Is there investment in education and knowledge development of actors?		Seed companies are part of the national seed association, which gives trainings and disseminates technical know-how.	Information, learning
		Seed companies give training to farmers and farmer cooperatives on how to produce quality seeds.	
		RSEs attended a training program from "government of Netherland" on how to produce quality sees. Another seed company took part of a training on seed production of the Alliance for Green Revolution Africa (AGRA).	
		Kebebew et al. 2013: "The most important bottlenecks constraining the productivity and production of tef in Ethiopia are:...vi) inadequate research investment to the improvement of the crop as it lacks global attention due to localized importance of the crop coupled with limited national attention; and vii) weak seed and extension system."	
		Setatow et al. 2013: "The research-extension program of the national agricultural research system played key role in the dissemination of the improved tef technologies through on-farm verification, demonstration and popularization. Tef is also considered as a priority crop by the national extension program of the Ministry of Agriculture due to its significance in food security and commercialization."	
		Fufa et al. 2011: "Tef has been under-resourced relative to other crops. Breeders have developed improved varieties, but the uptake of these has been limited and there has been little research outside breeding. "	
Is the knowledge base of actors sufficient? Do they have a high level of education?		ATA, MoA, EIAR, 2013: "Farmers have insufficient knowledge of and financial ability to purchase and use inputs, such as fertilizer and seed	Information, learning
		ATA, MoA, EIAR, 2013: "lack of awareness among farmers regarding the benefits of improved inputs use.	
		Alemu et al. 2013: "However, the performance of the Ethiopian seed system in general and that of the tef seed system in particular is recognized to be very low especially in terms of technology uptake."	
		Setatow et al. 2013: "Factors such as expensiveness and unavailability of seeds and lack of awareness have commonly been cited as the major constraints contributing to the low level of tef technology adoption (Teklu et al., 2001). Lack of awareness was reported by 34% of the farmers as the most important factor for the non-adoption of improved tef varieties. "	
		Alemu et al. 2010: "There is a lack of understanding and available information on the true performance of the widely available crop varieties....However, some success stories -- like Kuncho teff variety seeds --indicate that once farmers understand the advantage of a commercially-purchased variety (such as increased yield, potential for premium price earning, improved resistance to stress) then they quickly see the advantage of investing in these seeds. This shows that farmer education is critical to the success of these seeds."	
		Alemu et al. 2010: "Low farmer knowledge about the varieties that do deliver major improvements (e.g. yield increase, disease resistance) is the result of constraints in both research and extension services, which do not prioritize farmer education or promotion of improved seeds as a core activity. Many research institutions fail to produce adequate quantities of newly released varieties for farmer demonstration purposes, and extension agents are not reaching farmers with higher- yielding varieties or improved practices to augment those varieties. "	
		MoA, ATA 2013: Informal sector bottleneck identified: Farmers may lack adequate knowledge in best seed selection techniques that help maintain genetic uniformity of modern varieties and enhance the performance of existing local varieties."	

Does the activity rely on distortionary subsidies?		Kedir: Improved seed supply is to some extent indirectly subsidized through research funding on breeding, through free inspections/audits for seed companies, lower taxes (only turnover tax).	Profitability
		RSEs work on profit base, however, they are public enterprises and start capital is given by the regions.	
		ATA, MoA, EIAR, 2013: "RSEs are governed by respective RBoAs and receive operational support, including deployment of Bureau staff. "	
		Alemu et al. 2010: "As such, the public sector's hybrid maize sales currently help to subsidize the production of self- pollinated seeds and private sector producers will only move into self-pollinating crops if it becomes a financially viable enterprise."	
		Informal system is subsidized to the same extent as tef production and therefore very little.	
Does input supply generate net positive profit and is it still profitable in case of changes in demand/price?		Seed companies reported tef seed production not to be profitable since it is a self pollinating crop.	Profitability
		One private seed supplier reported liquidity problems since seeds from outgrowers have to be purchased at harvesting time but can not be sold until beginning of next planting season and branding is also expensive.	
		Kedir: "gap between grain and seed price about 400 Birr (25% of grain price)"	
		ATA, MoA, EIAR, 2013: "Given their limited collateral and risky seasonal revenue streams, agricultural cooperatives require a dedicated source of financing capital.	
		Shahidur et al. 2012: "Furthermore, production of self-pollinated seed is a loss-making enterprise for the public system, so the private-sector companies have incentives to invest. "	
		Alemu et al. 2013: "Even though, different public and private actors are involved in seed production, the pricing and marketing of the seed is made centrally by the government along with provisions of loan. "	
		Setatow et al. 2013: "Since the formal seed sector which consists of both the private and public seed enterprises is driven by profit, it is virtually engaged in the production of seeds of hybrid maize and wheat. In Ethiopia, the formal seed sector covers only 5% of the tef but 53% of the maize and 20% of the wheat seed requirement (Dawit et al., 2007)."	
		Alemu et al. 2010: "Public producers (i.e., ESE/RSEs) utilize out growers for multiplication of OPVs, but retain all processing, testing, storage, and distribution. Out growers are paid a 15 percent premium on the grain price, which in some years is not an adequate incentive. Low retrieval rates, compounded by expensive processing and distribution, makes this a much less profitable business. "	
		MoA, ATA 2013: Bottlenecks for intermediate sector: "Many community-based producers are not operationally or financially sustainable "	
		The informal seed sector makes just marginal profits.	
Does the activity have/give possibility to generate funds for investment, maintenance, expansion,		For the formal sector, tef seed production is often unprofitable. Informal sector can probably cover the production costs with the revenue but profits are very small.	Capital (financial)
		Seed companies reported tef seed production not to be profitable since it is a self pollinating crop.	
		On private seed supplier reported liquidity problems since seeds from outgrowers have to be purchased at harvesting time but can not be sold until beginning of next planting season and branding is also expensive.	
		ATA, MoA, EIAR, 2013: "Given their limited collateral and risky seasonal revenue streams, agricultural cooperatives require a dedicated source of financing capital.	
		Alemu et al. 2010: "Public producers (i.e., ESE/RSEs) utilize out growers for multiplication of OPVs, but retain all processing, testing, storage, and distribution. Out growers are paid a 15 percent premium on the grain price, which in some years is not an adequate incentive. Low retrieval rates, compounded by expensive processing and distribution, makes this a much less profitable business. Given that demand is low and costs are high, production of OPVs is not currently profitable for the public system. This means that production of self-pollinated seeds will likely remain the purview of the public sector, since it is currently not financially attractive for private companies. As such, the public sector's hybrid maize sales currently help to subsidize the production of self- pollinated seeds and private sector producers will only move into self-pollinating crops if it becomes a financially viable enterprise."	
Is the activity exposed to substantial financial risks?		generally no, just in case of improved seeds for private companies which are not profitable. Research	Capital (financial)
Is the activity insured against damages/losses)?		no, indirect insurance since state supported seed companies. but investment low in case of farmers,	Capital (financial)
Is self-organization, networking, initiative, association among actors		Seed companies are part of the national seed association, which gives trainings and disseminates technical know-how.	Self-organization
		OSE reported that they promote a new distribution channel for tef seeds through private farm implement suppliers. The advantage of this channel is the direct information path for feedback from farmers to implement suppliers and RSEs. Thereby the demand and preference of farmers can better be estimated for RSEs.	

enabled?		ATA, MoA, EIAR, 2013: "Improved seed usage was low in the past, yet recent production and adoption of improved seed in the country has grown substantially. This surge in production is partly attributed to new developments including the emergence of regional seed enterprises (RSEs) which have created an opportunity to address location-specific needs. The other advancement is in farmer-based seed multiplication schemes implemented by specialized local seed producer cooperatives.	
		ATA, MoA, EIAR, 2013: "As the bridge between activities of the formal and informal seed systems, community-based and cooperative seed producers have the advantage of being more closely linked with smallholder farmers and their needs. Community-based seed system empowerment encourages promotion of new tef seed varieties and will contribute to the effectiveness of improved seed based technology promotion. Participating farmers in a community-based seed production will serve as sources for seed, knowledge, technology transfer, and experience in deploying high yielding, adaptive to biotic and abiotic stress tef seed varieties.	
		Alemu et al. 2010: "There is considerable reliance on central planning, in which various state actors receive instructions from the top rather than being encouraged to develop their own decision-making capacities to serve national goals "	
Are actors able and motivated to re-establish function after a disruption?		Informal system highly motivated to produce tef again as it is a security and to some extent cash crop for farmers. The formal sector is less motivated, as incentives to produce tef seeds are low due to limited profits.	Self-organization
Is there opportunity for experimentation and innovation?		Shahidur et al. 2012: "Markets for self-pollinated varieties also face problems. Farmers perceive insignificant advantage from seed in mass production over farmer-saved or locally traded seed, and hence farmers have little incentive to purchase open-pollinated variety seed from the market."	Transformability
		Spielman et al. 2011:" Following market reforms in the 1990s, seed production and distribution were opened to the private sector. "	
		Spielman et al. 2011: "Finally, it is important to recognize that varietal improvement of many crops in Ethiopia, particularly open-pollinated crops such as wheat, will continue to depend on public breeding and seed production efforts, making the need for organizational reforms in the research system and seed sector as urgent as reforms in the policies governing the seed market itself. "	
		Alemu et al. 2010: "There is considerable reliance on central planning, in which various state actors receive instructions from the top rather than being encouraged to develop their own decision-making capacities to serve national goals "	
		MoA, ATA 2013: "Farmers lack input credit to adopt modern varieties "	
Does the activity and its leaders show openness to change, has this been shown in the past?		OSE reported that they promote a new distribution channel for tef seeds through private farm implement suppliers. The advantage of this channel is the direct information path for feedback from farmers to implement suppliers and RSEs. Thereby the demand and preference of farmers can better be estimated for RSEs.	Transformability

Farm implements (improved and unimproved) and pesticide supply

Question	Rating	Answer	Attrib-trib-ute
Does the activity have spare capacity (infrastructure, technical, know-how, financial) in case of increased demand?		ATA, MoA, EIAR 2013: " Existing farm implements (e.g., row planters, broad-bed makers, and ploughs) are inadequate and not readily available to farmers. A number of farm implements have been designed and created within the last two decades, including the “Erf” and “Mofer” attached moldboard ploughs, winged plough, broad-bed maker (BBM), tie-ridger, and mechanical broadcaster. These technologies play a significant role in improving labor and land productivity for farmers, particularly given the labor-intensive nature of tef farming. Some efforts have been made to mass produce and introduce these technologies to the user community, through the research extension system, third-party partner organizations, and public-private partnership models. However, excluding very few implements, such as the BBM, minimal efforts have been successful at the large-scale mass production and introduction of farm implements, beyond small groups of farmers or kebeles. This is driven in large part by a lack of awareness of the value of using such implements, the initial start-up costs required to develop and produce machinery, and difficulty in reaching farmers across a widespread geographic area, among other reasons."	Buffering capacity
		ATA, MoA, EIAR 2013: "Pesticides are currently costly and are not widely accessible for	

		farmers. The availability and affordability of pesticides in tef production is a major constraint for tef producers. This limited supply has not grown since, given the perceived low rate of return on investments in pesticides, especially when coupled with an investment in spraying equipment. The low active demand for pesticides ultimately discourages pesticide dealers and equipment suppliers."	
		ATA, MoA, EIAR 2013: " As discussed earlier, unions and primary cooperatives are major distribution channels for inputs. However, capacity limitations restrict their ability to actively engage in the supply and distribution of much-needed inputs. These limitations include financial, transportation equipment and logistics, and storage facilities, etc. “	
		Fufa et al. 2011: "There are a few row planter technologies available; however they are still being tested for their suitability to farmers’ conditions."	
		Fufa et al. 2011: "Two factories (in Addis Ababa and Hawassa) are making the threshers at a rate of 3 per week, but this could likely be scaled up with limited investment. The main challenge is determining how to make the 30- 40,000 Birr capital cost of the thresher affordable for rural entrepreneurs and/or cooperatives. Any interventions that address expanding access to mechanical threshers will need to consider innovating funding mechanisms."	
		Kelemu and Kebede 2013: "Among these, a moldboard plow which minimizes repeated plowings has been developed and is currently being used by many farmers. "	
		Visited farm implement suppliers reported very limited financial capacity and shortages in pesticide supply to be major constraints for responding to increased demand.	
		Abate: "- Innovation problem (also investment/starting capital problem)→ for threshers, vacuum cleaners (no importers/investors) - All innovation on technology is done by research centers - Nearly no national mechanic manufacturing industry - Tef needs spatial technology (doesn’t exist yet→ investment needed)"	
		ATA 2014: "Additional progress has also been made in introducing mechanized farming implements, both pre and post-harvest, to thousands of tef smallholders."	
Do supporting activities (logistics, communication) have spare capacity in case of increased demand, are they equitably accessible?		Fufa et al. 2011: "Limited Tef research outside breeding: The focus of Tef research has been on breeding, with limited attention paid to mechanization, processing and storage. The Tef mechanization group at the Melkassa research station is now focusing on this important topic and has developed one of several prototype row planters now being tested. However, Tef still remains an almost entirely un-mechanized crop and its labor intensity limits the amount that most farmers can grow. The failure to develop affordable and scalable processing technology (especially threshers) also constrains both profitability and yields (by increasing post-harvest losses). However, mechanization research in Tef and other crops is also being coordinated and conducted by the Melkassa Agricultural Research Center. Furthermore, in order to conduct comprehensive research on the crop, the facilities available at the research station need to be upgraded. These resource shortages are compounded by the fact that Tef is not an internationally recognized food crop and, as a result, international funds for research are limited. In addition, the crop has received little attention in terms of domestic public research funding and is second to last for funding among cereals."	Buffering capacity
		Fufa et al. 2011: "However, due to the absence of maintenance service in the locality, the thresher has been unoperable for some time in the Dejen area."	
		Logistics and Communication see whole chain	
Do input resources have spare capacity in case of increased demand and are they equitably accessible?		ATA, MoA, EIAR 2013: "Although many pesticides have been tested against pests that harm tef, only a few of them have been registered for use on tef. In fact, some of these pesticides have been banned or are out of production."	Buffering capacity
		Farm implement suppliers reported occasional supply shortages of some pesticides, often on seasonal base.	
Does the activity maintain stocks of inputs?		Visited farm implement suppliers kept very little stocks, due to financial constraints (average 1 week).	Buffering capacity
Are input storage systems distributed throughout the value chain?		For pesticides, there are various domestic as well as international factories supplying and storing pesticides. Pesticide dealers, cooperatives and farm implement suppliers are also well distributed throughout the country, therefore storage facilities are well distributed.	Buffering capacity
		For other farm implements, storage sysem is also well distributed.	
Is there sufficient labor force available for the activity and can it be adapted to fluctuations?		See whole chain	Capital (economic)
Are there sufficient resources to meet increas-		yes	Capital (phys-

es in demand in next 50 years?			ical)
Are there measures, management, stewardship, planning, protection schemes which are enforced to protect resources and habitats?		Amera and Abate 2008: "The Ethiopian Obsolete Pesticides Disposal Project, a project that mainly aimed at removing obsolete pesticides has been operational in Ethiopia for the last five years. It has been reported (MOARD (2007) Report) that a significant portion of the obsolete pesticides have been removed since then. However, it should be noted that as the obsolete pesticides are removed, new pesticides are imported and are possibly contributing to further accumulation."	Capital (environmental)
		ATA, MoA, EIAR 2013: " Ethiopia enacted pesticide registration decree 1990, since then, very few pesticides have been registered for use on tef production (e.g. 1999 only two were registered),... . One pesticide o special importance is herbicide 2-4-D, has been banned in many countries."	
		Amera and Abate 2008: "Considering the absence of effective controlling mechanisms in pesticides imports and their increased and inappropriate use in Ethiopia, an assessment of the impact on human health and the ecosystem is warranted."	
Are there critical emissions/impacts which the activity has on the environment/ecosystems/resources?		Amera and Abate 2008: The study was designed to assess the pesticide use, practice and hazards in the Ethiopian Rift Valley. Of the crops produced in the study area, maize is produced by the majority (94.3%) of the study participants followed by Tef (82%), vegetable (24.2%), fruits (21.6%) and wheat (11.6%). The protective equipment utilization in the area was almost none; alongside which 31% of the respondents claimed illness after spraying pesticide and 14.2% indicated the occurrence with in the family of a health related pesticide incident. 28.7 % of the farmers use DDT for Agriculture. About 50% of the respondents used empty pesticide containers for water/food storage and about 7% of them indicated that they sell empty containers for others to use. About 31% of the respondents stored pesticides any where in the house and about 6% of them stored pesticides even in the kitchen. Recently, Ethiopia has been considered as having the largest accumulations of obsolete pesticides in the whole of Africa. Study in the USA showed that long term exposure to 2,4-D causes damage to the nervous system, kidneys and liver. Given that the majority of the respondents do not use 2, 4-D properly, acute impacts on human health is highly likely. For example, over 55% of the respondents do not read pesticides labels, and ----do not use protective cloth. Given that 2, 4-D is one of the most common pesticide used in the area, all the acute symptoms reported by the respondents could be resulted mainly from this chemical.	Capital (environmental)
		Amera and Abate 2008: "Considering the absence of effective controlling mechanisms in pesticides imports and their increased and inappropriate use in Ethiopia, an assessment of the impact on human health and the ecosystem is warranted."	
		Amera and Abate 2008: "Although DDT is banned for use for agricultural purpose, recent survey conducted in the Rift Valley (see main report for the details) revealed that DDT is used as insecticides by farmers. One of the experts in the regional Agricultural Bureau also informed us that he has seen farmers spraying DDT on their fields. It was also observed that DDT is openly displayed in shops for sale."	
		Kelemu and Kebede 2013: "The traditional method of land preparation using maresha is cumbersome. The frequency of plowing is sometimes more than five times especially in areas like Shirka (Arsi Zone) where grass weeds are predominant. In order to combat such problems and reduce repeated plowings, the Nazareth moldboard plow was developed by the Agricultural Mechanization Research group based at Melkassa Agricultural Research Center. The modified oxen-pulled moldboard plow reduces the tillage requirement by 50% due to its complete inversion or turning of the furrow slice that result in the inhibition of weed germination and growth. This modified plow has been widely distributed to farmers across the country. "	
		ATA, MoA, EIAR 2013: "In addition, 2-4-D has been banned in many countries and its continued use in Ethiopia has produced a new generation of 2-4-D-tolerant broad-leaf weeds. Thus, new types of herbicides are urgently required, together with new types of knowledge dissemination on the appropriate application rates. "	
Do the actors have a good health status (physical and mental)?		Amera and Abate 2008: "Regarding pesticide poisoning incidence in the family, 60 (14.2%) indicated its occurrence....Regarding illness after pesticide application 131 (31.0%) indicated that they felt discomfort after application and 38 (9.0%) indicated that they sometimes feel discomfort after pesticide application. Head ache was felt by 109 (25.8%) whereas 90 (21.3%) indicated a feeling of nausea, 84 (19.9%) indicated vomiting, 43 (10.2%) indicated skin irritation, 41 (9.7%) indicated eye irritation and 9 (2.1%) indicated other discomforts after pesticide application.	Capital (social)
		Amera and Abate 2008: "Regarding protective equipment while they were spraying pesticides, 219 (51.9%) used normal clothes, 116 (27.5%) used cotton overalls, 34 (8.1%) used gloves, 36 (8.5%) used hat, 143 (33.9%) used boots while 59 (14.0%) sprayed bare feet. Twenty three (5.5%) of those who spray pesticides used glasses while 16 (3.8%) used	

		goggles for eye protection. As a protection of inhalation, 60 (14.2%) used handkerchief around their mouth and only 7 (1.7%) used mask."	
		Amera and Abate 2008: "Given that the majority of the respondents do not use 2, 4-D properly, acute impacts on human health is highly likely. For example, over 55% of the respondents do not read pesticides labels, and ----do not use protective cloth. Although it was not only for 2, 4-D, the respondents reported that they felt discomfort after application (31%), headache (26%), nausea (20%), vomiting (10%) and skin irritation (10%). Given that 2, 4-D is one of the most common pesticide used in the area, all the acute symptoms reported by the respondents could be resulted mainly from this chemical."	
Does the activity engage with multiple suppliers, buyers, and fellow stakeholders for trade?		ATA, MoA, EIAR 2013: "The third input discussed in this section is farming implements, which includes any type of machinery or instrument that aids in increasing productivity for the farmers in pre-farming and farming activities. Implements can be procured from international sources or manufactured locally using basic materials such as water bottles and wood. These implements are used to prepare the land before planting and also to enable efficient planting methods, such as planting in rows by first using an implement to create rows in the soil."	Connectivity
		Visited farm implement suppliers reported to have various pesticide suppliers and to sell their products to different customer groups such as small scale farmers, commercial horticulture farmers, home gardens, etc.	
		Abate: "- Innovation problem (also investment/starting capital problem)→ for threshers, vacuum cleaners (no importers/investors) - All innovation on technology is done by research centers - Nearly no national mechanic manufacturing industry - Tef needs spatial technology (doesn't exist yet→ investment needed)"	
Is the value chain between input producer and farmers very long and complex?		Tenna, Setatow: About 35% of the pesticides are distributed through cooperatives, which get them directly from AISE. The rest is distributed through pesticide dealers and farm implement shops. Further there are pesticide traders involved in the market.	Connectivity
		Tenna: AISE gets pesticides from some domestic factories and international distributors.	
Do logistics and communication support services enable appropriate connectivity?		See whole chain	Connectivity
Are there any single inputs/processes/ stakeholders that this activity depends upon, with no alternative?		Research	Connectivity
Would a failure in this activity cascade to the whole system?		Amera and Abate 2008: "According to the findings by the Holeta Research Center, the average loss due to weeds for field crops ranged between 49 to 65%. "	Connectivity
		Ayele: "In case of insect invasion/pest outbreaks, farmers rely on insecticides. But generally insecticide use is not that common and only applied regionally/seasonally."	
		Setatow: "No major fungus/disease problems in tef production known so far, since endemic plant. Therefore no need for fungicides at al. "	
		Setatow, Ayele: "Herbicides are used frequently but there is alternative of hand weeding available."	
		Begna 2014:"Furthermore, this suggests that herbicides are becoming the best alternative when labor is in short of and expensive to remove the weeds by hand."	
		ATA, MoA, EIAR 2013: "A final input to be considered is pesticides. Pests are a major concern in tef production, as pests have the capacity to damage large area of crop when they occur. Commonly occurring pests in Ethiopia include the armyworm and the locust. In particular, herbicides, such as 2-4-D, should be considered, given that tef is grown under a wide range of farming systems and therefore is exposed to a wide range of weeds that can affect production. One pesticide that is particularly important to tef is the herbicide 2-4-D. A review of literature shows that countrywide, tef yield losses due to weeds (if there is uncontrolled weed growth) range between 23% around the Debre Zeit area to 56% in Eastern Shoa."	
		Improved farm implements can be substituted by traditional technologies, however, costs for them are often higher.	
		Badebo 2013: "Among the diseases, tef rust head smudge damping-off and helminthosporium leaf spot are occasionally important (Sewalem S= WI., 2001; Ayele S= 2008). Tef is reported to be less affected by diseases under the current farmers' practices in Ethiopia; however, diseases like tef rust and head smudge are considered to be relatively important. The importance of tef rust might increase with change of agronomic practices such as row planting. Since there was no complete resistance against the two diseases,	

		emphasis on tef disease research should be given to integrated disease management (IDM)."	
		Zewdie and Damte 2013: "Effective weed management is one of many critical components of successful tef production. Weed control method in tef production remains to be one of the most expensive, time and energy consuming, and the least successful means of increasing yield. and weeding and cultural methods of weed control remain the most common methods in dealing with weeds (Kassahun and Rungsit, 2005).Tef is poor competitor with weeds; severe weed infestations particularly at its early growing stage reduce tef yields by at least 65% if left uncontrolled (Berhanu and Tessema, 1984; Kassahun and Likyelesh, 2001). Moreover, weeds reduce grain quality, harbor insect pests and make harvesting operation difficult. Nationwide estimates of the labor required for hand weeding of tef range from 40-138 man-days per hectare (Franzel S= WIv- 1989)."	
		Badebo 2013: "Despite the wide area coverage, the various cropping system and agro-ecologies where tef grows, it suffers less from epidemic damages from diseases and insect pests (Kebebew S= WI., 2011). "	
		Badebo et al. 2013: "The main causes for the low yield of tef are: i) biotic factors such as diseases, insects, weeds....Thus, the farmers prefer to use hand weeding (two times) and only use chemicals in rare circumstances under the close supervision of extension workers. Overall, while the use of the chemical was found to lower the need for Tef weeding, the chemical does not kill grass weeds, making hand weeding essential even for those farmers who do apply herbicide."	
		Fufa et al. 2011: "As a result, Tef weeding is a laborious task that is critical for productivity. Hand- weeding is the most widely used practice to control weeds in Tef production. In most Tef growing areas of the country, Tef weeding is done by humans. However, in some places, farmers use herbicides, particularly 2-4-D. The recommended rate of herbicide application is about 1 liter per hectare. However, in most places, farmers apply about 0.5 liter of herbicide per hectare except in the Adaa area where the farmers use the recommended rate. "	
		Fufa et al. 2011: "By its nature, Tef is a labor intensive crop and farmers currently use a high tillage frequency compared to other cereal crops grown in Ethiopia. The reason for the high tillage frequency is that the Tef seed is very small and thus germination is difficult in heavy, unbroken soil. In the areas visited, farmers use oxen with the traditional plough for tillage. Currently, there is an improved plough that has been developed by Melkassa Agricultural Research Center. This plow is said to reduce Tef tillage frequency by about half."	
		Kelemu and Kebede 2013: "Weeding in tef is laborious as it involves at least one hand-weeding even in addition to herbicide application. "	
Does the activity rely on other sources of income?		Visitef farm implement suppliers sold mostly pesticides and small amounts of seeds and farm implements. Further they do only rely to a limited amount on tef farmers as customers. Both suppliers had other sources of income (pension).	Diversity
Are there diverse ways of producing the product/conducting the activity?		Weeds: Hand weeding and herbicides. Farm implements: improved and unimproved farm implements	Diversity
Are products sold/distributed via multiple and diverse channels and markets?		Begna 2014: "It is recognized that 53.4% of pesticides suppliers are private in small shops, 25.3% farmer cooperative, 5.5% companies (AISCO, GUNA, and EAL)....Most of the pesticides are accessed through informal suppliers that would not give advices on the proper handling and safe uses. "	Diversity, redundancy
		Farm implements are mainly distributed via extension agents, research centers.	
Are multiple herbicides/pesticides used?		Very little variety in herbicides and pesticides available for tef. Therefore for tef, very high resistance pressure on weeds. Due to hand weeding however, there is some sort of integrated weed management.	Diversity
		Amera and Abate 2008: "(28.2%) indicated that they use bio-pesticides/natural enemies and IPM for crop production."	
		ATA, MoA, EIAR 2013: "Continued use of 2-4-D in Ethiopia has produced new generation of resistant broad leaf weeds."	
		ATA, MoA, EIAR 2013: "Furthermore, herbicides are effective against broad-leaved plants, but other grasses must be removed by hand. The herbicide that is currently the most available for weed control is 2,4-D, which was originally used to control only broad-leaved weeds. However, local weeds have developed resistance to 2,4-D meaning that the herbicide is no longer eliminating weeds effectively. As a result, farmers are now forced to do hand weeding in situations where the herbicide normally would have been applied. Another challenge with the use of 2, 4-D is that the chemical is a hormonal herbicide which needs to be applied at just the right time, before the tef crop enters into the joint stage (at the end of the tillering stage). If applied at incorrect times, it can produce flower ste-	

		rility in the tef crop, thus reducing grain yield. "	
Does the activity have multiple production sites/lines/machines which are spatially distributed? Are components substitutable?		Pesticides yes. Multiple production sites and distribution channels. Unimproved farm implements: produced throughout the whole country, different exchange mechanisms. Improved farm implements: only research centers developing and distributing them.	Diversity, redundancy
Are impacts caused by the activity borne by other actors who do not receive benefit/compensation?		Begna 2014: "As a result, pesticides have caused and been causing considerable effects in killing honeybees and their products decline. ...For this reasons, beekeepers identified indiscriminate applications of pesticides are as major constraints of beekeeping developments in their areas."	Equitability
Are there ethnical, gender, familiar dependencies/barriers which hamper connectivity?		See whole chain	Equitability
Are there equitable/fair rights, regulations, laws, institutional rules, policies, organizational activities and entitlements in the governance of the activity?		Yes, but not specific information.	Equitability
Can diverse actors participate in decision-making?		Rather yes. But little information available.	Equitability
Are small disturbances tolerated rather than avoided can they be managed?		Fufa et al. 2011: "However, due to the absence of maintenance service in the locality, the thresher has been inoperable for some time in the Dejen area."	Exposure to pressure
Has the activity been exposed to disturbances of different types in the past?		No direct disturbances reported.	Exposure to pressure
Are there long-term plans (e.g. 50 years) to manage supply, demand and capacity?		ATA 2014: "As technological advancements have soared in recent decades, farmers around the world have taken advantage of innovations to streamline their farming operations and maximize crop output. These productivity enhancing advancements, however, have thus far been slow to reach Ethiopia and its 15 million smallholder farmers. To change this, the Agricultural Transformation Agenda's Technology Access & Adoption effort aims to identify, evaluate, and promote new agronomic tools and technologies that can make the smallholder farmer's job easier, more effective, and more profitable."	Governance capacity
		ATA 2014: "Row planters As a starting point, the ATA and EIAR have been working together to identify, test, and refine domestically and internationally sourced mechanical row planters for tef planting in Ethiopia. The ultimate goal is to deliver low-cost planting devices for tef that can apply both seed and fertilizer across various soil types; ideally ones that are produced locally from sustainable materials. Threshers: Last year, the MoA Extension Directorate, the ATA, and the Regional BoAs identified, tested, and deployed nearly 70 multi-crop mechanical threshers using a variety of business models. This effort has been scaled up for 2014, deploying various models in target tef, wheat, and maize cluster woredas, while testing a range of different sustainable business models for delivering this post-harvest service. Harvesters: Mechanical harvesters also offer potential increased efficiencies and long-term cost savings for Ethiopia's farmers.	
		ATA, MoA, EIAR 2013: "Facilitate the development of improved farm implements by public and private enterprises Disseminate knowledge on integrated pest management and encourage pesticide production. ...Create awareness of and provide access to proven, efficient post- harvest technologies ...Develop, test, and introduce new post-harvest technology prototypes"	
Are the responsibilities for resources/conveyance/activity clearly defined?		Yes, but not specific information.	Governance ca-

			pacity
Does the actor have autonomy, control and ownership over the activity, and his own resources?		Yes	Governance capacity
Are there plans to address any risks from hazards and emergency situations with scripts for actors in case of such an event?		No information found.	Governance capacity
Is there collaboration between actors, universities, research institutions?		Little, but research very involved.	Information, learning
Are there early warning systems for disturbances?		No information found.	Information, learning
Is there an atmosphere of trust cultivated between actors?		Setatow: "Farmers prefer to buy pesticides in farm implement shops than purchase them through cooperatives. They have more trust in shops and believe they sell better products (cooperative only have standard/traditional pesticides).	Information, learning
		Visited farm implement suppliers sell products on credit to some farmers, however, only do this with few farmers, since others didn't pay back credits.	
Are lessons learnt from previous experiences, is activity modified in consequence?		No information found.	Information, learning
Is there investment in education and knowledge development of actors?		Amera and Abate 2008: "Less than half of the study subjects 143 (33.9%) indicated that they were trained on pesticide issues. Of those trained, 111 (26.3%) indicated that they were trained on how to use pesticides, 51 (12.1%) were trained on health and safety issues, 30 (7.1%) were trained on IPM, 30 (7.1%) were trained on disposal, 52 (12.3) were trained on application technology and 45 (10.7%) were trained on environmental effects of pesticides. "	Information and learning
		Sherif: " There is training for everyone on how to use pesticides, but farmers don't apply it. But knowledge/awareness problem on farmer level. Prevention is implemented top down, with trainings and also instructions written on Amharic on pesticide containers. Among extension agents and government, negative impacts of fertilizer and pesticides are an issue."	
		ATA, MoA, EIAR 2013: "In addition, 2-4-D has been banned in many countries and its continued use in Ethiopia has produced a new generation of 2-4-D-tolerant broad-leaf weeds. Thus, new types of herbicides are urgently required, together with new types of knowledge dissemination on the appropriate application rates. "	
		Fufa et al. 2011: "Furthermore, in order to conduct comprehensive research on the crop, the facilities available at the research station need to be upgraded. These resource shortages are compounded by the fact that Tef is not an internationally recognized food crop and, as a result, international funds for research are limited. In addition, the crop has received little attention in terms of domestic public research funding and is second to last for funding among cereals."	
		Farm implement suppliers get training 1-2 times a year, mostly on how to apply pesticides. Farm implement suppliers disseminate information to farmers/customers.	
Is the knowledge base of actors sufficient? Do they have a high level of education?		Amera and Abate 2008: "The training given to farmers on pesticide issues was also very minimal which lead to low level of awareness. About 50% of the respondents used empty pesticide containers for water/food storage and about 7% of them indicated that they sell empty containers for others to use. About 31% of the respondents stored pesticides any where in the house and about 6% of them stored pesticides even in the kitchen. The low level of awareness in the study area and the public health and environmental consequence resulting from the misuse of pesticides is alarming. ...The impacts of pesticides in Ethiopia are likely to be aggravated by the limited knowledge among users on toxicological and chemical properties of these substances."	Information and learning
		Sherif: " There is training for everyone on how to use pesticides, but farmers don't apply it. But knowledge/awareness problem on farmer level. Prevention is implemented top down, with trainings and also instructions written on Amharic on pesticide containers. Among extension agents and government, negative impacts of fertilizer and pesticides are an issue."	
		Begna 2014: "It is known that about 69% of the respondents have got an extension services and are already aware of when and how to properly use pesticides without producing effects on the environment and honeybees. As well, visit to retailers shops demonstrated presences basic information on users' manual (information) on the labels of some pesticides."	

		Amera and Abate 2008: "The perception of 148 (35.1%) of the farmers was considering pesticides as always good whereas 146 (34.6%) of the farmers perceived pesticides as sometimes harmful and 102 (24.2%) of the farmers perceived pesticide as sometimes good."	
		Amera and Abate 2008: "The use of proper protective equipment by the farmers who spray pesticides in the study area was also almost nil where 40% of those who spray pesticides indicated that they felt different illnesses after they sprayed pesticides. This might be related to the low level of awareness which might also be linked to the low level of trainings on how to use (26.3%), on health and safety (12.1%) and on environmental effects (10.7%) given to farmers. This low level of awareness could also be the reason for applying the dust formulations (17.1%) and granules (12.3%) using their bare hands and for the application of liquid formulations of pesticides pouring in bottles (10.9%) by their hands. The mixing habit on the other hand might also be accounted for some of the causes of pesticide incidents, including those resulting in death."	
		ATA, MoA, EIAR 2013: "However, excluding very few implements, such as the BBM, minimal efforts have been successful at the large-scale mass production and introduction of farm implements, beyond small groups of farmers or kebeles. This is driven in large part by a lack of awareness of the value of using such implements, the initial start-up costs required to develop and produce machinery, and difficulty in reaching farmers across a widespread geographic area, among other reasons.	
		ATA, MoA, EIAR 2013: "The use of 2-4-D herbicide at a recommended rate of 1 liter per hectare can help control broad-leaf weeds, yet this is not always effectively practiced. Focus group discussions with farmers reveal that farmers in the Ada'a area use the recommended rate of herbicide while farmers in Becho and Shashemene reported application of about 0.5 liters of 2-4-D per hectare, which is only half of the recommended rate."	
		Fufa et al. 2011: "While there is a mold board plough available that could help reduce tillage frequency in Tef production, very few farmers were found to be aware of its existence. In the areas visited, farmers use oxen with the traditional plough for tillage. Currently, there is an improved plough that has been developed by Melkassa Agricultural Research Center. This plow is said to reduce Tef tillage frequency by about half. However, except for a few farmers in the Adaa area, farmers are not aware of the existence of such a technology."	
		Fufa et al. 2011: "Apart from farmers in the Shashemene area and a few farmers in Dejen, the use of mechanical threshers for Tef is unknown. While there are private suppliers of the thresher in the Shashamene area, a single machine was introduced by SG200 to the Dejen area, Yetnora kebele for demonstration.	
Does the activity rely on distortionary subsidies?		Farm implements nearly only financed through public funding.	Profitability
Does input supply generate net positive profit and is it still profitable in case of changes in demand/price?		ATA, MoA, EIAR 2013: " This limited supply has not grown since, given the perceived low rate of return on investments in pesticides, especially when coupled with an investment in spraying equipment. The low active demand for pesticides ultimately discourages pesticide dealers and equipment suppliers."	Profitability
		Visited farm implement suppliers reported low margins/profits from pesticide sales due to big competition.	
Are wages/incomes fair?Are wages/incomes "living wages"?		Visited implement suppliers complained about low profitability of their businesses. Both rely on other sources of income to "feed" the family.	Capital (financial)
Does the activity have/give possibility to generate funds for investment, maintenance, expansion,		ATA, MoA, EIAR 2013: "This limited supply has not grown since, given the perceived low rate of return on investments in pesticides, especially when coupled with an investment in spraying equipment. The low active demand for pesticides ultimately discourages pesticide dealers and equipment suppliers."	Capital (financial)
		Visited implement suppliers complained about low profitability of their businesses. Both rely on other sources of income to "feed" the family.	
Is the activity exposed to substantial financial risks (e.g. outstanding debt)?		Fufa et al. 2011: "Two factories (in Addis Ababa and Hawassa) are making the threshers at a rate of 3 per week, but this could likely be scaled up with limited investment. The main challenge is determining how to make the 30- 40,000 Birr capital cost of the thresher affordable for rural entrepreneurs and/or cooperatives. Any interventions that address expanding access to mechanical threshers will need to consider innovating funding mechanisms."	Capital (financial)
Is the activity insured against damages/losses through disasters/shocks (income/production/infrastructure/personnel)?		Visited farm implement suppliers had no insurance at all.	Capital (financial)

Is self-organization, networking, initiative, association among actors enabled?		Abate: "- Small fields (for combiner, mechanic plowing) - Organisation problem of farmers (e.g. common tractor, clustering fields)"	Self-organization
Is there opportunity for experimentation and innovation?		Abate: "- Innovation problem (also investment/starting capital problem)→ for threshers, vacuum cleaners (no importers/investors) - All innovation on technology is done by research centers - Nearly no national mechanic manufacturing industry - Tef needs spatial technology (doesn't exist yet→ investment needed)"	Transformability

Farmers

Questions	Rating	Answers	Attribute
Does the activity have spare capacity (infrastructure, technical, know-how, financial,) in case of increased demand?		Farmers interviews: Capacity constraints for land, inputs and capital (very little savings, only limited access to credits). Storage capacities, labor force and draft forces are no problem.	Buffering capacity
		Kebebew: Highlands are more or less saturated at the moment concerning population density, farm sizes. Soil depletion a big problem in these areas. Possible to produce high yields, but integrated approach needed (crop rotation, reen manuring, double cropping)	
		Kebebew "Expansion to non traditional tef areas. There are large areas of land that are not used at the moment. Now tef is produced on approx. 3 mio ha, potential to be produced on up to 4-5 mio ha (in a sustainable way). Problems of these areas: irrigation needed, high rainfall areas, potential pest outbreaks	
		ATA, MoA, EIAR 2013: "Despite the relatively high cost structure, however, production has been increasing at approximately 11% per year (due to land expansion and increase in yield), with high latent demand resulting in price increases as well. Increased productivity is believed to contribute about 6% of that 11% growth while about 5% was attributed to expansion in area cultivated for tef."	
		ATA, MoA, EIAR 2013: "Yield-enhancing farming practices are not well utilized or applied	
		ATA, MoA, EIAR 2013: "Cropping systems (rotation, double, relay cropping, and agroforestry) are not efficiently practiced	
		ATA, MoA, EIAR 2013: "Improper straw handling and utilization	
		ATA, MoA, EIAR 2013: "Labor-intensive practices increase operating costs, especially gathering, piling, threshing and cleaning	
		ATA, MoA, EIAR 2013: "Traditional post-harvest activities incur large quality and quantity losses	
		Demeke and Di Marcantonio 2013: "Area under teff cultivation expanded from 2.14 million ha in 2004/05 to 2.76 million in 2010/11. ...According to the data of the Central Statistical Agency (CSA), teff production expanded by 72 percent between 2004/05 and 2010/11. This growth was achieved mainly due to 29 percent expansion in area under cultivation and 33 percent increase in yield levels."	
		Demeke and Di Marcantonio 2013: "With improved policy environment and enhanced investment to increase teff productivity, the country has the capacity to meet high domestic and export demand. Teff can be grown profitably in a large part of the country, from lowland to highland areas."	
		Worku et al. 2014: "Tef production has increased by 163% over the last decade, a combination of both area and yield increases of 50% and 73% respectively. Yield growth has thus been the main contributor to production growth. The number of tef famer has increased significantly over the last decade, an increase of 44%. "	
		Abate and Setatow 2010: " 40% of the sample households attached no importance to the market oriented production policy due to various production constraints, such as, scarcity of land (88%), large family size (71%) and lack of improved technologies (34%).	
		Setatow 2013: "In general, the current evidences showed that there is big gap between the potential tef yield and the actual farmers' yield. Narrowing the gap offers a very lucrative opportunity to increase tef production even by using available technologies."	
		Setatow 2013: "In general, the current evidences showed that there is big gap between the potential tef yield and the actual farmers' yield. Narrowing the gap offers a very lucrative opportunity to increase tef production even by using available technologies. ….. adopting strategies that could narrow the yield gap such as improved management practices and technical support services. ....Though adoption is limited only to a few varieties, a number of improved tef production technologies have been developed and disseminated to smallholders. Most of these technologies were also proved to be economically viable. While reasonable yields have been achieved under farmers' management conditions, current evidences from the national scaling up program unveiled that large gap exists in productivity. In this regard, tef production could be further increased by applying the recommended technologies involving integrated use of improved variety seeds, fertilizer, appropriate crop husbandry and effective pest control practices.	

		Fufa et al 2013: Tef is the dominant cereal crop in over 30 of the 83 high-potential agricultural Woredas, covering the highest area planted in the country. Yet, compared to the other major cereals, the tef yield is relatively low (around 1.2 t ha-1) since25-30% of each of pre- and post-harvest losses reduce the quantity available to consumers by up to 50%.	
Do supporting activities have spare capacity in case of increased demand?		Abate and Setatow 2010: "However, due to resource limitations and scanty support services, farmers have not yet actualized the policy the government had designed."	Buffering capacity
Do input resources have spare capacity in case of increased demand, and are they equitably accessible ?		Admasu 2009: They indicated absence of credit for purchasing fertilizer this year has worsened their condition despite high price of cereals crops in the market.	Buffering capacity
		From all the farmers visited, only 2 used credit system to access credits (RUSACOS) for fertilizer purchase. The rest didn't access credits or had no knowledge about the system.	
		ATA, MoA, EIAR 2013: "Production of seed is inconsistent, containing high variability in quality and quantity produced. Current complexities in seed distribution process cause delays and supply shortages. Though numerous improved tef varieties have been released, farmers have complained about the availability of the right quantity and seed, at the right time and place, from both the formal and informal seed sectors.	
		ATA, MoA, EIAR 2013: "Farmers have insufficient knowledge of and a lack of financial ability to purchase and use inputs, such as fertilizer and seed	
		ATA, MoA, EIAR 2013: "Major problems limiting the use of fertilizer include ever-increasing prices, lack of availability of the right quantity, lack of timely supply, and credit constraints	
		ATA, MoA, EIAR 2013: "Fertilizer prices remain high for farmers, partly due to importation and domestic distribution processes	
		ATA, MoA, EIAR 2013: "Pesticides are currently costly and are not widely accessible for farmers	
		ATA, MoA, EIAR 2013: "Institutional constraints limit the effectiveness of inputs suppliers and distributors	
		ATA, MoA, EIAR 2013: "Existing farm implements (e.g., row planters, broad-bed makers, and ploughs) are inadequate and not readily available to farmers	
		Melekot: "Input credit system in not effective. Huge gap between demand and supply of credits. Farmers use less fertilizer than recommended due to insufficient credit access and little savings. Father there are restrictions in the credit system in many regions, wherefore farmers have to pay at least 75% on cash."	
		Zelleke et al. 2012: "Fertilizer uptake and application is linked to credit access, which is currently severely limited; accordingly, fertilizer credit availability is a limiting constraint to further fertilizer use. For smallholders, on average the economics of fertilizer use are attractive, but the risk of negative cash flow is high; large farmers with significant commercialization can afford to bear this risk, but smallholders cannot.	
		Workshop: Input suppliers, farmers and both expert groups mentioned price increase/inflation of inputs to be a major problem for the tef value chain (especially for fertilizer and seeds). Unavailability of inputs was also mentioned by experts and farmers.	
		Farmer interviews: 4 out of 7 farmers reported shortage of improved seeds, high costs of fertilizer and seeds as well as shortage in capital (to buy inputs) to be major constraints. 1 farmer reported shortage of fertilizer to be a problem. Farmers reported fertilizer to be very expensive/little affordable and not always available in sufficient quantities. Pesticides and seeds were mentioned to be expensive (but less than fertilizer) and also not always available. All farmers have used improved seeds before and do so if improved seeds are available and they can pay them. But at the moment of visit, only 3 out of 7 used improved varieties.	
Does the activity maintain stocks of inputs and/or of products?		Setatow: farmers store small amounts of tef in bags, mostly on seasonal base	Buffering capacity
		Minten: "Storage in the value chain is mostly happening on farms. Farmers often sell other cereals first and keep tef since it's easy to store and prices rise during the season."	
		Demeke and Di Marcantonio 2013: "Teff can also be stored for many years without being seriously damaged by common storage insect pests."	
		Minten et al. 2012: "releases by the producer of teff stocks in storage over the year is rather smooth, and distress sales are of minor importance"	
		Abate and Setatow 2010: "When asked whether they store grain until the next harvest as they used to do before or not, 77% of the sampled farmers responded negatively manly due to urgent needs to repay fertilizer credits (94%), low production of farm products (57%), price attraction at harvest (33%) and fear of storage pests (18%). "	
		Minten et al. 2012: "Stock buildup is happening during the months of November until March. Stock withdrawal is mainly done between March and October.Stock release is highest during the period of July–August (Hamle), also the month when the sowing of teff takes place."	
		Farm interviews: Fertilizer and Pesticides are on average stored for up to 1 month. Seeds/tef are kept up to 8 month (1 season).	
		Fufa et al. 2011: "However, we learned from the field visits that the costs associated with Tef stocking is minimal compared to any other crops due to low vulnerability of the crop to pests, especially	

		weevils."	
Is there sufficient labor force available for the activity and can the labor force available for the activity be adapted to fluctuations?		Kebebew, Setatwo, Sherif: "At the moment, no problem of labor force supply. But with more literate children, less people want to work in agriculture. Also competitive sectors increase cost of labor, mainly in urban and periurban areas, where most of the tef is produced"	Capital (economic)
		ATA, MoA, EIAR 2013: "At farm-level, the most important challenge facing tef production is its labor requirement and the associated costs.	
		Abate: "Labor cost is increasing during harvesting time (if rain forecasted, price increases) (from 70B to 150 B) - problem of young people not wanting to work on farm anymore → solution: Mechanization, semimecanization	
		Expert group at workshop: Labor cost increase and low productivity of labor leading to higher production costs is one of the major problems.	
		Farmers reported labor costs generally to be high and to be increasing. But labor always available.	
Are there sufficient resources to meet increases in demand in next 50 years		Kebebew: Highlands are more or less saturated at the moment concerning population density, farm sizes. Soil depletion a big problem in these areas. Possible to produce high yields, but integrated approach needed (crop rotation, reen manuring, double cropping)	Capital (physical)
		Kebebew "Expansion to non traditional tef areas. There are large areas of land wiha are not used at the moment. Now tef is produced on approx. 3 mio ha, potential to be produced on up to 4-5 mio ha (in a sustainable way). Problems of these areas: irrigation needed, high rainfall areas, potential pest outbreaks	
Are resource (soil, water, land, fuel, forests, minerals…) use rates due to the activity below regeneration rates rather than depleting them?		Admasu 2009: "Repeated inorganic fertilizer application (without additional organic amendment) enhances activities of soil microorganisms for short duration, increasing mineralization of existing soil organic matter and depletion of carbon out of soil. Loss of soil organic carbon (humus) reduce the capacity of soil to maintain its natural nutrient reserves (fertility), deteriorate soil structure, weaken its resistance to erosion (increase erosion), reduce vegetation/biomass cover and consequently worsening land degradation situation. This is very real in Ethiopia's small holder farming condition, where total removal of crop residue out of the field is a norm for fuel and/or animal feed, and application of yard manure is almost absent as it is also a source of fuel in rural households across the country. As a result, the soil is deprived of its much needed ingredient to maintain its natural buffering capacity (safeguarding its nutrient reserves) and the vicious circle continues."	Capital (environmental)
		Mengistu and Mekonnen 2012: Consequently, crop yields are low, in fact decreasing in many areas, and the sustainability of the current farming system is at risk (Stangel, 1995). This declining soil fertility (Fekadu & Skjelvag, 2002) coupled with terminal drought (Edmeades et al., 1989; Hailu et al., 2000; Dejene, 2009) is posing serious threat to crop production and consequently food security in Ethiopia as elsewhere in Sub – Saharan Africa.	
		ATA, MoA, EIAR 2013: With the exception of virgin land (not yet open to the plow), arable soils in Ethiopia require the use of plant nutrients (chemical fertilizers or organic sources) since they are depleted from essential nutrients.	
		Admassu et al. 2013: "Due to the declining area under forest, wildlife has been under pressure since the early 1970s…. Threats to biodiversity include undervaluation of environmental resources, deforestation due to agri- cultural expansion and settlement, lack of adequate knowledge of biological resources, and overexploitation. "	
Are there critical emissions/impacts which the activity has on the environment/ecosystems/resources?		Kebebew: Soil degradation: - in case of teff, nearly all biomass removed from tef (you cut it very low because straw is so valuable) - high plowing intensity (3-4 times in average) - mostly in highlands→ and tef mostly planted in highlands	Capital (environmental)
		Tefera et al. 2002: "Production of teff, the main cereal crop in the region, requires fine land preparation to allow the small teff seeds to germinate. However, fine tillaging also makes the soil vulnerable to erosion during the early part of the main rainy season. For example, in Metu woreda, two test plots with teff and maize at the same slope (18%) exhibited runoff rates of 437 mm and 112 mm, respectively. The situation is worse when it comes to sowing fine seeds like teff (Eragrostis tef) which demand fine seedbeds and cattle trampling to compact the soils for better germination and weed control. A teff-seedbed preparation at Jima (where the rainfall is over 1500 mm per year) resulted in a soil loss of about 37 t/ha per year on a 9% slope (unpublished data), while the same type of soil at Colette (rainfall above 1000 mm per year) had a soil loss of 16 t/ha year on a 6 % slope (As rat 1992). The former is 4.5 times higher while the latter is 2 times higher than a tolerable level of soil erosion of a given field.	
		Abate: Soil degradation: " main cause is small plot size and therefore overgrazing, overuse, no crop rotation."	
		Assefa et al. 2009:"The soil loss in tef fields was three times greater than that of finger millet and wheat, and twice that of maize-------The main reason for the high soil loss recorded in tef fields is that the period of land preparation occurs during the middle of the rainy season with high intensity rains, while preparation for the other crops tillage occurred earlier when rains were less intense. Another contributing factor may be compaction (or trampling) by animal feet just before sowing tef."	

Are there measures, management, stewardship, planning, protection schemes which are enforced to protect resources and habitats?		Kebebew: Forest: There are some laws to protect forests, but not really enforced. Now some big reforesting programs going on.	Capital (environmental)
		Kebebew: Soil conservation: "There are some big scale soil conservation programs, community projects. Knowledge on soil conservation ususally quite high but problem of means to prevent erosion. Integration problem.	
		Kebebew: "Pesticide use: There are some strong reglementation on how to use pesticides, but not enforced much".	
		Kebebew: Water protection: Not much reglementation nor enforcement to protect water sources from contamination through pesticides or fertilizer use".	
		Zerihun et al. 2014: "Ethiopia's ecological system is very fragile and vulnerable to climate change, in part due to stress on natural resources. The key challenges include soil degradation, deforestation and loss of biodiversity, besides weak environmental management and enforcement capacity. ...Interventions made during the last decade have brought results and the forest cover has started to grow. The total forest cover tripled from 3% in 2000 to 9% in 2013, as a result of large- scale reforestation campaigns."	
		Admassu et al. 2013: "An estimated 16.4 percent of the total land area of Ethiopia is under some form of protection. Federal and regional governmental offices as well as environ- mental nongovernmental organizations are helping local communities reverse the current degradation trends in protected areas. "	
Are multiple varieties of the same crop used? Are the varieties used adapted to local environmental conditions/resistant to diseases?		Mengitsu and Mekonnen 2012: There are several varieties of tef cultivated in wider agroecologies of Ethiopia which could not have similar performance elsewhere. These varieties are classified as early, intermediate and late based on their maturity period. Some are engineered for highland areas, others to mid – altitude and still others to lowland areas.	Capital (environmental)
		Tef can be grown under drought-prone and waterlogged areas in different soil types	
		Kebebew: "o in time, nr. of varieties will be reduced strongly (from several 1000 down to 50 -100 varieties)→ but there are mechanisms to conserve varieties	
Is the nutrient balance on the farm balanced (no nutrient import)?		Kebebew: - slight depletion (use crop rotation and fertilizer to work against it) - tef monocropping mostly in areas where soil is not suited for other crops - depletion should be reflected in fertilizer need increase→ but in reality maintain stable fertilizer supply - but in some areas use up to 400kg/ha	Capital (environmental)
Are products/inputs bought, sold/distributed via multiple diverse channels and markets? Do actors interact with multiple suppliers/customers?		ATA, MoA, EIAR 2013: "...The share of total cereal sales through the wholesale market made by cooperatives is still rather limited as none of the stated percentages is higher than 10 percent. Second, the share of cooperatives has been growing until the years 2007–2009, but is on the decline since. For example, the share of cooperatives has declined from 9 percent in 2005 to 2 percent in 2011 in the case of teff	Connectivity
		ATA, MoA, EIAR 2013: Large demand sinks, that could connect farmers more closely to end buyers, are not well-developed	
		ATA, MoA, EIAR 2013:Intervention 1: Link smallholder tef producers (through cooperatives) to direct market outlets	
		Abate and Setatow 2010: " The most important marketing problems cited in the study districts were traders conspiracy (74%), instant and excess supply of farm products (61.6%), price fluctuation (56%), interferences of brokers (50%) and lack of market information (48%). This is a clear indication that marketing services were virtually nonexistent in the study districts."	
		Minten et al. 2012: "Farmers were asked for each marketing transaction to give details on the specifics of that transaction.4 The majority of the sales are to traders at local wholesale markets or to traders with a fixed shop, often in regional markets. Farmers traveled on average 1.5 hours to get to the place of sales"	
		Visited farmers reported to sell up to 20 buyers in average. Mostly traders, consumers and seed enterprises.	
		For input supply, visited farmers rely on 1 supplier for fertilizer (cooperatives). Seeds and pesticides can be purchased from about 5 different suppliers, such as farmer unions, seed enterprises, development agents, neighbors and pesticide /farm implement dealers.	
		Minten et al. 2012: "Fifth, the government has strongly supported the establishment of cooperatives in the last decade. At the end of the last decade, they were almost the sole providers of improved inputs in the country. However, while they have been successful in organizing farmers towards the commercialization of export crops such as coffee, they have been less successful in output markets of cereal crops (as is also often the case in other countries). Moreover, they seem to be over their peak and the shares of cooperatives in cereal wholesale markets have seemingly declined in the last couple of years. "	
		Fufa et al. 2011: "Farmers' immediate sale of Tef grain is one of the causes for reduced potential income from Tef production at farm-level. "	

		Fufa et al. 2011: "Farmers reported weak bargaining power in Tef marketing. Practices that could increase farmers' market power, such as collective marketing through cooperatives, forward sales or contract farming, are almost entirely unknown for Tef, although they are practiced for other commodities such as coffee."	
		Gebreselassie and Sharp 2008: "The most commercialized households also spent more on education and healthcare. On average, the least commercialized farmers spent only 32 Birr per person per year on education, while their more commercialized neighbors spent more than twice this (about 84 Birr/ person/year)."	
Do logistics and communication support services enable appropriate connectivity?		Price information: Minten: "Up to date, there is no well functioning official system on price information that actors can access. Usually farmers and traders have to inform themselves about prices through fellow-traders/farmers. But nowadays better access to cellphones and better roads, so better information flow."	Connectivity
		Minten et al. 2012: "We see the highest commercial surpluses achieved by farmers that face the lowest transportation costs. Commercial surplus decreases to almost zero for those farmers that are most remote; these farmers drop to subsistence levels."	
		Demeke and Di Marcantonio 2013: "On the other hand, transport costs from farm gate to wholesale market in Addis Ababa were found to be high and this is attributed to the use of smaller trucks rather than bigger trucks and bulk transport systems. In addition to building roads, the government should facilitate the transition from small scale to large scale grain transport, storage and trading practices."	
		Abate and Setatow 2010: " About 57% of the sampled farmers confirmed that roads and transport services have made it difficult for them to sell their products in nearby towns."	
		Minten et al. 2012: "Third, we find that producer prices over space decline in line with transportation costs"	
		Visited farmers need 20 minutes until 2 hours of travelling time to sell their tef. During rainy season roads to their villages are sometimes blocked and villages only accessible by donkeys.	
Would a failure in this activity cascade to the whole system?		Yes. But very unlikely that the whole tef production would brake down.	Connectivity
Are crop, livestock and forest production systems connected, and used symbiotically?		Livestock: Ayele: Tef very dependent on livestock, livestock very dependent on straw	Connectivity
		Kebebew: Tef is highly dependent on draft force of oxen, since it is a culture demanding crop with at least 3-4 times of tilling.	
		Forest: Kebebew: Forests used for firewood, fodder use, grazing of animals in the forests, wood source for farm implements like plow. Farmers therefore can not survive without forests. But since forests in such bad shape, farmers plant some trees around their farms to produce farm implements. Tef puts somewhat more pressure on forests than other crops, since crop residues are used for fodder and not as fuel source. But at the same time, there is less pressure on forests due to grazing since tef straw can be used as fodder.	
Are there ethnical, gender, familiar dependencies/barriers which hamper connectivity?		Sherif: "No ethnical barriers/tensions in tef growing areas (only in pastoral areas)."	Connectivity
		Sherif: "Women are neglected in traditional rural households. For instance, women don't plow, decisions are mostly taken by men. These cultural barriers are slowly changing (on farms with young farmer sin power, women plow sometimes, women are part of decision-taking process). In extension, women and male have right to same access to extension, but in reality extension nearly only given to male farmers."	
		Minten et al. 2013: "family, kin and ethnic relationship are often presumed to be important in agricultural trade, ... This suggests indeed tight and often family networks between farmers and urban brokers."	
Is income generated by diverse activities/products?		Ayele, Sherif: "Typical tef farmer plants tef as major crop and 3-4 other crops (pulses, cereals, horticulture), always livestock included. Usually tef farms are highly diversified/mixed farming.	Diversity
		Abate and Setatow 2010: "About 4% and 13% of sample households reported off farm and non farm activities, respectively. In most cases, smaller farms with less than 1 ha of land holding per household subsidize farm activities with off-farm income. "	
		Fufa et al 2013: "Farmers grow tef not only for its grain but also because of the straw which is a good source of animal feed. "	
		Visited farmers also reported diversity to be quite high. 5 out of 7 farmers reported to work off-farm in winter and during bad years (e.g. charcoal production, construction, casual work).	
Are there diverse ways of producing the product/conducting the activity?		Abate: Mechanization for tef production is still insufficient/not solved: no mechanical harvesting due to lodging and seed size, reliance on hand weeding due to grass weeds, row seeding challenged due to muddy soil.	Diversity
		Zewdie and Damte 2013: "Effective weed management is one of many critical components of successful tef production. Weed control method in tef production remains to be one of the most expensive, time and energy consuming, and the least successful means of increasing yield. and weeding and cultural methods of weed control remain the most common methods in dealing with weeds	

		(Kassahun and Rungsit, 2005).Tef is poor competitor with weeds; severe weed infestations particularly at its early growing stage reduce tef yields by at least 65% if left uncontrolled (Berhanu and Tessema, 1984; Kassahun and Likyelesh, 2001). Moreover, weeds reduce grain quality, harbor insect pests and make harvesting operation difficult. Nationwide estimates of the labor required for hand weeding of tef range from 40-138 man-days per hectare (Franzel S= WIv- 1989)."	
		Fufa et al. 2011: "While conservation tillage has been shown to be effective for Tef in other countries (e.g., the USA), it has not been practiced widely in Ethiopia to date. However, over the last 10 years, after introduction by an NGO (Sasakawa Global 2000), some farmers in the Ada Lume and Bachoo woredas have been using no till method on Tef with high yields. This implies that much of the Tef land tilling operation may actually be done due to tradition, rather than for technical reasons."	
Are crop rotations used?		Demissie: "In tef growing area, less crop rotation used than in other areas. In tef belt, rarely rotated, in the northern highlands, rotation is nearly nil"	Diversity
		ATA, MoA, EIAR 2013: Cropping systems (rotation, double, relay cropping, and agroforestry) are not efficiently practiced. In monocultures, increases in crop-specific weed infestations, pests, and diseases are often observed over time. Continuously growing the same crop will tend to exploit the same soil root zone, which can lead to a decrease in available nutrients for plant growth and to a decrease in root development.	
		Kebebew, Setatow: Most farmers use crop rotation. Tef yields decrease significantly and weed problems emerge if not rotated. Problems: plot size, price for alternative crops has to be high as well	
		All visited farmers reported to use crop rotation, however, no information on quality/efficiency of crop rotation.	
		Zelleke et al. 2012: "Crop rotation, fallowing, and green manuring are largely diffi- cult to implement in densely-populated areas with small farm sizes, and even more so where food supply is insecure"	
		Katema 1997: "It is mainly cultivated as a monocrop, but occasionally under a multiple cropping system. In such cases it is usually grown as an intercrop with rapeseed (Brassica napus), safflower (Carthamus tinctorius) and sunflower (Helianthus annuus) or relay-cropped with maize (Zea mays) and sorghum (Sorghum bicolor). It is also cropped sequentially in a crop-rotation system in the mid- and high-altitude areas after chickpea (Cicer arietinum), field pea (Pisum sativum), faba bean (Vicia faba) and grass pea (Lathyrus sativus); while at low-and some mid-altitude areas it is 'grown after haricot bean (Phaseolus vulgaris). Usually a 4-5 year rotation cycle is practised."	
Is the farm and landscape diverse (patchy, mosaic pattern, heterogeneous conditions of soil, ecosystems, topography, microclimate, biodiversity)?		Mengistu and Mekonnen 2012: "Records from meteorological stations show much spatial and temporal variability of rainfall in Ethiopia and as a result the country is characterized by many agro ecologies."	Diversity
		Kebebew: Diversity on landscape level - same for tef than other crop areas - varies from place to place (but always about 5 crops grown) - generally compared to Europe or similar, diversity is higher	
		Gebre-Selassie and Bekele 2012: "Ethiopia has one of the most biodiverse ecosystems in the world."	
		Zelleke et al. 2012: "Ethiopia is classified into as many as 34 agro-ecological zones,18 with highly varied soil types and fertility status, climate, rainfall, altitude, topography, crop growing period, and the like. "	
Does the activity have multiple production sites/machines which are spatially distributed		ATA, MoA, EIAR 2013: Tef is grown in almost all regions of the country under diverse agro-climatic conditions: from sea level up to 3,000 m.a.s.l.This versatility gives tef (and wheat) an advantage as it has a wider altitudinal range than any other cereal in Ethiopia, though it is mostly cultivated in the mid-altitude areas.	Diversity, redundancy
		Fufa et al 2013: "Tef is the dominant cereal crop in over 30 of the 83 high-potential agricultural Woredas, covering the highest area planted in the country. "	
Are there any single inputs/processes/stakeholders that this activity depends upon, with no alternative?		Kebebew: Tef is highly dependent on draft force of oxen, since it is a culture demanding crop with at least 3-4 times of tilling.	Diversity, redundancy
		Labor: As mentioned in the workshop, there is a very high dependency on labor forces, since mechanization is low and tef very labor intense.	
		As reported in the farm interviews, farmers depend heavily on inorganic fertilizer (since organic fertilizer is no real alternative), and to some extent on pesticides (only in case of pest outbreaks) without alternatives. Improved seeds can be substituted by own/neighbors seeds and herbicides can be avoided by hand weeding.	
		Gebre-Selassie and Bekele 2012:" Lack of farm oxen is another constraint faced by the farmers. This used to force farmers to engage in distress sales.----Another possible arrangement, traditionally called mekenajo, involves the exchange of farm oxen between farmers who collectively own only one animal."	
		Fufa et al. 2013: "In both Ada and Dejen areas, DAP and Urea fertilizers contributed for the highest share of cost of production for tef. These two fertilizers together attributed for 36% and 38% of the total costs of tef production in Ada and Dejen, respectively. Next to fertilizers, costs for hand weed-	

		ing and harvesting contribute to significant amounts of the overall expenses at both locations."	
Is the land tenure of the activity equipped with fair rights? Is there equitable access to land for the activity?		Abate: Possible for people from diaspora to get new land. Land can be leased (you pay based on fertility, long term contract (5-20 years)). Small farmers can only grow if they organize themselves (same variety, cluster land) - no land entitlement - no private land at al, all government owned	Equitability
		Abate: consolidation problem: o not happening o average distribution 45min walking, closest 15 o problem of different soil fertility of plots, rainfall distributing, pest incidence, weed pressure, sawing date o the only way consolidation could happen is through land entitlement (economic pressure makes them work together) o should be enforced by government o e.g. to improve crop rotation	
		Minten: "- redistributions don't take place much anymore - give farmers land certificates (mostly given in the 90s)→ have user rights - no disincentive for innovation→ once households have certificates, there is more investment in farms - people which don't have land don't get it today→ can only rent"	
		Abate and Setatow 2010: "To alleviate land shortage, about 52.7% of sampled farmers rented-in land for crop production during the survey period. This shows that an informal land market appears to exist. Without considering rent-in land, about 5% and 20% of the sampled farmers reported that their farm sizes had increased and decreased, respectively, while about 75% of the respondents indicated no change during 2002-2007."	
		Abate et al. 2005: "According to the analysis, land size remains a key variable in explaining differentiation in output, especially in keeping farmers near to or on the production frontier. Reduction in farm size and land fragmentation contributed to technical inefficiencies. ...Frequent redistribution and allocation of land has resulted in fragmentation, an in too small farms to support the livelihood. This in turn decreases farm productivity and efficiency. "	
		Gebre-Selassie and Bekele 2012: " Only use and not ownership rights are guaranteed. As land is the common property of the "Nations, Nationalities and Peoples of Ethiopia", it cannot be sold, exchanged and mortgaged. On the one hand, it gives the Government the right to expropriate the land for public purposes and to give to private investors. The policy promotes insecurity of tenure because it allows, among other things, periodic redistribution (or at least the threat of such redistribution) it promotes fragmentation of land and growing pressure on land resources because it discourages rural people from leaving their farms for other employment opportunities; "	
		Hagos and Holden 2013:" Land certification appears to have contributed to enhanced calorie availability (calorie intake), and more so for female-headed households, either through enhanced land rental market participation or increased investment and productivity on owner-operated land. Results also show that members of households that accessed additional land through the land rental market had a significantly higher body mass index.-----hus, the recent restrictive regional land law that allows for only short-term rental contracts and does not allow more than 50 percent of land to be rented out may threaten future tenure security and may undermine the benefits from existing tenure reform."	
Is there equitable/fair access to inputs (generational, gender, racial, religious etc.)?		Minten et al. 2013: "family, kin and ethnic relationship are often presumed to be important in agricultural trade, ... This suggests indeed tight and often family networks between farmers and urban brokers."	Equitability
		Sherif: "No ethnical barriers/tensions in tef growing areas (only in pastoral areas)."	
		Sherif: "Women are neglected in traditional rural households. For instance, women don't plow, decisions are mostly taken by men. These cultural barriers are slowly changing (on farms with young farmer sin power, women plow sometimes, women are part of decision-taking process). In extension, women and male have right to same access to extension, but in reality extension nearly only given to male farmers."	
Can diverse actors participate in decision-making?		Sherif: "Women are neglected in traditional rural households. For instance, women don't plow, decisions are mostly taken by men. These cultural barriers are slowly changing (on farms with young farmer sin power, women plow sometimes, women are part of decision-taking process). In extension, women and male have right to same access to extension, but in reality extension nearly only given to male farmers."	Equitability
Are impacts caused by the activity borne by other actors who do not receive benefit/compensation?		None known beside the environmental impacts.	Equitability
Are small		Yakob (FEWSNET) Coping mechanisms for droughts	Expo-

disturbances tolerated rather than avoided (e.g. pest and disease pressure, shortages), can they be managed?		1. expand income through alternative sources (daily labor by more household members, charcoal) 2. sell more livestock or other assets 3. increase loans 4. switching in consumption (from tef to maize) 5. switching income from cloth to food (inessential to essential) 6. migration (seasonal) 7. full family migration	sure to pressure
		ATA, MoA, EIAR 2013: "Early planting time is advantageous in areas with a short growing season; if unpredicted drought incidence or pest infestation occurs, the field can be re-planted with tef as a reliable cash crop	
		ATA, MoA, EIAR 2013: "Tef is highly adaptable to a wide range of soil types. It has the ability to perform well in black soils and, in some cases, in low soil acidities. In addition, tef has the ability to withstand waterlogged, rainy conditions, often better than other cereal crops (other than rice).	
		ATA, MoA, EIAR 2013: "The role of tef as a security crop in the dry land is well known. Tef is a reliable cereal during unreliable rainfall, especially during the occurrence of unpredictable dry spells. This makes tef an important crop for drought-prone and food-insecure areas. Its production is currently expanding to include many drought-prone areas of the country.	
		Ayele: Farmers traditionally wait until soil is muddy before they plant tef. With changing rain patterns this becomes a problem, since they run the risk of not having enough rain towards the end of the growing season. It now is advice to seed early and in case of early drought reseed again. Additionally, raw seeders can not be used in muddy soil."	
		Kebebew: " Tef is a security crop in drought prone areas. Even if affected by drought, once tef has geminated, it gives some yield, for instance straw."	
		Ayele, Kebebew: " Pest outbreaks are getting more common, but still not major problem. Mostly for tef grown outside traditional growing area. Can be fought with cultural practices, pesticides, but sometimes still high loss (shootfly).	
		Demeke and Di Marcantonio 2013: "Teff is relatively resistant to many biotic and abiotic stresses and can be grown under different agro- ecological conditions, ranging from lowland to highland areas. Teff can also be stored for many years without being seriously damaged by common storage insect pests."	
		Abate et al. 2005: "Both the grain and straw fetch a relatively higher price in the market in comparison to other cereal crops. Secondly, tef is an adaptive crop to the changing environment in the country and therefore farmers face low risk. In some environments, where farmers face a complete crop failure due to moisture stress, tef is their choice to get some harvest."	
		ATA, MoA, EIAR 2013: "Tef resists moderate drought, but most cultivars require at least three good rains during their early growth, flowering, and seed-setting stages, and a total of 200 to 300 mm of water. Some early-maturing cultivars can obtain the 150 mm they need from water retained in soils at the end of the normal growing season. In terms of temperature, while tef has some frost tolerance, it will not survive a prolonged freeze. It also tolerates high temperatures (at its lower altitudinal range) well above 35oC9.	
		Farmers got some sporadic help from NGO's in form of food aid and credits. But generally very little and insufficient support for most affected areas. Generally, farmers get support from relative, rarely from neighbors when affected by disasters.	
		From the shock-affected farmers visited, some were able to survive bad years due to savings. Others worked off farm in winter or even during summer in bad years and gave their livestock to not drought affected relatives. In one village however, people also migrated to cities.	
		Katema 1997: "Traditionally, farmers alleviate the problems of waterlogging through preparing a raised seedbed, similar to a cumber-bed, by a hand-or oxen-pulled broad bed maker after the land has been well ploughed."	
Has the activity been exposed to disturbances of different types in the past?		Ayele: Heavy rains, floods: "Problem of seeds and fertilizer being washed out of the fields. Most problematic in highland areas. With climate change, a higher incidence of heavy rains is expected. "	Exposure to pressure
		Ayele: Unexpected rains at the end of growing season can cause shattering, lodging or even germination of tef seed (during threshing). "	
		From the 7 farmers visited, 6 were in the past exposed to rainfall variation/drought, 5 to pest outbreaks (shootfly, ants, grasshoppers), 3 to river overflow, 2 to minor tef rust outbreaks .	
Are there plans to address any risks from hazards and emergency situations with scripts for actors in case of such an event? ?		Mengitsu and Mekonnen 2012: "There are various agricultural management practices in place for adaptation to water stress including supplementary irrigation, diversification of crop varieties, adjustment of cropping calendar and diversification of different enterprises. "	Governance capacity
Does governance show responsiveness to disturbances, to society?		Some flood affected farmers got chickpea seeds as help from extension agents. Government also constructed dams and organized soil conservation programs in some flood affected areas. Others also received emergency food aid.	Governance capacity

Are there long-term plans (e.g. 50 years) to manage supply, demand and capacity?		Overall Vision for the Tef Value Chain: An efficient and well-functioning tef value chain that enables a sustainable increase in smallholder tef farmer productivity and profitability while providing high quality output at an affordable price to tef consumers.	Governance capacity
		Minten: " In the past there was little attention given to tef. But since 3 years GoE pays more attention to tef, ATA set tef as a priority crop 3 years ago."	
Are there early warning systems for disturbances?		Josef: "There are several early warning information systems on food security, including issues such as commodity prices, crop yields, livestock health, health, conflicts, natural shocks (droughts, floods), etc. There are 6 month forecasts on food security situation in Ethiopia."	Information, learning
		Gebre-Selassie and Bekele 2012: " According to these farmers, many face the risk of crop failure as a result of unexpected rain because of inadequate extension services given by the office of agriculture, coupled with a general disregard for weather forecasts. "	
		ATA 2014: "Climate change and variability has led to visible shifts in the cropping calendar which makes the use of climate information for agronomic decision making very important. However, there is a big gap between what farmers need and available seasonal climate forecasts in the country. ...In Ethiopia, weather and seasonal climate forecasts of the National Meteorological Agency (NMA) cover wide areas. However, such regional-scale outlooks are far from providing a climate service which is adaptable to farmers' needs. ...Of course, even the most downscaled, accurate forecast has limited benefits unless demand is created among farmers, training them to use the data to make agronomic decisions during the crop season. To help promote this, the MoA, NMA and ATA are helping to train Development Agents and farmers to monitor rainfall, thereby empowering local, independent decisions and creating a better understanding of the true benefits of adopting new technologies in all areas of agriculture."	
Are lessons learnt from previous experiences, is activity modified in consequence?		From visited farmers, some planted different crops on flood affected fields or planted chickpea or salad after the floods. Some rented land to still be able to plant tef.	Information, learning
Is the attitude towards doubts, uncertainty and failures open and constructive?		Minten: "- not too open and constructive: more a hiding of mistakes or failures. For instance did a study on tef row planting: in first year found out that it didn't change yields in big way. Once they asked them what is benefit of rowplanting they answered that it doubles the yields. Because it was told in advance by government that method would double yield→ so they don't want to say anything different than gvt. Don't want to talk about bad results of method from gvt.	Information, learning
Are extension and advisory services available?		Spielman et al. 2011: "The hierarchical "culture" underlying the extension system does little to encourage and exploit the inherent resourcefulness of those who work closely with farmers and rural communities (Gebremedhin et al. 2006; Davis et al. 2007). And although extension has been decentralized to the administrative control of regional governments and woreda administrations, continued imposition of targets from above and weak local capacity have not yet permitted the emergence of a dynamic demand-driven system. "	Information, learning
		Ayele: "- 2.1 out of 6.6 mio tef farmers use improved technologies."	
		Sherif: "Access to extension is nearly 100% ensured, but quality/motivation of extension agents often a problem (have to live in remote rural areas without electricity, have little autonomy to decide, often agriculture was not their preferred field of study). Farmers get 2-3 trainings per year. Programs lack to include knowledge of farmers (in theory they are participatory, but in reality not).	
		Sherif 2013: "In general, the reported major limitations of the e diverse agricultural extension approaches implemented in Ethiopia are: (i) poor research-extension linkages; (ii) limited set of technologies and technical information; (iii) lack of market integration; iv) lack of well-planned and need-based timely training; (v) failure to address gender; (vi) weak monitoring and evaluation system; (vii) poorly organized credit service delivery system; and (viii) lack of consultation with farmers on the implementation of the packages."	
		Sherif 2013: "The numbers of Development Agents (DAs) in Ethiopia have expanded rapidly, and at the present time it exceeds 60,000. Although most DAs have the basic technical expertise and theoretical knowledge, they are deficient in specific skills which farmers demand. Most DAs have inadequate technical and business skills, and lack in entrepreneurial mind-sets. Moreover, DAs carry out the extension program from their own perspectives while farmers seek to diversify their farming system within specific agro-ecological areas. In general, due their age, lack of on-farm experience, and their narrow subject matter focus, most DAs lack the practical, hands-on skills and knowledge to enable them work with farmers effectively. Hence, DAs require training in key areas such as intensification and diversification of farming systems, agricultural marketing, and communication skills."	
		All visited farmers have access to extension, but some complain that extension quality is bad/that they have little trust in extension agents. Majority makes use of extension 1-2 times a year.	
		ATA 2014: "The core "TIRR" technology package (Tef, Improved seed, Reduced seed rate, and Row planting) prioritized for tef farmers by the agricultural extension system last year, led to significant	

		increases in crop yields across the country. Detailed analysis of the 2013 TIRR package, with a sample of 1,300 farmers, showed average yield increases of 44% vs. the control group and 72% vs. the CSA national average. For the 2014 planting season, a scaled-up target of 3.5 million farmers has been set, with plans to provide increased access to improved inputs and financial resources, agronomic training, and marketing support. In addition, plans are also in place to expand farmer access to pre and post harvest technologies, such as walking tractors, row planters, broad bed makers, harvesters, and threshers."	
		Setatow 2013: "In order to promote the adoption of improved technologies in the smallholder sector, a number of extension activities have been conducted in the last several decades in the major tef growing areas. The research-extension program of the national agricultural research system played key role in the dissemination of the improved tef technologies through on-farm verification, demonstration and popularization. Tef is also considered as a priority crop by the national extension program of the Ministry of Agriculture due to its significance in food security and commercialization. For instance, during the 2009/10 cropping season, about 22% of the tef farmers in Ethiopia participated in the national extension package program with the area covered by the extension program amounting to 19% of the total tef acreage (Fig. 2)."	
Is an atmosphere of trust and respect cultivated between actors?		ATA, MoA, EIAR 2013: Lack of trust in the market is identified as the most important reason for the persistence of small grain traders, whose long-term relationships (especially with tef sellers) are the best guarantee that buyers and sellers will not be cheated. At present, some farmers and consumers believe that traders are not fully benefiting farmers, but rather are exploiting them. This is a major driver behind organizing farmers into formal associations, such as cooperative unions	Information, learning
		One of the major problems for the tef value chain that emerged from the workshop was lack of trust between actors. Especially problematic is also the lack of trust in cooperatives that was reported.	
		Some visited farmers reported trust in cooperatives and traders to be a problem.	
		Fufa et al. 2011: "Moreover, most of the Tef produce is sold to local assemblers that farmers report are using unfairly calibrated weighing scales. Traders may also manipulate Tef prices using various mechanisms such as collusion and the use of privileged information, especially during the harvest months when there is a Tef glut on the market."	
Is there investment in education and knowledge development of actors?		ATA, MoA, EIAR 2013: Insufficient priority is given to tef research, resulting in limited institutional and resource capacity Limited basic research on tef exists to serve as a basis for further exploration	Information, learning
		ATA, MoA, EIAR 2013: Tef varieties released so far do not adequately address lodging, biotic/abiotic stress, shattering, food products, etc.	
		Limited applied research in many areas such as socioeconomics, soil, physiology, food chemistry, crop protection and mechanization	
		Zelleke et al. 2012: "Government spending in extension has also established over 8,500 Farmer Training Centers (FTCs) and trained 63,000 Development Agents (DAs) from 2002 – 2008."	
Is the knowledge base of actors sufficient?		ATA, MoA, EIAR 2013: Farmers have insufficient knowledge of and financial ability to purchase and use inputs, such as fertilizer and seed	Information, learning
		Melekot: "Farmers don't use recommended fertilizer rates because of a lack of knowledge about the credit system. Little awareness on credit access, saving culture."	
		Kebebew, Sherif: "Knowledge on soil conservation is quite high, but ones that have knowledge don't apply it. Integration problem (neighbor fields)."	
		Sherif: Pesticides: "- there is training for everyone on how to use pesticides, but farmers don't apply it - but there is top down training, also written on Amharic on pesticide containers - but in extension policies, negative impacts of fertilizer and pesticides are an issue - but knowledge/awareness problem on farmer level"	
		Sherif: Farmers have some knowledge how to mitigate shocks, for instance planting tef as an escape crop, raised seedbed against floods."	
		ATA, MoA, EIAR 2013: Unfortunately, knowledge of mineral nutrient roles in the plant system is very limited, and most times, farmers apply the incorrect fertilizer formulas, due to insufficient information. When farmers apply unbalanced nutrient levels, the yield gain is often insignificant, making the use of fertilizers appear very costly, with little or no return on investment....As mentioned earlier, the inaccurate application of fertilizer is believed to be driven by the low rate of return, which makes fertilizer appear very costly, causing farmers to ration their use, which in turn leads to lower productivity than anticipated (lower rate of return on input use).	
		ATA, MoA, EIAR 2013: One major challenge impacting tef productivity is the use of unsustainable, traditional methods of land preparation, sowing, and planting. Results from research conducted in 2011 in Debre Zeit and at 1,400 FTCs and farmer trials indicate that there are several yield-enhancing practices that farmers should employ to increase productivity in a sustainable manner.	
		Amera and Abate 2008: "The low level of awareness in the study area and the public health and environmental consequence resulting from the misuse of pesticides is alarming."	
		Zelleke et al. 2012: "Overall, severe erosion can be attributed to weak knowledge dissemination and limited enforcement of land management guidelines, rather than a lack of identified technologies	

		and practices. ...Dissemination of knowledge regarding soil fertility is poor, with few farmers aware of what soil fertility issues are relevant to them. "	
		Minten et al. 2012: "farmers are often very well aware of current prices for the major crops that they grow."	
		From all the farmers visited, only 2 used credit system to access credits (RUSACOS). The rest didn't access credits or had no knowledge about the system.	
Does tef production generate net positive profit and is it still profitable in case of changes in demand/price?		Ayele: - unit price of tef high, higher than any other crop (per ha). Yields per ha have increased from 1.2t/ha to 2.6t/ha and some farmers up to 4t/ha.	Profitability
		Setatow: tef has highest value/cost ration of all crops in Ethiopia. At the moment no price risk for tef since prices stable or increasing.	
		Abate: "Nowadays farmers make big profits from tef possible. But need for fertilizer has increased and fertilizer prices as well.	
		ATA, MoA, EIAR 2013: "In addition, while wholesale prices for tef are relatively high, making the crop attractive to some producers as a cash crop, the production costs are also high as reflected by the high fertilizer prices and the labor intensity of cultivation, weeding, harvesting, and threshing."	
		ATA, MoA, EIAR 2013: "Tef market prices are volatile, due to lack of standardization, seasonality, etc. Price volatility significantly affects the margin obtained by farmers and reduces incentives to increase production and productivity."	
		Demeke and Di Marcantonio 2013: "As the most preferred cereal among better off households, especially urban areas, teff fetches relatively high price in the market, making it attractive cash crop to farmers. Policy makers may rather need to consider higher teff prices as an opportunity for poor rural households to earn more income from the sale of the grain, which is grown as cash crop."	
		Demeke and Di Marcantonio 2013: "Real prices increased in 2006 and 2008 but declined significantly between 2009 and 2011. In fact, real prices in April 2011 were the lowest in the entire period of 2000 to 2012. The gap between nominal and real prices has widened since 2008, and much of the nominal increases were due to the high general inflation rates in the country. The incentive to grow teff as a cash crop has improved further. Poor farmers growing teff have benefited in recent years as the relative price of teff (which they sell) has increased while that of other staple crops such as maize (which they buy for consumption) has declined."	
		Demeke and Di Marcantonio 2013: "The results of the MAFAP price indicators show that the level of disincentive to teff farmers is considerable during the period 2005 to 2010. While producers failed to gain fully from recent high world prices, consumers are protected as they pay significantly lower price than the border price equivalent. Ban of cereal export, overvalued exchange rates, underdeveloped markets and distribution of imported cereals at subsidized prices (at times of high food prices) have kept domestic prices below the reference prices. Food aid may have also contributed to the lower domestic price levels14. ...Farmers have continued to grow teff probably because other crops also face the same disincentives. High domestic demand and relatively high prices in the local market have also encouraged teff farmers. Teff can be grown profitably in a large part of the country, from lowland to highland areas. "	
		Farmers at the workshop complained that prices are fluctuating, specifically dropping at harvest time.	
		Minten et al. 2012: "Consistent with this structure, we find that margins in these major commercial domestic staple value chains are surprisingly small and that the average share of the final retail price that the producer receives reaches about 80 percent. "	
		Abate et al. 2005: "Both the grain and straw fetch a relatively higher price in the market in comparison to other cereal crops. Secondly, tef is an adaptive crop to the changing environment in the country and therefore farmers face low risk. In some environments, where farmers face a complete crop failure due to moisture stress, tef is their choice to get some harvest."	
		Worku et al 2014: "Teff is by far the most important cash crop in the country. ...Income from tef is 34% higher than income from coffee, and almost triple the income that farmer make from the sales of sesame."	
		Setatow 2013: "Furthermore, VCR results showed that the profitability of fertilizer application is higher for tef than for the other major cereals including maize and wheat (Table 3)..... Hence, the MRR values on Table 2 showed that the adoption of improved tef production technologies in diverse agro-ecologies provides significant economic gains to farmers."	
Does the activity rely on distortionary subsidies?		Anderson and Masters 2009: ...three forms of distortions in agriculture still persist: control over input markets; ad hoc government interventions in output (mainly cereal) markets; and disincentives through depressed prices, caused by the continued inflow of food aid. "	Profitability
Does the activity have/give possibility to generate funds for investment,		Tef sells at higher market prices than all other cereals; it can serve as a cash crop	Capital (financial)
		Demeke and Di Marcantonio 2013: "With only 1.3 tons per hectare, teff yield is the lowest among cereal crops. This is mainly due to limited use of improved seeds, inefficient agronomic practices and fragmented farm plots."	
		From visited farmers, only two farmers reported to save money from selling tef. The rest sells little tef or generally generates little savings from their farming activity.	

maintenance, expansion,		Abate: "Saving culture doesn't exist much in Ethiopia and farmers usually have little savings".	
Is the activity exposed to substantial financial risks (e.g. outstanding debt)? (volatility of prices? Market power?)		ATA, MoA, EIAR 2013: "Tef market prices are volatile due to lack of standardization, seasonality, etc."	Capital (financial)
		Zelleke et al. 2012: "Fertilizer uptake and application is linked to credit access, which is currently severely limited; accordingly, fertilizer credit availability is a limiting constraint to further fertilizer use. For smallholders, on average the economics of fertilizer use are attractive, but the risk of negative cash flow is high; large farmers with significant commercialization can afford to bear this risk, but smallholders cannot.	
		In shock-prone areas, farmer reported tef production to be a risk due to high labor intensity and high input costs (fertilizer).	
		Abate et al. 2005: "Both the grain and straw fetch a relatively higher price in the market in comparison to other cereal crops. Secondly, tef is an adaptive crop to the changing environment in the country and therefore farmers face low risk. In some environments, where farmers face a complete crop failure due to moisture stress, tef is their choice to get some harvest."	
		Minten et al. 2012: "Price variability remained high, especially during the drought in 2003 and just before and after the cereal price spike in 2007 and 2008.	
Is the activity insured against damages/losses?		From all the visited farmers only 2 were insured (weather index insurance) for a period of time.	Capital (financial)
Are wages/incomes fair, are they "living wages"?		The visited farmers showed very different income level, from low income even in good years to always decent/good incomes. But generally high spatial variation in income with higher incomes closer to cities.	Capital (social)
Is self-organization, networking, initiative, association among actors enabled?		Abate: "Problem/lack in organization of farmers (e.g. to use common tractor, to consolidate field)	Self-organization
Does the actor have autonomy, control and ownership over the activity/ resources?		Sherif: The extension system is on of the instrument of GoE to control/influence people since they are the most widely available government employees in the countryside. Extension agents have little autonomy, get their instructions top-down.	Self-organization
		Gebre-Selassie and Bekele 2012: " Only use and not ownership rights are guaranteed. As land is the common property of the "Nations, Nationalities and Peoples of Ethiopia", it cannot be sold, exchanged and mortgaged. "	
Are actors able and motivated to re-establish function after a disruption?		No specific information found. But motivated for sure, as it is their livelihood base.	Self-organization
Is there opportunity for experimentation and innovation/ are there incentives for innovation?		Demeke and Di Marcantonio 2013: "Less implicit taxation and improved prices of teff will improve the livelihood of around 50% of small farmers in the country. ...There are new technologies of teff which can dramatically increase yield but famers are unlikely to adopt them unless teff market is expanded to include export and prices are attractive;	Transformability
		Abate: There is little innovation in term of technology adaptation and development, which is also due to little investment in development/import of innovative technologies (e.g. threshers, cleaning machines). Problem of capital access for investment and adoption through farmers. All technology development done by research center. Nearly no domestic mechanic manufacturing industry which is necessary, since tef needs spatial technology (only produced in Ethiopia). "	
		In the workshop, farmers reported lack of access to improved technologies to be on of the main problems for them (e.g. row seeders, tractors, combiners).	
		Abate: "Adoption of improved technologies is hampered through small plot sizes (combiner, mechanic plowing).	
Does the activity and its leaders show openness to change, has this been shown in the past?		Mengistu and Mekonnen 2012: "Currently, only few farmers adjust their sowing time in response to perceived climate change as they have no access to information based on long term data (Elizabet et al., 2009). Under such situations, the cropping calendar of farmers remains as it is despite change in timing of rainfall. "	Transformability

Trade

Questions	Rating	Answers	Attribute
Does the activity have spare capacity (infrastructure, technical, know-how, financial) in case of increased demand? (how much?)		Some of the visited traders complained about limited credit access and liquidity problems. Tef supply and storage capacities were reported to be no constraint in case of increased demand.	Buffering capacity
		Yergalem, Sherif: "Cooperatives often have financial constraints, constraints in access to loans....due to credit system, cooperatives usually unable to buy outputs from their members due to financial limitations. Often no storage and financial capacity of cooperatives to market tef(buy all tef from members). Government gives credits to unions, but not enough"	
		Minten et al. 2012: "Great strides have been made in terms of improving market fundamentals such as roads, telecommunications, and market institutions -----These improvements have contributed to reducing transaction costs and improving market efficiency.------ Performance of the market has greatly improved, particularly in terms of increased market integration and dramatically lower costs and margins of trade.	
		Visited traders reported that availability of tef is generally high. However, there are always seasonal variations.	
		Minten et al. 2013: "Ninety-nine percent of the transactions were paid immediately and in cash. In only 2 percent of the transactions did the farmer receive input advances from the buyer."	
Does the activity maintain stocks of inputs and/or of products?		Visited traders usually keep tef stocks only for about 1 month, since price fluctuation make storing risky and traders have limited financial resources to store tef.	Buffering capacity
		Mintenn et al. 2013: " Few of the traders report to be involved in long-time storage. "	
		Fufa et al. 2013: "However, we learned from the field visits that the costs associated with tef stocking is minimal compared to any other crops due to the low vulnerability of the crop to p sets especially weevils."	
		Fufa et al. 2013: "There is very little apparent stocking of tef with Ehel Berenda traders as they stock only enough to satisfy petty trade during the day. Storage of tef could not beobserved at any point along the value chain, either with traders at surplus areas or with millers at Addis Ababa. However, given that daily tef trade volumes only fluctuate by a factor of two in the central market, compared with 10 times or more between high and low seasons in the surplus areas, storage is likely to be taking place somewhere between the assembler and wholesaler."	
Do supporting activities (logistics, communication) have spare capacity in case of increased demand, are they equitably accessible?		In rainy season access to some areas problematic. High price variation in Addis.	Buffering capacity
		Minten et al. 2013: "Farmers were asked for each marketing transaction to give details on the specifics of that transaction.4 The majority of the sales are to traders at local wholesale markets or to traders with a fixed shop, often in regional markets. Farmers traveled on average 1.5 hours to get to the place of sales and on-farm sales or sales in the village are therefore relatively less important, in contrast with other countries in Africa (Chamberlin and Jayne 2012). "	
		"While urban distribution margins do not change over the year, we note a slight increase in margins between rural markets and urban wholesale markets during the harvest season compared to the off-season period. This might be partly driven by higher transport costs during the harvest period (Minten et al. 2012)."	
Is there sufficient labor force available for the activity?		See whole value chain	Buffering capacity
Does the activity engage with multiple suppliers, buyers, and fellow stakeholders for trade? RATING?		Visited traders usually have hundreds of suppliers and customers. There are multiple kinds of suppliers and customers, ranging from cooperatives, farmers, traders, assemblers, individual consumers, big scale consumers, NGOs, etc.	Connectivity
		Minten et al. 2013: "Table 3.2 shows that urban brokers/traders work with a rather limited number of suppliers—seven on average over a 12 month period—and that they procure almost two-thirds of their supplies from the zones that they are originally from. "	
		Fufa et al. 2013: "Eleni (2001) notes that the structure of the value chain, including the reliance on brokers, is rational from the traders' point of view, given the high variation in tef quality observed and the difficulty in testing this at the point of sale."	
		Fufa et al. 2013: "The price of tef in the central market is determined by the supplied grain quality, which is usually based on place of origin and color. The price and quality determination is often done by the brokers that have long years of experience in trading and established relationships with the regional traders. Again, at Ehil Berenda Market in Addis Ababa, no value addition in terms of cleaning, storage or re-packaging takes place, and the grain is sold at spot while it is still loaded on the trucks. Millers, institutions, regional traders, hotels and sometimes consumers are the main buyers at this stage.“	

		Yergalem: "Cooperatives: o don't have good market information on markets outside their area (usually just sell to own cooperative union or regional market) o nearly no linkage between consumers and farmer cooperatives ...o sense of membership limited: cooperatives are often unable to deliver needed services to members→ sense of membership declining (also between primary coops and unions) o trend at the moment: declining membership sense→ members sell products to other markets instead of coops	
Are products/inputs bought, sold/distributed via multiple diverse channels and markets?		Minten et al. 2012: "The share of total cereal sales through the wholesale market made by cooperatives is still rather limited as none of the stated percentages is higher than 10 percent. Second, the share of cooperatives has been growing until the years 2007–2009, but is on the decline since. For example, the share of cooperatives has declined from 9 percent in 2005 to 2 percent in 2011 in the case of teff	Connectivity
		Minten et al. 2013: "Farmers were asked for each marketing transaction to give details on the specifics of that transaction.4 The majority of the sales are to traders at local wholesale markets or to traders with a fixed shop, often in regional markets. Farmers traveled on average 1.5 hours to get to the place of sales and on-farm sales or sales in the village are therefore relatively less important, in contrast with other countries in Africa (Chamberlin and Jayne 2012). "	
		Minten et al. 2013: "Direct sales to consumers make up 7 percent of all transactions. Sales to cooperatives or government institutions (such as the Ethiopian Grain Trade Enterprise) are rather limited: they make up less than 1 percent of the sales transactions."	
		Minten et al. 2012: "Second, the share of cooperatives has been growing until the years 2007–2009, but is on the decline since. For example, the share of cooperatives has declined from 9 percent in 2005 to 2 percent in 2011 in the case of teff and from about 10 percent in 2009 to 7 percent in 2011 in the case of wheat "	
		Fufa et al. 2013: "The tef supply chain is characterized by the heavy involvement of brokers and middlemen. This is observed in tef supply chain case of Addis Ababa market (Fig. 4). Brokers are the major players in Addis Ababa Ehel Berenda Market."	
		Sherif: even though cooperatives usually can give 15% higher prices to farmers, very little tef is sold through cooperatives(market power/seasonality)	
		Ayele: " o Farmer don't sell tef to coops because it's more complicated, traders pay directly cash and sometimes extra expenses to coops if it has to be stored "	
Are there any single inputs, etc. that this activity depends upon, with no alternative?		Minten et al. 2013: "In contrast with the farm level, credit is much more prevalent in the value chain midstream and downstream. Questions were asked on the importance of credit as well as advances. While few of the rural traders pay their suppliers on credit, this is much more important for urban wholesalers (60 percent) and urban retailers (45 percent). However, the credit is mostly of short duration. "	Connectivity
Is the value chain between input producer and farmers very long and complex?		ATA, MoA, EIAR 2013: Market transaction costs are artificially elevated due to a complex supply chain	
		Fufa et al. 2013: "Cereal markets in Ethiopia in general are considered to be long and complex (Rashid and Asfaw, 2011). The tef supply chain is characterized by the heavy involvement of brokers and middlemen."	
		Minten et al. 2013: "we find—in contrast to conventional wisdom—that value chains are relatively short and that average farmers obtain a high share, of about 80 percent, of the final consumer price in the major terminal market, Addis Ababa."	
		Minten et al. 2013: "This illustrates that the prevalent structure of the value chain from these major production zones to the urban city are rather short, from producer to regional trader to urban trader/broker to urban retailer. In the most common case, there are therefore three intermediaries found between farmers and urban consumers. This finding is against conventional wis- dom.6 Note that 32 percent of the urban retailers obtain their products directly in rural areas (bypassing the urban wholesale markets), making the value chain even shorter. On the other hand, the value chain can also be longer, as rural traders procure 13 percent of their produce from rural assemblers or farmer-traders and 10 percent of the urban whole- salers/brokers obtain produce from other urban wholesalers/brokers."	
		ATA, MoA, EIAR 2013: "The complexities of the tef supply chain are also evident through the price premiums resulting from multiple handovers. There are frequently 5 or more handovers of tef between producers and consumers, with each trader or broker taking a profit margin as well as incurring transport and storage costs.	
Do logistics and		See whole value chain	Con-

communication support services enable appropriate connectivity?		Ayele: "access to markets nearly everywhere, even in rural areas (but transport costs are higher)"	nectivity
Would a failure in this activity cascade to the whole system?		Minten et al. 2013: "Given this rapid urbanization, especially so in developing countries, and the increasing importance of the manufacturing and service sectors in these countries' economies, more people are making a living outside agriculture, do not grow their own food, and rely on market purchases for their food needs. "	Connectivity
Is income generated by diverse activities/products?		Visited traders all traded various crops, even though tef was the major crop for all of them.	Diversity
		2 out of 4 traders also hade non-trade income sources, such as milling, real estate business, etc.	
Is there room for actors to have and express diverse opinions?		Generally yes. No specific information found.	Diversity
Are there multiple policy options which support backup systems during a disturbance?		None known.	Diversity, redundancy
Does the activity have multiple production sites/lines/machines and are they spatially distributed?		Visited traders only have one storage location, however on country base, traders and storage locations are well distributed.	Diversity, redundancy
		Minten et al. 2013: " Ninety-two percent of all the teff sales by the interviewed urban wholesale traders was destined to Addis Ababa. While Addis Ababa was seen in the past as a clearing house for national cereal trade, i.e. the national cereal trade went through Addis Ababa as all major traders were stationed there (Gabre-Madhin 2001), this is seemingly less the case now than before. The larger agricultural marketing flows in the country, as well as improved communications, might have contributed to that change (Minten et al. 2012). "	
		ATA, MoA, EIAR 2013:"It is estimated that roughly 70% of the marketed production of tef in Ethiopia routes through Addis Ababa channels and markets. "	
Are there critical emissions which the activity has on the environment?		No	Equitability
Are there equitable/fair rights, regulations, laws, institutional rules, policies, organizational activities and entitlements in the governance of the activity?		Yergalem: "Government supports cooperatives in multiple ways:- organizing cooperatives (support and managing them at regional, zona, district and kabaly level, delegated person at each level) - training trough delegates: capacity building, market linkage, auditing and inspection service, legal issue service, finance service - financial support: exempted from income tax"	Equitability
		Abate: "Government opinion on traders - have to be avoided/minimized - → but are needed (Abate), to bring tef from peripheries to capital (add value to product) - goal should just be that high gross profit goes not to traders - get rid of unofficial/illegal traders→ through controls "	
		Demeke and Di Marcantonio 2013: The market is affected by lack of formal grades and standards, lack of adequate warehouse facilities, lack of reliable market information, and inadequate contract enforcement mechanisms."	
Is there equitable/fair access to inputs (generational, gender, racial, religious etc.)?		Minten et al. 2013: "family, kin and ethnic relationship are often presumed to be important in agricultural trade, ... This suggests indeed tight and often family networks between farmers and urban brokers."	Equitability
Has the activity been exposed to disturbances of different types in the past?		Export ban. Affected traders in Addis. Inflation can affect traders. Conflict with Eritrea, no more export to Eritrea.	Exposure to pressure
		Tef traders reported to have been affected by export ban and other market interventions by GoE. Usually, these interventions led to lower margins, but business was still profitable. Strong price surges as for tef in the past decade lead to financial shortages, as traders need more capital to purchase tef.	
Are small disturbances tolerated rather than avoided, can they be managed?		Ayele: " At the moment traders and cooperatives are probably speculating that export ban is lifted and store tef. But high costs of storing and locked up money."	Exposure to pressure
Are there long-term		ATA, MoA, EIAR 2013: "Interventions/Visions for the tef value chain: -Link smallholder tef	Gov-

plans (e.g. 50 years) to manage supply, demand and capacity?		producers (through cooperatives) to direct market outlets - Improve tef market transparency and enforce standardization by adding tef to ECX in the future"	ernanc e capacity
Are lessons learnt from previous experiences, is activity modified in consequence?		ATA, MoA, EIAR 2013: "Interventions/Visions for the tef value chain: -Link smallholder tef producers (through cooperatives) to direct market outlets - Improve tef market transparency and enforce standardization by adding tef to ECX in the future"	Information, learning
Are there mechanisms and access to information about the state of the value and supply chains (incl. market prices)?		Minten et al. 2012: "Currently, there are no well-coordinated channels through which this information is communicated to various participants. The Ethiopian Commodity Exchange (ECX) may at some point play this role, but as of mid-2009, trade in cereals was too small for the ECX prices to serve as reliable indicators of overall market conditions. "	Information, learning
		ATA, MoA, EIAR 2013: "Today, farmers attempt to access price information either by physically visiting the major markets or by communicating with other farmers before delivering their tef to market. On the other hand, traders get price information through their personal networks. Currently, because of the rapid diffusion of mobile phone networks, market information among traders has been easily accessed. However, even though the Central Statistical Agency collects prices from 119 markets to feed Consumer Price Indices, they are released too late to be used as a decision making tool by farmers and traders. Similarly, the Ethiopia Grain Trade Enterprise collects market information from about 25 markets throughout the country, but it is rarely published in time to be used by smallholder farmers or the broader market47."	
		Minten et al. 2013: "While they might not have sold teff recently, farmers are often very well aware of current prices for the major crops that they grow. "	
		ATA, MoA, EIAR 2013: "Moreover, based on field visits to market trading days and group discussions with farmers, it has been reported that much of the tef produce sold to local assemblers is manipulated through the use of unfairly calibrated weighing scales. Traders may also manipulate tef prices using various mechanisms, such as collusion and the use of privileged information, especially during the harvest months when there is a tef glut in the market."	
		Ayele: "- Market information available nearly everywhere (at least where access to mobile and contact to Addis)"	
Are performance, capacity and quality (both of resources and food product) evaluated throughout all points in the value chain?		ATA, MoA, EIAR 2013: "The tef market is under-developed and contains many small players. These small players drive volatility in the market and contribute to a lack of standardized, quality-grade tef. This in turn drives an inconsistency in product and sales, as the market contains varying types and colors of tef, and sale prices differ dramatically by geography and season."	Information, learning
		Fufa et al. 2013: "Eleni (2001) notes that the structure of the value chain, including the reliance on brokers, is rational from the traders' point of view, given the high variation in tef quality observed and the difficulty in testing this at the point of sale."	
		Fufa et al. 2013: "The price of tef in the central market is determined by the supplied grain quality, which is u sually based on place of origin and color. The price and quality determination is often done by the brokers that have long years of experience in trading and established relationships with the regional traders. Again, at Ehil Berenda Market in Addis Ababa, no value addition in terms of cleaning, storage or re-packaging takes place, and the grain is sold at spot while it is still loaded on the trucks. Millers, institutions, regional traders, hotels and sometimes consumers are the main buyers at this stage.	
		Demeke and Di Marcantonio 2013: Significant price difference between different grades of teff has not encouraged bulking and large scale operations. Grades and quality have to be checked visually throughout the supply chain and every time the commodity changes hands. Like other cereals, high marketing costs and risk have contributed to inefficient teff markets. The market is affected by lack of formal grades and standards, lack of adequate warehouse facilities, lack of reliable market information, and inadequate contract enforcement mechanisms."	
Is an atmosphere of trust and respect cultivated between actors?		Fufa et al. 2011: "Gabre-Madhin (1999) identifies the lack of trust in the market as the most important reason for the persistence of brokers, whose long-term relationships (especially with Tef sellers) are the best guarantee that buyers and sellers will not be cheated. However, the brokers impose their own costs: they charge around 30 Birr/qtl for loading/unloading Tef and connecting buyers with sellers. "	Information, learning, transparency
		Visited traders reported that there is generally a high level of trust. Transactions are often done on credit, so high trust.	
		ATA, MoA, EIAR 2013: "Interviews with processors suggest that previous attempts by end-buyers or traders to purchase tef directly from farmers failed due to a lack of trust and transparency in market information, in terms of the price and quality of tef. Lack of trust in	

		the market is identified as the most important reason for the persistence of small grain traders, whose long-term relationships (especially with tef sellers) are the best guarantee that buyers and sellers will not be cheated42. Having years of experience, major “power” players in the supply chain (see exhibit above) are local and Addis-based brokers who largely determine price and quality through their own informal standards and grading systems."	
		ATA, MoA, EIAR 2013: "At present, some farmers and consumers believe that traders are not fully benefiting farmers, but rather are exploiting them. This is a major driver behind organizing farmers into formal associations, such as cooperative unions43."	
		ATA, MoA, EIAR 2013: "Moreover, based on field visits to market trading days and group discussions with farmers, it has been reported that much of the tef produce sold to local assemblers is manipulated through the use of unfairly calibrated weighing scales. Traders may also manipulate tef prices using various mechanisms, such as collusion and the use of privileged information, especially during the harvest months when there is a tef glut in the market."	
		Abate: "- no honest trading in Ethiopia - farmers, traders…all are cheating (sand in tef to alter weight) "	
		Yergalem: "o sense of membership limited: cooperatives are often unable to deliver needed services to members→ sense of membership declining (also between primary coops and unions) o trend at the moment: declining membership sense→ members sell products to other markets instead of coops	
Is there investment in education and knowledge development of actors? Is the knowledge base of actors sufficient?		Minten et al. 2013: "While they might not have sold teff recently, farmers are often very well aware of current prices for the major crops that they grow. "	Information, learning, transparency
		ATA, MoA, EIAR 2013: "Moreover, based on field visits to market trading days and group discussions with farmers, it has been reported that much of the tef produce sold to local assemblers is manipulated through the use of unfairly calibrated weighing scales. Traders may also manipulate tef prices using various mechanisms, such as collusion and the use of privileged information, especially during the harvest months when there is a tef glut in the market."	
Does the activity rely on distortionary subsidies?		No	Profitability
Is the activity still viable in case of changes in demand/supply		Fufa et al. 2011: "The literature also suggests that transaction costs in cereal markets have decreased over time from over 30 Birr/quintal to less than 6 Birr/quintal, with commensurate declines in traders’ margins (Rashid and Asfaw, 2011). This finding is consistent with the relatively low price mark- up margin between producer and consumer prices of Tef observed in July 2011."	Profitability
Does the activity generate a net positive profit?		Minten et al. 2013: "The bulk of the margin between farmers and retailers consists of the margin between rural and urban wholesale markets. On average for the four qualities, the urban–rural wholesale margin makes up 54 percent of the total margin between farm gate prices and urban teff flour prices. The margin between farm gate and rural wholesale markets, between urban wholesale and retail, and for milling and cleaning contribute the rest, i.e. 15 percent, 19 percent, and 13 percent respectively.	Profitability
		Minten et al. 2013: "While urban distribution margins do not change over the year, we note a slight increase in margins between rural markets and urban wholesale markets during the harvest season compared to the off-season period. This might be partly driven by higher transport costs during the harvest period (Minten et al. 2012)."	
		Fufa et al. 2013:"Empirical investigations, such as a review by Rashid and Asfaw (2011), showed significant integration of grain markets in Ethiopia which also suggests that transaction costs in cereal markets have decreased over time from over 300 Birr ton-1 to less than 60 Birr ton-1, with commensurate declines in traders’ margins (Rashid and Asfaw, 2011). This finding is c onsistent with the relatively low price mark-up margin between producer and consumer prices of tef observed in July 2011 (Fig. 3)."	
		Minten et al. 2012: "Teff is characterized by the lowest margin and maize by the highest. This might partly reflect the higher value of teff compared to other crops and the difference in absolute retail margins between the different cereals is thus significantly smaller, possibly reflecting the fixed costs of retailing of cereals (Gardner 1975). Third, we note mostly a decline in the retail margins over time when the first half of the decade is compared to the second half. "	
		Visited trader reported tef trade to be more profitable than other crops, 50% or more percent of their income is deriving from tef trade, and income from trading activity is good/ enough to generate some savings from it.	
Does the activity have		Minten et al. 2013: "We find that rural–urban value chains are relatively short. Consistent	Capital

possibility to generate funds for investment, maintenance, expansion,		with this structure, we find that margins in these major commercial domestic staple value chains are surprisingly small and that the average share of the final retail price that the producer receives reaches about 80 percent."	(financial)
		Visited trader reported tef trade to be more profitable than other crops, 50% or more percent of their income is deriving from tef trade, and income from trading activity is good/ enough to generate some savings from it.	
Is the activity insured against damages/losses (income/production/infrastructure/personnel)?		None of the visited traders had a formal insurance. However, 2 out of 4 traders reported that there is some informal system between traders to help out each other in case of financial difficulties.	Capital (financial)
Is the activity exposed to substantial financial risks (e.g. outstanding debt)?		Half of the visited trades complained about strong price fluctuations for tef, making their activity risky. However, when asked if tef trade is a financial risk for them, all of them gave a distinct negative answer.	Capital (financial)
		Minten et al. 2013: "Ninety-nine percent of the transactions were paid immediately and in cash. In only 2 percent of the transactions did the farmer receive input advances from the buyer...In contrast with the farm level, credit is much more prevalent in the value chain midstream and downstream. Questions were asked on the importance of credit as well as advances. While few of the rural traders pay their suppliers on credit, this is much more important for urban wholesalers (60 percent) and urban retailers (45 percent). However, the credit is mostly of short duration. ""	
		ATA, MoA, EIAR 2013: "The tef market is under-developed and contains many small players. These small players drive volatility in the market and contribute to a lack of standardized, quality-grade tef. This in turn drives an inconsistency in product and sales, as the market contains varying types and colors of tef, and sale prices differ dramatically by geography and season."	
Are wages/incomes fair? Are wages/incomes "living wages"?		Visited trader reported tef trade to be more profitable than other crops, 50% or more percent of their income is deriving from tef trade, and income from trading activity is good/ enough to generate some savings from it.	Capital (financial)
Is self-organization, networking, initiative, association among actors enabled?		Yergalem, Ayele: Cooperatives get support from government to establish linkages to potential customers.	Self-organization
Does the actor have autonomy and control over the activity, and his own resources?		Yes	Self-organization
Are actors able and motivated to re-establish function after a disruption?		Depends on financial capacity and how severely the were hit. But besides financial capacity, trust is a major factor in tef trade. Therefore, if a traders is trusted, he can easier establish function after a disruption.	Self-organization
Is there opportunity for experimentation and innovation?		Demeke and Di Marcantonio 2013: Significant price difference between different grades of teff has not encouraged bulking and large scale operations. Grades and quality have to be checked visually throughout the supply chain and every time the commodity changes hands. Like other cereals, high marketing costs and risk have contributed to inefficient teff markets. The market is affected by lack of formal grades and standards, lack of adequate warehouse facilities, lack of reliable market information, and inadequate contract enforcement mechanisms."	Transformability
Does the activity and its leaders show openness to change, has this been shown in the past?		As mentioned by Abate, there farmer cooperatives in general are little innovative and make little use of the big potential of marketing tef.	Transformability
Is it easy to change values/systems/ways of thinking/doing things in the surrounding culture?		See whole value chain	Transformability

Processing and Retail

Question	Rating	Answers	Attribute
Does the activity have spare capacity (infrastructure, technical, know-how, financial) in case of increased demand?		Fufa et al. 2011: "..most Tef consumers buy Tef directly from a trader or a mill, have it milled at their own expense and then process it into Injera at home. The exceptions to this are Tef processing cooperatives, mostly in Addis Ababa, who make Injera on a moderate scale (up to 5,000 items per day) and sell it to institutional customers (such as schools and hotels) and supermarkets. Estimates suggest that this sector processes less than 1% of all Tef consumed in Ethiopia, with the rest processed by families in their own homes or informal neighborhood processors whose contribution is difficult to estimate."	Buffering capacity
		ATA, MoA, EIAR 2013: "Today, however, there are no such commercial processors, and the only seemingly large players, such as Mama Fresh Injera, hold a negligible market share. By example, Mama Fresh Injera, considered one of the dominant retail tef consumers, had a purchase volume in 2011 of 1,800 tons of tef, which comprised 0.12% of the total tef market."	
		ATA, MoA, EIAR 2013: "As seen in Exhibit 34, export of fresh and dry injera is increasing, but remains nominal. For example, in 2011, the export volume for fresh and dry Injera from Ethiopia was 18,000 quintals. This is 0.21% of the overall tef market production and represents only 56 million ETB of export revenue."	
		ATA, MoA, EIAR 2013: "Milling and processing development: as discussed earlier, tef value addition, particularly through milling (cleaning grain and making flour) and processing (baking injera and other products) remains in a rudimentary state. Few Addis millers, or millers in other major cities, engage in creating tef flour from tef grain. Similarly, processing of tef flour into injera is limited to a small number of urban processors. Increasing systematic demand can be done by creating more large-scale milling and processing enterprises, and linking them to large-scale end-consumers, such as universities, hospitals, and restaurants, etc., in major tef market destinations (e.g., near Ehel Berenda in Addis)."	
		Minten et al. 2012 cereal: Data from the Addis Ababa Trade and Industry Office Database on the number of mills in the city indicate an important increase of mills in the last decade. While the number of mills per kebele was less than one in the middle of the decade, this has increased to an average of five by 2011 (however, this increase is also likely explained by increasing formalization of the milling sector). It is possible that the increasing availability of mills has led to an increase of competition and a relative reduction in milling costs. This is found to be the case in the retail data that CSA collects as to construct the CPI. Using these data, it is found that the real milling charges at the end of 2010 had dropped to half of the level that was being charged 10 years earlier (Figure 7.1)."	
		All visited mills reported to be frequently affected by power cuts and none of them had a backup system. Enjera companies also reported electricity to be the major constraint for production, as it is often not available and generator is very expensive.	
		3 out of 4 mills reported financial constraints to buy tef and act as retailers. Therefore they can only provide services. Microprocessors and some enjera companies also all reported financial constraints to buy tef stocks for instance.	
		All of the mills reported to have spare milling and storage capacities. Enjera microprocessors and companies also all have spare capacities.	
Do supporting activities have spare capacity in case of increased demand?		See whole value chain	Buffering capacity
		In rural areas, where mill only give milling service, they don't rely on logistics services, as customers bring their own tef. It can be assumed that tef is usually bought on the next market or self produced and then brought to the next mill. For microprocessors, the same applies.	
Does the activity maintain stocks of inputs and/or of products?		Setatow: "Mills have no big storage capacities normally"	Buffering capacity
		None of the visited mills, microprocessors or enjera companies keeps big tef stocks due to financial limitations. Enjera and flour stocks are not kept as well since they are perishable.	
Are input resources equitably accessible?		Apart from price issues, yes.	Buffering
		Visited enjera companies and especially microprocessors are affected by	

		higher tef prices as their margins get smaller.	capacity
Is there sufficient labor force available for the activity?		See whole value chain	Buffering capacity
Are there critical emissions which the activity has on the environment?		Ashagrie: "No direct impacts known"	Capital (environmental)
		No negative impacts reported in processors interviews.	
Are wastes reused and recycled?		Refer 2001: "Studies have shown that in milling, tef gives a 99 percent return in flour, whereas wheat yields 60-80 percent (Cicero and Backdate, 1939). Analytical Data physical characteristics of the grain or flours from tef or a combination of tef seeds, grain flour and ash are given in Tables 6 and 7, respectively. "	Capital (environmental)
		Residues from milling are used as fodder for livestock/donkeys, old enjera is usually dried and sold in dry form.	
Do the actors have a good health status (physical and mental)?		Visited microprocessors reported smoke from their ovens to affect health. Since most microprocessors produce enjera on firewood ovens, they are exposed daily to high levels of fine dust. Same applies for millers, which are generally not wearing any protection equipment.	Capital (environmental)
Are there any single inputs/processes/stakeholders that this activity depends upon, with no alternative?		Of course there is high dependency on tef for enjera producers. Mills are more diversified.	Connectivity
		Mills and big enjera companies usually rely on electricity without alternative. Some do have backup systems, but they increase the production costs significantly. Microprocessors rely mostly on firewood.	
Are products/inputs bought, sold/distributed via multiple diverse channels and markets? Do actors interact with multiple suppliers/customers?		Fufa et al. 2013: "Except at the level of millers and injera bakers, there is limited value addition along the tef value chain. Millers add value to tef as they clean the grains and make flour. Suppliers of tef flour are also emerging, particularly in Addis Ababa, Dire Dawa and Harar, and it is possible to find tef flour packages of different sizes in some supermarkets. The bakers add value to tef as they change the tef flour to injera that is directly supplied to institutions, hotels, super markets, shops and consumers. "	Connectivity
		ATA, MoA, EIAR 2013: "Interviews with processors suggest that previous attempts by end-buyers or traders to purchase tef directly from farmers failed due to a lack of trust and transparency in market information, in terms of the price and quality of tef. Lack of trust in the market is identified as the most important reason for the persistence of small grain traders, whose long-term relationships (especially with tef sellers) are the best guarantee that buyers and sellers will not be cheated42. Having years of experience, major “power” players in the supply chain (see exhibit above) are local and Addis-based brokers who largely determine price and quality through their own informal standards and grading systems."	
		Visited mills and big enjera companies usually have a high number of customers (from 20 to 100s).	
Do logistics and communication support services enable appropriate connectivity?		See whole value chain	Connectivity
		In rural areas, where mill only give milling service, they don't rely on logistics services, as customers bring their own tef. It can be assumed that tef is usually bought on the next market or self produced and then brought to the next mill. For microprocessors, the same applies.	
Would a failure in this activity cascade to the whole system?		ATA, MoA, EIAR 2013: ".. most tef consumers buy the grain directly from a trader or mill, have it milled at their own expense, and then process it into injera at home. The exceptions to this are tef processing cooperatives, mostly in Addis Ababa, who make injera on a moderate scale (up to 5,000 items per day) and sell it to institutional customers, such as schools, hotels, and supermarkets. Estimates suggest that this sector processes less than 1%44 of all tef consumed in Ethiopia, with the rest processed by families in their own homes, or by informal neighborhood processors whose contribution is difficult to estimate."	Connectivity
Are there ethnical, gender, familiar dependencies/barriers which hamper connectivity?		None reported.	Connectivity
Is income generated by diverse activities/products? Does the activity rely on other sources of income?		Visited millers all milled a range of cereals, even though tef was the main product. Enjera companies usually are little diversified and rely highly on enjera business. Microprocessors often have alternative income sources like small shops or only produce enjera as extra income.	Diversity
Are there diverse ways of producing		Fufa et al. 2013: "It was also found out that processing of tef grain is limited	Diversity

the product/conducting the activity?		only to flour and injera making mainly with small number of urban processors. The nutritionally rich nature of tef has not been explored for the latent potential as an industrial crop. "	
		ATA, MoA, EIAR 2013: "In Ethiopia, the use of tef is limited to a few, specific, traditional food products, such as injera. New food products made from tef could be developed for value-addition and income generation, either locally, through research, or based on the adaption and testing of recipes that have been developed abroad. In Europe and the United States, for example, different baked and cooked food products have been developed from tef. These products target the gluten-intolerant sector (2-4% of population) which has driven the increasing popularization of, and demand for, tef-based products and tef flour to be used in cooking."	
		Milling of tef is nowadays mostly done with electric mills, however, there are traditional grinders to mill tef available as well.	
Are inputs sourced from multiple and diverse sources and are they spatially distributed?		Visited mills rely on milling stones which usually have to be bought in Addis Ababa. The rest of the inputs for mills and enjera producers can be purchased from diverse sources, with exception of electricity and water.	Diversity, redundancy
Does the activity have multiple production sites/lines/machines?		Setatow: "Small mills are distributed everywhere"	Diversity, redundancy
		Mills and microprocessors are distributed throughout the whole country. Enjera companies are mainly concentrated in Addis Ababa.	
Are impacts caused by the activity borne by other actors who do not receive benefit?		None known	Equitability
Is there equitable/fair access to inputs (generational, gender, racial, religious etc.)?		No discrimination reported	Equitability
Can diverse actors participate in decision-making?		As businesses are mostly small, decisions can be made by the microprocessors or milling customers themselves.	Equitability
Can small disturbances be managed? Did it take long for the activity to recover from past disturbances?		As reported by visited millers, there are no coping mechanisms for electricity shortcuts since they don't have financial capacities to purchase generator and generator milling would be to expensive. Therefore they often loose customers and income due to electricity shortcuts. If tef prices rise, less tef is milled compared to other crops and therefore mills make less profits.	Exposure to pressure
		Enjera microprocessors are more flexible as not dependent on electricity.	
		Enjera companies also reported to loose customers due to electricity shortcuts or water shortages, as enjera quality varies if when made on fire-wood stoves/with cistern-water. If tef prices rise, enjera companies further get financial problems as their margins are small.	
Has the activity been exposed to disturbances of different types in the past?		Processors interviews: Electricity shortcut, water shortage, tef shortage/bad quality of tef, fluctuating tef prices,	Exposure to pressure
Are there plans to address any risks from hazards and emergency situations with scripts for actors in case of such an event?		None known specifically for processing	Governance capacity
Are there long-term plans (e.g. 50 years) to manage supply, demand and capacity?		Bekele: "The problem of power cuts should be solved within next 2-3 years due to construction of Nile and other dams (overcapacities planned)"	Governance capacity
		ATA; MoA, EIAR 2013: "In Ethiopia, the use of tef is limited to a few, specific, traditional food products, such as injera. New food products made from tef could be developed for value-addition and income generation, either locally, through research, or based on the adaption and testing of recipes that have been developed abroad. ....In order to expand value-addition opportunities in Ethiopia, work must be done to test and promote the development of tef-based food products. From here, Ethiopia can begin large-scale development of its ability to create and mass manufacture these products for international export as well as domestic demand.	
Are there early warning systems for disturbances?		None known specific for processing step.	Information, learning
Are lessons learnt from previous experiences, is activity modified in consequence?		Enjera companies all have invested into some electricity and water backup system. Some further established long term contracts with tef suppliers (farmer cooperatives) to be less affected by price fluctuations.	Information, learning
		Microprocessors and mills don't have financial capacity to invest in backup	

		systems.	
Is an atmosphere of trust and respect cultivated between actors?		ATA, MoA, EIAR 2013: "Interviews with processors suggest that previous attempts by end-buyers or traders to purchase tef directly from farmers failed due to a lack of trust and transparency in market information, in terms of the price and quality of tef. Lack of trust in the market is identified as the most important reason for the persistence of small grain traders, whose long-term relationships (especially with tef sellers) are the best guarantee that buyers and sellers will not be cheated42. Having years of experience, major "power" players in the supply chain (see exhibit above) are local and Addis-based brokers who largely determine price and quality through their own informal standards and grading systems."	Information, learning
		Fufa et al. 2011: "Interviews with processors suggested that previous attempts to purchase Tef directly from farmers was a failure due to a lack of trust as well as a lack of market transparency in terms of quality of product and the associated pricing.	
Are performance, capacity and quality monitored throughout all points in the value chain?		Tef quality was reported to be a major problem for some enjera producers, as there is no quality grading system. Tef quality affects enjera quality.	Information, learning
		Ashagrie, Bekele: "Tef quality varies throughout season. Further no quality awareness among farmers/cooperatives and problem of postharvest handling of tef."	
Is there investment in education?		Fufa et al. 2011: "On the other hand, Tef food product development efforts are at early stages of research. Tef product development efforts, particularly the blending of cereals in an attempt to prepare different food menus, are under way by Haramaya University and the Ethiopian Health and Nutrition Research Institute (EHNRI). However, significant research has been not undertaken by EHNRI to specifically target Tef in attempt to improve its nutritional quality. According to an expert discussion with EHNRI researchers, it was identified that they promote consumption of maize for price reasons, arguing that there is no significant difference in the nutritional quality between Tef and maize."	Information, learning
Is the knowledge base of actors sufficient?		ATA, MoA, EIAR 2013: Limited information available on tef food product development	Information, learning
		ATA, MoA, EIAR 2013: "Tef-based product development: despite the high potential for developing tef-based products, efforts in the space have thus far been insignificant. However, being highly nutritional and gluten-free, the development of tef-based products is expected to attract increasing attention from food-related research institutions and food processing companies. "	
		There is wast traditional knowledge on enjera production.	
Does the activity rely on distortionary subsidies?		No direct subsidies known.	Profitability
Does the activity generate net positive profit and is it still profitable in case of changes in demand/price?		Mills: Minten 2012: Fifth, retail and milling margins declined significantly. Comparing the first part of the decade with the second part, it is estimated that both margins dropped by half. The drop in milling margins is possibly driven by the more widespread availability of mills, as shown in the case of Addis Ababa.22	Profitability
		Visited millers reported tef milling to be more profitable than milling other crops.	
		Enjera companies and microprocessors reported margins to be generally small and to become almost 0 if tef prices rise. Enjera export however is very profitable.	
Does the activity have possibility to generate funds for investment, maintenance, expansion?		Fufa et al. 2011: "Nevertheless, according to the data from the customs authority shows, starting from 2008, Ethiopia has been exporting processed Tef, especially in the form of fresh Injera and Dry Injera (Dirkosh) and the export is steadily increasing as observed from below chart."	Capital (financial)
		Bekele:"Big companies have access to credits (banks, MFI's) but need collateral. Microprocessors can form group collateral to get credits from MFI's. But system still little used."	
		Export business is very profitable for enjera companies. Margins for milling and domestic enjera production are rather small and vary with fluctuating tef prices. Nearly all visited processors complained about financial limitations for investment (e.g. in generators).	
Is the activity insured against damages/losses?		Only big enjera companies and mills have a formal insurance for their business.	Capital (financial)
Is the activity exposed to substantial		Setatow: "In rural areas, mills only give milling service. In urban areas also act	Capital

financial risks (e.g. outstanding debt)?		as retailers and buy tef from traders and sell flrou to restaurants, hotels".	(financial)
		Visited mills which only give milling services and small scale enjera producers don't run big financial risks, since the don't conduce big investment. Big scale enjera producers however run bigger risk due to bigger investments.	
Is self-organization, networking, initiative, association among actors enabled?		Generally it is possible. Enjera companies even get GoE support to link to farmer cooperatives as tef suppliers.	Self-organization
Are actors able and motivated to re-establish function after a disruption?		Motivation was not told to be a problem but mostly actors have limited savings or access to credits to re-establish function after a disruption.	Self-organization
Does the actor have autonomy and control, ownership over the activity, and his own resources?		Generally yes, but dependency on electricity.	Self-organization
Is there opportunity for experimentation and innovation?		Customers want white enjera only made from tef. New products made with red tef or mixed with other cereals are badly accepted.	Transformability
Does the activity and its leaders show openness to change, has this been shown in the past?		Fufa et al. 2013: "Except at the level of millers and injera bakers, there is limited value addition along the tef value chain. Millers add value to tef as they clean the grains and make flour. Suppliers of tef flour are also emerging, particularly in Addis Ababa, Dire Dawa and Harar, and it is po ssible to find tef flour packages of different sizes in some supermarkets. The bakers add value to tef as they change the tef flour to injera that is directly supplied to institutions, hotels, super markets, shops and consumers. On the other hand, tef food product development efforts are at early stages of research. The blending of cereals in an attempt to prepare different food menu is being studied by Haramaya University, and the Ethiopian Health and Nutrition Research Institute (EHNRI). "	Transformability
		ATA; MoA, EIAR 2013: "In Ethiopia, the use of tef is limited to a few, specific, traditional food products, such as injera. New food products made from tef could be developed for value-addition and income generation, either locally, through research, or based on the adaption and testing of recipes that have been developed abroad. ....In order to expand value-addition opportunities in Ethiopia, work must be done to test and promote the development of tef-based food products. From here, Ethiopia can begin large-scale development of its ability to create and mass manufacture these products for international export as well as domestic demand.	
Is it easy to change values in the surrounding culture?		Customers want white enjera only made from tef. New products made with red tef or mixed with other cereals are badly accepted.	Transformability

Consumption

Question	Rating	Answers	Attribute
Do input resources have spare capacity in case of increased demand, and are they equitably accessible?		Demeke and Di Marcantonio 2013: "The share of teff in total cereal consumption has sharply declined since 1961: its share declined from 31 percent in 1961-70 to 18 percent in 2001-2007 (Figure 1). There is a considerable shift from teff to maize consumption which is likely to have been influenced by a number of factors but mainly by the relatively cheaper price of the latter."	Buffering Capacity
		Minten et al. 2013: "The lowest prices are observed at the harvest period (December–February) and the highest toward the end of the year (August–October). Retail prices increased by 15 percent and producer prices by about 40 percent in the months of August–October compared to the harvest price. Similar seasonal price amplitudes have also been found in other studies (Rashid and Negassa 2011; Minten et al. 2012) and the survey year thus illustrates a seemingly typical pattern. "	
		In the past decade, tef prices have risen substantially from about 200Birr/quintal in 2000 to 900 Birr/quintal in 2011 (Setatow 2013). This, despite an increase in tef production of 163% in the same period of time, mostly owed to expansion in area under cultivation (50%) and increase in yield levels (73%) (Worku et al. 2014). The substantial price increase therefore must be caused by growing demand for tef. However, it also reveals the limited buffering capacity of tef production.	
		Visited consumer cooperatives reported seasonal variation in accessibility of tef, with highest prices and lowest availability during rainy season (July-October).	
		Visited consumer cooperatives all reported financial and storage capacity constraints.	

Do supporting activities have spare capacity in case of increased demand?		See fertilizer	Buffering Capacity
Does the activity maintain stocks of inputs and/or of products?		Generally, there is no big storage of tef throughout the value chain (Fufa et al. 2011, Abate). Due to it's high value and fluctuating prices, storage of tef is risky (Minten).	Buffering Capacity
		Visited consumer cooperatives keep stocks for maximum one month, but generally try to keep little stocks to maintain financial liquidity.	
		Visited farmers mostly kept some tef stocks for own consumption throughout the year. Therefore the rural consumers/which are at the same time tef producers) probably keep tef stocks throughout the year.	
Are there critical emissions which the activity has on the environment?		Only indirectly through tef production. For instance soil erosion and impacts of herbicide and fertilizer use.	Capital (environmental)
Do the actors have a good health status (physical and mental)?Do the actors have access to healthcare/health insurance?		ATA, MoA, EIAR 2013:" Tef has the highest amount of protein among cereals consumed in E, high amount of energy (2 after maize), high levels of Ca, P, FE, Cu, Barium, Thiamin, a well balanced amino acid composition and high lysine levels. It is gluten free and given its composition, tef could play an important role in school feeding programs/emergency food aid programs and to fight malnutrition of youth. Consumption of injera contributes to prevention of many diseases and conditions that can result from unbalanced diet, e.g. anemia, obesity, osteoporosis, diabetes	Capital (social)
		Fufa et al. 2011: "People in rural areas are unable to afford much Tef and rely mostly on maize, sorghum, wheat and barley to make Injera and other staple foods. Guush et.al. (2011) report that whereas the average urban Ethiopian derives 600 calories per day from Tef (around 30% of total daily caloric intake), for rural residents this figure is only around 200 calories per day. This disparity has nutritional consequences, since Tef is the most nutritionally valuable staple grain in Ethiopia."	
Does the activity engage with multiple suppliers, buyers, and fellow stakeholders for trade?		Individual consumers have many choices for purchasing tef. Consumer cooperatives as well, even though they have difficulties linking directly to farmer cooperatives.	Connectivity
Do logistics and communication support services enable appropriate connectivity?		Berhane et al. 2011: "Given the poor market integration and inefficiency in the mobility of goods and information among regions (see e.g., Negassa & Myers 2007; Osborne 2004), one would expect such regional consumption variations to follow the regions' specialization in the production of specific grains. However, as can be seen from Table 3.6, this is not consistently the case for all grains. For example, in the period 2003/04, reports showed Oromia as the highest teff producer, both in terms of total and precipitate production, after Amhara region (EEA 2004, 56). However, Oromia's share of consumption expenditure on teff (8 percent) is a little less than its expenditure share on maize (11 percent) and wheat (10 percent), and not comparable to its contribution in production (compared to Amhara, which is 13 percent). In direct contrast, Afar, a region known in Ethiopia for its limited teff production potential, allocated higher budgets to teff (10 percent) compared to Oromia, which allocated only 8 percent of its food budget to teff. Teff accounts for the largest share of regional food expenditure in the regions of Amhara and Tigray, after Addis Ababa, which is the highest consumer nationally.	Connectivity
		Minten et al. 2013: "Consumption levels of teff per household show less variation over space. However, the most remote farmers have slightly lower consumption levels of teff."	
		See whole value chain	
Are there any single inputs/processes/stakeholders that this activity depends upon, with no alternative?		Demeke and Di Marcantonio 2013:"share of teff in total cereal consumption has sharply declined since 1961 (31-18%), a shift from teff to maize consumption"	Connectivity
		Demeke and Di Marcantonio 2013: "Teff accounted for about 11 percent of the per capita calorie intake in 2001/07; Teff is the single most important staple in urban areas, accounting for 30% per capital calorie intake in 2001/07. Tef remains a luxury cereal and consumption is mostly an urban phenomena, average urban Ethiopian derives 600 calories per day from tef (around 30% of total daily calories uptake), in rural only 200 calories per day. Less expensive grain such as maize and sorghum dominate cereal consumption in rural areas."	
		Minten et al. 2012: "We note strong differences in the types of cereals consumed between urban and rural areas. Urban consumers eat three times as much teff as their rural counterparts, i.e. 61 kg versus 20 kg "	
		Fufa et al. 2011: "While other cereals such as maize, wheat and sorghum are a major part of the diet for the majority of the rural population, Tef is an almost daily food item for the	

		urban population. Tef contributes approximately 600 kcal/day in urban areas, compared with 200 kcal/person/day in rural areas (Guush et.al, 2011). "	
		Worku et al. 2014: "The consumption of high value foods is on the rise. ..the share of maize and sorghum are relatively declining in importance, while the share of tef remains stable. Within the tef sector, ready-to eat-injera and the more expensive white tef are on the rise while cheap red and mixed tef are on the decline. "	
		Berhane et al. 2011: "Teff boasts the highest income elasticity among cereals in both rural and urban areas: one percent increase in income increases demand by more than one percent. In fact, in rural areas, teff is more of a luxury foodgrain, often consumed in special festivities, or offered for special guests, and in some instances only older family members eat it. Cross-price elasticity estimates also suggest that sorghum is complementary to teff in urban areas, perhaps engendering the common practice by poorer urban residents in Ethiopia of mixing sorghum with teff. "	
		Tafere et al. 2011: "Teff, processed cereals, pulses, animal products, services, and other non-food have very high income elastic demands (>1), showing that their proportional consumption increase exceeds the proportional income increase, which eventually leads to a higher expenditure share of these goods. These results are consistent with the perception that teff and animal products are generally considered superior food types in the country."	
		Worku et al. 2014: "the low consumption by the poor is partly explained by the high prices of tef which are twice as high as the cheapest cereal"	
		Consumer cooperatives distribute subsidized goods (sugar, wheat flour, oil) for GoE. This is a profitable income source for them, even though margins are fixed. However, cooperatives are actually depending on these incomes to subsidized their other activities such as tef distribution. Therefore consumer cooperatives are indirectly dependent on subsidies.	
Are there diverse ways of producing the product/conducting the activity?		As teff prices go up, even middle income households tend to mix teff flour with cheaper cereals such as sorghum maize or rice in preparing injera (Berhane, et al, 2011)	Diversity
		Demeke and Di Marcantonio 2013: "For rural households and urban poor, teff is more of a luxury while maize and wheat are necessity food grains. Hence, from food security perspective, maize, sorghum and wheat are more critical than teff.."	
		Fufa et al. 2011: "However, due to the recent price hike in the price of the crop, exclusive consumption of Tef 'Injera' has become difficult for most middle and lower income households in urban areas. Thus, these households have began mixing Tef flour with the flour of other cereals such as sorghum (mixed with brown Tef), maize, rice and wheat (often mixed with white Tef) in making Injera. This is also practiced by hotels and Injera suppliers."	
		Fufa et al. 2011: "People in rural areas are unable to afford much Tef and rely mostly on maize, sorghum, wheat and barley to make Injera and other staple foods. Guush et.al. (2011) report that whereas the average urban Ethiopian derives 600 calories per day from Tef (around 30% of total daily caloric intake), for rural residents this figure is only around 200 calories per day. This disparity has nutritional consequences, since Tef is the most nutritionally valuable staple grain in Ethiopia."	
		Baye 2014: "Teff is the preferred grain for making injera, primarily for its better sensory attributes (for example, taste, color, smell) and shelf life (Zegeye 1997; Yetneberk et al. 2004). Besides, the ability to easily roll (softness) injera is an important quality attribute since this allows easy wrapping of the sauces (wot) consumed with it. In this regard, the superiority of teff was demonstrated by the minimal force required to bend fresh, 24-, and 48- hour stored injera relative to injera made from other grain (Yetneberk et al. 2004). Similarly, incorporating teff flour into the sorghum flour has been shown to improve the sensory attributes of sorghum injera (Yetneberk et al. 2005). Moreover, blending teff with wheat, as is often observed in less privileged households (Piccinin 2002), has been found to be nutritionally beneficial, as it allows higher phytate degradation due to the higher endogenous phytase activity in wheat (Egli et al. 2004; Good 2009). "	
Are sources of nutrition varied and diverse?		Demeke and Di Marcantonio 2013: "It is nutritionally rich with high levels of iron and calcium, as well as highest amount of protein among cereals consumed in Ethiopia."	Diversity
		Berhane et al. 2011: "Food consumption patterns in Ethiopia are diverse, and unlike in many other countries, no single crop dominates the national food basket (e.g., rice in most of East Asia, maize in Latin America, or cassava in Central Africa). The Ethiopian food basket consists of a wide variety of grains and other staples. Moreover, given dependence on own production, particularly in rural areas, food grain consumption varies at different times of the year. As in many other traditional societies, dietary preferences and consumption patterns are heavily influenced by cultural values and traditions and may not necessarily reflect availability or the nutritional quality of specific food items. "	
		Berhane et al. 2011: "More specifically, food consumption patterns in Ethiopia are directly related to the geography of food production. Traditionally, people consumed what	

		they produced; due to poor market linkages and the tendency to be food self-sufficient, household consumption patterns are often linked to food grain production. "	
		Fufa et al. 2013: "Processing tef grain into flour and injera is limited to a small number of urban processors. However, tef has great potential as an industrial crop. It is nutritionally rich and free of gluten; hence, it can be safely consumed by patients suffering from celiac disease (Dekking and Koning, 2005). Tef is also high in fiber, making it an ideal substitute for other cereals such as wheat and barley for diet foods, and it has also got high iron content (important in preventing pregnancy-related anemia) and calcium contents. "	
		Tafere et al 2011: "These demand adjustments are particularly significant in Ethiopia, where many households consume inadequate quantities of calories, proteins, and other nutrients.....The share of the so-called high- value products in total expenditures is low: animal products make up 4 percent of total consumption; fruits and vegetables count for less than 3 percent."	
Are the consumption sites spatially distributed?		Minten et al. 2013: "Consumption levels of teff per household show less variation over space. However, the most remote farmers have slightly lower consumption levels of teff.1"	Diversity
Are impacts caused by the activity borne by other actors who do not receive benefit/compensation?		No direct impacts. Indirectly the high demand for tef in urban areas and abroad increases tef prices and therefore drives poorer rural consumer into consuming nutritional less favorable crops such as maize or wheat.	Equitability
Is there equitable/fair access to inputs/food (generational, gender, racial, religious etc.)?		Demeke and Di Marcantonio 2013: "Real prices increased in 2006 and 2008 but declined significantly between 2009 and 2011. In fact, real prices in April 2011 were the lowest in the entire period of 2000 to 2012. The gap between nominal and real prices has widened since 2008, and much of the nominal increases were due to the high general inflation rates in the country.Compared to other staples, the price of teff has increased at faster rate in recent years, hence the price gap between teff and other staples is widening. In particular, the price gap between teff and maize has widened considerably since 2008 (Fufa, et al, 2011)."	Equitability
		ATA, MoA, EIAR 2013: "The second major implication of this price variability is that it imposes high costs of purchase on consumers in certain seasons, affecting consumption patterns over the year. "	
Has the activity been exposed to disturbances of different types in the past? Are small disturbances tolerated rather than avoided (e.g. pest and disease pressure, shortages), can they be managed?		Ashagrie: "Price shocks is main shock for consumer"	Exposure to pressure
		Yakob: " Coping mechanisms 1. switching in consumption (from tef to maize) 2. switching income from cloth to food (inessential to essential)"	
		Ashagrie: "Drought: In earlier years, when serious drought happened, people shifted to rice "	
		Ayele: "- consumption: higher prices, but for food security not as severe anymore as 10 years ago when it still was a staple food (also for urban food consumers)"	
		Fufa et al. 2011: "However, due to the recent price hike in the price of the crop, exclusive consumption of Tef 'Injera' has become difficult for most middle and lower income households in urban areas. Thus, these households have began mixing Tef flour with the flour of other cereals such as sorghum (mixed with brown Tef), maize, rice and wheat (often mixed with white Tef) in making Injera. This is also practiced by hotels and Injera suppliers."	
Are there plans to address any risks from hazards and emergency situations with scripts for actors in case of such an event?		Ayele: "Programs to support consumers: - no support from government → indirectly incentive for consumers to shift to other staple foods"	Governance capacity
		Abate: "- government supports rural areas→ rural areas support government - from perspective of tef, farmers are indirectly supported by government (easier credit access, seed access…) but consumers rather neglected by government"	
		Export was imposed by government to decrease demand and prices for tef.	
		Demeke and Di Marcantonio 2013: "consumers are protected as they pay lower prices than world price"	
Are there long-term plans (e.g. 50 years) to manage supply, demand and capacity?		Ayele: "- government encourages formation of these consumer cooperatives, consumer have more stable and fair prices, non profit oriented, very small margins (160 kebeles in addis with each one cooperative)"	Governance capacity
		ATA, MoA, EIAR 2013: "Overall Vision for the Tef Value Chain: An efficient and well-functioning tef value chain that enables a sustainable increase in smallholder tef farmer productivity and profitability while providing high quality output at an affordable price to tef consumers."	

Are there mechanisms and access to information about the state of the value and supply chains (incl. Market prices)?		There is currently no well-coordinated price information system that can be consulted by all actors involved in tef marketing (Minten et al. 2012, ATA, MoA, EIAR 2013). As traders are well connected through personal networks, they usually have an better information on market prices than farmers and consumers (ATA, MoA, EIAR 2013).	Information, learning
Is an atmosphere of trust and respect cultivated between actors?		See trade	Information, learning
IS their knowledge base of actors sufficient?		Some of the visited consumer cooperatives reported limited knowledge/education among management board of cooperative to be a problem.	Capital (social)
Does the activity rely on distortionary subsidies?		Indirectly to a small extent. Export ban, indirect subsidies to tef farmers, consumer cooperatives. Directly not.	Profitability
		Consumer cooperatives distribute subsidized goods (sugar, wheat flour, oil) for GoE. This is a profitable income source for them, even though margins are fixed. However, cooperatives are actually depending on these incomes to subsidized their other activities such as tef distribution. Therefore consumer cooperatives are indirectly dependent on subsidies.	
Is tef still consumed in case of changes in supply/price?		Demeke and Di Marcantonio 2013: "For rural households and urban poor, teff is more of a luxury while maize and wheat are necessity food grains. Hence, from food security perspective, maize, sorghum and wheat are more critical than teff.."	Profitability
		Fufa et al. 2011: "However, due to the recent price hike in the price of the crop, exclusive consumption of Tef 'Injera' has become difficult for most middle and lower income households in urban areas. Thus, these households have began mixing Tef flour with the flour of other cereals such as sorghum (mixed with brown Tef), maize, rice and wheat (often mixed with white Tef) in making Injera. This is also practiced by hotels and Injera suppliers."	
Does the activity have possibility to access food (e.g. through savings, financial services such as credit, allocation of more of household budget etc.)		Minten et al. 2013: "Consumption levels of teff per household show less variation over space. However, the most remote farmers have slightly lower consumption levels of teff."	Capital (financial)
		Abate: "- consumers at the moment can not save any money because of high food prices (implication for investment, economic growth)	
		Abate: "- low purchasing power of consumers"	
		Visited consumer cooperatives all reported financial constraints and low tef purchasing power. Since they are non profit oriented, tef purchase and distribution doesn't allow them to acquire savings.	
		Fufa et al. 2011: "However, due to the recent price hike in the price of the crop, exclusive consumption of Tef 'Injera' has become difficult for most middle and lower income households in urban areas.."	
Is the activity insured against damages/losses (income/production/infrastructure/personnel)?		Visited consumer cooperatives have no insurance so far. However, there are plans to establish a cooperative insurance company.	Capital (financial)
Are actors able and motivated to re-establish function after a disruption?		Motivation: "Ashagrie: ""- Very difficult to change habit of consuming enjera. Government has tried (former?) to go for maiz, wheat…, but not possible to change eating habbits. Like other African Countries to eat rice of maize…but not possible in Ethiopia. - People want white enjera…they put rice in it to make it whiter.	Self-organization
		Fufa et al. 2013:Tef is likely to remain a favorite crop of the Ethiopian population, and the crop is also gaining popularity as a health food in the western world. It is a gluten free crop, which makes it is suitable for patients with celiac disease, which is a n allergy to gluten protein (Dekking and Koning, 2005)."	
Does the actor have autonomy and control over the activity, and own resources?		Generally yes	Self-organization
		Consumer cooperatives' autonomy is somewhat limited, since government decides on margins for subsidized goods, etc.	
Is self-organization, networking, initiative among actors enabled and encouraged?		Ayele: "- government encourages formation of these coop, consumer have more stable and fair prices, non profit oriented, very small margins, some have storage facilities, some not (160 woredas in addis with each one cooperative)"	Self-organization
Are actors able and motivated to react timely to disruptions,		They can swith to other, cheaper cereals.	Self-organization

re-establish function, improve management practices, and re-structure if neces-sary?			
Is it easy to change values/systems/ways of thinking/doing things in the sur-rounding culture?		Fufa et al. 2011: "This study has identified that consumers have unique preference for specific varieties of Tef produced from some specific localities, with preferences based on a function of color, taste and preparation practices. This feature makes it difficult to achieve economies of scale within the trading system. ...The Ethiopian Grain Trading Enterprise (EGTE) has a mandate to stabilize the price of staple crops by intervening in the market and storing surpluses at market time. However, EGTE has found it difficult to purchase or sell Tef in bulk, because of the local differences in varieties and tastes. "	Trans-forma-bility
		Mintnen et al. 2013: "The majority of this teff sold was white, making up two-thirds of all teff sold, and the quantities of mixed and red teff sold are rather small.3 Minten et al. (2013) show that the shift from red and mixed teff to white teff varieties is a major change that has happened in the last ten years in these production areas."	
		Bekele: "Tef/Enjera demand - rises due to: o urbanization o lifestyle change (women have less time, work too) o growing export markets"	
		Ashagrie: "- Very difficult to change habit of consuming enjera. Government has tried (former?) to go for maize, wheat…, but not possible to change eating habits. Like other African Countries to eat rice of maize…but not possible in Ethiopia. - People want white enjera…they put rice in it to make it whiter "	

Appendix 2. Stakeholder questionnaires

Input suppliers' questionnaire

Questionary: Seed Supplier

Name: ______________________

Company: ______________________

Phone Nr.: ______________________

Location: ______________________

Tef seed trading: __________quintals/year

Nr. of clients: __________

Kind of clients: ______________________

____

____

Services you provide: ______________________

____

____

Crop-seed sold: ______________________

____

____

Years of experience in activity: __________

What is the biggest constraint/problem for you in your activity?

____

____

____

____

____

____

INPUTS

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

Alternatives

Improved seeds ______________________ □□□□□

Packing materials ______________________ □□□□□

Fertilizer ______________________ □□□□□

Pesticides ______________________ □□□□□

Energy sources : ______________________ □□□□□

Other: ______________________ □□□□□

2. Do you maintain stocks of inputs and products? (no - - - - > 1 year)

Seeds □□□□□

Packing materials □□□□□

Fertilizer □□□□□

Pesticides □□□□□

Other: ______________________ □□□□□

Other: ______________________ □□□□□

3. Are the following inputs affordable throughout the whole year?

(always expensive - - - always cheap)

Seeds □□□□□

Packing materials □□□□□

Fertilizer □□□□□

Pesticides □□□□□

Other: ______________________ □□□□□

Other: ______________________ □□□□□

4. Are there sufficient quantities of inputs available throughout the whole year?

Seeds □□□□□

Packing materials □□□□□

Fertilizer □□□□□

Pesticides □□□□□

Other: ______________________ □□□□□

5. Is there sufficient seed growing farmers available and can the farmers available for the activity be adapted to fluctuations?

□□□□□

Has this changed over the past years? _____

6. In case of increased demand for tef seeds, would you be able to increase tef seed production?

Storage facilities □□□□□

Inputs □□□□□

Contract Farmers □□□□□

Funding for inputs & farmers □□□□□

Other: _____ □□□□□

7. What does a contract for a seed producing farmer look like?

_____

_____

_____

8. Are the farmers spatially distributed?

□□□□□

9. What are the improved seeds selected for? Yield, biotic stress, abiotic stress, growing period?

_____

_____

_____

MARKET

10. From how many different farmers do you purchase seeds? _____

11. From what institutions do you purchase improved seeds? _____

12. Is an atmosphere of trust and respect cultivated between actors? (to farmers)

□□□□□

13. Is there any government support for your activity? (e.g. subsidies, taxes, knowledge transfer, etc.)

_____

_____

_____

_____

_____

14. Are there any government laws, regulations which affect your activity? (Social, Economic, Environment)

_____

_____

_____

_____

_____

INCOME

15. Is the income from your business sufficient/can the whole family live from this income?

□□□□□

16. Does the **tef seed trading** give you the possibility to generate savings?

□□□□□

17. Is your income generated by **diverse** products?

□□□□□

18. How much of the income derives from tef seeds?

_____%

19. Would your business still be profitable in case of rising tef prices? (do you still find tef seed producers?)

□□□□□

20. Is tef seed production a financial risk for you?
(E.g. due to price volatility, high investments?)

□□□□□

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

□□□□□

22. 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: _____	☐	☐

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

	Formal	Informal	no	yes
Infrastructure	☐	☐	☐	☐
Personnel	☐	☐	☐	☐
Stocks	☐	☐	☐	☐

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

☐☐☐☐☐

25. Do you make use of these services?

☐☐☐☐☐

DISASTERS/SHOCKS

26. Which types of disturbances/disasters **which affected your activity** have you witnessed in the past? In the future?
(E.g. price shocks, electricity shortcuts, cereal shortage,…)

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

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

_____
_____
_____

28. In case of such a disaster (e.g. earthquake, drought, economic shock), are you able to re-establish function by your own? (financially, stocks, access to resources, etc.)

☐☐☐☐☐

29. In case of such a disaster (e.g. supply shortage, process disruption, labour shortage, market fluctuations etc.), do you have emergency plans or similar?

☐☐☐☐☐

30. 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 _____
_____
_____

31. 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 _____
_____
_____

32. Would you make part of a tef value chain workshop?

Questionary: Farmer Cooperatives

Name: _____

Cooperative Name: _____

Phone Nr.: _____

Location: _____

Cooperative Members: _____

Crops: _____

_____

_____

Tasks of Cooperative: _____

_____

_____

_____

_____

What is the biggest constraint/problem for the cooperative?

_____

_____

_____

_____

_____

_____

_____

_____

INPUTS

1. What input resources are you purchasing and supplying to the farmers?

   _____

   _____

   _____

2. Are there sufficient quantities of inputs accessible throughout the year?
   (never - - - always)

   Fertilizer ☐☐☐☐☐
   Pesticides ☐☐☐☐☐
   Seeds ☐☐☐☐☐
   Farm implements ☐☐☐☐☐
   Lime ☐☐☐☐☐
   Other: _____ ☐☐☐☐☐

3. Are input resources affordable throughout the year?
   (always expensive - - - always cheap)

   Fertilizer ☐☐☐☐☐
   Pesticides ☐☐☐☐☐
   Seeds ☐☐☐☐☐
   Farm implements ☐☐☐☐☐
   Lime ☐☐☐☐☐
   Other: _____ ☐☐☐☐☐

4. Do you maintain stocks of inputs and products? (No - - - ->1 year)

   Fertilizer ☐☐☐☐☐
   Pesticides ☐☐☐☐☐
   Seeds ☐☐☐☐☐
   Farm implements ☐☐☐☐☐
   Lime ☐☐☐☐☐
   Tef ☐☐☐☐☐
   Other: _____ ☐☐☐☐☐

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

Fertilizer	☐☐☐☐☐
Funding for inputs	☐☐☐☐☐
Pesticides	☐☐☐☐☐
Seeds	☐☐☐☐☐
Storage Capacities	☐☐☐☐☐
Other: _____	☐☐☐☐☐

6. In your opinion, are the following resources needed for your activity in good condition?

Buildings	☐☐☐☐☐
Energy sources	☐☐☐☐☐
Transport infrastructure	☐☐☐☐☐
Communication infrastructure	☐☐☐☐☐
Other: _____	☐☐☐☐☐

7. 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: _____	☐	☐

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

9. Did the cooperative in the past have any budget/liquidity problems due to credit supply?
☐☐☐☐☐

MARKET

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

11. What type of buyers are they? _____

12. Do you purchase your inputs from **various** suppliers? (1 - - - - many)

Fertilizer	☐☐☐☐☐
Pesticides	☐☐☐☐☐
Seeds	☐☐☐☐☐
Farm implements	☐☐☐☐☐
Other: _____	☐☐☐☐☐

13. How is physical access to market? (road, transport means)
Distance to next market: _____h ☐☐☐☐☐

14. Are your storage locations spatially distributed?
☐☐☐☐☐

15. Is there any government support for the cooperatives? (e.g. subsidies, taxes, knowledge transfer, etc.)

_____
_____
_____
_____
_____

16. Are there any government laws, regulations which affect your activity? (Social, Economic, Environment)

_____
_____
_____
_____
_____

INCOME

17. Is the cooperative profitable/ self-sustainable?
☐☐☐☐☐

18. Can the cooperative generate savings with it's activities?

□□□□□

19. Can the cooperative generate savings due to **tef production**?

□□□□□

20. How important is tef production for the cooperative?

□□□□□

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

□□□□□

22. Does the cooperative have any kind of insurance for the case of loss of:

	Formal	Informal	no	yes
Infrastructure	☐	☐	☐	☐
Personnel	☐	☐	☐	☐
Stocks	☐	☐	☐	☐
Other _____	☐	☐	☐	☐

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

□□□□□

24. Do you make use of these services?

□□□□□

DISASTERS/SHOCKS

25. Which types of disturbances/disasters **which affected the cooperative** have you witnessed in the past? Which shocks affected tef production in particular?
(E.g. budget problems, financial shocks, droughts, floods, ,...)

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

26. Did it take long for the cooperative to recover from these disturbances?

1. □□□□□
2. □□□□□
3. □□□□□
4. □□□□□
5. □□□□□

27. In case of such a disaster (e.g. tef yield loss, budget shocks, drought), is the cooperative able support it's members? How? (e.g. financial help, stocks, etc.)

□□□□□

_____

_____

28. In case of such a disaster (e.g. tef yield loss, budget shocks, drought), is the cooperative able to re-establish function by it's own? (savings, stocks, etc.)

□□□□□

29. Are there programs/measures from the **government** or **community** to support cooperatives before (prevention), during and after such disturbances? (e.g. financial help, technical assistance, etc.)

Before _____

_____

_____

During _____

_____

_____

After _____

_____

_____

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)

    □□□□□

Questionary: 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?

_____

_____

_____

_____

_____

_____

_____

_____

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 _____

_____

_____

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 ☐

Questionary: Mills

Name: _____

Company: _____

Phone Nr.: _____

Location: _____

Tef flour production: _____quintals/month

Nr. of clients : _____

Kind of clients: _____

_____

_____

Services you provide: _____

_____

_____

Crops you mill: _____

_____

_____

Years of experience in milling: _____

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

_____

_____

_____

_____

_____

_____

Mills and spare parts ☐☐☐☐☐

Other: _____ ☐☐☐☐☐

Other: _____ ☐☐☐☐☐

5. Is there sufficient labour force available for the activity and can the labour force available for the activity be adapted to fluctuations?

☐☐☐☐☐

Has this changed over the past years? _____

6. In case of increased demand for tef flour (higher flour prices), would you be able to increase tef milling capacity?

Production facilities (mills, etc.) ☐☐☐☐☐

Labour forces ☐☐☐☐☐

Inputs (tef) ☐☐☐☐☐

Funding for inputs & labour forces ☐☐☐☐☐

Energy ☐☐☐☐☐

Storage capacities ☐☐☐☐☐

Other: _____ ☐☐☐☐☐

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

☐☐☐☐☐

8. Does personnel have access to health care?

☐☐☐☐☐

MARKET

9. Do you purchase your input supplies from **various** suppliers? (only 1 - - - many)

Tef ☐☐☐☐☐

Mills and spare parts ☐☐☐☐☐

Energy sources ☐☐☐☐☐

Packing Material ☐☐☐☐☐

Other: _____ ☐☐☐☐☐

10. Is an atmosphere of trust and respect cultivated between actors? (e.g to traders)

☐☐☐☐☐

11. Do you have access to market price information?

□□□□□

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

□□□□□

13. Are there critical emissions/impacts which your activity has on the environment? If yes, which?

_____ □□□□□

14. Are there critical emissions/impacts which your activity has on others?

_____ □□□□□

15. Are there secondary products sold from tef milling?

_____

16. Are wastes reused and recycled?

□□□□□

17. How big is the percentage of waste? _____%

18. Is there any government support for the mills like yours? (e.g. subsidies, taxes, knowledge transfer, etc.)

_____
_____
_____
_____
_____

19. Are there any government laws, regulations which affect your activity? (Social, Economic, Environment)

_____
_____
_____
_____
_____

INCOME

20. Is the income from your business sufficient/can the whole family live from this income?

□□□□□

21. Does the **tef milling** give you the possibility to generate savings?

□□□□□

22. Is your income generated by **diverse** products?

□□□□□

23. How much of the income derives from tef milling?

_____%

24. How much of the income derives from tef retail services/tef flour selling?

_____%

25. Would your business still be profitable in case of changes rising tef prices?

□□□□□

26. Is tef milling a financial risk for you?
(E.g. due to price volatility, high investments?)

□□□□□

27. 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: _____	☐	☐

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

□□□□□

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

	Formal	Informal	no	yes
Infrastructure	☐	☐	☐	☐
Personnel	☐	☐	☐	☐
Others	☐	☐	☐	☐

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

□□□□□

31. Do you make use of these services?

□□□□□

DISASTERS/SHOCKS

32. Which types of disturbances/disasters **which affected your activity** have you witnessed in the past? In the future?
(E.g. price shocks, electricity shortcuts, cereal shortage,…)

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

33. Did it take long for you and your activity to recover from these disturbances?

1. □□□□□
2. □□□□□
3. □□□□□
4. □□□□□
5. □□□□□

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

_____
_____
_____

35. In case of such a disaster (e.g. earthquake, drought, economic shock), are you able to re-establish function by your own? (financially, stocks, access to resources, etc.)

□□□□□

36. In case of such a disaster (e.g. supply shortage, process disruption, labour shortage, market fluctuations etc.), do you have emergency plans or similar?

□□□□□

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 _____
_____
_____

Would you make part of a tef value chain workshop?

Date: Sunday 2nd or 9th of August

Location: Debre Zeit Agricultural Research Centre

Time: 10.30 AM- 3.30 PM

Reimbursement:
- Transport costs
- Lunch offered
- Compensation of 300 Birr

02.08.15 ☐ 09.08.15 ☐

Enjera companies' questionnaire

Questionary: Enjera Companies

Name: _____

Company: _____

Phone Nr.: _____

Location: _____

Enjera production per year: (or month) _____/year

Amount of enjera exported per year: _____/year

Nr. of clients in Ethiopia: _____

Type of clients: _____

_____

_____

_____

_____

_____

_____

_____

_____

Years of experience in enjera production: _____

What are the biggest constraints/problems for you in enjera production?

_____

_____

_____

_____

_____

_____

_____

_____

INPUTS

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

	Alternatives
Energy sources _____	☐☐☐☐☐
Packing materials _____	☐☐☐☐☐
Mills and spare parts _____	☐☐☐☐☐
Other: _____	☐☐☐☐☐
Other: _____	☐☐☐☐☐

2. Do you maintain stocks of inputs and products? (no - - - - > 1 year)

Tef	☐☐☐☐☐
Tef flour	☐☐☐☐☐
Energy sources (fuel?)	☐☐☐☐☐
Packing Materials	☐☐☐☐☐
Mills/spare parts	☐☐☐☐☐
Other: _____	☐☐☐☐☐
Other: _____	☐☐☐☐☐

3. Are the following inputs affordable throughout the whole year?

(always expensive - - - always cheap)

Tef		☐☐☐☐☐
Energy sources	electricity ☐	☐☐☐☐☐
	fuel ☐	☐☐☐☐☐
Packing materials		☐☐☐☐☐
Mills and spare parts		☐☐☐☐☐
Other: _____		☐☐☐☐☐
Other: _____		☐☐☐☐☐

4. Are there sufficient quantities of inputs available throughout the whole year?

Tef		☐☐☐☐☐
Energy sources	electricity ☐	☐☐☐☐☐
	fuel ☐	☐☐☐☐☐
Packing materials		☐☐☐☐☐

INPUTS

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

	Alternatives	*(not at all - - very)*
Tef	_____	□□□□□
Other enjera ingredients	_____	□□□□□
Energy sources	_____	□□□□□
Packing materials	_____	□□□□□
Ovens and spare parts	_____	□□□□□
Rapeseed	_____	□□□□□
Other:	_____	□□□□□

2. Are the following inputs affordable for you throughout the whole year?

	(always expensive - - - always cheap)
Tef	□□□□□
Other enjera ingredients (cereals, etc.)	□□□□□
Energy sources	□□□□□
Packing materials	□□□□□
Ovens and spare parts	□□□□□
Rapeseed	□□□□□
Other: _____	□□□□□

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

	(never - - - always)
Tef	□□□□□
Other enjera ingredients	□□□□□
Energy sources	□□□□□
Packing materials	□□□□□
Ovens and spare parts	□□□□□
Rapeseed	□□□□□
Other: _____	□□□□□

8. Do you sometimes purchase enjera from other sources than own production?

_____

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

□□□□□

10. Does personnel have access to health care?

□□□□□

MARKET

11. Do you/can you purchase your input supplies from **various** suppliers?

	(only 1 - - - many)
Tef	□□□□□
Other enjera ingredients	□□□□□
Energy sources	□□□□□
Packing Material	□□□□□
Other: _____	□□□□□

12. Is an atmosphere of trust and respect cultivated between actors? *(no - - - yes)*

□□□□□

13. Are suppliers spatially/geographically distributed? *(no - - - yes)*

□□□□□

PRODUCTION

14. Do you have multiple production sites and are they spatially distributed?

□□□□□

15. Are there secondary products sold from enjera production?

_____

16. Are wastes reused and recycled?

□□□□□

17. How big is the percentage of waste? _____%

18. Is there any government support for the enjera producing companies like yours? (e.g. subsidies, tax reductions, knowledge transfer, etc.)

_____
_____
_____
_____
_____

19. Are there any government laws, regulations which affect your activity? (Social, Economic, Environment, Taxation, Export, Hygiene,)

_____
_____
_____
_____
_____
_____

INCOME

20. Are wages/incomes fair? (compared to average wages) *(no - - - yes)*

□□□□□

21. Does the activity give you the possibility to generate savings?

□□□□□

22. How much of the income derives from enjera production?

_____%

23. Is your income generated by **diverse** products?

□□□□□

24. Would the activity still be profitable in case of higher tef prices?

□□□□□

25. Does company income rely on non-enjera activities as well?

□□□□□

26. Is your activity/business exposed to substantial financial risks? (E.g. due to price volatility, high investments?)

□□□□□

27. Do you have access to credits/loans for investment?

(difficult access - - - easy access)

□□□□□

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

	Formal	Informal	no	yes
Infrastructure	☐	☐	☐	☐
Personnel	☐	☐	☐	☐
Others	☐	☐	☐	☐

29. Is there investment in/access to education and knowledge development of actors?

□□□□□

30. Is there opportunity for experimentation and innovation? (laws, financial, market demand,...)

□□□□□

31. Is self-organization, networking, initiative, association among actors enabled?

□□□□□

DISASTERS/SHOCKS

1. Which types of disturbances/disasters **which affected your activity** have you witnessed in the past? In the future? *(E.g. strong tef price fluctuations due to droughts, economic shocks, government policies, electricity shortcuts,...)*

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

2. Did it take long for you and your activity to recover from these disturbances?

(short - - - long)

1. □□□□□
2. □□□□□
3. □□□□□
4. □□□□□
5. □□□□□

4. Do you maintain stocks of inputs and products? *(no - - - > 1 year)*

Tef	☐☐☐☐☐
Other enjera ingredients	☐☐☐☐☐
Energy sources	☐☐☐☐☐
Packing Materials	☐☐☐☐☐
Ovens/spare parts	☐☐☐☐☐
Rapeseed	☐☐☐☐☐
Enjera	☐☐☐☐☐
Other: _____	☐☐☐☐☐

5. Is there sufficient labour force available for the activity and can the labour force available be adapted to fluctuations? *(no - - - yes)*

☐☐☐☐☐

Has this changed over the past years? How? _____

6. In case of increased demand for enjera (higher enjera prices), would you have the capacity to increase tef production? *(no - - - yes)*

Production facilities	☐☐☐☐☐
Labour forces	☐☐☐☐☐
Inputs	☐☐☐☐☐
Funding for inputs & labour forces	☐☐☐☐☐
Energy	☐☐☐☐☐
Transport	☐☐☐☐☐
Other: _____	☐☐☐☐☐

7. In your opinion, are the following resources needed for enjera production in good condition? *(no - - - yes)*

Buildings	☐☐☐☐☐
Energy sources	☐☐☐☐☐
Water sources	☐☐☐☐☐
Machinery/ovens	☐☐☐☐☐
Transport infrastructure	☐☐☐☐☐
Communication infrastructure	☐☐☐☐☐
Other: _____	☐☐☐☐☐

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

_____

_____

_____

4. In case of such a disaster (e.g. earthquake, drought, economic shock), are you able to re-establish function by your own? (financially, stocks, access to resources, etc.) *(no - - - yes)*

☐☐☐☐☐

5. Are there emergency plans/measures to address risks in case of such an event?

☐☐☐☐☐

6. 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 _____

_____

_____

Would you make part of a tef value chain workshop?

Date: Sunday 2nd or 9th of August

Location: Debre Zeit Agricultural Research Centre

Time: 10.30 AM- 3.30 PM

Reimbursement:
- Transport costs
- Lunch offered
- Compensation of 300 Birr

02.08.15 ☐ 09.08.15 ☐

Questionary: Enjera Microprocessors

Name: _____

Phone Nr.: _____

Location: _____

Enjera production per day: _____/day

Amount of tef used for enjera _____%

Nr. of clients: _____

Kind of clients: _____

_____

_____

Years of experience in enjera production _____

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

_____

_____

_____

_____

INPUTS

1. Are the following inputs affordable throughout the whole year?
   (always expensive - - - always cheap)

Tef		☐☐☐☐☐
Other enjera ingredients (cereals, etc.)		☐☐☐☐☐
Energy sources	firewood ☐	☐☐☐☐☐
	electricity ☐	☐☐☐☐☐
Packing materials		☐☐☐☐☐
Water		☐☐☐☐☐
Ovens and spare parts		☐☐☐☐☐
Rapeseed		☐☐☐☐☐
Other: _____		☐☐☐☐☐

2. Are there sufficient quantities of inputs available throughout the whole year?

Tef		☐☐☐☐☐
Other enjera ingredients (cereals)		☐☐☐☐☐
Energy sources	firewood ☐	☐☐☐☐☐
	electricity ☐	☐☐☐☐☐
Packing materials		☐☐☐☐☐
Water		☐☐☐☐☐
Ovens and spare parts		☐☐☐☐☐
Rapeseed		☐☐☐☐☐
Other: _____		☐☐☐☐☐

3. Do you maintain stocks of inputs and products? (no - - - - > 1 year)

Tef	☐☐☐☐☐
Other enjera ingredients (cereals)	☐☐☐☐☐
Firewood	☐☐☐☐☐
Packing Materials	☐☐☐☐☐
Ovens/spare parts	☐☐☐☐☐
Rapeseed	☐☐☐☐☐

Enjera ☐☐☐☐☐

Other: _____ ☐☐☐☐☐

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

	Alternatives
Tef _____	☐☐☐☐☐
Other enjera ingredients _____	☐☐☐☐☐
Energy sources _____	☐☐☐☐☐
Water _____	☐☐☐☐☐
Packing materials _____	☐☐☐☐☐
Ovens and spare parts _____	☐☐☐☐☐
Rapeseed _____	☐☐☐☐☐
Other: _____	☐☐☐☐☐

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

Production facilities ☐☐☐☐☐

Time/ labour forces ☐☐☐☐☐

Inputs ☐☐☐☐☐

Funding for inputs ☐☐☐☐☐

Energy ☐☐☐☐☐

Other: _____ ☐☐☐☐☐

6. From your perception, how is the health status of the labour forces (including you)? (bad - - - - good)

☐☐☐☐☐

7. Do you have access to health care?

☐☐☐☐☐

MARKET

8. Do you purchase your input supplies from **various** suppliers? (only 1 - - - - many)

Tef ☐☐☐☐☐

Other enjera ingredients ☐☐☐☐☐

Other: _____ ☐☐☐☐☐

9. Is an atmosphere of trust and respect cultivated between actors?

☐☐☐☐☐

10. Do you have access to market price information?

☐☐☐☐☐

11. Is there government support for your activity? (e.g. subsidies, taxes, knowledge transfer, support for self organisation etc.)

_____

_____

_____

_____

_____

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

☐☐☐☐☐

13. Do you make use of these services?

☐☐☐☐☐

14. Are there any government laws, regulations which affect your activity? (Social, Economic, Environment, Taxation, Hygiene)

_____

_____

_____

_____

_____

15. Are there secondary products sold from the activity?

_____

16. Are wastes reused and recycled?

☐☐☐☐☐

17. How big is the percentage of waste? _____%

INCOME

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

□□□□□

19. Does the activity give you the possibility to generate savings?

□□□□□

20. Is your income generated by **diverse** products?

□□□□□

21. How much of the income derives from enjera production?

_____%

22. In case tef prices rise a lot (like 10 years ago), would your business still be profitable?

□□□□□

23. Is it a financial risk for you to produce enjera? (E.g. due to price volatility, high investments?)

□□□□□

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

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

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

□□□□□

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

	Formal	Informal	no	yes
Infrastructure	☐	☐	☐	☐
Personnel	☐	☐	☐	☐
Others	☐	☐	☐	☐

DISASTERS/SHOCKS

27. Which types of disturbances/disasters **which affected your activity** have you witnessed in the past? In the future?
(E.g. price fluctuations due to droughts, economic shocks, government policies,…)

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

28. Did it take long for you and your activity to recover from these disturbances?

1. □□□□□
2. □□□□□
3. □□□□□
4. □□□□□
5. □□□□□

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

_____
_____
_____

30. In case of such a disaster (e.g. earthquake, drought, economic shock), are you able to re-establish function by your own? (financially, stocks, access to resources, etc.)

□□□□□

31. 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 ____

____

____

32. 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 ____

____

____

Would you make part of a tef value chain workshop?

Date: Sunday 2nd or 9th of August

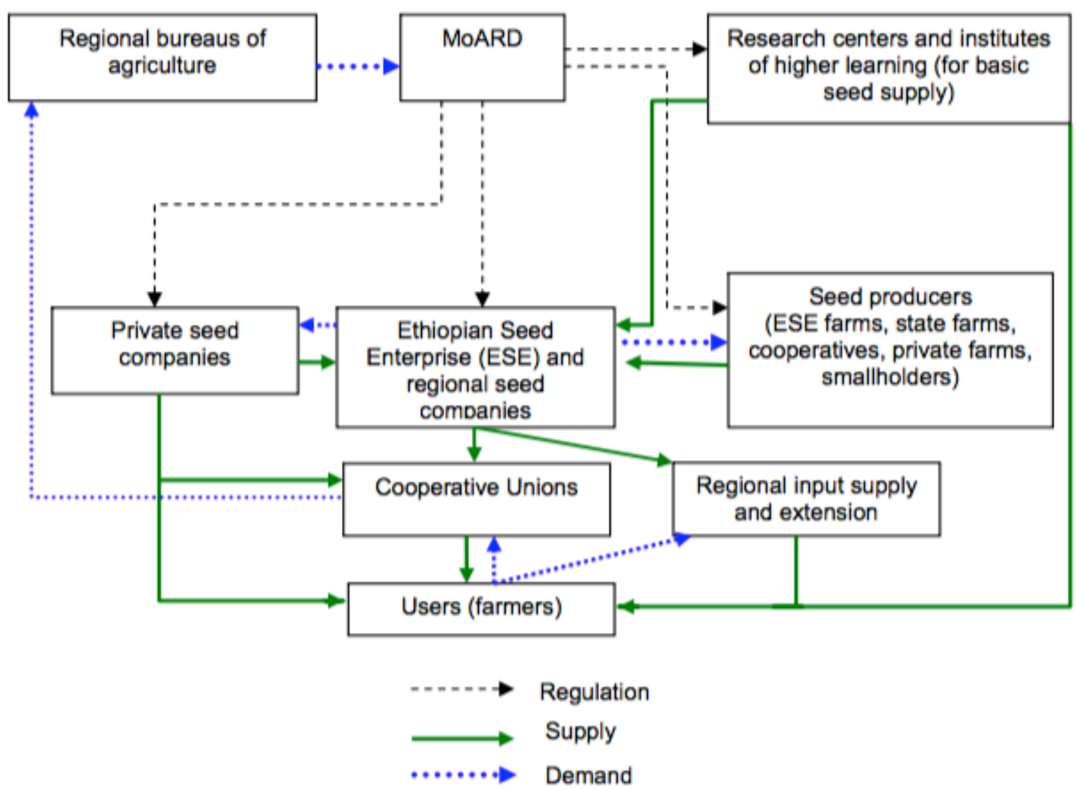
Location: Debre Zeit Agricultural Research Center

Time: 10.30 AM- 3.30 PM

Reimbursment:
- Transport costs
- Lunch offered
- Compensation of 300 Birr

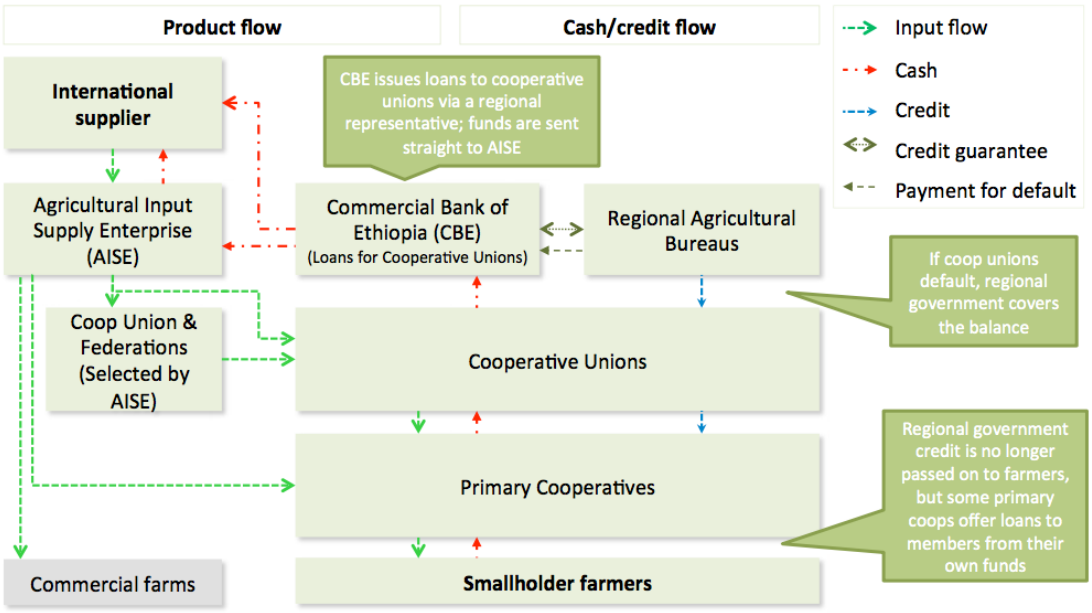
02.08.15 ☐ 09.08.15 ☐

Appendix 3. Seeds system



Source: Spielman et al. 2011.

Appendix 4. Input credits system



Source: IFPRI, 2012; stakeholder interviews

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